The 19th Particles and Nuclei International Conference (PANIC11)

Scientific Program

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The 19th Particles and Nuclei International Conference (PANIC11)

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Monday 25 July 2011

Opening Remarks - Kresge Auditorium (08:30-08:55)

Chair: Richard Milner(MIT)

Dr. Susan Hockfield, President of MIT, and Professor Edmund Bertschinger, Head of the MIT Department of Physics.

Plenary 1 - Kresge Auditorium (08:30-10:05)

Chair: Susan Seestrom (Los Alamos National Laboratory)

08:55 P1-1 Seeking the Origin of Mass: Higgs Searches at Colliders : Wade FISHER (Michigan State University)

The Higgs boson could be the final piece of the puzzle in the Standard Model of particle physics and its discovery may be the key to understanding the origin of mass. Experiments at the Tevatron and the LHC are actively looking for signs of this elusive particle and their searches are rapidly evolving. This presentation will cover the newest results from Higgs searches at collider experiments. The presentation will also explore the prospects for these searches, as well as the interplay of the Tevatron and LHC searches of today with results from previous experiments.

09:30 P1-2 Searches for Physics Beyond the Standard Model at the Tevatron and LHC : Peter WITTICH (Cornell University)

We are at an auspicious moment in experimental particle physics - we have very large data samples at the Tevatron and are exploring a new energy regime with ever larger data samples at the Large Hadron Collider. The coincidence of these two events suggests that we will soon be able to address the question, what lies beyond the standard model? Particle physicss current understanding of the universe is encoded in the standard model. The model has been tested to extreme precision - better than a part in ten thousand - but we suspect that it is only an approximation, and that physics beyond this standard model will appear in the data of the Tevatron and LHC in the near future. In this talk I will discuss the current status of searches for new physics, what hints we have in the data, and what we might expect in the future.

Plenary 1 - Kresge Auditorium (10:45-12:00)

Chair: Cynthia Keppel (Hampton University)

10:45 P1-3 The Radial Distribution of the Proton and its Constituents : Haiyan GAO (Duke University)

Nucleons (protons and neutrons) are the building blocks of visible matter. They are also natural laboratories for testing and understanding how quantum chromodynamics, the theory of strong interaction, works in the non- perturbative region, where ordinary matter lives. In this talk, I will review recent progress in the study of the structure of the proton and the insight one gains about its radial distribution and constituents. This work is supported in part by the U.S. Department of Energy under contract DE- FG02-03ER41231.

11:20 P1-4 The Quark-Gluon Structure of the Nucleon : Naomi MAKINS (University of Illinois)

The proton is a unique bound state: we know that its fundamental constituents are quarks and gluons, and we have a fine theory, QCD, to describe the strong force that binds these constituents together. However, two key features make it a baffling, complex system: the confining property of the strong force and the relativistic nature of the system. Real understanding of the proton can only be claimed when precise calculations (via lattice QCD) can be performed and tested, and when an accurate picture of the system's substructure can be developed – likely via effective degrees of freedom – to guide our intuition. The excitement and challenge of the search for this inutitive picture is well illustrated by the ongoing research into the orbital angular momentum of the quarks. Experiment continues to provide new clues about the motion of the up, down, and sea quarks, while theory continues to make progress in the interpretation of the data and in fundamental questions concerning even the definition of L in this context. An overview will presented of the quest for L and other aspects of the proton's puzzling substructure.

Parallel 1A - Parity Violating Scattering - W20-307 (Mezzanine Lounge) (13:30-15:30)

Chair: Rolf Ent (JLab)

13:30 1A-1 Strangeness Contributions to the Nucleon Vector Form-Factors: Results from HAPPEX-III : Mark DALTON (University of Virginia)

Precision measurements of parity violation in electron-nucleus elastic scattering are sensitive to possible strange quark contributions to the electric and magnetic form-factors of the nucleon. Such measurements provide a unique opportunity to illuminate the role of the quark-antiquark sea in nucleon structure. Recent results from the HAPPEX-III collaboration on parity-violation in electron-proton scattering will be discussed. This high precision measurement is an important complement to the existing world data, probing a kinematic region where previous results have suggested a significant strangeness contribution.

13:50 1A-2 Gamma-Z box contributions to parity violating elastic electron-proton scattering : Carl CARLSON (College of William and Mary)

Parity-violating elastic electron-proton scattering measures the Z-boson coupling to the proton, or Q-weak, which in turn gives a low momentum transfer measurement of the Weinberg angle. To determine Q-weak accurately, all radiative corrections must be well- known. There has been disagreement on the gamma-Z box contribution to Q-weak, which prompted the need for further analysis of this term. We will discuss some of the motivation and history of this term, and present our evaluation of the gamma-Z box diagrams, discuss the uncertainties in the evaluation, and compare to related work of other authors.

14:10 1A-3 e-2H Parity Violating Deep Inelastic Scattering (PVDIS) at CEBAF 6 GeV : Kai PAN (MIT)

The parity violating (PV) asymmetry Ad in e$-$2H deep inelastic scattering (DIS) was measured in Hall A at Jefferson Lab at $Q^2 = 1.11$ and 1.90 $(GeV/c)^2$ at x$\approx$ 0.3 to a statistical precision of 3% and 4%, respectively. The combination of the two measurements will provide the first significant constraint on higher-twist (HT) effects in PVDIS. With HT effects thus measured, this experiment will constrain the poorly known effective weak coupling constant combination (2C2u – C2d). The measurement will also allow the extraction of couplings C3q from high energy $\mu-$C DIS data. Precision measurements of all these phenomenological couplings are essential to comprehensively search for possible physics beyond the Standard Model. The experiment DAQ system will be introduced. Current data analysis progress and preliminary results will be presented.

14:30 1A-4 Combined Measurement of Neutral and Charged Current Cross Sections at HERA : Rik YOSHIDA (Argonne National Laboratory)

A combination is presented of the inclusive cross sections measured by the H1 and ZEUS Collaborations in neutral and charged current deep-inelastic ep scattering at HERA. The combination uses data from unpolarised ep scattering taken during the HERA-I phase as well as measurements with longitudinally polarised electron or positron beams from the HERA-II running period. The combination method takes the correlations of systematic uncertainties into account. The inclusion of the large HERA-II data set leads to an improved uncertainty especially at large four momentum transfer squared Q^2.

14:50 1A-5 Neutron Structure Functions at Large x : Cynthia KEPPEL (Hampton University / Jefferson Lab)

While an impressive amount of high quality nucleon structure function data exists from hydrogen, deuterium, and other targets, the lack of a neutron target has made direct comparisons between proton and neutron structure functions nearly impossible at large x where nuclear effects become large. The behavior of the d quark as x approaches 1 is particularly sensitive to the deuterium corrections, and the impact on the parton distribution functions (PDFs) from uncertainties in the deuteron wave function at short distances, nucleon off-shell effects, the use of relativistic kinematics, as well as the use of less a restrictive parametrization of the d/u ratio have been evaluated within a global PDF analysis. These results will be discussed, as well as compared to those from the Barely Off-Shell Nucleon Structure (BONUS) Experiment. The BONUS experiment employed a novel radial time projection chamber to detect spectator protons resulting from electron-deuteron interactions in coincidence with electrons in the CEBAF Large Acceptance Spectrometer in Hall B at Jefferson Lab - thereby ensuring an inclusive electron-neutron scattering event. BONUS measured with beam energies from 1.1 to 5.3 GeV, focusing on the resonance and large x regimes. Final neutron structure function results from BONUS will be presented.

15:10 1A-6 Parity-Violation in DIS at JLab at 12 GeV : Paul SOUDER (Syracuse University)

The observation of parity-violation in deep inelastic scattering from deuterium was one of the key experiments that established the Standard Model. With the advent of the 12 GeV upgrade at JLab, we can perform a new version of that classic experiment with greatly reduced errors. The new experiment will improve the sensitivity to the axial hadronic coupling constants to neutral currents by more than an order of magnitude. In addition, the experiment can detect the presence of isospin violation at the quark level. Finally, we are sensitive to the presence of di-quarks in the nucleon. With a hydrogen target, the apparatus cam measure the ratio of d/u quarks at large Bjorken x. The apparatus will be based on a large solenoid magnet. After passing through a series of baffles that eliminate neutral particles and low momentum particles, the electrons will be detected by GEM detectors. A calorimeter and a Cerenkov detector will provide triggering and identification of the electrons. Pipeline electronics will be needed to handle the large data rates.

Parallel 1B - Nuclear Effects & Hadronization - W20-306 (20 Chimneys) (13:30-15:30)

Chair: Christine Aidala (LANL)

13:30 1B-1 New Hints To The Cause Of The EMC Effect : Douglas HIGINBOTHAM (Jefferson Lab)

Deep-inelastic scattering cross section ratios plotted as a function of Bjorken x show that quark structure in nuclei is different than in free nucleons. Recent EMC type data from Jefferson Lab Hall C show that the slope in the $0.3 < \times < 0.7$ region scales as the local nuclear density and not the average nuclear density. This result led to the comparison between $x > 1$ short-range correlation plateaus and the magnitude of the EMC effect slope. A clear linear relation between the two effects has now been shown. In this talk, I will discuss the EMC effect, the short-range correlation plateaus and how we can use the relationship between the two to extract free neutron information.

13:50 1B-2 Coulomb Sum Rule at 0.55 GeV/c<= $|q|$ <=1.0 GeV/c : Huan YAO (Temple University)

In order to test the Coulomb sum rule in nuclei, a precision measurement of inclusive electron scattering cross sections in the quasi-elastic region was performed at Jefferson Lab. Incident electrons of energies ranging from 0.4 GeV/c to 4 GeV/c scattered off He4,C,Fe and Pb nuclei at four scattering angles (15, 60, 90, 120 deg) and scattered energies ranging from 0.1 GeV/c to 4 GeV/c. The Rosenbluth method with proper Coulomb corrections is used to extract the transverse and longitudinal response functions at three-momentum transfers 0.55 GeV/c<= $|q|$ <=1.0 GeV/c. The Coulomb Sum is determined in the same —q— range as mentioned above and will be compared to predictions. Analysis progress and preliminary results will be presented.

14:10 1B-3 Dihadron Fragmentation Functions in Perturbative QCD : Jian ZHOU (Temple University)

Using perturbative QCD, we compute dihadron fragmentation functions for a large invariant mass of the dihadron pair. The main focus is on the Interference Fragmentation Function(IFF). This function is of quite some interest because it could serve as golden tool for addressing the transversity distribution of the nucleon. If the QCD interaction was switched off, the IFF will vanishes due to time reversal invariance, which means that it is entirely generated by final state interactions. The perturbative calculation of such final state interactions at large invariant mass can be naturally done in the collinear higer-twist framework. This work may shed new light on the mechanism of the final state interaction. Our calculation also reveals that the IFF and the Collins fragmentation function have a closely related underlying dynamics. By considering semi-inclusive deep-inelastic scattering, we further show that collinear factorization in terms of dihadron fragmentation functions, and collinear factorization in terms of single hadron fragmentation functions provide the same result in the region of intermediate invariant mass.

14:30 1B-4 Studies of Hadronization Mechanisms using Pion Electroproduction in Deep Inelastic Scattering from Nuclei : William BROOKS (Universidad Tecnica Federica Santa Maria)

Atomic nuclei can be used as spatial analyzers of the hadronization process in semi-inclusive deep inelastic scattering. The study of this process using fully-identified final state hadrons began with the HERMES program in the late 1990s, and is now continuing at Jefferson Lab with a number of different final state hadrons. In the measurement described here, electrons and positive pions were measured from a 5 GeV electron beam incident on targets of liquid deuterium, carbon, iron, and lead using the CLAS large-acceptance detector in Hall B. A high-precision comparison of the heavier targets to deuterium was facilitated by having a two-target system. The two-target system allowed the liquid deuterium cryotarget to be located in the beam simultaneously with the solid targets, separated by 5 cm, thus minimizing accepance differences and eliminating time-dependent corrections to the comparisons of the two targets. The broadening of the transverse momentum of positive pions has been studied in detail as a function of multiple kinematic variables, and interpreted in terms of the transport of the struck quark through the nuclear systems. New insights are being obtained into the hadronization process from these studies, as well as new constraints on the interpretation of such experiments. Experiments of this type will be extended in the next few years with the 12 GeV Upgrade of Jefferson Lab in approved experiment E12-06-117, and also later at the future Electron-Ion Collider.

14:50 1B-5 The Search for QCD in Nuclei: a Jefferson Lab Perspective : Dutta DIPANGKAR (Mississippi State University)

One of the long standing goals of nuclear physics is to effectively demonstrate that Quantum Chromo Dynamics (QCD), with its colored quark-gluon degrees of freedom, is the ultimate source of the strong nuclear force. Exclusive processes in nuclei are essential in studies of the role of color in nuclei. This is because manifestation of the underlying quark-gluon degrees of freedom of QCD naturally gives rise to a distinct set of phenomena. We will discuss a few of these fundamental prediction of QCD, such as the phenomenon of Color Transparency, and give an overview of the extensive experimental searches for signatures of QCD in nuclei at Jefferson Lab, Hall-C. We will showcase some of the recent results from these searches, such as the conclusive demonstration of the energy scale for the onset of Color Transparency. We will also talk about the future prospects and the experiments being planned after the the 12 GeV upgrade of JLab.

15:10 1B-6 Gluon Saturation in QCD at High Energy: Beyond Leading Logarithms : Guillaume BEUF (Brookhaven National Laboratory)

The high-energy limit of hadronic scattering processes cannot be described within the standard framework of leading-twist perturbative QCD. Indeed, the logarithmic enhancement of initial-state soft gluon radiation results in the generation of strong gluonic fields, whose dynamics is non-linear. That is the phenomenon of gluon saturation. However, the typical transverse momentum scale (the saturation scale) associated with the transverse correlation length of those strong gluonic fields becomes semi-hard in the high-energy limit. Hence, gluon saturation is a strong field but weak-coupling phenomenon, which can be addressed from QCD first principles. The high-energy evolution of inclusive enough observables is given by the JIMWLK equation, or in the multi-color limit by the Balitsky-Kovchegov equation. At a strict leading logarithmic accuracy, these equations give results which are incompatible with the data, in particular for proton structure functions at HERA. However, a very good agreement with the data is achieved when the running of the QCD coupling is taken into account, which is a next-to-leading logarithm effect. I will discuss several topics related to next-to-leading logarithmic corrections to the Balitsky-Kovchegov equation: the effect of running coupling corrections on the asymptotic behavior of the solutions of that equation, the phenomenological implications of running coupling effects, and the resummation of the dominant part of other higher order corrections via a better treatment of kinematics at leading logarithmic accuracy.

Parallel 1C - Recent Baryon Results I - W20-201 (West Lounge) (13:30-15:30)

Chair: Kim Maltman (York University)

13:30 1C-1 Baryon Spectroscopy with Polarized Photon Beams at ELSA : Daniel ELSNER (Physikalisches Institut, Universitaet Bonn)

The puzzle of the excitation spectrum of the nucleon, composed of broad and overlapping resonances, is still unresolved. The measurements of polarization observables, which increase the sensitivity to small resonance contributions, will be essential to reduce the ambiguities in the existing descriptions of the spectrum. This is a prerequisite to get a hand in the properties of individual states. At the electron stretcher ring ELSA of the Universit́at of Bonn, with maximum beam energy of 3.5 GeV, real photon are used to perform single- and double polarization experiments with the Crystal Barrel/TAPS experiment. The experimental setup includes a phi-symmetric calorimeter system covering almost the complete solid angle, surrounding a longitudinally or transversally polarized butanol target. The system is ideally suited to detect single and multiple neutral meson final states. Linearly polarized photon beams provide the basis for the measurement of azimuthal beam asymmetries, such as Sigma (unpolarized target) and G (longitudinally polarized target), while circularly polarized photon beams allow the extraction of the beam-target asymmetry E. First results for the double polarization observables in single and multi-meson photoproduction will be presented. Funded by the Deutsche Forschungsgemeinschaft within the SFB/TR 16.

14:00 1C-2 Baryon Spectroscopy with CLAS at Jefferson Lab : Eugene PASYUK (Jefferson Lab)

Among the most exciting and challenging topics in sub-nuclear physics today is the study of the structure of the nucleon and its different modes of excitation, the baryon resonances. Yet, in spite of extensive studies spanning decades, many of the baryon resonances are still not well established and their parameters (i.e., mass, width, and couplings to various decay modes) are poorly known. Much of this is due to the complexity of the nucleon resonance spectrum, with many broad, overlapping resonances. A large part of the experimental program in Hall B of the Jefferson Lab is dedicated to baryon spectroscopy. Photoprodcution experiments are essential part of this program. CEBAF Large Acceptance Spectrometer (CLAS) and availability of circularly and linearly polarized tagged photon beams provide unique conditions for this type of experiments. Recent addition of the Frozen Spin Targets gives a remarkable opportunity to measure double and triple polarization observables for different pseudo-scalar meson photoproduction processes. For the first time, a complete or nearly complete measurement becomes possible and will allow model independent extraction of the reaction amplitude. An overview of the experimental program and its current status will be presented.

14:30 1C-3 An Alternative View of the Dynamical Origin of the P11 Nucleon Resonances: Results from the Excited Baryon Analysis Center : Hiroyuki KAMANO (Jefferson Lab)

An understanding of the spectrum and structure of the excited nucleon (N*) states is a fundamental challenge in the hadron physics. Increasing amount of the precise data from recent experiments at electron/photon beam facilities, such as JLab, Mainz, Bonn, GRAAL, and SPring-8, has opened a great opportunity for establishing the spectrum of high N* states and extracting various form factorscharacterizing the N* structure.

The N* states, however, couple strongly to the meson-baryon continuum states and appear only as resonance states in the γN and πN reactions. Such strong couplings to the meson-baryon continuum states will affect significantly the N* properties and cannot be neglected in extracting the N* parameters from the data and making physical interpretations. It is thus well recognized nowadays that a comprehensive study of all relevant meson production reactions with πN, ηN, $\pi\pi$N, KY, ωN, ... final states based on a coupled-channels framework is necessary for a reliable extraction of the N* properties.

To address this issue, the Excited Baryon Analysis Center (EBAC) of Jefferson Lab is making continuous effort to explore the nature of the N* states through a comprehensive analysis of the world data of various meson production reactions. The analysis is pursued with a dynamical coupled-channels (DCC) model, the EBAC-DCC model [1], within which the unitarity among relevant meson-baryon channels including the three-body $\pi\pi$N channel is fully taken into account.

In this contribution, we present a new picture for the dynamical origin of the P11 nucleon resonances resulting from the EBAC-DCC analysis [2], and discuss a crucial role of the multi-channel reaction mechanisms in determining the spectrum, branching ratio and form factors of the N* states.

References:

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[2] N. Suzuki, B. Julia-Diaz, H. Kamano, T.-S. H. Lee, A. Matsuyama and T. Sato, Phys. Rev. Lett. 104, 042302 (2010).

14:50 1C-4 A Plausible Explanation Of The Delta(5/2+) (2000) Puzzle : Pedro GONZALEZ (Universidad de Valencia)

From a Faddeev calculation for the pion-(Delta rho)(N(1675))system, performed with the Fixed Center Approximation within a Chiral Unitary framework, we show the plausible existence of three dynamically generated I (JP) = 3/2 (5/2+) baryon states below 2.3 GeV whereas only two resonances, Delta(5/2+) (1905) (****) and Delta(5/2+) (2000) (**), are cataloged in the Particle Data Book Review[1]. However, a careful look at Delta(2000)(5/2+) (**), shows that its nominal mass is in fact estimated from the masses (1724±61), (1752±32) and (2200125) respectively extracted from three independent analyses of different character[2,3,4]. Moreover a recent new data analysis[5] has reported a Delta(5/2+) with a pole position at 1738 MeV.

Our results give quantitative theoretical support to the existence of two distinctive resonances, Delta(5/2+)(∼1740) and Delta(5/2+)(∼2200). We propose that these two resonances should be cataloged instead of Delta(5/2+)(2000). This proposal gets further support from the possible assignment of the other calculated baryon states in the I = 1/2, 3/2 and spin-parity JP =1/2+, 3/2+ sectors to known baryonic resonances. In particular the poorly established Delta(1/2+) (1750)(*) may be naturally interpreted as a pion-N(1/2-)(1650) bound state.

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15:10 1C-5 Meson Photoproduction with the Crystal Ball at MAMI : Sven SCHUMANN (Massachusetts Institute of Technology)

Since 2004 the Crystal Ball/TAPS detector setup at the Mainz Mikrotron (MAMI) is used for meson production experiments with an energy-tagged photon beam. The Mainz Microtron (MAMI) is an accelerator complex which at its present stage, MAMI C, delivers an electron beam with a maximum energy of 1.6 GeV. An important aspect of the MAMI accelerator is the potential to provide polarised beams with a polarisation of up to 80%.

The Crystal Ball / TAPS detector setup at MAMI is used for experiments with energy-tagged real photons produced in the bremsstrahlung process by the Glasgow tagging system. The Crystal Ball as a spherical segmented photon spectrometer (672 NaI(Tl) crystals) in combination with the TAPS detector as a forward wall provides a solid angle coverage of nearly 4π; additional inner detector systems are used for particle identification and track reconstruction.

Both an unpolarised lH2 and a polarised frozen-spin butanol target with either transverse or longitudinal target polarisation are available. With this set-up, various single and double polarisation observables in meson production channels like π or eta photoproduction are now experimentally accessible. The research program of the Crystal Ball / TAPS experiment covers baryon spectroscopy of N* and $\triangle$ resonances as well as precise measurements of cross sections and polarisation observables in π and η production at their respective thresholds. In particular, measurements in the pion threshold region provide a test of the current understanding that the pion is a Nambu-Goldstone boson due to spontaneous chiral symmetry breaking in QCD. Specifically, detailed predictions of ChPT and its energy region of convergence can bet tested, as well as strong isospin breaking due to the mass difference of the up and down quarks.

Furthermore, the double polarisation observable F will be sensitive to the d-wave multipoles, which have recently been shown to be important in the near threshold region. Recent results, an overview of ongoing experimental work and an outlook to future possibilities will be presented.

Parallel 1D - Kaonic Atoms and Hypernuclear Physics - 4-149 (13:30-15:30)

Chair: Reinhard Beck (University of Bonn)

13:30 1D-1 Probing Strong Interaction - the SIDDHARTA Experiment : Johann ZMESKAL (Stefan Meyer Institute, Vienna, Austria)

Strong interaction processes were intensively studied at low energy with exotic atoms,touching one of the fundamental problems in hadron physic today - the still unsolved question of how hadron masses are generated. In light exotic hadronic atoms the Bohr radius is still much larger than the typical range of strong interaction formulated in QCD, and the average momentum of the bound hadron is very small. For light atoms, especially for hydrogen atoms, a detectable energy shift of the ground state is expected (with respect to the pure QED value), as well as an observable broadened ground state level, caused by nuclear absorption. By measuring these observables, the s-wave kaon-nucleon scattering lengths at zero energy could be extracted, which are sensitive measures of the chiral and isospin symmetry breaking pattern in QCD.

The low-energy K-N system is of special interest as a testing ground for chiral SU(3) symmetry due to the large mass of the strange quark. Chiral Perturbation Theory (ChPT) is inapplicable for this channel, because of the existence of the lambda(1405) resonance just below the K-p threshold. Non-perturbative coupled-channel techniques based on the chiral SU(3) effective Lagrangian are used to deal with this problem. With SIDDHARTA the strong interaction induced shift of the ground state of kaonic hydrogen atoms and the absorption width were measured, with best accuracy up to now, at DAFNE (Laboratori Nazionali di Frascati). In addition a first attempt was taken to determine the shift and width of kaonic deuterium. The results of both measurements will be presented as well as the description of the SIDDHARTA apparatus. Finally, a short overview of the proposed upgrade of SIDDHARTA at DAFNE will be given.

This work was partly supported by the LEANNIS network of the European project HadronPhysics of the 7th framework programme and the SIDDHARTA joint research activity of the European project HadronPhysics of the 6th framework programme.

14:00 1D-2 K^- Nuclear Potentials Based on Chiral Meson-Baryon Amplitudes : Jiri MARES (Nuclear Physics Institute, Rez, Czech Republic)

The study of the interaction of antikaons with baryonic systems, which is realized in kaonic atoms, kaonic nuclear clusters or even in dense strange hadronic matter, is of current interest [1,2,3]. The underlying meson-baryon interactions at low energies can be systematically evaluated within an SU(3) chiral approach combined with coupled channel T-matrix resummation techniques [4,5,6]. In the present work [7], we construct the K^- meson self energy operator from in-medium subthreshold K^-N scattering amplitudes within the chirally motivated model [6]. We demonstrate how the strong energy and density dependence of the K^-N scattering amplitudes at and below threshold leads to a deep K^- nuclear potential V_{K-} for kaonic atoms and K^- nuclear quasibound states. Selfconsistent evaluations yield K^- potential depths $-ReV_{K-}(_0)$ of order 100 MeV. Chiral single-nucleon amplitudes do not account for multi-nucleon absorption which becomes increasingly important at subthreshold energies. Allowing for K^-NN absorption, better agreement with K^-

atoms was achieved, leading to increased potential depths, $-ReV_{K^-}(_0)$ 175 MeV. Our approach provides a microscopic link between shallow K^- nuclear potentials [4,8] obtained from threshold K^-N interactions and phenomenological deep ones deduced from kaonic atom data fits [9,10]. Consequences for selfconsistent dynamical calculations of K^- nuclear quasibound states, for their binding energies and widths, are reported and discussed, as well.

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14:30 1D-3 Hypernuclei Formation Probability as a Function of the Atomic Mass Number A : Germano BONOMI (University of Brescia and INFN Pavia)

The creation of an hypernucleus [1], that is a nucleus in which a nucleon is replaced by an hyperon, requires the injection of strangeness into the nucleus. This is possible in different ways [2], mainly using a π^+ or a K- beams on nuclear targets; recently also electron beams have been used. The FINUDA experiment at the DAΦNE Φ accelerator machine of the INFN "Laboratori Nazionali di Frascati" produced Λ-hypernuclei by stopping, in thin nuclear targets (0.1-0.2 g/cm2), the negative kaons originating from the Φ decay through the strangeness-exchange reaction K-(stop) + AZ → AΛZ $+\eta-$, where AZ indicates the target nucleus and AΛZ the Λ hypernucleus in which a Λ particle replaced a neutron. FINUDA unconventional and innovative apparatus allowed the positioning of 8 different target modules around the interaction region. In this way different targets could be studied contemporaneously, with the same apparatus and with the same analysis technique, allowing for a direct comparison between different nuclei. In particular FINUDA could study the production of Λ-hypernuclei on 7Li, 9Li, 12C, 13C and 16O targets. Both the Λ binding energy and the hypernuclei production probabilities have been measured and will be presented and discussed. The new measurements on 7Li, 9Li, 13C and 16O along with previous measurements on 12C allowed for a meaningful study of the formation of Λ p-shell hypernuclei from the two-body capture of K- at rest giving for the first time the possibility of disentangling the effects due to atomic wave-function of the captured K- from those due to the pion optical nuclear potential and from those due to the specific hypernuclear states [3]. References

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14:50 1D-4 The third generation (e,e$'$K+) hypernuclear spectroscopic experiment at JLab Hall-C :Daisuke KAWAMA (Tohoku University)

The third generation (e,e$'$K+) hypernuclear spectroscopic experiment(JLab E05-115 experiment) has been performed in 2009 at JLab Hall-C. The goal of the experiment is the precise hypernuclear spectroscopic study in the wide mass region. The experimental targets used for the experiment were 7Li, 9Be, 10B, 12C and 52V.

The analysis of the experiment is now in progress. The analysis consists of mainly three phases: 1. Particle tracking and kaon identification, 2. Missing mass scale calibration and 3. Cross section analysis. The tracking and kaon PID have been well established up to now and the current issue of our analysis is the missing mass calibration and cross section analysis.

In this presentation, I will show the hypernuclear spectrum especially for the light hypernuclei focusing on the mass accuracy and cross section.

15:10 1D-5 Search for KbarNN Bound State by Stopped K- Absorption Reactions on 3He at J-PARC : Hiroyuki FUJIOKA (Kyoto University)

Nowadays, the possible existence of antikaon-nuclear bound states, mediated by strong attraction between I=0 Kbar-N pairs, is one of hot topics in strangeness nuclear physics [1-5]. Experimental observations of K-pp bound states were reported by the FINUDA experiment at DAFNE [6] and the DISTO experiment at SATURNE [7], both of which claim the binding energy is around 100MeV, larger than those obtained by various kinds of theoretical calculations based on sub-threshold Kbar-N interaction [1-5]. From an experimental point of view, further kinematically complete experiments, like DISTO, are awaited before establishing the existence of such an exotic system. For example, two experiments will be carried out at J-PARC; the E15 experiment with the 3He(in-flight K-, n) reaction, and the E27 experiment with the d(π^+, K+) reaction. The FOPI experiment at GSI, which uses the same p$^+$p reaction as DISTO but with higher energy, was carried out recently. While FINUDA investigated Lambda-proton pairs from K- absorption in p-shell nuclei, the AMADEUS experiment at DAFNE plans to measure not only charged but also neutral particles from K- absorption in 3He and 4He.

In this contribution, we would like to discuss the experimental feasibility of stopped K- absorption in 3He with the J-PARC E15/E17 setup [8]. By detecting the Lambda-proton pair from the [K_- + 3He $--$ > Λ + proton + neutron] reaction with the cylindrical detector system, the correlation among all the three particles in the final state will be extracted by the Dalitz plot analysis. Different correlations are expected for different reactions, such as two-nucleon absorption followed by final state interaction, whose importance was claimed by Magas et al. [9] and Pandejee et al. [10] for the FINUDA data, and the direct production of K-pp bound states, and so on.

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Parallel 1E - Neutrino Oscillations I - 4-163 (13:30-15:30)

Chair: Joseph Formaggio (MIT)

13:30 1E-1 T2K Neutrino Oscillation Results : Kimihiro OKUMURA (Institute for Cosmic Ray Research, Univ. of Tokyo)

The T2K (Tokai to Kamioka) is a 2nd generation long baseline neutrino oscillation experiment that sends a muon type neutrino beam from the Japan Proton Accelerator Research Complex (J-PARC) accelerator in Tokai, Japan, 295 km away to the underground detector, Super-Kamiokande (SuperK), in Kamioka, Japan. The neutrino beam is monitored by an on-axis non-magnetic detector, INGRID, and an off-axis magnetic near detector, ND280, both at J-PARC and the oscillated neutrino signal will be detected by the SuperK far detector at Kamioka, which is a water cerenkov detector with a 22.5kton fiducial mass that detects both muon and electron type neutrinos. In addition, the primary proton beam and the secondary muons in the neutrino beamline are monitored to provide accurate determinations of the neutrino beams. Detection of and searches for the muon neutrino disappearance and the electron neutrino appearance will determine or set limits on the neutrino mixing parameters, $\sin^2(2^*\theta_{23}), \Delta M^2$, and $\sin^2(2^*\theta_{13})$. The first neutrino data taken in 2010 has been analyzed and the neutrino oscillation results based on this new T2K data will be presented in this talk.

13:50 1E-2 The latest results from the IceCube experiment. : Joanna KIRYLUK (Lawrence Berkeley National Laboratory)

The recently completed IceCube observatory is a 1 km3 neutrino detector with powerful capabilities to explore the Universe. The primary goal of IceCube is to observe cosmic neutrinos with energies in the TeV to PeV range.

The IceCube detector consists of 86 vertical strings with optical sensors that are deployed at depths between 1.5 and 2.5 km in the glacial ice at the South Pole. The sensors detect Cherenkov radiation from charged particles produced in neutrino interactions. The surface array IceTop consists of 162 Cherenkov ice tanks and covers 1 km2 area. It is used for the study of cosmic rays with energies in the hundreds TeV to hundreds PeV range. I ceCube has been collecting data since the deployment of the first string in 2005. Initial searches have been made for point sources of extra-terrestrial muon neutrinos and for diffuse fluxes of extra-terrestrial neutrinos of all flavors. Other topics include studies of atmospheric neutrinos, neutrino oscillations, indirect searches for Dark Matter and signatures of supersymmetry in neutrino interactions. The IceCube physics program and the latest results will be discussed.

14:10 1E-3 Short-Baseline Neutrino Physics at MiniBooNE : Eric ZIMMERMAN (University of Colorado)

MiniBoone (E898/944 at Fermilab) is a short-baseline neutrino oscillation experiment with a 600-MeV muon neutrino (or antineutrino) beam and an 800-ton mineral oil-based detector. The experiment has collected data since 2002. With a well-understood flux in both neutrino and antineutrino configurations and the world's largest neutrino interaction data set in this energy range, oscillation searches and uniquely precise cross-section measurements have been made. Excesses in both ν_e–like and anti $-\nu_e$–like events have been observed in the oscillation searches, although a simple two-neutrino mixing model does not fit the energy distributions well. The latest oscillation results will be presented, as well as selected absolute cross-section measurements and plans for the future.

14:30 1E-4 New Solar Neutrino Measurements in Borexino : Laura CADONATI (University of Massachusetts Amherst)

Borexino is an ultra-low background experiment for the spectroscopy of low-energy neutrinos. Its primary physics goal is the real time detection of solar neutrinos with energies below 2 MeV, using 300 tons of liquid scintillator in an un-segmented detector at the underground Gran Sasso Laboratory, in Italy.

This talk presents new results from the analysis of Borexino data collected since 2007, with particular emphasis on the measurement of the flux of neutrinos produced in the 7Be electron capture reaction in the Sun. This measurement benefits from an intense calibration campaign for the control of the systematics, and uses a larger data set than previously released results, yielding a total uncertainty of about 5%.

We also report on the day/night effect measured by Borexino in the 7Be energy region and discuss the impact of these results for the validation of the MSW-LMA oscillation model in vacuum, constraints of uncertainties in the pp flux evaluation, and consequences for the global analysis of solar neutrino experiments. Finally, we update on the analysis of the solar neutrino flux from the pep reaction, which, combined with the measurements of 7Be and 8B neutrino fluxes in Borexino, will provide a unique spectroscopic analysis of the solar neutrino flux within a single detector.

14:50 1E-5 Latest News from Double Chooz Reactor Neutrino Experiment : Masahiro KUZE (Tokyo Institute of Technology)

Double Chooz is a reactor-neutrino oscillation experiment that aims to measure the last unknown neutrino mixing angle Θ13, and the first in the series of second-generation experiments with new concepts. It utilizes two reactor cores in EDF-Chooz nuclear power plant, in Ardennes, France, with a total thermal power of 8.5 GW. Two identical neutrino detectors will be located at distances of 1.05 km (far) and 0.4 km (near), enabling to cancel many of the systematic uncertainties by taking the ratio of number of neutrinos detected. The neutrino target is 8.3 tons of liquid scintillator doped with Gadolinium, and scintillation photons are detected by 390 ten-inch photomultipliers. The construction started with the far detector, and its main detector vessel was completed by the end of 2010, including liquid filling, photomultipliers and data acquisition. Commissioning data-taking has started. During the first half of 2011, remaining part of detectors such as outer-veto system with plastic scintillators and calibration systems will be installed. The experiment will start with only the far detector (Phase I), with an expected sensitivity reach of $\sin 2(2\Theta 13) < 0.06$, thus largely surpassing the current limit of $\sin 2(2\Theta 13) < 0.15$ set by the CHOOZ experiment. In the "double" mode with the near detector (Phase II), planned to follow after 1.5 years, it will reach $\sin 2(2\Theta 13) < 0.03$. In this paper, the latest status of the experiment and progress from data analysis will be reported.

15:10 1E-6 Neutrino and B-meson oscillation: A simple common treatment : Boris KAYSER (Fermilab)

We explain a simple, common treatment of the quantum mechanics of neutrino oscillation and B-factory experiments. This treatment takes quantum entanglement into account, but avoids Einstein-Podolsky-Rosen puzzles, and non-intuitive kinematical assumptions.

Parallel 1F - Dark Forces and Dark Matter - 4-153 (13:30-15:30)

Chair: Jesse Thaler (MIT)

13:30 1F-1 Searches for Light New Physics with BABAR : Bertrand ECHENARD (Caltech)

We present the results of direct searches for light new physics with BABAR. These include light pseudoscalar Higgs bosons, invisibly decaying dark matter candidates and hidden sector gauge and Higgs bosons.

13:50 1F-2 Experimental search for a new vector boson A' : Bogdan WOJTSEKHOWSKI (TJNAF)

The A′ EXperiment (APEX) will search for a new vector boson, A', with weak coupling $\alpha' \gtrsim 6 \times 10^{-8}\alpha$ to electrons ($\alpha = e^2/4\pi$) in the mass range 65 MeV $< m_{A'} <$ 550 MeV. New vector bosons with such small couplings arise naturally from a small kinetic mixing of the "dark photon" A' with the photon — one of the very few ways in which new forces can couple to the Standard Model — and have received considerable attention as an explanation of various dark matter related anomalies. A' bosons are produced by radiation off an electron beam, and could appear as narrow resonances with small production cross-section in the trident e^+e^- spectrum. We plan to search for the A' by using the CEBAF electron beam at energies of $\approx$ 1–4 GeV incident on $0.5 - 10\%$ radiation length multi-foil Tungsten targets, and measure the resulting e^+e^- pairs using the High Resolution Spectrometers and a septum magnet in Hall A at Jefferson Lab. With a 33-day run, the experiment will achieve very good sensitivity because the statistics of $e + e^-$ pairs will be $\sim 10,000$ times larger in the explored mass range than any previous search for the A' boson. This talk will discuss the experiment and present the results of a pilot run.

14:10 1F-3 Searching for Old (and New) Light Bosons with the Axion Dark Matter Experiment (ADMX) : Gianpaolo CAROSI (Lawrence Livermore National Laboratory)

In the past few decades the case for the existence of a non-baryonic Cold Dark Matter (CDM) has grown steadily stronger. One potential candidate is the Axion, an extremely light (micro-eV to milli-eV) pseudoscalar boson that would exist as a consequence of the Peccei-Quinn solution to the strong-CP problem (or why the neutron has no measurable electric dipole moment). Relic axions generated in the early universe have a non-thermal production mechanism and are thus a natural CDM candidate. Though axions couple very weakly to ordinary particles Pierre Sikivie recognized that they could be detected through the Primakoff effect in which dark matter axions could be resonantly converted to microwave photons in the presence of a strong magnetic field.

Here I will discuss the Axion Dark Matter eXperiment (ADMX), which uses a large tunable microwave cavity, immersed in a strong superconducting solenoid magnet to search for dark matter axions. ADMX has been running at Lawrence Livermore National Laboratory in various forms since the mid-1990s and we have recently finished a search for axions with a new ultralow noise microwave receiver based on a SQUID amplifier. The success of this precursor experiment with the SQUID amplifier has paved the way for a definitive axion search, based at the University of Washington, which will see a system noise temperature lowered from 1.8 K to 100 mK. This will greatly increase the sensitivity and scan rate to even pessimistic axion models allowing large regions of plausible axion model space to be explored in just a few years.

Recently it has been recognized that the ADMX experiment is well suited for searches of other new weakly coupled bosons such as chameleon particles and hidden sector photons. Chameleon particles are a class of scalar bosons whose effective mass is a function of their surroundings and are a possible candidate for dark energy as well as dark matter. They can be detected in ADMX by using RF power to excite chameleon modes in the cavity, which are then trapped by the cavity walls. By switching off the RF power a residual RF "afterglow" of decaying chameleons could then be detected. Hidden sector photons, also known as paraphotons, may exist from many extensions to the standard model and could mix with regular photons. As a result these hidden sector photons could be generated by pumping RF power into an external cavity and exciting the hidden sector photon field which would then be detected in the ADMX cavity a short distance away (essentially a "microwaves through walls" experiment). Proof of concept experiments have been performed on bothsearch techniques and results will be discussed along with future possible searches.

14:30 1F-4 Searching for Dark Forces in Electron-Proton Scattering : Rebecca RUSSELL (MIT)

Some dark matter scenarios motivated by evidence of dark matter annihilation predict a light gauge boson that couples to charged leptons. The DarkLight experiment will be sensitive to the lightest possibilities (10-100 MeV mass) of these particles. This experiment at Jefferson Lab will use a 1 MW 100 MeV electron beam incident on a hydrogen gas target to study the production of an electron-positron pair in electron-proton scattering. A dark boson would be observable as a narrow resonance on a large radiative QED background in the invariant mass spectrum of this pair.

14:50 1F-5 Sticky Dark Matter in the Effective Field Theory Approach : Andriy BADIN (Duke University)

There is experimental evidence that Dark Matter (DM) makes up about 25% of the Universe mass and it is expected to be nonrelativistic in most models. We explore possibility of creation and existence of the bound state of Dark Matter and standard model (SM) particles. Such bound states can be potentially created and detected during direct DM search experiments (DAMA, CDMS, XENON etc.).

We work in model-independent approach to determine conditions under which such bound states can be created. Our results appear to be dependent on nuclei used in DM direct detection experiments. In this scenario we determine the region of DM parameter space that provides simultaneous fit to DAMA and CDMS data.

15:10 1F-6 Determining H_0 and Q_0 from Supernova Data : Baolian CHENG (Los Alamos National Laboratory)

Since 1929 when Edwin Hubble showed that the Universe is expanding, extensive observations of redshifts and relative distances of galaxies have established the form of expansion law. Mapping the kinematics of the expanding universe requires sets of measurements of the relative size and age of the universe at different epochs of its history. There has been decades effort to get precise measurements of two parameters that provide a crucial test for cosmology models. The two key parameters are the rate of expansion, i.e., the Hubble constant (H0) and the deceleration in expansion (q0). These two parameters have been studied from the exceedingly distant clusters where redshift is large. It is indicated that the universe is made up by roughly 73% of dark energy, 23% of dark matter, and 4% of normal luminous matter; and the universe is currently accelerating. Recently, however, the unexpected faintness of the Type Ia supernovae at low redshifts ($z< 1$) provides unique information to the study of the expansion behavior of the universe and the determination of the Hubble constant. In this work, We present a method based upon the distance modulus redshift relation and use the recent supernova Ia data to determine the parameters H0 and q0 simultaneously. Preliminary results will be presented and some intriguing questions to current theories are also raised.

Parallel 1G - P- and T-violating weak decays - Kresge - Rehearsal A (13:30-15:30)

Chair: Klaus Kirsch (PSI-ETHZ)

13:30 1G-1 Tracing Remnants of the Baryon Vector Current Anomaly in Neutron Radiative β-Decay : Daheng HE (University of Kentucky)

We show that a triple-product correlation in the neutron radiative β-decay rate, characterized by the kinematical variable $\eta \equiv (\mathbf{l}_e \times \mathbf{l}_\nu) \cdot \mathbf{k}$, where $n(p) \to p(p') + e^-(l_e) + \overline{\nu}_e(l_\nu) + \gamma(k)$, isolates the pseudo-Chern-Simons term found by Harvey, Hill, and Hill as a consequence of the baryon vector current anomaly and $SU(2)_L \times U(1)_Y$ gauge invariance at low energies. The correlation appears if the imaginary part of the coupling constant is nonzero, so that its observation at anticipated levels of sensitivity would reflect the presence of sources of CP violation beyond the Standard Model. We compute the size of the asymmetry in $n \to pe^- \bar{\nu}_e \gamma$ decay as a function of the coupling, compute the effect of the correlation induced by electromagnetic final-state interactions in $O(\alpha)$, and discuss the role nuclear processes can play in discovering the effect.

13:50 1G-2 Transverse Electron Polarization in the Neutron Decay - Direct Search for Scalar and Tensor Couplings in Weak Interaction : Kazimierz BODEK (Institute of Physics, Jagiellonian University)

The Standard Model (SM) predictions of T-violation for weak decays of systems built up of u and d quarks are by 7 to 10 orders of magnitude lower than the experimental accuracies attainable at present. It is a general presumption that time reversal phenomena are caused by a tiny admixture of exotic interaction terms. Therefore, weak decays provide a favorable testing ground in a search for such feeble forces. Physics with very slow, polarized neutrons has a great potential in this respect. Our experiment seeks for small deviations from the SM in two observables, N and R, that are for the first time addressed experimentally in free neutron decay and that are exclusively sensitive to real and imaginary parts of the same linear combination of the scalar and tensor interaction coupling constants. N and R coefficients scale the two components of the transverse electron polarization.

The experiment has been carried out on the polarized cold neutron beam facility FUNSPIN of the SINQ spallation source at the Paul Scherrer Institute, Villigen, Switzerland. The transverse polarization of electrons from the neutron decay was analyzed in the Mott scattering from lead nuclei. The analysis of the experimental data has been completed recently leading to, among others, the best direct constraint for the imaginary part of the R-parity violating MSSM contribution.

The success of the applied technique results in a new project devoted to the simultaneous measurement of seven correlation coefficients: H, L, N, R, S, U and V. Five of them (H, L, S, U and V) have never before been measured in weak decays. Such a systematic exploration of the transverse electron polarization will generate from the neutron decay alone a complete set of constraints for the real and imaginary parts of the weak scalar and tensor interactions on the level of 5x10-4 or better.

14:10 1G-3 Muon Capture on the Proton and Determination of the Nucleon's Pseudoscalar Form Factor gP : Peter WINTER (University of Washington)

The singlet rate of ordinary muon capture (OMC) is one of the most direct probes for extracting the nucleon's pseudoscalar form factor, gP. The experimental determination of gP spans a long history including OMC efforts and one experiment using radiative muon capture. However, the situation prior to MuCap was inconclusive due to ambiguities in the interpretation as well as technical challenges. The MuCap experiment was designed to give an unambiguous measurement of gP. A first result gP $= 7.3 + -1.1$ has been published in 2007 which is consistent with the prediction from chiral perturbation theory and provides an important test of QCD symmetries.

The muon capture experiment MuCap uses a negative muon beam stopped in a time projection chamber as an active target filled with ultra-pure hydrogen gas which is surrounded by a decay electron detector. The capture rate is obtained from the difference of the negative muon's disappearance rate in hydrogen and the positive muon's lifetime recently measured to 1 ppm precision by the MuLan collaboration. After the data for our published result was taken, the MuCap system underwent some important upgrades before the full statistics were acquired. The analysis of the full data with a 2-3 times better precision is currently at an advanced state. Two main data sets taken with different TPC gain were analyzed independently, and our final data selection cuts were established. Recently, we have removed a hidden relative offset between the data sets, and the two results show good consistency. The collaboration is working hard to finalize the analysis, in order to present the completed, full analysis of the MuCap experiment at PANIC11. This work was supported in part by the U.S. National Science Foundation, the U.S. Department of Energy and CRDF, PSI, and the Russian Federation and Academy of Sciences.

14:30 1G-4 Beyond the Standard Model with Precision Nucleon Matrix Elements on the Lattice : Huey-Wen LIN (University of Washington)

Precision measurements on nucleons provide constraints on the Standard Model and can discern the signatures predicted for particles beyond the Standard Model. Knowing the Standard-Model inputs to nucleon matrix elements will be necessary to constrain the couplings of dark matter candidates such as the neutralino, to relate the neutron electric dipole moment to the CP-violating theta parameter, or to search for new TeV-scale particles though non–V-A interactions in neutron beta decay. However, these matrix elements derive from the properties of quantum chromodynamics at low energies, where perturbative treatments fail. Using lattice gauge theory, we can nonperturbatively calculate the QCD path integral on a supercomputer. In this talk, I will describe a few representative areas in which LQCD can contribute to the search for BSM physics, with emphasis on disallowed operators in neutron decay, and outline prospects for future development.

14:50 1G-5 Muon Decay Parameters from TWIST : Arthur OLIN (TRIUMF/U. of Victoria)

The TRIUMF Weak Interaction Symmetry Test (TWIST) collaboration has completed a simultaneous measurement of the muon decay parameters ρ, δ, and $\mathrm{P}\mu\Xi$ [1] through the analysis of the momentum and angle distributions of positrons from polarized positive muon decay. The final results represent an improvement in precision of approximately one order of magnitude compared to prior experiments, testing the validity of the standard model in a system dominated by leptonic interactions. Implications for physics beyond the standard model will be summarized, along with the challenges of reducing systematic uncertainties to the level of a few parts in ten thousand.

[1] R. Bayes et al., Phys. Rev. Lett. 106, 041804 (2011)

15:10 1G-6 The MuLan Experiment: A New Measurement of the Fermi Constant : Robert CAREY (Boston University)

Three of the most important inputs to the Standard Model of Elementary particle physics are the fine structure constant, the mass of the Z and the Fermi constant, G_F, the last of which is determined through measurements of the muon lifetime. Until about 10 years ago, incomplete theoretical calculations limited the precision with which G_F could be extracted from experiment. When van Ritbergen and Stuart finished their work on the missing radiative corrections in 1999, the precision was entirely limited by knowledge of the muon lifetime, paving the way for a new measurement. The MuLan collaboration published its first result in

2007 (11 ppm on τ_μ, 5.5 ppm on G_F). I will report on our final result, based on large-scale production runs in 2006 and 2007. The overall error on τ_μ is about 1 ppm. In my talk, I will explain how this very simple measurement is made and describe our strategies for controlling the systematic errors.

Parallel 1H - Electroweak Cross Sections at the TeV Scale - Kresge - Rehearsal B (13:30-15:30)

Chair: Beate Heinemann (UC Berkeley)

13:30 1H-1 ATLAS Measurements of Electroweak Boson Production Cross Sections : Christian GOERINGER (Universitaet Mainz)

Differential and inclusive cross sections for electroweak boson production are presented, in the electron, muon and tau decay channels. Single W and Z production is measured both inclusively and in association with jets. Diboson production is also measured, in W+photon, Z+photon and WW processes. Various cross section ratios are also presented, where this improves the sensitivity of the measurements to parton densities or Standard Model couplings. The data ae compared to precise standard model predictions.

13:50 1H-2 ATLAS Measurements of Isolated Photon Cross Sections : Marcello FANTI (Universita di Milano e INFN)

A measurement of the cross section for the inclusive production of isolated prompt photons in pp collisions at a centre-of-mass energy $\sqrt(s) = 7$ TeV is presented, as well as a measurement of diphoton production. Photon candidates are identified by combining information from the calorimeters and from the inner tracker. Residual background in the selected sample is estimated from data based on the observed distribution of the transverse isolation energy in a narrow cone around the photon candidate. The results are compared to predictions from next-to-leading order perturbative QCD calculations.

14:10 1H-3 Tevatron Measurements of Electroweak Boson Production : Ryan HOOPER (Lewis University)

With a large and still increasing data, W and Z boson physics at the Tevatron $p\bar{p}$ collider is particularly useful for studying many aspects of the Standard Model. In this presentation, we present measurements of electroweak boson properties, distributions and charge asymmetries. We examine both solitary W and Z production as well as production in associating with jets. These measurements are compared to NLO QCD predictions, used to extract fundamental StandardModel parameters as well as constrain parton distributions functions.

14:30 1H-4 Tevatron Results on Diboson Production : Wesley KETCHUM (University of Chicago)

We present the results from studies aimed at an experimental measurement of the WZ/ZZ diboson production in various final states using data recorded at the Fermilab Tevatron collider. Because diboson production is topologically similar to associated Higgs production with a W or Z boson, searches for diboson production offer a chance to develop and refine new analysis techniques that may aid in the discovery of the Higgs boson. We display new techniques using multivariate analyses for b tagging and quark/gluon jet discrimination in measurements of WZ and WW production as well as new limits on trilinear gauge couplings.

14:50 1H-5 Measurement of inclusive Wgamma and Zgamma production at CMS : Rahmat RAHMAT (University of Mississippi)

In this analysis we set the first measurements of the Wgamma and Zgamma cross sections at $\sqrt(s) = 7$ TeV at CMS and measure the WW γ, ZZγ, and Z$\gamma\gamma$ trilinear gauge boson couplings. Standard model predictions are consistent with the results of this analysis.

15:10 1H-6 W and Z production in the forward region with the LHCb experiment : Philip James ILTEN (Dublin)

Results are presented of W and Z boson production in pp collisions at $\sqrt(s) = 7$ TeV by the LHCb experiment. These studies are of particular interest due to LHCb's unique forward acceptance in pseudo-rapidity (η) of $2 < \eta < 5$. The results may either be interpreted as a test of Standard Model predictions, or may be used to constrain better parton density functions in this kinematical regime.

Parallel 1I - CKM & CP Violation - Kresge - Little Theatre (13:30-15:30)

Chair: Ulrik Egede (Imperial College)

13:30 1I-1 CKM and CP violation results from BABAR : Marcello ROTONDO (INFN)

We present recent BABAR results on measurements of CKM unitarity triangle sides and angles. In particular, we describe recent measurements of inclusive and exclusive semileptonic B decays and measurements related to the determination $|Vub|$, and of the angle gamma from$B \to D(*)K$. We also discuss recent measurements of charmless hadronic B decays. In particular, we measure the branching fractions, longitudinal polarization fraction f_L and charge asymmetry in $B \to \rho(f_0)K*$ events, and report results of studies of $B \to \phi\phi K$ and $B0 \to K + \pi - \pi 0$.

13:50 1I-2 CP violation results from CDF : Austin NAPIER (Tufts University)

We present world-leading results on CP-violating asymmetries and branching fractions of several decay modes of B0, Bs , and Λ_b hadrons into charmless two-body, and charmed, final states collected by the CDF detector. We also report a new measurement of CP-violating asymmetries in D*-tagged D0 → h + h- (h = K, or π) decays, where any enhancement from the standard model prediction would be unambiguous evidence for NP.

14:10 1I-3 Studies of CP violation in $B_s^0 \to J/\psi + \phi/f_0$ decays : Ricardo MAGANA (CINVESTAV)

We report a new measurement of the lifetime, decay rate difference and CP violating phase for B_s^0 mesons obtained from an analysis of the decay distribution in a sample of ~ 7000 $B_s^0 \to J/\psi + \phi$ decays selected in a 8 fb^{-1} data sample of $p\bar{p}$ collisions at $\sqrt{s} = 1.96$ recorded with the DØexperiment at the Fermilab Tevatron. We combine the result of this analysis with other constraints on the CP violation parameters for the B_s^0 system, including results from a study of the $B_s^0 \to J/\psi + f_0$ final state.

14:30 1I-4 Search for CP violation in the $B_s^0 - \bar{B}_s^0$ system : Moritz KARBACH (Dortmund)

The determination of the mixing induced CP-violating asymmetry in decays such as $B_s^0 \to J/\psi\phi$ is one of the key goals of the LHCb experiment. Its value is predicted to be very small in the Standard Model but can be significantly enhanced in many models of New Physics. The steps towards a precise determination of this phase with a flavour-tagged, time-dependent, angular analysis of the decay $B_s^0 \to J/\psi\phi$ will be presented, and first results shown from this measurement programme, using data collected in 2010 and the early months of the 2011 run. Results will also be shown, and prospects discussed, from related measurements.

14:50 1I-5 B_s^0–$\overline{B_s^0}$ and B_d^0–$\overline{B_d^0}$ Mixing from Lattice QCD : Elizabeth FREELAND (University of Illinois Urbana-Champaign)

We present the current status of the Fermilab Lattice and MILC collaborations calculation of hadronic matrix elements relevant to B_s^0–$\overline{B_s^0}$ and B_d^0–$\overline{B_d^0}$ mixing. Our study includes all five parity-symmetric operators of the SUSY basis. These operators cover both Standard Model and Beyond the Standard Model contributions to B mixing. We present results for matrix elements (or mixing parameters), bag parameters, and the ratio of B_s to B_d matrix elements, ξ. We discuss these results, including a full error budget, in the context of both Standard-Model expectations and Beyond-the-Standard-Model needs.

15:10 1I-6 Measurements on B-hadron angular correlations at 7 TeV with the CMS experiment : Leonardo SALA (ETH Zurich)

Measurements of the angular correlations between beauty and anti-beauty hadrons produced in LHC pp collisions at $\sqrt{s} = 7$ TeV is presented, probing for the first time the small angular separation region. The B hadrons are identified by the presence of secondary vertices from their decays and their kinematics reconstructed combining the decay vertex with the primary interaction vertex. The results are compared with predictions based on perturbative QCD calculations at leading and next-to-leading order.

Parallel 1J - Collider Searches Beyond the Standard Model - Kresge Auditorium (13:30-15:30)

Chair: Peter Wittich (Cornell University)

13:30 1J-1 Search for Squarks and Gluinos Using Different Final States with the ATLAS Detector : Marc HOHLFELD (University of Mainz)

The most sensitive channels to Supersymmetry in proton-proton collisions are composed of jets and missing transverse momentum final states. Several channels are considered: one vetoing any lepton, another one explicitly asking for one electron or muon in the final state and finally multileptons. In the first two cases, we also considered channels with one jet tagged as a b-jet. We will report on these searches with the ATLAS detector, based on data recorded in 2011.

13:50 1J-2 ISR Tagging : David KROHN (Harvard University)

The production of new particles at a hadron collider like the LHC is always accompanied by QCD radiation attributable to the initial state (i.e. ISR). This tends to complicate analyses, so ISR is normally regarded as a nuisance. Nevertheless, we show that ISR can also be valuable, yielding information that can help in the discovery and interpretation of physics beyond the Standard Model. To access this information we will introduce new techniques designed to identify ISR jets on an event-by-event basis, a process we term ISR tagging. As a demonstration of their utility, we will apply these techniques to SUSY di-squark (di-gluino) production to show that they can be used to identify ISR jets in roughly 40% (15%) of the events, with a mistag rate of around 10% (15%). We then show that, through the application of a new method which we will introduce, knowledge of an ISR jet allows us to infer the squark (gluino) mass to within roughly 20% of its true value.

14:10 1J-3 Search for Supersymmetry at CMS in all-hadronic final states : Matthias SCHROEDER (University of Hamburg)

We present results of searches for Supersymmetry in all hadronic final states with jets and missing transverse energy, including the case of jets identified as b-jets. These searches are performed with data collected by the CMS experiment at the LHC in pp-collisions at a center of mass energy of 7 TeV. Various data driven techniques used to measure the Standard Model background are demonstrated. The results are interpreted within the CMSSM as well as more general, simplified models.

14:30 1J-4 Search for R-Parity violating SUSY and Long Lived Particles with the ATLAS Detector : Michael MAZUR (University of Bonn)

New particles with long lifetimes (stopping or not in the detector) are a generic feature of many models for physics beyond the Standard Model. We report on these searches with the ATLAS detector, based on data recorded in 2010 and 2011. Searches of emu resonance interpreted in R-parity violating SUSY models will be also covered.

14:50 1J-5 Correlations Between High-pT Physics and Flavour Physics: Flavour Violating Squark and Gluino Decays : Tobias HURTH (Johannes Gutenberg University Mainz)

We consider scenarios with large flavour violating entries in the squark mass matrices focusing on the mixing between second and third generation squarks. These entries govern both, flavour violating low energy observables on the one hand and squark and gluino decays on the other hand. We first discuss the constraints on the parameter space due to the recent data on B mesons from the B factories and Tevatron. We then consider flavour violating squark and gluino decays and show that they can still be typically of order 10% despite the stringent constraints from low energy data. Finally we discuss on the impact for searches and parameter determinations at future collider experiments such as the upcoming LHC or a future International Linear Collider.

Reference: Tobias Hurth and Werner Porod, JHEP 0908:087,2009

15:10 1J-6 Search for Supersymmetry at CMS in lepton or photon final states : Konstantinos THEOFILATOS (ETH Zurich)

We present results of searches for Supersymmetry in signatures involving lepton or photon final states. These searches are performed with data collected by the CMS experiment at the LHC in pp-collisions at a center of mass energy of 7 TeV. Various data driven techniques used to measure the Standard Model background are demonstrated. The results are interpreted within the CMSSM as well as more general, simplified models.

Parallel 1K - Hydrodynamics - W20-407 (13:30-15:30)

Chair: Peter Jacobs (LBNL)

13:30 1K-1 Nearly perfect fluidity: from cold atoms to the quark gluon plasma : Thomas SCHAEFER (North Carolina State University)

The quark gluon plasma created in ultra-relativistic heavy ion collisions and dilute ultracold Fermi gases near unitarity are both strongly correlated quantum fluids that exhibit nearly perfect fluidity, that means the ratio of shear viscosity to entropy density approaches a lower bound that is believed to follow from the uncertainty relation, and that has been made more precise using calculations based on string theory. We will review these arguments and summarize recent efforts to extract transport properties of the quark gluon plasma and of ultra-cold Fermi gases.

14:00 1K-2 The viscosity of quark-gluon plasma at RHIC and the LHC : Ulrich HEINZ (The Ohio State University)

The specific shear viscosity eta/s of quark-gluon plasma (QGP) can be extracted from experimental elliptic flow data in heavy-ion collisions by comparing them with the dynamical model VISHNU which couples a viscous fluid dynamic description of the QGP with a microscopic kinetic description of the late hadronic rescattering and freeze-out stage. A robust method for determining eta/s from the collision centrality dependence of the eccentricity-scaled elliptic flow is presented. The systematic uncertainties associated with this extraction method are discussed, with specific attention to our presently restricted knowledge of initial conditions and possible corrections from bulk viscosity. Extrapolations to Pb + Pb collisions at the LHC are presented and, where possible, compared with recent experimental results from the ALICE Collaboration.

14:30 1K-3 Spin Transport in Strongly Interacting Fermi Gases : Ariel SOMMER (Dept. of Physics, MIT-Harvard Center for Ultracold Atoms, and RLE, MIT)

We study spin transport in an ultracold gas of fermionic lithium-6 in a mixture of two spin states. The two spin components are spatially separated from each other and interactions are tuned to a Feshbach scattering resonance. The relaxation dynamics near equilibrium give access to the spin transport coefficients. We measure the spin drag coefficient and the spin diffusivity over a wide range of reduced temperatures. At high reduced temperatures we observe the expected power law dependence of the spin transport coefficients on reduced temperature. At low reduced temperatures we observe spin transport in the quantum degenerate regime, where the spin diffusivity becomes on the order of Planck's constant divided by the atomic mass.

14:50 1K-4 Universal Quantum Viscosity in a Unitary Fermi Gas : Chenglin CAO (Duke University)

We measure the shear viscosity in a two-component Fermi gas of atoms, tuned to a broad s-wave Feshbach resonance. At resonance, the atoms strongly interact and exhibit universal behavior, where the equilibrium thermodynamic properties and the transport coefficients are universal functions of the density n and temperature T. We determine the shear viscosity in units of $\hbar n$ as a function of the reduced temperature at the trap center from two experiments, one for each of two temperature ranges. At low temperature, we use breathing mode damping to measure the shear viscosity. At high temperature, we use anisotropic expansion of the cloud to find viscosity, which exhibits the predicted $T^{3/2}$ scaling. The trap-averaged entropy per particle and shear viscosity are used to estimate the ratio of the shear viscosity to the entropy density, which is compared to that of a perfect fluid.

15:10 1K-5 Latest flow results from PHENIX at RHIC : Eric RICHARDSON (University of Maryland)

At the Relativistic Heavy Ion Collider (RHIC), key insights into the bulk properties of the hot and dense partonic matter arise from the study of azimuthal anisotropy (v_2) of the produced particles. The v_2 values indicate that the matter undergoes rapid thermalization and behaves hydrodynamicaly at low p_T. Furthermore, the quark scaling of v_2 for different particle species suggests that thermalization occurs at the quark level and that v_2 is the same for all quark flavors. Recently a low energy scan ($\leq \sqrt{s_{NN}} = 62.4$ GeV) began at RHIC to search for the QGP critical point, where a change in the v_2 signal from higher energies could play a key role in its identification. This talk will present the latest flow results from PHENIX and discuss theirimplications.

Parallel 1L - Heavy Ion Collisions I - W20-491 (13:30-15:30)

Chair: Jim Thomas (LBNL)

13:30 1L-1 First Results with Heavy-Ion Collisions at the LHC from ALICE : Domenico ELIA (INFN Bari (Italy))

ALICE is a general-purpose experiment designed to measure the properties of strongly-interacting matter created in heavy-ion collisions at the LHC. During the first PbPb data taking, in November 2010, collisions at a centre-of-mass energy per nucleon pair of 2.76 TeV have been recorded, allowing a first characterization of the hot and dense state of matter produced in this new energy domain, a factor 14 higher than previously studied at RHIC. The first results will be presented, in particular describing the measurements of the charged-particle multiplicity, elliptic flow, suppression of high-momentum hadrons with respect to pp collisions, Bose-Einstein correlations, and their dependence on the collision centrality. Comparisons to RHIC results and model predictions where available will be also made. Finally, an outlook of the upcoming results and perspectives for the next heavy-ion run at the end of this year will be discussed.

13:50 1L-2 Charged Particle Production in $\sqrt{(}s_{NN}) = 2.76$ TeV $Pb + Pb$ Collisions : Dominik DERENDARZ (Polish Academy of Sciences)

A broad program of measurements using heavy ion collisions is underway in ATLAS, with the aim of studying the properties of QCD matter at high temperatures and densities. Measurements of inclusive charged particle production, which is dominated by low momentum particles, is a way to study the bulk properties of the matter, as it scales directly with the entropy produced in the early stages of the collision and is thus sensitive to the low x physics of the initial state. This talk describes measurements performed using up to 9 pb-1 of lead-lead collision data provided at a nucleon-nucleon center-of-mass energy of 2.76 GeV by the Large Hadron Collider and collected by the ATLAS Detector during November and December 2010. The charged particle multiplicity is measured for particles down to low transverse momentum and large pseudorapidity using a variety of methods and magnetic field configurations. The spectrum of charged particles is also measured, which reflects both the bulk dynamics of the system as well as jet fragmentation.

14:10 1L-3 Two-particle correlations in pp and PbPb collisions in CMS : Wei LI (MIT)

Results on two-particle angular correlations will be presented in proton-proton and lead-lead collisions at center of mass energies (per nucleon pair) of 0.9, 2.36, 7 TeV and 2.76 TeV, respectively, over a broad range of pseudorapidity and azimuthal angle. At all the above energies and in both collision systems, a complex two-dimensional correlation structure is observed. In the context of an independent cluster parameterization of short-range correlations, the cluster size and its decay width are extracted from the two-particle pseudorapidity correlation function in pp collisions. Long-range azimuthal correlations are studied differentially as a function of charged particle multiplicity and particle transverse momentum in pp collisions at 7 TeV. In high multiplicity events, a pronounced structure emerges in the two-dimensional correlation function for particle pairs with intermediate pT of $1-$ GeV/c, $2.0 < |\Delta\eta| < 4.8$ and close-by in azimuthal angle, known as the "ridge". In PbPb collisions a qualitatively similar feature, a significant correlated yield for partners with small $|\Delta\Phi|$ but large longitudinal separation is observed.

14:30 1L-4 Two-particle "ridge" correlations from high-energy QCD evolution : Adrian DUMITRU (Baruch College (CUNY) and RIKEN-BNL)

Long-range correlations in rapidity for particle pairs with small azimuthal separation have been observed experimentally in heavy-ion collisions at RHIC and in high multiplicity proton-proton collisions at the LHC. Such correlations between causally disconnected regions provide information about the "little bang", i.e. particle production in high-energy collisions. I present some early attempts to understand these "ridge" correlations within the Color Glass Condensate small-x effective theory. However, I argue also that quantitative results require further theoretical developments such as the evolution of the gluon four-point function, and non-Gaussian valence color charge fluctuations.

14:50 1L-5 Dimuon results in PbPb and pp collisions in CMS : Manuel CALDERON DE LA BARCA SANCHEZ (UC Davis)

The unprecedented center of mass energy available at the LHC offers unique opportunities for studying the properties of the strongly-interacting QCD matter created in PbPb collisions at extreme temperatures and very low parton momentum fractions. With its high precision, large acceptance for tracking and calorimetry, and a trigger scheme that allows analysis of each minimum bias Pb + Pb event, CMS is fully equipped to measure di-muons in the high multiplicity environment of nucleus-nucleus collisions. Such probes are especially relevant for these studies since they are produced at early times and propagate through the medium, mapping its evolution. The capabilities of the CMS experiment to study di-muons production in pp and PbPb collisions based on 2010 LHC runs will be reviewed. In particular, CMS is able to measure primary and secondary J/psis, as well at their polariation, but also the 3 Upsilon states, differentially in pT and rapidity in pp. In heavy ion, the observation of quarkonia at $\sqrt(s) = 2.76$TeV will be presented, and the Z boson inclusive and differential measurement as probe of the initial state will be detailed.

15:10 1L-6 Quarkonium Production in p-p and Pb-Pb Collisions with ALICE at the LHC : Hugo PEREIRA (CEA, Saclay)

ALICE is the LHC experiment dedicated to the study of heavy ion collisions. The main purpose of ALICE is to investigate the properties of a new state of deconfined nuclear matter, the Quark Gluon Plasma. Quarkonium measurements will play a crucial role in this investigation. During the 2010 LHC campaign, ALICE took p$-$p data at $\sqrt(s) = 7$ TeV and Pb$-$Pb data at $\sqrt(s_{NN}) = 2.76$ TeV. The 2011 LHC campaign is about to start and should drastically improve our statistics. We will present the latest results of quarkonium production in both p-p collisions at $\sqrt(s) = 7$ TeV and Pb$-$Pb collisions at $\sqrt(s_{NN}) = 2.76$ TeV measured by the ALICE experiment at both mid- and forward-rapidities.

Parallel 2A - Generalized Parton Distributions - W20-307 (Mezzanine Lounge) (16:00-17:40)

Chair: Rolf Ent (JLab)

16:00 2A-1 Hard Exclusive Electroproduction of Vector Mesons at HERMES : Witold AUGUSTYNIAK (Soltan Institute for Nuclear Studies, Warsaw)

Hard exclusive vector-meson production in lepton-nucleon scattering provides a convenient tool for the study of the mechanism of vector-meson production and also, in a model-dependent way, the structure of the nucleon. The hard production is closely related to nucleon structure through Generalized Parton Distributions (GPDs). A wealth of information is contained in the Spin Density Matrix Elements (SDMEs) which are the observables describing how the spin components of the virtual photon are transferred to those of the vector meson. Of particular interest are transverse-target single-spin azimuthal asymmetries providing information on the GPD E. Hard exclusive electroproduction of vector mesons was studied with the HERMES spectrometer at the DESY laboratory by scattering 27.6 GeV longitudinally polarized electrons or positrons off unpolarized hydrogen (H) and deuterium (D) as well as off transversely polarized hydrogen internal gas targets. Results of the measurements of SDMEs for exclusive $\rho0$ and φ production on unpolarized H and D targets, and for $\rho0$ production on the transversely polarized H target will be reported. The differences between the sets of SDMEs for $\rho0$ and φ mesons will be pointed out and discussed. The dependences of particular elements on the squared four-momentum transfers Q2 and t' for $\rho0$ and φ mesons as well as signatures of unnatural-parity-exchange amplitudes will be presented and discussed. The transverse-target single-spin azimuthal asymmetry measured for $\rho0$, φ and ω mesons will also be presented and compared with theoretical predictions. In addition, real and imaginary parts of ratios of the natural and unnatural-parity-exchange helicity amplitudes of exclusive $\rho0$ production will be shown that have been extracted from the data.

16:30 2A-2 Overview of Recent DVCS Results from HERMES : Sergey YASHCHENKO (DESY Zeuthen)

Hard exclusive leptoproduction of real photons on nucleons and nuclei, Deeply Virtual Compton Scattering (DVCS), is one of the theoretically cleanest ways to access Generalized Parton Distributions (GPDs). The theoretical framework of GPDs includes Parton Distribution Functions and Form-Factors as limiting cases and moments of GPDs, respectively, and can provide a three-dimensional representation of the structure of hadrons at the partonic level. The HERMES experiment at DESY, Hamburg, collected a wealth of data on DVCS utilizing the HERA polarized electron or positron beams with an energy of 27.6 GeV and longitudinally and transversely polarized or unpolarized gas targets (H, D or heavier nuclei). The azimuthal asymmetries measured in the DVCS process allow access to the imaginary and/or real part of certain combinations of GPDs. For the last two years of HERA running, the HERMES collaboration installed a recoil detector to improve selection of DVCS events by direct measurement of recoil protons. An overview of recent HERMES results on DVCS including first results obtained with the recoil detector is presented.

17:00 2A-3 Deeply Virtual Compton Scattering and Meson Production at JLab/CLAS : Hyon-Suk JO (IPN-Orsay)

One of the most important goals of the nuclear physics community is to elucidate the three dimensional spatial and spin structure of partons in the nucleon. This is one of the CLAS Collaboration's highest priority programs, especially for the 12 GeV upgrade (CLAS12). An important theoretical tool developed to access and codify exclusive reactions such as deeply virtual Compton scattering (DVCS) and exclusive meson production (DVMP) in terms of QCD degrees of freedom is the framework of generalized parton distributions, or GPDs. This talk will outline the scope of the CLAS and CLAS12 experiments on DVCS and DVMP. Examples of the results obtained to date will be shown, and their impact on the applicability of the GPD mechanism to this class of reactions addressed. Initial results from the 6 GeV program indicate that DVCS may already be interpretable in the GPD framework, while the GPD mechanism cannot be successfully applied to DVMP, e.g. π, η, ρ and ω production, at current JLab energies without a significant modification of the way that GPDs are presently parameterized. However, an exception is φ production, in which the GPD mechanism appears to apply and which is especially sensitive to gluon distributions. The results expected in the near future, and plans for experiments of this genre for the CLAS12 spectrometer will also be discussed.

17:20 2A-4 A Flexible Parameterization of Generalized Parton Distributions and Their Role in Deeply Virtual Compton Scattering and Neutral Meson Leptoproduction : Gary GOLDSTEIN (Tufts University)

A physically motivated parameterization of the chiral-even generalized parton distributions (GPDs) has been obtained from a global analysis using available experimental data including nucleon electromagnetic form factors, deep inelastic scattering and DVCS. Additional information provided by lattice calculations of the higher moments of GPDs is also considered. Recently extracted observables from DVCS at JLab and Hermes are reproduced by our fit and predictions are made for higher energy regimes. Our scheme uses a Reggeized diquark model and concomitant helicity amplitude relations, which allow the extension to the chiral-odd sector. Having obtained the chiral-odd GPDs, we are able to explain the features of exclusive neutral meson electroproduction. Our analysis is applied to existing and forthcoming spin-dependent $\pi 0$ and η data in the kinematical region of intermediate Bjorken x and Q2 in the multi-GeV region, accessible at present and currently planned facilities.

Parallel 2B - Parton Distribution Functions and Fits - W20-306 (20 Chimneys) (16:00-17:40)

Chair: Christine Aidala (LANL)

16:00 2B-1 Transverse Momentum Dependent partonic distribution and fragmentation functions : Mariaelena BOGLIONE (University of Turin - INFN Torino (Italy))

Our knowledge on the 3-dimensional momentum structure of the nucleons is encoded in the Transverse Momentum Dependent partonic distribution and fragmentation functions (TMDs). A brief and updated review of the TMDs and the processes in which they might play a role is presented.

16:30 2B-2 Towards a Global NNLO Partion Distribution Functions Fit Using the NNPDF Methodology : Alberto GUFFANTI (Albert-Ludwigs-Universitaet Freiburg)

A precise determination of Parton Distribution Functions with a reliable estimate of the associated uncertainties is crucial for exploiting the full discovery potential of the LHC experiments. The NNPDF methodology, based on Monte Carlo techniques for the uncertainty determination and the use of Neural Networks as unbiased interpolating functions, coupled to the most up-to-date perturbative QCD theory predictions for observables, has proven itself capable of delivering a global NLO fits satisfying the requirements for precision phenomenology at hadron colliders. In this contribution I will review the basics of the NNPDF methodology and the status of the NNPDF global fits. In particular I will discuss the recent effort towards a global NNLO fit, which is a fundamental tool for high precision studies at the LHC, the related phenomenology and the future developments of the NNPDF fits.

17:00 2B-3 Determination of PDFs and alphas from Inclusive and Jet Measurements in DIS at HERA : Guenter GRINDHAMMER (Max Planck Institute for Physics)

A NLO QCD fit of the parton density functions (PDFs) of the proton with a simultaneous determination of the strong coupling $\alpha_s(M_Z)$ is presented. The analysis is based on the same combined H1 and ZEUS inclusive DIS cross section measurements as used in the HERAPDF1.5 fit, together with jet cross section measurements provided by both H1 and ZEUS collaborations. The inclusion of the jet data significantly reduces the correlation between the gluon PDF and the strong coupling, improving the precision of the gluon PDF and providing an accurate determination of $\alpha_s(m_Z)$ using DIS data from HERA only.

17:20 2B-4 The CTEQ-JLab parton distributions at large x : Cynthia KEPPEL (Hampton University / Jefferson Lab)

We critically examine uncertainties in parton distribution functions (PDFs) at large x arising from nuclear effects in deuterium F2 structure function data. Within a global PDF analysis, we assess the impact on the PDFs from uncertainties in the deuteron wave function at short distances and nucleon off-shell effects, the use of relativistic kinematics, as well as the use of less a restrictive parametrization of the d/u ratio. We find that in particular the d-quark and gluon PDFs vary significantly with the choice of nuclear model. We highlight the impact of these uncertainties on the determination of the neutron structure function, and on W boson production and parton luminosity at the Tevatron and the LHC. Finally, we discuss prospects for new measurements sensitive to the d-quark and gluon distributions but insensitive to nuclear corrections.

Parallel 2C - Recent Baryon Results II - W20-201 (West Lounge) (16:00-17:40)

Chair: Curtis Meyer (Carnegie Mellon University)

16:00 2C-1 Excited-state hadron masses from lattice QCD : Colin MORNINGSTAR (Carnegie Mellon University)

Progress in computing the spectrum of excited baryons and mesons in lattice QCD is described. Large sets of spatially-extended hadron operators are used. First results for the stationary-state energies of QCD in finite volume in the isovector meson sector are presented. The calculations include both single-hadron and multi-hadron operators and use the stochastic LapH method of estimating the low-lying effects of quark propagation.

16:20 2C-2 Nucleon Excitations in 2+1 Flavor QCD : Md Selim MAHBUB (University of Adelaide)

A determination of the excited state spectrum of hadrons presents a significant challenge to the first-principles approach of Lattice QCD. This presentation will commence with a brief overview of the correlation-matrix methods developed recently by the CSSM Lattice Collaboration for the isolation of excited states of the nucleon. The utility of our method is shown by exploring the first twelve excited states of the nucleon in positive and negative parity channels. Of particular interest is the Roper resonance, the first positive-parity excited-state of the nucleon. A low-lying Roper state is observed in full QCD calculations for the first time, showing significant curvature as the chiral regime is approached. A level ordering between the Roper and the first negative parity ground state consistent with the physical spectrum is anticipated only at pion masses within the order of 10 MeV of the physical mass. The contrast of this result from that of quenched QCD is discussed.

16:40 2C-3 Properties of the Lambda(1405) Hyperon Studied at CLAS Using Photoproduction : Kei MORIYA (Indiana University)

The internal structure of the $\Lambda(1405)$ hyperon has remained an unresolved mystery in hadron physics for decades. Observed as a resonance in $\sigma\pi$ just below the N-Kbar threshold, it is the first excited Λ state; yet the nature of this resonance, where it belongs in the hierarchy of hyperons, and some of its basic properties, remain unsettled. In previous experiments, the invariant mass spectrum (lineshape) has been observed to be distorted from a simple Breit-Wigner form, and since the 1960's, this has lead to theoretical speculation on the nature of this resonance and the dynamics involved in forming it.

Dalitz was among the first to point out that the strong attraction of the N-Kbar channel near threshold could produce a quasi-bound state that can only decay to the below-threshold $\Sigma\pi$ mode. The otherwise highly successful constituent quark model has difficulties in assigning the $\Lambda(1405)$, since naively the mass is calculated to be almost degenerate with the $\Lambda(1520)$. In recent years, advances in chiral unitary models have made definite predictions for the lineshape of the $\Lambda(1405)$, based on a strong coupling approach, to dynamically generate the $\Lambda(1405)$ from constituent mesons and baryons. Furthermore, the chiral unitary model predicts that there are two $I = 0$ poles for the $\Lambda(1405)$, one coupling strongly to the $\Sigma\pi$ decay mode, and the other a narrower resonance that couples more strongly to N-Kbar. The composite nature of the $\Lambda(1405)$ has repercussions, such as to the nature of baryon resonances above 1.9 GeV in mass which may decay to $\Lambda(1405)$, and also the topic of kaon condensation in the nuclear medium.

Past experiments have shown distortions of the lineshape of the $\Lambda(1405)$, but had statistics too limited to draw strong conclusions. With the CLAS collaboration at Jefferson Lab, we have studied the $\Lambda(1405)$ via photoproduction with unprecedented statistics from a proton target. The large multi-particle acceptance of the CLAS detector allows us to measure and compare the lineshapes and differential cross sections of all three decay modes $\Sigma + \pi^-, \Sigma 0\pi 0$, and $\sigma - pi^+$ from near the production threshold up to center-of-mass energies of 2.84 GeV. As predicted in the chiral unitary models, the line shapes and differential cross sections of the $\Lambda(1405)$ are indeed quite different for each decay channel. This lends support to the idea that the $\Lambda(1405)$ has strong dynamical components that distinguish it from other known resonances. In addition, the cross sections of the nearby $\Sigma(1385)$ and $\Lambda(1520)$ resonances have also been measured, and comparisons to the $\Lambda(1405)$ cross section will be shown.

Another basic property of the $\Lambda(1405)$ that has previously been experimentally unconfirmed is its spin and parity quantum numbers. Past experiments have not shown a conclusive result for the expected spin and parity of JP= $^1\!/_2-$. In the CLAS experiment we found a substantial polarization of the photoproduced $\Lambda(1405)$, which is measured through the daughter Σ^+, and we determined the parity of the parent $\Lambda(1405)$ from how this polarization was transferred. Our spin-parity analysis shows that indeed the assignment of $^1\!/_2-$ is correct.

17:00 2C-4 Photoproduction of Mesons off the Deuteron : Bernd KRUSCHE (Deparment of Physics, University of Basel)

Photoproduction of mesons off the deuteron B. Krusche Department of Physics, University of Basel, Switzerland For the CBELSA/TAPS and Crystal Ball/TAPS collaborations The nuclear excitation scheme has been under intensive investigation with meson photoproduction experiments during the last few years world wide. Currently, large efforts are under way at the CLAS experiment at Jlab, the ELSA accelerator in Bonn, and the MAMI accelerator in Mainz to investigate single and double polarization observables for different meson production reactions using longitudinally and transversely polarized targets, linearly and circularly polarized photon beams as well as the polarization of the recoil protons. These new data sets should provide stringent constraints for partial wave analyses of meson photoproduction off the proton. However, a full classification of the nucleon resonances includes also the iso-spin structure of their electromagnetic excitations which requires the measurement of meson photoproduction reactions off the neutron as well as coherent photoproduction from light nuclei. In addition, due to SU(3) selection rules, some states are electromagnetically much stronger excited on the neutron than on the proton. Photoproduction off mesons off nucleons bound in light nuclei, in particular in the deuteron, is so far the only practical method to investigate the electromagnetic excitation spectrum of the neutron. We have studied during the last few years in a series of experiments at the Bonn ELSA accelerator and the Mainz MAMI facility many different final states and investigated in detail systematic effects related to the 'nuclear' environment. The result is, that for many reaction channels reliable results for the elementary cross sections off free nucleons can be extracted.

The detector systems at both accelerators are electromagnetic calorimeters with almost 4p solid angle coverage (Crystal Barrel/TAPS at ELSA, Crystal Ball/TAPS at MAMI). They allow a detailed study of reactions which are not accessible at other facilities, in particular those which have only photons and neutrons in the final state. The obtained results cover e.g. $\pi n, 2\pi n, \eta n, \eta\pi n, \eta' n$ final states. A very interesting and unexpected finding is a prominent structure in the excitation function of the n(γ, η)n reaction. This reaction shows a narrow peak around W=1.7 GeV, which has no counter part in the p(γ, η)p reaction, except perhaps a much less prominent little dip-like structure around the same energy. Fits of the observed width of the peak typically give results in the range from 20–50 MeV FHWM, however the experimental resolution is of the same order. This structure has been seen in the experiments at ELSA and MAMI, but also by the GRAAL experiment and at Tohoku-LNS. The statistical significance is beyond any doubts. Very recently, we have also observed it in quasi-free η-photoproduction off neutrons bound in ^{3}He nuclei, indicating that the nuclear environment is not important and the structure is really a feature of the the elementary n(γ, η)n reaction. It's nature is so far not understood. We will discuss different scenarios.

Currently, measurements off polarization observables for the quasi-free n(γ, η)n reaction in this energy range are under way at ELSA (observable E from longitudinally polarized target, circularly polarized photon beam) and MAMI (observables T, F from transversely polarized target and circularly polarized beam). First preliminary results will be discussed.

17:20 2C-5 Coupled-Channel Bethe-Salpeter Approach to Pion-Nucleon Scattering. : Maxim MAI (HISKP and Bethe Center, Universitaet Bonn)

We analyze s-wave pion-nucleon scattering in a unitarized chiral effective Lagrangian including all dimension two contact terms. We find that both the S11(1535) and the S11(1650) are dynamically generated, but the S31(1620) is not. We further discuss the structure of these dynamically generated resonances.

Parallel 2D - Particle Astrophysics - 4-149 (16:00-17:40)

Chair: Ralph Engel (Karlsruhe Institute of Technology)

16:00 2D-1 Results from the Telescope Array Experiment : Pierre SOKOLSKY (University of Utah)

The Telescope Array (TA) Experiment is the largest experiment studying ultrahigh energy cosmic rays in the northern hemisphere. TA is a hybrid experiment, which means it consists of a large surface array of scintillation counters plus three fluorescence detectors overlooking the surface array. TA has been collecting data for about three years. Measurements of the spectrum and composition of cosmic rays between about 1 and 100 EeV will be presented, and searches for anisotropy in their arrival directions will be described.

16:20 2D-2 Overview of the results of the Pierre Auger Observatory : Piera L. GHIA (Pierre Auger Collaboration)

The Pierre Auger Observatory, implementing fluorescence and water Cherenkov detection in a "hybrid" extensive air shower array, has been designed to study cosmic rays with energies in excess of 10^{18} eV with unprecedented sensitivity. Taking data since 2004, it has already provided relevant results on the suppression of the flux of cosmic rays at the highest energies, on the astrophysical nature of their origin with respect to alternative non-acceleration models, on their correlation with extragalactic nearby matter. Detailed observations of the characteristics of extensive air showers have allowed to infer the mass composition of ultra-high energy cosmic rays, as well as to test the predictions of hadronic interactions models at energies not accessible to man-made accelerators. The recent enhancements of the Observatory — AMIGA and HEAT — extend the energy range of operation down to 10^{17} eV and make it possible to study the energy region around the second knee and the ankle of the cosmic ray spectrum with high precision and statistics. We will present here an overview of the most recent results obtained by the Pierre Auger Collaboration.

16:40 2D-3 Effects of the Galactic Magnetic Field on Observed Properties of Ultra-High Energy Cosmic Rays : Azadeh KEIVANI (Louisiana State University)

We present the results of propagating ultra-high energy protons and iron nuclei through several models of the galactic magnetic field (GMF) using the CRT code. In this analysis, the particles have been injected from the locations of active galactic nuclei (AGN) in the VCV catalog. We analyze the correlations of the observed arrival directions with the AGN directions and study differences of the energy spectrum observed at earth from that injected at the AGN.

17:00 2D-4 High-Energy Neutrino Flux Studied in the ANTARES Deep-Sea Telescope : Herbert LOEHNER (KVI, University of Groningen)

Scientific problems of high current interest include the origin of extremely energetic cosmic particles, an explanation of dark matter, and the quest for particles beyond the Standard Model. The detection of high-energy neutrino sources might provide inside into cosmic acceleration mechanisms or hint to exotic particles possibly annihilating into neutrinos. Advanced technology and a good understanding of neutrino interactions allow for the study of the deep cosmos in the "light" of neutrinos, the only particle that reaches Earth undisturbed. ANTARES, located in the Mediterranean Sea, is the largest neutrino detector currently operating in the Northern hemisphere and aims to detect high-energy neutrinos up to 10 PeV, exploiting the Earth as a filter and thus removing the overwhelming atmospheric muon flux. Completed in 2008, the detector covers an instrumented volume of 0.05 cubic km by a 3-dimensional array of about 900 photo sensors grouped in triplets and distributed along twelve vertical lines. We will briefly review the detection technique, primarily based on muon neutrinos which initiate a charged muon track, and the performance of the instrument, which also serves as a cabled infrastructure for sea and environmental sciences. For the performance verification, the results on the depth dependence of the atmospheric muon flux will be presented which is in good agreement with previous experiments.

A search has been conducted on the diffuse flux of high energy muon neutrinos from astrophysical sources. The world's most significant limits for the Southern sky have been achieved and certain models predicting cosmic neutrino fluxes can be excluded. The status of the ongoing search for neutrino point sources will be presented. Attempts have been made to open the sensitivity to all neutrino flavors by studying showers, produced by electron-neutrinos or in neutral-current interaction events and the quality of selection and energy determination will be shown. Finally, the prospects of KM3NeT, the future neutrino telescope of several cubic-km size in the Mediterranean Sea, will be discussed.

17:20 2D-5 Supernova Nucleosynthesis and Neutrino Oscillation : Taka KAJINO (National Astronomical Observatory, University of Tokyo)

Still unknown mass and oscillation properties of neutrinos take the important keys to resolve many fundamental questions such as why B- and L-symmetries are broken in our Universe, why we need unified theory of elementary particles beyond the standard model, why the core-collapse supernovae explode, etc. We here discuss how to determine the total neutrino mass and oscillation parameters from supernova nucleosynthesis, the Galactic chemical evolution (GCE), and the CMB anisotropies.

Supernovae are unique sources in nature that provide three flavors of neutrinos among various neutrino sources. The neutrino interactions with abundant nuclei produce extremely rare elemental isotopes such as Li7, B11, Na23, Ar40, V50, rare Mn-Fe-Co-Ni isotopes, Nb92, Tc98, La138, Ta180, and many others. Especially, La138 and Ta181 among them are the typical isotopes that are very sensitive to the neutrino properties. We first discuss how to produce Ta180 in the SN neutrino-process and propose a nucleosynthetic method to constrain the average energy of electron-type neutrinos. We secondly discuss how to resolve the degeneracy of average energies between electron-type neutrinos and their anti-particles from the r-process nucleosynthesis. The r-process requires neutron-rich condition that is affected by the charged-current neutrino interactions. Since the Li-Be-B abundance is also extremely small compared with those of neighboring nuclei, several isotopes like Li7 and B11 are strongly influenced by the SN neutrino-process. We here discuss the Galactic chemical evolution of Li-Be-B isotopes, including meteoritic abundance studies, in order to determine the energy hierarchy of SN neutrinos among all electron-, mu-, and tau-type neutrinos.

Having identified these average neutrino energies from SN nucleosynthetic studies, we finally discuss the neutrino oscillation effects on SN nucleosynthesis. We find that the Li-Be-B synthesis in carbon-rich He-layer is strongly affected by the oscillation effects, while the La138 and Ta180 synthesis in the inner O-Ne-Mg layer is free from these effects. Combining these interesting features, we can determine the unknown neutrino-oscillation parameter. The optical observations by using SUBARU Telescope and Hubble Space Telescope and also the meteoritic studies of pre-solar X-grains are underway to detect these isotopes. If time is still left, we would like to discuss shortly how to determine the total neutrino mass from the cosmological studies of the CMB temperature and polarization anisotropies.

Parallel 2E - Neutrino Interactions - 4-163 (16:00-17:40)

Chair: Joseph Formaggio (MIT)

16:00 2E-1 Charged current neutrino scattering in MINERvA : Ronald RANSOME (Rutgers University)

MINERvA is a neutrino detector in the NuMI beamline of FNAL, with a central fully active scintillator detector and targets of iron, lead, carbon, water, and LHe upstream of the central detection region. MINERvA began operations in late 2009 with a partially compete detector and has been fully operational since early 2010. Data have been taken with both neutrino and anti-neutrino beams. The objective is to measure inclusive and exclusive cross sections for neutrino-nuclear interactions with unprecedented statistics and detail off a wide range of nuclear targets. We will present preliminary results for ratios of Pb/Fe/scintillator inclusive and charged current quasi-elastic scattering kinematic distributions.

16:20 2E-2 Charm Dimuon Production in Neutrino-Nucleon Interactions in the NOMAD Experiment : Oleg SAMOYLOV (Joint Institute for Nuclear Research)

We present our new measurement of charm dimuon production in neutrino-iron interactions based upon the full statistics collected by the NOMAD experiment. After background subtraction we observe 15,340 charm dimuon events, providing the largest sample currently available. The analysis exploits the large inclusive charged current sample (about 9 million events after all analysis cuts) to constrain the total systematic uncertainty to about 2%. The extraction of strange sea and charm production parameters is also discussed.

16:40 2E-3 Study of Neutrino Interactions by T2K Near Detector Complex : Bruce BERGER (Colorado State University)

T2K is a 2nd generation long baseline neutrino oscillation experiment. High intensity muon neutrino beams produced at the Japan Proton Accelerator Research Complex (J-PARC) are detected by the Super-Kamiokande (Super-K) underground detector 295km away. The near detector complex ND280 at J-PARC has been built 280m from the primary proton target in order to precisely measure various neutrino beam properties and neutrino interactions. Greater than 10^{20} protons have already been delivered on the primary target and neutrino data has been steadily logged by both the ND280 and the Super-K detectors. The results of the neutrino interaction studies will be presented.

17:00 2E-4 Relativistic models for quasi-elastic neutrino-nucleus scattering : Maria Benedetta BARBARO (Turin University - Department of Theoretical Physics, Italy)

Two relativistic approaches to quasielastic neutrino-nucleus scattering will be illustrated and compared: one is phenomenological and based on the superscaling behavior of electron scattering data and the other relies on the microscopic description of nuclear dynamics in relativistic mean field theory. The role of meson exchange currents in the two-particle two-hole sector will be explored.and the corresponding predictions for differential and total cross sections will be presented and compared with the MiniBooNE data.

17:20 2E-5 Neutrino Quasielastic Scattering on Nuclear Targets: Parametrizing Transverse Enhancement (Meson Exchange Currents) : Arie BODEK (University of Rochester)

We present a parametrization of the observed enhancement in the transverse electron quasielastic (QE) response function for nucleons bound in carbon as a function of the square of the four momentum transfer (Q2) in terms of a correction to the magnetic form factors of bound nucleons. The parametrization should also be applicable to the transverse cross section in neutrino scattering. If the transverse enhancement originates from meson exchange currents (MEC), then it is theoretically expected that any enhancement in the longitudinal or axial contributions is small. We present the predictions of the "Transverse Enhancement" model (which is based on electron scattering data only) for the neutrino and anti-neutrino differential and total QE cross sections for nucleons bound in carbon. The Q2 dependence of the transverse enhancement is observed to resolve much of the long standing discrepancy in the QE total cross sections and differential distributions betweenlow energy and high energy neutrino experiments on nuclear targets.

Parallel 2F - Dark Matter I - 4-153 (16:00-17:40)

Chair: Enectali Figueroa-Feliciano (MIT)

16:00 2F-1 Results from the Second Science Run of ZEPLIN-III : Henrique ARAUJO (Imperial College London)

We present new results from the second run of the ZEPLIN-III dark matter experiment, a two-phase xenon detector operating at the Boulby mine (UK). ZEPLIN-III has been upgraded with low background photomultipliers, which have delivered nearly 20-fold background reduction. A new veto detector, featuring a tonne of plastic scintillator, has been installed around the main instrument, bringing about further improvement in sensitivity as well as valuable diagnostic information. Results from 200 days of science exposure will be presented.

16:20 2F-2 Searching for Dark Matter with COUPP : Hugh LIPPINCOTT (Fermilab)

COUPP is an experimental campaign with the goal of detecting dark matter in the form of Weakly Interacting Massive Particles (WIMPs) using continuously sensitive bubble chambers, operated under mildly superheated conditions. Recoils of dark matter particles off the target nuclei in the chamber would produce single, isolated bubbles, which are detectable both optically and acoustically. Under normal operating conditions, the detector has an energy threshold for nuclear recoils of approximately 10 keV but is insensitive to electron recoils, which typically constitute the background in dark matter searches. Nuclear recoils can be discriminated from alpha decays in the target liquid with the acoustic signal produced by the bubbles, which show excess power at high frequencies for alpha events.

Recent results from a 4 kg chamber (COUPP-4) at a shallow depth produced new limits on WIMP-nucleon interactions while also demonstrating the acoustic rejection of alpha events. The COUPP-4 detector is now taking data in SNOLAB, producing stronger limits on both alpha rejection and dark matter interactions. The COUPP collaboration is also actively working on installing a 60 kg chamber at SNOLAB, with the goal of achieving world-best sensitivity to spin- independent dark matter. This talk will summarize the recent results from COUPP-4 and describe progress on COUPP-60.

16:40 2F-3 EDELWEISS : Hans KRAUS (University of Oxford)

The EDELWEISS-II collaboration has performed a direct search for WIMP dark matter with an array of ten 400 g heat-and-ionization cryogenic detectors equipped with interleaved electrodes for the rejection of near-surface events. Results from eleven months of continuous operation at the Laboratoire Souterrain de Modane will be shown and their interpretation in terms of limits on the cross-section of spin-independent interactions of WIMPs and nucleons presented. The result obtained demonstrates the excellent background rejection capabilities of these simple and robust detectors in an actual WIMP search experiment. New results with 800 g detectors will be also presented together with the prospects for this experiment and the ton scale EURECA project.

17:00 2F-4 Direct Dark Matter and Axion Detection with CUORE : Marco VIGNATI (Universita di Roma/INFN-Roma)

The Cryogenic Underground Observatory for Rare Events (CUORE) is an experiment to search for neutrinoless double beta decay in Te-130 and other rare processes. CUORE is a bolometric detector composed of 988 TeO2 crystals, with the total mass of about 1 tonne. The large detector mass, low backgrounds, and the low energy threshold of a few keV make the experiment well suited for direct detection of galactic dark matter particles and solar axions. We discuss the development of a novel low-energy trigger that enables such searches, and present the preliminary results from a test run with four CUORE-like crystals at Gran Sasso National Laboratories in Italy.

17:20 2F-5 Status and Prospects of the DMTPC Directional Dark Matter Experiment : Jocelyn MONROE (MIT)

The DMTPC directional dark matter detection experiment is a low-pressure CF4 gas time projection chamber, instrumented with charge and scintillation photon readout. This detector design strategy emphasizes reconstruction of WIMP-induced nuclear recoil tracks, in order to determine the direction of incident dark matter particles. Directional detection has the potential to make the definitive observation of dark matter using the unique angular signature of the dark matter wind, which is distinct from all known backgrounds. This talk will review the experimental technique and current status of DMTPC.

Parallel 2G - Precision tests of CPT and QED - Kresge - Rehearsal A (16:00-17:40)

Chair: Klaus Jungmann (University of Groningen)

16:00 2G-1 Testing Lorentz Invariance and other Fundamental Symmetries in 3He/129Xe Clock-comparison Experiments : Sergei KARPUK (Institut fur Physik, Johannes-Gutenberg Universitaet Mainz)

We discuss the design and performance of a very sensitive low-field magnetometer based on the detection of free spin precession of gaseous, nuclear polarized 3He or 129Xe samples with a SQUID as magnetic flux detector. Characteristic spin precession times T2 of up to 60 h were measured in low magnetic fields (about μ T) and in the regime of motional narrowing. With the detection of the free precession of co-located 3He/129Xe nuclear spins (clock comparison), the device can be used as ultra-sensitive probe for nonmagnetic spin interactions, since the magnetic dipole interaction (Zeemanterm) drops out in the weighted frequency difference [1]. We report on searches for a) Lorentz violating signatures by monitoring the Larmor frequencies of co-located He/129Xe spin samples as the laboratory reference frame rotates with respect to distant stars (sidereal modulation) [2] and b) spindependent short-range interactions induced by light, pseudoscalar bosons such as the axion invented to solve the strong CP problem. We found upper limits on Lorentz and CPT violation of the bound neutron of ¡ 3.7x10-32 GeV [2] and on the scalar- and pseudoscalar couplings gs gp in the axion-mass window from 10-2 eV to 10-6 eV [3].

[1] C.Gemmel, W.Heil, S.Karpuk et al., Eur. Phys. J. D, 57, 303-320, (2010)

[2] C.Gemmel, W.Heil, S.Karpuk et al., Phys. Rev. D, 82, 111901 (R), 2010.

[3] M. Burghoff, C. Gemmel, W.Heil et al., Workshop Proceedings on Experimental and Theoretical Approaches to Quantum States of Neutrons in Gravitational Fields, Les Houches 2010

16:20 2G-2 Testing CPT with Antiprotonic Helium and Antihydrogen : Eberhard WIDMANN (Stefan Meyer Institute, Vienna, Austria)

Low-energy antiprotons are an ideal tool to study fundamental symmetries, especially CPT symmetry, by precision spectroscopy of exotic atoms containing an antiproton. The ASACUSA collaboration at the Antiproton Decelerator of CERN focuses on laser and microwave spectroscopy of antiprotonic helium and antihydrogen. Antiprotonic helium [1] is an exotic three-body system consisting of a helium nucleus, an electron and an antiproton. The antiproton occupies highly excited metastable states, which allows the determination of its mass and magnetic moment by precision laser and microwave spectroscopy and comparison to three-body QED calculations. Thus the most accurate value for the antiproton mass [2] and magnetic moment [3] were obtained. Anthydrogen, the simplest neutral antimatter atom, promises CPT tests of highest precision by comparison to hydrogen, which is one of the best studied atoms. ASACUSA is preparing an experiment to measure the ground-state hyperfine structure of antihydrogen [4], the corresponding quantity for hydrogen being measured to relative precision of 10^{-12} in the hydrogen maser. A major break through occurred in 2010 when ASACUSA for the first time demonstrated antihydrogen formation [5] in a so-called "cusp trap" suitable for the production of an antihydrogen beam, which is essential for our proposed experiment.

References

[1] R.S. Hayano, M. Hori, D. Horvath, and E. Widmann, Rep. Prog. Phys. 12, 1995 (2007).
[2] M. Hori et al., Physical Review Letters 96, 243401 (2006).
[3] T. Pask et al., Physics Letters B 678, 55 (2009).
[4] E. Widmann, R. S. Hayano, M. Hori, and T. Yamazaki, Nucl. Instr. Meth. B214, 31 (2004).
[5] Y. Enomoto et al., Physical Review Letters 105, 243401 (2010).

16:40 2G-3 The first direct observation of positronium hyperfine splitting : Taikan SUEHARA (International Center for Elementary Particle Physics, The University of Tokyo)

Positronium (electron-positron bound state) is a purely leptonic system and is thus suitable for precision tests of QED. Energy difference between ortho-positronium (o-Ps) and para-positronium (p-Ps), i.e. hyperfine splitting in positronium (Ps-HFS), can be affected by new physics effects beyond the Standard Model, such as the presence of a hypothetical particle which couples to the virtual photon created from o-Ps by its quantum oscillation ($e+e- \to \gamma^* \to e+e-$).

The most direct method to measure Ps-HFS is to cause a transition between o-Ps and p-Ps by applying an electromagnetic radiation whose energy is just at the Ps-HFS. However, it has never been directly measured due to the lack of suitable radiation sources at the Ps-HFS frequency (203 GHz; millimeter wave). Indirect measurements have been performed in the 70's to the 80's, utilizing Zeeman splitting with ∼1 Tesla static magnetic field and ∼3 GHz RF. Recent updates in theoretical QED calculations of $O(\alpha^3)$ resulted in a discrepancy of 3.9 σ (15 ppm) with the existing experimental results. The origin of the discrepancy should be identified, whether it is from an experimental error or from an unknown physics. To suppress the systematic effects due to the indirect method (error of static magnetic field, etc.), we developed a new direct measurement system of the Ps-HFS using a 203 GHz radiation source.

The transition observation needs a powerful radiation field because the cross section of the hyperfine transition is extremely small ($\tau = 3 \times 10^7$ sec). We utilize a gyrotron, a novel high-power radiation source in sub-THz to THz region, to obtain an intense 203 GHz field. Our gyrotron can output more than 500 W of 203 GHz radiation. To cause the hyperfine transition, we developed a Fabry-Perot cavity, which can accumulate the gyroton power up to 10 kW. A metal-mesh mirror and a Cu convex mirror are built, tested and used for the cavity. Length of the cavity is precisely (¡ 100 nm level) controlled by a piezo walking stage to maintain maximum resonance. In our setup, sodium-22 is used as a positron source. The positron is stopped in a gas target filled in the Fabry-Perot cavity to create positronium. Since p-Ps has a very short lifetime of 125 picoseconds compared to o-Ps of 142 nanoseconds, o-Ps is the only remnant after several nanoseconds from the positron emission. Some of the o-Ps is converted into p-Ps in the 10 kW 203 GHz field. Since p-Ps decays into two photons of monochromatic 511 keV energy while o-Ps decays into three photons of continuous energy, we can identify the delayed 511 keV pair events as the signal.

We are performing a prototype run from January to March 2011. Preliminary results give a more than 3 sigma evidence of the signal events. A statistics of up to 5 sigma is expected in this run. This is anticipated to be the first observation of direct hyperfine transition of positronium. A precise measurement of the hyperfine splitting value will be performed from the next run, which targets ∼10 ppm precision in several years.

17:00 2G-4 The proton radius puzzle : Antognini ALDO (Institut fuer Teilchenphysik (IPP))

At the Paul Scherrer Institute, Switzerland, the CREMA collaboration [1] has measured the 2S-2P transition frequency (Lamb shift) in muonic hydrogen (mu+p) with 15 ppm precision by means of laser spectroscopy [2]. From this measurement the rms charge radius of the proton was determined.

The new proton radius value $r_p = 0.84184(67)$ fm is 10 times more precise than previously obtained. However, it disagrees by 4 standard deviations from the value extracted from hydrogen spectroscopy and 5 standard deviations from electron-proton scattering data. The origin of the discrepancies is not yet known. It may come from theory of the muonic hydrogen energy levels (used to deduce our new value), from problems in hydrogen spectroscopy experiments or hydrogen energy level theory (both used to deduce the “H” value), from unexpected proton shape or it occurs from uncalculated or new effects.

Experimental setup, measurements, results and future perspectives will be presented. Additionally the key issues and excluded explanations regarding the observed discrepancy will be discussed. The discrepancy simply raises new questions in the muonic sector, in bound-state QED and around the proton structure, holding the potential for new insights.

[1] https://muhy.web.psi.ch/wiki/index.php/Main/HomePage

[2] R. Pohl et al, Nature, 466, 213-216 (2010)

17:20 2G-5 Confinement of antihydrogen for 1000 seconds : Makoto FUJIWARA (TRIUMF/University of Calgary)

Atoms made of a particle and an antiparticle are unstable, usually surviving less than a microsecond. Antihydrogen, made entirely of antiparticles, is believed to be stable, and it is this longevity that holds the promise of precision studies of matter-antimatter symmetry. We have recently demonstrated trapping of antihydrogen atoms by releasing them after a confinement time of 172 ms [1]. A critical question for future studies is: how long can anti-atoms be trapped? Here we report the observation of anti-atom confinement for 1000 s, extending our earlier results by nearly four orders of magnitude [2]. Our calculations indicate that most of the trapped anti-atoms reach the ground state. Further, we report the first measurement of the energy distribution of trapped antihydrogen which, coupled with detailed comparisons with simulations, provides a key tool for the systematic investigation of trapping dynamics. These advances open up a range of experimental possibilities, including precision studies of CPT symmetry and cooling to temperatures where gravitational effects could become apparent.

[1] G. Andresen et al. (ALPHA Collaboration), Nature (London) 468, 673 (2010).

[2] G. Andresen et al. (ALPHA Collaboration), Nature Physics (London), doi:10.1038/nphys2025 (2011) [arXiv:1104.4982].

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Parallel 2H - Heavy Quark Production - Kresge - Rehearsal B (16:00-17:40)

Chair: Andre Hoang (University of Vienna)

16:00 2H-1 Inclusive b-$\bar{b}$bar Production in ATLAS : Patrick JUSSEL (University of Innsbruck)

The QCD production of high-pT B-hadrons is an important process as a probe of perturbative QCD. High-pT B-hadrons also form a significant background to many new physics channels at the LHC. Measurements are presented of the inclusive differential b-jet cross section, where b-jets are those containing a B-hadron. The results are compared to calculations of the B cross-section based on Monte Carlos and on higher order QCD. Future prospects for studying B-physics with ATLAS are also briefly described.

16:40 2H-2 b-quark production at 7 TeV with the CMS experiment : Valery ANDREEV (UCLA)

Measurements performed by the CMS experiment of the cross section for inclusive b-quark production in proton-proton collisions at $\sqrt(s) = 7$ TeV are presented. The measurements are based on different methods, such as inclusive jet measurements with secondary vertex tagging or selecting a sample of events containing jets and at least one muon, where the transverse momentum of the muon with respect to the closest jet axis discriminates b events from the background. The results are compared with predictions based on perturbative QCD calculations at leading and next-to-leading order. Measurements of the total and single differential cross sections for $B+, B0, Bs$ mesons and Λ_b baryons produced in pp collisions at $\sqrt{s} = 7$ TeV are presented. The results are compared with predictions based on perturbative QCD calculations at leading and next-to-leading order.

17:00 2H-3 Charm Mass Determination from QCD Charmonium Sum Rules at Order α_s^3 : Vicent MATEU (MIT)

We determine the MS-bar charm quark mass from a charmonium QCD sum rules analysis. On the theoretical side we use input from perturbation theory at $O(\alpha_s^3)$. Improvements with respect to previous $O(\alpha_s^3)$ analyses include (1) an account of all available $e+e-$ hadronic cross section data and (2) a thorough analysis of perturbative uncertainties. Using a data clustering method to combine hadronic cross section data sets from different measurements we demonstrate that using all available experimental data up to c.m. energies of 10.538 GeV allows for determinations of experimental moments and their correlations with small errors and that there is no need to rely on theoretical input above the charmonium resonances. We also show that good convergence properties of the perturbative series for the theoretical sum rule moments need to be considered with some care when extracting the charm mass and demonstrate how to set up an appropriate set of scheme variations to obtain an appropriate estimate of the perturbative uncertainty. As the final outcome of our analysis we obtain $m_c(m_c) = 1.277 \pm 0.006_s tat \pm 0.013_{\text{syst}} \pm 0.019_{\text{pert}} \pm 0.009_\alpha \pm 0.002_{\text{GG}}$ GeV. The perturbative error is an order of magnitude larger than the one obtained in previous $O(\alpha_s^3)$ sum rule analyses.

Parallel 2I - Heavy Flavor Rare Decays - Kresge - Little Theatre (16:00-17:40)

Chair: Kay Kinoshita (University of Cincinnati)

16:00 2I-1 Rare Decay Searches with BABAR : Andrew M. RULAND (UT Austin)

We present recent BABAR results of searches for rare decays with new physics sensitivity. In particular, we describe recent inclusive and exclusive studies of b $\rightarrow$ s γ and b $\rightarrow$ d γ radiative processes, $\text{B}, \text{D} \rightarrow X\,1+1-, \text{D} \rightarrow 1+1$ and $\text{B}_+, \text{D}_{s+} \rightarrow 1+\nu$.

16:20 2I-2 Searches for new physics through rare decays from CDF : Robert HARR (Wayne State University)

We report the latest results of a CDF search for B $\rightarrow \mu\mu$ decays and updated measurements of branching fractions, polarization, and muon forward-backward asymmetry in B $\rightarrow$ K $\mu\mu$ final states using 7/fb of data. Increased statistics with respect to the previous iteration and several analysis improvement provide results that are the most sensitive from a single-experiment to date.

16:40 2I-3 Rare decays at LHCb : Ulrik EGEDE (Imperial College)

FCNC decays of heavy flavour hadrons are highly sensitive to the effects of physics beyond the Standard Model. Important observables include the branching ratio of B(s,d) $\rightarrow \mu^{+}\mu^{-}$, the angular distributions in the decay B0 $\rightarrow$ K $\mu^{+}\mu^{-}$ and the life- time distribution of Bs $\rightarrow \varphi\gamma$. First results on some of these studies and related topics will be reported, using the 2010 dataset and the first data of the 2011 run.

17:00 2I-4 Radiative and Semileptonic Penguin Decays : Tobias HURTH (Johannes Gutenberg University)

The huge datasets collected at the two B factories, Belle and BaBar, have made it possible to explore the radiative penguin process (a b quark decays into a s or d quark and a photon) and the electroweak penguin process (b to s plus a lepton pair) in detail, all in exclusive channels and inclusive measurements. Theoretical tools have also advanced to meet or surpass the experimental precision, especially in inclusive calculations and the various ratios of exclusive channels. We discuss recent progress in perturbative and nonperturbative corrections to inclusive penguin modes. Moreover, we analyse the physics reach of exclusive penguin modes in view of the unknown power corrections.

References:

1) Radiative and Electroweak Penguin Decays of B Mesons,
   Tobias Hurth and Mikihiko Nakao, Ann.Rev.Nucl.Part.Sci.60:645-677, 2011; arXiv:1005.1224[hep-ph]

2) New Physics Reach of the Decay Mode B to K* leptonpair, Ulrik Egede, Tobias Hurth, Joaquim Matias, Marc Ramon, Will Reece, JHEP 1010:056,2010, arXiv:1005.0571[hep-ph]

17:20 2I-5 More Opportunities to Probe New Physics in b -¿ s lbar l : Danny VAN DYK (TU Dortmund)

We present recent phenomenological results for the decays B $\rightarrow$ V (*to* P1 P2) lbar l and B $\rightarrow$ K lbar l in the kinematic region in which the dilepton invariant mass is large, of order mb . We propose a number of new angular observables that exhibit reduced sensitivity to either non-perturbative hadronic uncertainties or short-distance couplings. We confront the Standard Model predictions for these decays with presently available data on B $\rightarrow$ {K, K , Xs } modes. We derive the currently most stringent constraints on the associated short-distance couplings C9,C10 of $\triangle$B = 1b $\rightarrow$ s transitions. These are used to put forward a window of compatible values for the branching ratio of Bs + decays.

Parallel 2K – Hydrodynamics - W20-407 (16:00-17:40)

Chair: Ron Soltz (Lawrence Livermore National Laboratory)

16:00 2K-1 Equation of State of Strongly Interacting Fermi Gas : Mark KU (Massachusetts Institute of Technology)

We observe the superfluid phase transition in the thermodynamics of strongly interacting fermionic atoms at a Feshbach resonance. The transition is seen in the chemical potential, entropy, compressibility and heat capacity, which displays the characteristic lambda-like feature. We provide a new value of the Bertsch parameter and directly obtain the critical temperature, validated via a condensate fraction measurement. Our high-precision measurement of the equation of state of the Fermi gas employs in-situ imaging, and density reconstruction via the inverse Abel transformation. The low noise local density distribution in an external potential directly probes the equation of state under the local density approximation. Regions of low density allow us to extract the chemical potential and the temperature using the virial expansion of the equation of state. We validate our method using the non-interacting Fermi gas. The experimental results are compared to recent Monte-Carlo calculations.

16:20 2K-2 Event-by-event hydrodynamics for heavy ion collisions with fluctuating initial profiles : Zhi QIU (Ohio State University Physics)

Heavy-ion collisions create deformed quark-gluon plasma (QGP) fireballs which explode anisotropically. The viscosity of the fireball matter determines its ability to convert the initial spatial deformation into momentum anisotropies that can be measured in the final hadron spectra. A quantitatively precise empirical extraction of the QGP viscosity thus requires a good understanding of the initial fireball deformation. This deformation fluctuates from event to event, and so does the finally observed momentum anisotropy. Previous hydrodynamic calculations dealt with this problem only in an average way, by evolving (for each impact parameter) only a single hydrodynamic evolution of an ensemble-averaged smooth initial profile. We here study the spectrum of initial fluctuations in shape and orientation of the fireball and perform event-by-event hydrodynamic simulations to extract the resulting spectrum of fluctuations in the magnitude and direction of the corresponding final anisotropic flow components. We found that the average elliptic flow from an ensemble of individually evolved fluctuating fireballs is smaller than that obtained from a single smooth initial profile with the same average eccentricity. This has important quantitative consequences for the extraction of the QGP viscosity from elliptic flow data.

16:40 2K-3 Triangular Flow in Relativistic Heavy Ion Collisions in an Event-by-Event Hybrid Approach : Hannah PETERSEN (Duke University)

Triangular flow has been shown to be an interesting new observable to gain insights about the properties of hot and dense strongly interacting matter as it is produced in heavy ion collisions at RHIC and LHC. We will present triangular flow results for Au+Au collisions at the highest RHIC energy calculated in a hybrid approach that includes a non-equilibrium initial evolution and an ideal hydrodynamic expansion with a hadronic afterburner in 3+1 dimensions. By comparing the hybrid approach calculation with a pure transport approach, the influence of viscosity is studied. In addition, the potential of triangular flow for constraining the initial state granularity will be discussed. We compare the results from Au+Au collisions at 200 GeV per nucleon to Pb+Pb at LHC energies and smaller systems (Cu+Cu) and find that the fluctuations/v3 values at LHC are surprisingly similar, whereas in Cu+Cu the fluctuations are more important and triangular flow is similar in magnitude to elliptic flow over a broad range of impact parameters. Furthermore, the longitudinal long-range correlations of the triangular flow event plane angle are explored for initial conditions from a partonic and a hadronic transport approach. We conclude that longitudinal long-range correlations are not a unique signature for flux tube-like initial conditions, but can also be produced by other mechanisms.

17:00 2K-4 Elliptic Flow Measured in a Large Phase Space in $\sqrt{s_{NN}} = 2.76$ TeV Pb + Pb Collisions : Soumya MOHAPATRA (SUNY Stony Brook)

A broad program of measurements using heavy ion collisions is underway in ATLAS, with the aim of studying the properties of QCD matter at high temperatures and densities. At momentum scales of a few GeV, elliptic flow (a $\cos 2$ modulation of the eventwise azimuthal distribution) is a sensitive probe of the transport properties of the strongly coupled medium. At higher momentum it is thought to reflect differential energy loss of jets passing through the medium with different path lengths. This talk describes measurements performed using up to 9 pb-1 of lead-lead collision data provided at a nucleon-nucleon center-of-mass energy of 2.76 GeV by the Large Hadron Collider and collected by the ATLAS Detector during November and December 2010. Our elliptic flow results extend both to large pseudorapidity, using the large acceptance Inner Detector ($|\eta| < 2.5$) and the Forward Calorimeters ($|\eta| < 4.9$), and high transverse momentum. Comparisons to earlier data will provide insight into whether the matter formed at the LHC has different properties to that formed at lower center of mass energies.

17:20 2K-5 Hydrodynamic flow in Pb+Pb collisions observed via azimuthal angle correlations of charged hadrons : Eric Andrew APPELT (Vanderbilt University)

Azimuthal angle correlations of charged hadrons were measured in $\sqrt{s_{NN}} = 2.76$ TeV Pb+Pb collisions by the CMS experiment. The distributions exhibit anisotropies that are correlated with the event-by-event orientation of the reaction plane. Several methods were employed to extract the strength of the signal: the event-plane, cumulant and Lee-Yang Zeros methods. These methods have different sensitivity to correlations that are not caused by the collective motion in the system (non-flow correlations due to jets, resonance decays, and quantum correlations). The second Fourier coefficient of the charged hadron azimuthal distributions was measured as a function of transverse momentum, pseudorapidity and centrality in a broad kinematic range: $0.3 < p_T < 12.0$ GeV/c, $|\eta| < 2.4$), as a function of collision centrality.

Parallel 2L - Heavy Ion Collisions II - W20-491 (16:00-17:40)

Chair: Gunther Roland (MIT)

16:00 2L-1 Fragmentation Functions in Medium, two-particle correlations and Jets in PHENIX at RHIC : Michael TANNENBAUM (Brookhaven National Laboratory)

For the past decade, measurements of semi-inclusive single identified particle spectra and two-particle correlations in p-p and A+A collisions at RHIC have produced a treasure trove of results which indicate a suppression of hard-scattered partons in the medium produced in A+A collisions. It still remains to be determined unambiguously whether the partons emerge from the medium having lost energy (or even emerge from well within the medium without having lost energy) then fragment normally outside; whether vacuum fragmentation is modified inside the medium; or whether partons are stopped or absorbed so that only surface emission occurs. One important lesson learned is that the away-side pTa distribution of particles opposite to a trigger particle (e.g. a pizero), which is itself the fragment of a jet, does not measure the fragmentation function. The key to measuring the fragmentation function and its possible modification is to know the energy of the original parton which fragments. This can be accomplished by measuring the correlated hadrons opposite to a direct-single-gamma from the reaction g+qgamma+q. Additionally, for this reaction the parton opposite to the gamma is highly likely to be a u quark. Comparison to the xi=ln 1/z representation of fragmentation functions measured in e+ e- collisions, where z is the fragmentation variable, becomes useful for direct-gamma-h measurements over the full z or xi range when a semi-log plot is used. Measurements will be shown for p-p and AuAu collisions where a modification is clearly seen. Although the fragmentation function can not be measured using two-particle correlations where both particles are fragments of jets, the ratio of the away parton transverse momentum to the trigger parton transverse momentum and, hence, the fractional imbalance of the outgoing jets can be deduced from these measurements. Results will be shown for Au+Au compared to p-p collisions and compared to results from fully reconstructed jets at LHC. Finally, measurements of reconstructed jets in PHENIX from p-p and A+A collisions will be presented.

16:20 2L-2 High pT inclusive hadron and photon spectra in pp and PbPb collisions : Sevil SALUR (UC Davis)

At RHIC, one of the first observed signatures of 'jet quenching' in heavy-ion collisions was the dramatic suppression of high-pt charged hadron spectra with respect to a scaling of the proton-proton spectra by the number of binary nucleon-nucleon collisions – a scaling that is observed for direct photons, which escape the produced medium without interacting strongly. In this talk, the charged particle transverse momentum spectra are presented for $\sqrt{(s)} = 0.9$ and 7 TeV pp collisions and $\sqrt{(s)} = 2.76$TeV PbPb collisions collected with the CMS detector during the 2010 LHC run. To extend the statistical reach of the measurements, calorimeter-based high-ET jet triggers are employed to enhance yields at high pT. Using a combination of xT scaling and direct interpolation at fixed pT, we construct a reference at $\sqrt{(s)} = 2.76$ TeV for studying high-pT particle suppression in the dense QCD medium produced in heavy-ion collisions. The nuclear suppression factor R_{AA} for charged hadrons is obtained for transverse momenta up to 70GeV/c. In addition, the differential cross section for inclusive production of isolated prompt photons is shown as a function of the photon transverse energy based on a 2.96 pb-1 sample of 7 TeV pp collisions. The status of the prompt photon analysis in PbPb collisions is discussed.

16:40 2L-3 Direct photon production at RHIC : Yoki ARAMAKI (RIKEN)

Direct photon and neutral pion production in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV has been measured by the PHENIX experiment at RHIC, and we will report recent results. Direct photons are produced in the initial hard partonic scatterings, are not affected by the strong interaction, and can be described by perturbative QCD. Consequently, they are offer a powerful probe of the nature of the produced medium. We will present direct photon spectra and nuclear suppression factors in Au+Au collisions. We will also show first results from flow analysis of direct photons, which can provide a glimpse of the early space-time evolution in the collision. The yield of π^0 is suppressed by a factor of 5 in Au+Au compared to expectations from nucleon-nucleon collisions, but no suppression is observed in d+Au. The energy loss of hard scattered partons in the medium created in Au+Au should depend on the effective path length, and we report on how the yield suppression depends on the azimuthal angle with respect to the reaction plane.

17:00 2L-4 Massive QCD antenna radiation in medium : Hao MA (Universidad de Santiago de Compostela)

Medium modifications of jets have previously been thoroughly studied by calculating the gluon radiation spectrum off a highly energetic quark traversing a hot and dense QCD medium. But the study of the interference effects, the building block of the QCD jet calculation in vacuum, between different radiators has been missing for quite a long time. In this work we calculate, in the eikonal approximation, the gluon radiation spectrum off a quark-antiquark antenna passing through a deconfined QCD plasma with the masses of the quark and antiquark turned on. The massive quark-antiquark antenna involves both the dead cone effect and the Landau-Pomeranchuk-Migdal (LPM) effect, and takes into account the correlation between both of the emitters leading to an additional strong suppression of gluon radiation at angles smaller than the opening angle of the quark-antiquark pair. Furthermore, the quark-antiquark antenna spectrum is infrared divergent. We calculate the medium-induced energy loss of heavy quarks (charm and bottom) and compare it to well-known results (BDMPS/GLV). The implications on jet quenching observables in heavy ion collisions is also discussed.

17:20 2L-5 Non-perturbative Jet Quenching from Geometric Data : Jinfeng LIAO (Brookhaven National Laboratory)

Measured RHIC data for the geometric feature of jet quenching, in particular the in-plane and out-of-plane difference (v2 of high Pt hadrons), strongly favors a physical scenario from non-perturbative origin. Currently two proposals successfully describe such geometric data: strong enhancement of quenching near phase boundary, or cubic path-length dependence motivated by AdS/CFT results. I will discuss how and why both scenarios could describe current data, the appealing physics behind the near Tc scenario, and possible future tests for distinguishing the two. Reference: PRL102:202302,2009 (with Shuryak); arXiv:1101.0290 (with Jia, Horowitz); In preparation (with Jia)

Tuesday 26 July 2011

Plenary 2 - Kresge Auditorium (08:30-10:15)

Chair: Johanna Stachel (University of Heidelberg (Germany))

08:30 P2-1 Glimpsing the Fly in the Cathedral: Marking the Centennial of the First Description of the Atomic Nucleus : Brian CATHCART (Kingston University)

One hundred years ago Ernest Rutherford delivered a paper to an obscure society in Manchester, England, suggesting that almost the entire mass of the atom of matter was concentrated in a "central charge" that was relatively insignificant in size. This was the birth of the nucleus, or "the fly in the cathedral" as the popular writers would soon call it. Rutherford's remarkable insight was prompted by unexpected results in an experiment conducted by an undergraduate, it was the fruit of deep thought by a man not normally considered a theorist, and it was so surprising and unlooked-for in the wider world of science that years passed before its significance was accepted. Yet in retrospect we can see that it was anything but fortuitous.

My paper relates the narrative of the discovery, from Ernest Marsden's scattering experiments in 1909 through Rutherford's long months of reflection to his landmark 1911 paper for the Manchester Literary and Philosophical Society and beyond, to the slow, even reluctant international awakening to his idea. But the paper also examines what lay behind this sequence, both the extraordinary energy, determination and ingenuity of Rutherford himself and the deliberate policy of all-out assault on the atom which he adopted while at Manchester. The records show that from the month of his arrival there in 1907 he rapidly and almost brutally converted the university's physics department – then one of the world's best equipped for experimental research – into an instrument of his particular vision. In consequence, not only was he placed in the position to surprise the world with the discovery of the nucleus, but it was largely he and his colleagues and students who were able to confirm and capitalize on that discovery. The physicist A.S. Eve once remarked: "You are a lucky man, Rutherford, always on the crest of a wave." The reply was: "Well I made the wave, didn't I?" There can be no finer example of Rutherford's capacity to make a wave as well as ride it than the story of the first description of the atomic nucleus.

Brian Cathcart is the author of "The Fly in the Cathedral: How a small group of Cambridge physicists won the international race to split the atom" (Farrar, Straus and Giroux, 2005) and "Test of Greatness: Britains Struggle for the Atom Bomb (John Murray 1994)".

09:05 P2-2 New Physics Discoveries at the Quark and Lepton Luminosity Frontiers or From precision tests to LHC discoveries & Back : Gilad PEREZ (Weizmann Institute)

We briefly describe the uniqueness of the Standard Model (SM) quark and lepton flavor sectors, and discuss the current status of flavor precision measurements. The data implies that SM extensions have a rather non-generic flavor structure, which lead to a new physics (NP) flavor puzzle. This puzzle, generically, can not be associated with a scale. Yet, under a concrete set of assumptions, we translate the current bounds to insights on the characteristic mass scales of different microscopic extensions of the SM. We introduce the concept of NP flavor alignment and emphasize the importance of flavor diagonal information, which is extracted at the energy frontier (at the Tevatron and LHC experiments), for the understanding of flavor dynamics at a scale well beyond the direct reach of near future experiments.

09:40 P2-3 Probing Hadron Structure & New Physics with Parity Violating Electron Scattering : Jeffery MARTIN (The University of Winnipeg)

Parity-violating electron scattering opens up a new window on the structure of matter. Usually, electron scattering is thought of as an electromagnetic process, which certainly would not violate parity! But by measuring tiny parity-violating signals, the weak neutral-current interaction between the electron and the target can be isolated and measured precisely. This has led to a series of experiments that have sought to characterize the strange quark structure of the proton, which utilize the difference in the way the photon and the Z-boson couple to quarks to get their sensitivity. More recent experiments have even become sufficiently precise to extract the weak mixing angle itself, the parameter that describes gamma-Z mixing in the standard model. In this way, by comparing with measurements done at high-energy collider experiments, the running of the weak mixing angle with energy scale can be deduced and compared with standard-model predictions. Because the measurements are so precise, if a deviation from the standard model were found, this could herald the effects of new physics at the TeV scale. I will review these and other applications in the field of parity-violating electron scattering, focusing on recent progress, and with a view the future of this exciting and important field.

Plenary 2 - Kresge Auditorium (10:45-12:00)

Chair: Dan-Olof Riska (University of Helsinki (Finland))

10:45 P2-4 Neutrino Cross Sections : Geralyn ZELLER (Fermilab)

The discovery of neutrino oscillations has opened up a host of new questions about neutrinos and their properties; questions which we are currently in a global race to answer. The results inherently hinge upon knowledge of neutrino interaction cross sections. Neutrino cross sections in the few-GeV energy range are particularly important for many of these oscillation experiments and are unfortunately poorly known. With the advent of intense manmade neutrino beams, this situation is quickly changing. Detailed studies of neutrino-nucleus interactions in this complex energy region are now being made and revealing surprises of their own. Recent neutrino scattering measurements from a variety of experiments will be presented along with projections for what the future holds.

11:20 P2-5 Probing Neutrino Masses and Mixings with Accelerator and Reactor Neutrinos : Mike SHAEVITZ (Columbia University)

Neutrino oscillations have been well established and indicate that neutrinos have mass and that there is mixing among the different neutrino types. On the other hand, the pattern of the oscillations has raised a number of questions. In this talk, I will present the status and plans for exploring some of these questions using accelerator and reactor neutrinos. With respect to oscillations among the three standard neutrinos, the current program for measuring the third mixing angle,$\theta13$, will be presented along with future plans to search for CP violation and the mass hierarchy. Finally, the status of possible oscillations to sterile neutrinos will be described including the results from LSND, MiniBooNE and the recent reanalysis of reactor oscillation data.

Parallel 3A - Form Factors & Radii - W20-307 (Mezzanine Lounge) (13:30-15:30)

Chair: Rolf Ent (JLab)

13:30 3A-1 The Charge Radius of the Proton, a 5 Sigma Discrepancy? : Gil PAZ (The University of Chicago)

Recently, the charge radius of the proton was extracted, for the first time, from muonic hydrogen. The value was 5 sigma away from similar measurement of regular hydrogen. The extraction of the charge radius depends on a theoretical input. Together with Richard J. Hill, we are studying the hadronic uncertainty in the theoretical prediction, using the tool of an effective field theory, namely NRQED. In the talk I will report on the results of this study. I will also report on a previous study of the model-independent extraction of the charge radius from electron-proton scattering, which found that previous extractions have typically underestimated their errors.

References:

R. Pohl et al., Nature 466, 213 (2010)

R.J. Hill, G. Paz, PRD 82, 113005 (2010)

13:50 3A-2 Resolution Of The Proton Size Puzzle via Form Factor of Off-Shell Proton : Gerald MILLER (Physics Department, University of Washington)

The recent, extremely precise extraction of the proton radius[1] from the measured energy difference between the 2P3/2(F=2) and 2S1/2(F=1) states of muonic hydrogen (H) has created considerable interest. Their analysis yields a proton radius that is smaller than the CODATA[2] value (extracted mainly from electronic H) by about 4% or 5.0 standard deviations. This implies[1] that either the Rydberg constant has to be shifted by 4.9 standard deviations or that the QED calculations for hydrogen are insufficient. Since the Rydberg constant is extremely well measured, and the QED calculations seem to be very extensive and highly accurate, the muonic H finding presents a significant puzzle to the entire physics community.

Our analysis[3] is motivated by the fact that muonic hydrogen is far smaller than electronic hydrogen and therefore more sensitive to corrections arising from hadron structure. In particular, we consider the lowest order correction associated with off-shell behaviour at the photon-nucleon vertex, showing that it can very naturally account for the difference reported by Pohl et al.. Our term in the energy proportional is to the lepton mass to the fourth power and therefore does not affect electronic hydrogen. Since at the present state of development of hadronic physics it is not possible to provide a precise value for this correction, our result may be viewed as a phenomenological study of the sensitivity of muonic hydrogen to important aspects of proton structure. It should spur further study of processes which could be sensitive to off-shell changes in proton structure. In alternate language, the explanation which we present may be viewed as a new contribution from proton polarization that is not constrained by dispersion relations, but which can be studied in systems other than the hydrogen atom.

Acknowledgments

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14:10 3A-3 Final Results of the GEp(III) Experiment at Jefferson Lab : Charles F. PERDRISAT (College of William and Mary)

A recent experiment at JLab[1] has measured the two polarization transfer components Pt and Pl in elastic (pol)ep → e(pol)p scattering, and obtained the ratio GEp/GMp in the formerly unexplored Q^2 region at 5.2, 6.7 and 8.5 GeV^2. In the one-photon Born approximation, $G_{Ep}/G_{Mp} \sim Pt/Pl$. The experiment used the recoil polarization method. Coincident ep events were detected with the High Momentum Spectrometer (HMS) in Hall C for the proton, and a large lead-glass electromagnetic calorimeter for the electron. A new, double polarimeter consisting of two CH2 analyzer blocks, each 55 cm thick and followed by a pair of large drift chambers, was installed in the detector hut of the HMS. This experiment was the next step in a series started in 1998 in Hall A, resulting in a continuous scan of the GEp/GMp-ratio between 0.5 and 8.5 GeV2. The first two experiments, GEp(I)[2,3] and GEp(II)[4], revealed a very nearly linear decrease of the ratio; in contrast the new data from GEp(III) indicate that the slope is smoothly decreasing, and may be tending toward a constant, as required by pQCD. The overall systematic decrease of the ratio is in stark disagreement from form factors obtained by the Rosenbluth separation technique and using cross section data. The discrepancy between the results of the two methods has been interpreted as an indication of a hitherto neglected two-photon contribution. The final results from this recent measurement will be reported and compared with the latest theoretical predictions and interpretations.

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[2] M.K. Jones et al, Phys. Rev. Lett. 84, 1398 (2000).

[3] V. Punjabi et al, Phys. Rev. C 71, 055202 (2005), Erratum-ibid. C 71, 069902 (2005).

[4] O. Gayou et al, Phys. Rev. Lett. C 88, 092301 (2002).

14:30 3A-4 Measurements of the Two-Photon Exchange Effect in Lepton-Proton Elastic Scattering at CLAS : Robert BENNETT (Old Dominion University)

Recent results from experiments at Jefferson Laboratory, Newport News VA, which measured the ratio of the electric to magnetic form factors of the proton, G_E/G_M, have forced us to reexamine the single photon exchange approximation in lepton-proton elastic scattering. Discrepancies between the ratio obtained via the time-tested Rosenbluth separation method and newer polarization transfer measurements, which differ by as much as a factor of three, may be resolved by considering the effect of two photon exchange (TPE) processes. The CLAS TPE experiment at Jefferson Laboratory, will determine the effect of two-photon exchange in elastic lepton-proton scattering by precisely measuring the ratio of positron-proton to electron-proton elastic cross sections over a large kinematic range ($0.1 < \epsilon < 0.96, 0.2 <= Q^2 <= 2.0 GeV^2$). We accomplish this by directing the 5.5 GeV primary electron beam, provided by the Continuous Electron Beam Accelerator Facility (CEBAF), onto a set of radiators and converters to produce simultaneous and identical beams of electron and positrons which collide with our proton target. Acceptance and efficiency concerns are minimized by only considering the ratios of the elastic cross sections and by switching polarity of magnets in the beamline and the spectrometer. Guided by the results of a short 2006 test run and extensive GEANT based modeling, new shielding and beamline components were designed to maximize luminosity. We took data from November 2010 − February 2011. The unique experimental design and challenges of the TPE experiment and the current analysis status will be presented.

14:50 3A-5 The OLYMPUS Experiment : Richard MILNER (MIT-LNS)

The OLYMPUS experiment at the DORIS storage ring, DESY, Hamburg, Germany is under realization to carry out in 2012 a precise measurement of the ratio of positron-proton to electron-proton elastic scattering at 2 GeV to determine the contributions beyond single photon exchange in elastic electron-proton scattering at multi-GeV energies. OLYMPUS uses the existing Bates Large Acceptance Spectrometer Toroid (BLAST) together with a new internal hydrogen gas target, which has been installed at the DORIS ring. Results from recent beam tests, the status of the experiment and the plans for data taking will be presented.

15:10 3A-6 Studies of Nucleon Form Factors with 12 GeV CEBAF and SuperBigbite : Jens-Ole HANSEN (Jefferson Lab)

The ground-state electromagnetic nucleon form factors are among the most fundamental quantities that describe the non-perturbative QCD structure of the proton and neutron. A number of experiments aiming to measure the electric and magnetic elastic form factors of the neutron, GEn and GMn, and proton, GEp, at very high momentum transfer of up to Q2 = 10 − 14 GeV2 are planned to be carried out with the future 11 GeV electron beam at CEBAF. These experiments will determine the nucleon form factors with unprecedented precision to Q2-values up to three times higher than those of existing data, providing a powerful test of current theory of non-perturbative structure and confinement. We review the approved proposals and the conceptual design of a new spectrometer, SuperBigBite, that will be used in these and other future experiments at Jefferson Lab.

Parallel 3B - Transverse Spin & TMDs - W20-306 (20 Chimneys) (13:30-15:30)

Chair: Christine Aidala (LANL)

13:30 3B-1 Accessing TMDs at HERMES : Luciano PAPPALARDO (INFN - Ferrara)

In recent years, Transverse Momentum Dependent (TMD) parton distribution functions are being recognized as crucial ingredients for a complete understanding of the nucleon structure. Describing correlations between the quark or the nucleon spin with the quark transverse momentum (i.e. spin-orbit correlations), they allow for a tridimensional description of the nucleon structure in momentum space (nucleon tomography) and could provide insights into the yet unmeasured quark orbital angular momentum. Eight leading-twist TMDs contribute to the cross-section for lepton-hadron Semi Inclusive Deep Inelastic Scattering (SIDIS) in conjunction with a fragmentation function. At HERMES, TMDs are probed for various hadron types through the analysis of specific azimuthal modulations of the SIDIS cross-section. In particular, relevant observables were recently measured in either single- and double-spin asymmetries with a transversely polarized target. An overview of the main results and their interpretation in terms of TMDs is presented.

14:00 3B-2 Constraining Quark Transversity through Collins Asymmetry Measurements at STAR : Renee FATEMI (University of Kentucky)

The transversity distribution, δ q(x), characterizes the number density of transversely polarized partons inside a transversely polarized nucleon. A complete description of the partonic structure of the nucleon within the parton model framework requires measurements of δ q(x) in addition to the momentum, q(x), and helicity, $\triangle$q(x), distribution functions. The quark transversity distributions are accessible via measurements of the azimuthal asymmetry of pions within the jets produced in collisions of transversely polarized protons. The extraction of δq(x) from this asymmetry requires knowledge of the Collins functions, measured by the Belle Collaboration. The STAR Detector at the Relativistic Heavy Ion Collider is capable of full jet reconstruction at mid-rapidity and identification of neutral jet-like events at forward rapidities during the 2006 polarized proton run. This presentation will focus on progress toward asymmetry measurements of leading charged pions in mid-rapidity jets from 1 pb−1 of $\sqrt{}$ s = 200 GeV transversely polarized (58%) proton data. The data provide precision of σ0.01 for an average quark momentum fraction $< x >= 0.2$ and fragmentation fraction $0.1 < z < 0.6$. Highlights from the forward single spin asymmetries will also be discussed.

14:30 3B-3 Applications of Semi-Inclusive Meson-Electro Production in Hall C at JLab : Stephen WOOD (Jefferson Laboratory)

At high energies, semi-inclusive meson electro-production factorizes into a hard process of a virtual photon striking a quark and a subsequent process of the quark evolving into a leading meson. Recent measurements at JLab indicate that this factorization is valid even at relatively low Q^2 and that this reaction can be used as a flavor tagged probe of quark structure at JLab, particularly after the 12 GeV upgrade. The spectrometers in JLab's upgraded Hall C, will make precise comparisons of positive and negative pion electro-production on the proton and deuteron. Comparisons of the distributions of the pions in these reactions can be used to extract information about the transverse momenta of up and down quarks in the proton. Furthermore, precise comparisons of positive and negative pion production on deuterium will be used to test the assumption of charge symmetry in parton distribution functions to the 1% level.

14:50 3B-4 Transverse Spin and Transverse Momentum Dependent Effects Measured at COMPASS : Rainer JOOSTEN (Universitaet Bonn)

The measurement of transverse spin and transverse momentum dependent (TMD) effects in semi-inclusive deep inelastic scattering (SIDIS) is one of the main parts of the physics program of the COMPASS experiment, a fixed target experiment located at the CERN SPS.

The transverse spin and TMD distribution functions of the nucleons constituents are crucial for a complete description of the nucleon itself. Already in the collinear parton model the distributions of the quarks transverse spin inside a transversely polarized nucleon (transversity) have to be taken into account in addition to the unpolarized and the helicity parton distribution functions in order to fully describe the quark structure of the nucleon at leading twist. Being chirally odd, transversity cannot be measured in inclusive deep-inelastic scattering (DIS) but is accessible e.g. in SIDIS of leptons on transversely polarized nucleons. At COMPASS, three channels have been analyzed to access the transversity distribution functions:

- the azimuthal distribution of single hadrons, involving the Collins fragmentation function,
- the azimuthal dependence of a plane containing a hadron pair, involving the two-hadron interference fragmentation function, and
- the measurement of the transverse polarization of Lambda hyperons in the final state. Recently, also the intrinsic transverse momentum of quarks inside of a nucleon gained closer attention, extending the simple collinear approximation. Today, TMD distribution functions are considered an important ingredient in understanding the structure of the nucleon, and in total eight TMD distribution functions are needed for a complete description at leading twist. All these distributions contribute to the full single hadron SIDIS cross-section and can be extracted looking at the azimuthal distributions of the produced hadrons.

For a transversely polarized nucleon target eight azimuthal modulations have to be taken into account, and three TMDs contribute in addition to transversity already at leading twist. Among these, the Sivers and the pretzelosity functions are the ones presently studied most.

Already in SIDIS from an unpolarized nucleon target azimuthal asymmetries can yield important information on the structure of the nucleon, giving access to the average quark transverse momentum as well as to the so far unmeasured Boer-Mulders TMD. At COMPASS these asymmetries are measured using spin averaged data from polarized targets. In this presentation, the measurements of these functions in SIDIS by the COMPASS collaboration using a 160 GeV/c longitudinally polarized muon beam on transversely polarized nucleon targets are reviewed. From 2002 to 2004, a 6LiD target has been used, probing the spin structure of the deuteron, while in 2007 and 2010 complementary information on the proton was obtained using a NH3 target. The latest results on transversity from all three channels analyzed at COMPASS and on the TMD distribution functions from single hadron production will be presented and evaluated in the context of the current theoretical interpretation of these asymmetries.

15:10 3B-5 Measurement of the transverse single spin asymmetry of forward η mesons in $p^\uparrow + p$ collisions in PHENIX. : David KLEINJAN (University of California - Riverside)

The measurement of inclusive meson transverse single spin asymmetries (A_N) from transversely polarized $p + p$ collisions provide insight into the structure of the nucleon. Forward η meson A_N measurements are of particular interest, because other inclusive meson A_N measured by PHENIX and other experiments show significant asymmetries in the forward region. Several mechanisms have been proposed that attempt to explain these non-zero asymmetries, and additional measurements of A_N for different probes further constrain these models. Therefore, measurements of A_N with inclusive η mesons at forward rapidities are an important tool for the understanding of these asymmetries. Using the PHENIX detector at the Relativistic Heavy Ion Collider (RHIC), we study $p^\uparrow + p$ collisions. In 2008, the PHENIX experiment collected 5.2 pb^{-1} integrated luminosity in $p^\uparrow + p$ collisions at $\sqrt{s} = 200$ GeV. The status of the asymmetry analysis of η mesons at forward rapidity will be shown.

Parallel 3C - Meson Spectroscopy and Exotics - W20-201 (West Lounge) (13:30-15:30)

Chair: Colin Morningstar (Carnegie Mellon University)

13:30 3C-1 Hadron Spectroscopy with COMPASS : Boris GRUBE (Technische Universitaet Muenchen)

COMPASS is a multi-purpose fixed-target experiment at the CERN Super Proton Synchrotron aimed at studying the structure and spectrum of hadrons. One primary goal is the search for new hadronic states, in particular exotic mesons and glueballs using hadron beams.

Its large acceptance, high resolution, and high rate capability make the COMPASS experiment an excellent device to study the spectrum of light mesons in diffractive and central production up to masses of about 2.5 GeV/c^2. In addition COMPASS is able to measure final states with charged as well as neutral particles, so that resonances can be studied in different reactions and decay channels.

A short pilot run in 2004 with a 190 GeV/c π^- beam on a Pb target showed a significant spin-exotic $J^{PC} = 1^{-+}$ resonance around 1660 MeV/c^2 in $\pi^-\pi^+\pi^-$ final states produced at large squared four-momentum transfers $0.1 < t' < 1.0$ (GeV/c)^2.

In this talk, we will give an overview of the results from large data samples collected with negative and positive hadron beams on H_2, Ni, and Pb targets in 2008 and 2009.

For pion diffraction in the region of large momentum transfer, COMPASS sees a surprisingly strong target-material dependence of the production strength for the $\pi^-\pi^+\pi^-$ waves with different spin projection quantum numbers M. Utilizing the information from the electromagnetic calorimeters, the results of the charged three-pion final state is compared to the $\pi^-\pi^0\pi^0$ channel. In addition COMPASS studies the diffractive dissociation of kaons by using Cherenkov detectors for beam particle identification. These detectors are also employed to tag protons in the positive hadron beam. The beam protons are used to measure mesons from central production as well as to study diffractively produced baryon resonances.

14:00 3C-2 Excited light meson spectroscopy from lattice QCD : Christopher THOMAS (Jefferson Lab)

I report on recent progress in calculating excited meson spectra using lattice QCD, emphasising results and phenomenology. With novel techniques we can now extract extensive spectra of excited mesons with high statistical precision, including spin-four states and those with exotic quantum numbers. As well as isovector meson spectra, I will present new calculations of the spectrum of excited light isoscalar mesons, something that has up to now been a challenge for lattice QCD. I show determinations of the flavour content of these mesons, including the eta-eta' mixing angle, providing a window on annihilation dynamics in QCD. I will also discuss recent work on using lattice QCD to map out the energy-dependent phase shift in pi-pi scattering and future applications of the methodology to the study of resonances and decays.

14:30 3C-3 Study of Light Hadron Spectroscopy at BESIII : Yadi WANG (University of Science and Technology of China)

Based on the samples of 2.25X108 JPsi events and 1.06X108 ψ' events collected with the BESIII detector, the recent results on light hadron spectroscopy from BESIII will be presented in this talk. The ppbar threshold enhancement observed BESII was confirmed in $\psi' \to \pi^+\pi - \mathrm{J}/\psi(\mathrm{J}/\psi \to \gamma pp)$ decay, but no similar narrow structure was seen in $\psi' \to \gamma pp\mathrm{J}/\psi \to \gamma\pi^+\pi - \eta'$ the X(1835) was confirmed and two new additional structures were observed; the search for possible new structure in $\mathrm{J}/\psi \to \omega\pi\pi\eta$ has also been performed; at last the mixing of a0(980)-f0(980) was studied via the isospin breaking processes $\mathrm{J}/\psi \to \phi f0 \to \phi a0$ and $\chi_{c1} \to \pi 0 a0 \to \pi 0 f0$.

14:50 3C-4 Amplitude Analysis of Charmonium Decays at CLEO-c : Mihajlo KORNICER (Indiana University)

Charmonium states below the open-charm threshold provide not only a rich laboratory for studying the charm-quark dynamics, but also a venue to explores the spectrum and interactions of mesons consisting of light quarks. We perform amplitude analyses of the decay processes $\psi \to \gamma x^{c1} \to \gamma\eta\pi^+\pi^-$ and $\psi \to \gamma x^{c1} \to \gamma\eta'\pi^+\pi^-$ using $26 \times 106\psi(2S)$ produced in the CLEO-c detector. We observe a structure in the $\eta'\pi$ invariant mass at 1700 MeV/c2 that is best described by 1^{-+} wave with the mass and width consistent with previous reports for the exotic candidate π1(1600). We also find evidence for the a0(980) $\to \eta'\pi$ decays, which have not been directly observed before. When comparing the $x^{c1} \to \eta\pi^+\pi^- \mathrm{and} x^{c1} \to \eta'\pi^+\pi^-$ decays we observe differences in the $\pi^+\pi^-$ spectra, especially in the region around the f0(980) mass. We utilize the $\pi^+\pi^-$-scattering data to construct two independent S-wave amplitudes for KK $\to \pi\pi \mathrm{and} \pi\pi \to \pi\pi$ production mechanisms, and measure the relative S-wave KK $\to \pi\pi$ production in the $\eta'\pi^+\pi^-$ channel that is significantly higher than the corresponding production in the $\eta\pi^+\pi^-$ channel.

15:10 3C-5 GlueX: Detector Construction and Event Simulations : Naomi JARVIS (Carnegie Mellon University)

The GlueX experiment[1] at Jefferson Lab is designed to map out the spectrum of light hybrid mesons and, in particular, identify those with exotic quantum numbers[2]. Exotic hybrid mesons populate states that cannot be described as a simple quark-antiquark pair, but require the introduction of a gluonic excitation. Their existence is predicted by lattice QCD[3], but their experimental signature is still limited. The experimental building (Hall D) is nearing completion and major parts of the detector construction are well under way. An overview of the final detector and its construction status will be presented, together with some results from the ongoing simulation analyses to identify the exotic quantum number states in GlueX.

1. The GlueX Collaboration, "Physics and Detector Performance Metrics for the GlueX Experiment", GlueX-doc-1063, (2008). (http://argus.phys.uregina.ca/cgi-bin/public/DocDB/ShowDocument?docid=1063)

2. C. A. Meyer and Y. Van Haarlem, "The Status of Exotic-quantum-number Mesons", Phys. Rev. C82, 025208 (2010).

3. J. J. Dudek, et al., "Toward the excited meson spectrum of dynamical QCD", Phys. Rev. D82, 034508 (2010), J. J. Dudek et al., "Isoscalar meson spectroscopy from lattice QCD", Submitted to Phys. Rev. Lett. (2011), arXiv:1102.4299[hep-lat].

Parallel 3D - Nuclear Astrophysics I - 4-149 (13:30-15:30)

Chair: Dustin McNulty (Idaho State University)

13:30 3D-1 The Shear Viscosity over Entropy Density Ratio in Nuclei : Naftali AUERBACH (Tel Aviv University)

Experiments at the Relativistic Heavy Ion Collider (RHIC) suggest that the state of matter produced in the experiments has a low shear-viscosity to entropy-density ratio. In some super-symmetric gauge theories one is able to determine the value of this ratio. It has been conjectured that this value is also the lower limit for a large class of physical systems. We address the question, what is the value of this ratio in regular, finite nuclei at low temperature. We use experimental results for the widths of giant vibrational states in nuclei in order to calculate the above ratio. Another type of collective motion is the process of fission. Applying a classical macroscopic approach to describe spontaneous and induced fission one can also extract a value for this ratio. We find that the values of the shear viscosity over entropy density in nuclei are not very different from the ones found in the RHIC experiments. Using the conjectured lower limit for this ratio we present lower limits for the widths of giant resonances in nuclei.

13:50 3D-2 Chiral asymmetry and axial anomaly in magnetized relativistic matter : Igor SHOVKOVY (Arizona State University)

The dynamical generation of the chiral shift parameter is studied in dense relativistic matter in a magnetic field. By making use of the gauge invariant regularizations, we show that the presence of the chiral shift parameter essentially modifies the form of the axial current, but does not affect the conventional axial anomaly relation. A nonzero chiral shift parameter leads to a relative shift of the longitudinal momenta in the dispersion relations of opposite chirality fermions. This is expected to play an important role in transport and emission properties of matter in various types of compact stars as well as in heavy ion collisions.

14:10 3D-3 Chiral nuclear forces with explicit Delta resonance : Hermann KREBS (Ruhr-University Bochum)

Description of light nuclei and low energy nuclear reactions can be given in a model-independent way by using chiral effective field theory of QCD. In this framework nuclear forces are described by pion and nucleon (Delta) rather than fundamental quark degrees of freedom in harmony with the symmetries of QCD. In my talk I will discuss chiral nuclear forces derived within this framework and present our first results on the three-nucleon forces calculated up to next-to-next-to-next-to-leading order in chiral effective field theory with explicit Delta degrees of freedom. We find sizeable Delta-resonance contributions to the three-nucleon forces which have not been taken into account so far. It will be interesting to see if these contributions will be able to resolve known discrepancies like A_y-puzzle in the three-nucleon sector.

14:30 3D-4 Non-congruence of liquid-gas phase transition of asymmetric nuclear matter : Toshiki MARUYAMA (Japan Atomic Energy Agency)

Liquid-gas (LG) phase transition [1] and the relevant equation of state (EOS) is one of the most important issues in nuclear physics and astrophysics. In the collapsing stage of supernovae and the crust region of compact stars or during the heavy-ion collisions, low-density nuclear matter with non-uniform structures is expected. Such structured matter can be regarded as a mixed phase during the LG phase transition [2,3]. The mixed phase in thermal equilibrium is often obtained by simply applying the Maxwell construction or more carefully by solving the Gibbs conditions. The Maxwell construction can be used in the case of congruent transition: the coexisting two phases have the same particle fraction with different densities. However, asymmetric nuclear matter or charge-neutral nuclear matter which consists of proton, neutron and electron, becomes generally non-congruent and the particle fractions take different values in each phase. The Gibbs conditions (equilibrium of chemical potentials and pressure between two phases) then give EOS different from that of the Maxwell construction. First, we explore the LG mixed phase in the bulk calculation [3], where two phases coexist without the geometrical structures. In the case of symmetric nuclear matter, the system behaves congruently. Therefore the Maxwell construction is relevant. For asymmetric nuclear matter, on the other hand, the phase equilibrium is no more attained by the Maxwell construction since the particle fractions in the L and G phases become completely different. Subsequently we explore the charge-neutral nuclear matter with electrons by fully applying the Gibbs conditions to figure out the geometrical (pasta) structures of the LG mixed phase [4,5]. We discuss the effects of the surface and the Coulomb interaction on the mixed phase with pasta structures. We also discuss the thermal effect on the pasta structures.

[1] J. Pochodzalla et al, Phys. Rev. Lett. 75, 1040 (1995)

[2] G. D. Ravenhall, C. J. Pethick and J. R. Wilson, Phys. Rev. Lett. 50, 2066 (1983)

[3] Ph. Chomaz, M. Colonna and J. Randrup, Phys. Rep. 389, 263 (2004)

[4] T. Maruyama et al, Phys. Rev. C 72, 015802 (2005); Recent Devel. Phys. 7, 1 (2006)

[5] S. S. Avancini et al, Phys. Rev. C 74, 024317 (2008)

14:50 3D-5 Polarized Pairing in Neutron Star Crusts : Alexandros GEZERLIS (University of Washington)

Low-density neutron matter is relevant to the study of neutron-rich nuclei and neutron star crusts. Unpolarized neutron matter has been studied extensively over a number of decades, while experimental guidance has recently started to emerge from the field of ultracold atomic gases. The fact that the matter in the inner crust of a neutron star is superfluid has clear observational ramifications; these have not been unambiguously extracted before, due to the absence of dependable microscopic calculations. In this talk, I will discuss recent work on population-imbalanced neutron matter, carried out using a Quantum Monte Carlo method. This system is not only of possible relevance to magnetars and to density functionals of nuclei, but is also quite similar to experimentally realizable settings in cold-atom experiments.

15:10 3D-6 Asymmetric Neutrino Reaction And Pulsar Kick In Magnetized Proto-Neutron Stars In Fully Relativisitc Framework : Tomoyuki MARUYAMA (College of Bioresource Sciences, Nihon University)

A new type of neutron star, called magnetar, which is associated with a super strong magnetic field has been discovered. It is therefore requisite to improve models of hot and dense hadronic matter which is presumed to manifest in the neutron star under strong magnetic field. Neutrino emission as well as GW is the unique observable that provides signals of the change of internal structure of the neutron star. In this work we show, for the first time, our calculated scattering and absorptive neutrino cross sections in the hot and dense hadronic matter with hyperons under strong magnetic field. We treat the magnetic field with the perturbative way, omit the contribution from the convention current and consider only the spin-interaction. As a result we can get a significant angular dependence of the neutrino absorption part ($\nu_e \to e-$). Furthermore, we solved Boltzman equation for the neutrino transfer in 1D attenuation approximation, and find that the net neutrino emission increases by a few % in the forward direction along B and decreases in the opposite direction at any matter densities. We conclude that the asymmetry contributes to an aligned drift flux in the direction B and dominates over diffusive flux, leading to an origin of pulsar kicks.

Parallel 3E - Neutrino Experiments I - 4-163 (13:30-15:30)

Chair: Geralyn Zeller (Fermilab)

13:30 3E-1 NOvA Experiment : Jaroslaw NOWAK (University of Minnesota)

The NOvA experiment has started taking data with the Near Detector placed in a surface building in November 2010. The far detector of the NOA long baseline experiment is currently under construction and will be located in Ash River, 810 km away from Femilab and 14 mrad off the beam axis. The totally active scintiallator detector is designed to identify electron neutrinos that result from the oscillation of beam muon neutrinos. The narrow neutrino beam will be provided by the upgraded NUMI beamline at Fermilab. Among main goals of the NOvA experiment are precise measurement of the values of the atmospheric neutrino oscillations, determining the value of the theta13 mixing angle and subsequently the CP violation effect enhanced by the matter effects. The far detector in Northern Minnesota will also be sensitive to neutrinos from supernova. The current status of the experiment will be presented as well as the planned schedule for completion of remaining crucial elements of the project. I will present physics program for the NOvA experiment and preliminary data obtained with the prototype detector.

13:50 3E-2 Measuring the Mass Scale of Neutrinos : Joseph FORMAGGIO (Massachusetts Institute of Technology)

Over the past decade, experiments studying neutrinos from atmospheric, solar, and reactor sources have shown conclusively that neutrinos change flavor and, as a consequence, have a small but finite mass. Yet, the scale of neutrino masses remains an open question that is of great importance for many areas of physics. The most direct method to measure the neutrino mass scale is still via beta decay. The talk will focus primarily on the status of the KArlsruhe TRItium Neutrino experiment (KATRIN), currently under construction. KATRIN combines an ultra-luminous molecular windowless gaseous tritium source with an integrating high-resolution spectrometer to gain sensitivity to the absolute mass scale of neutrinos. The projected sensitivity of the experiment on the neutrino mass is 0.2 eV at 90% C.L. In this talk, I will discuss the status of the KATRIN experiment and other beta decay experiments.

14:10 3E-3 The KM3NeT Consortium and the Northern Hemisphere Neutrino Telescope : Andrea BERSANI (INFN Genova)

The KM3NeT Consortium is currently carrying on a research and development activity to build a cubic kilometre-scale neutrino telescope in the deep Mediterranean Sea. The KM3NeT Consortium follows on from the NEMO and NESTOR pilot projects, which have produced several prototypes and the ANTARES collaboration, which has built and is operating a 0.1 cubic kilometre volume deep-sea neutrino telescope. The KM3NeT Mediterranean neutrino telescope will complement the Antarctic Icecube observatory, allowing the complete survey of the sky using neutrinos as a probe. The main physics goals of KM3NeT include the detection of neutrinos from astrophysical sources such as active galactic nuclei, supernova remnants and gamma-ray bursts as well as the search for new physics, such as neutrino signals from neutralino annihilation. To achieve the best performance, an extensive optimisation process is underway, looking for the best geometrical configuration of the detector for maximum sensitivity, and evaluating the most reliable technical solutions to allow long-term, low-maintenance operations. Both these aspects were the subject of the recently-published KM3NeT Technical Design Report and are presented at this conference.

14:30 3E-4 Measurement of the bound beta-decay of the free neutron : Johannes SCHOEN (Technische Universitaet Muenchen)

In this contribution an experiment to measure the bound decay of the neutron into a hydrogen atom and an electron anti-neutrino is described. Observation of such a decay would open an alternative pathway to physics beyond the Standard Model of particle physics, in particular right handed current admixtures in the weak interaction as well as the handedness of the neutrino. The experiment is planned at the through going beam-tube SR6 at the FRM-2 high flux reactor in Garching. Although the branching ratio of the decay into monoenergetic hydrogen atoms with Ekin = 326eV is expected to be only 4×10^{-6} , a sufficient decay rate due to the high flux of neutrons in the experiment is expected. However, the measurement poses a significant experimental challenge due to the very large expected background. Simulations have shown that the measurement is feasible, with proper shielding being the critical factor. A possible experimental setup is currently being studied, testing different detection techniques for H(2s). These comprise the use of charge exchange reactions into H(minus) ions or detection the Lyman alpha light with photodetectors. We will report on the status of the experiment, emphasizing different test results and outline plans for the future installation at a high flux reactor.

14:50 3E-5 The Daya Bay neutrino experiment : Wei WANG (University of Wisconsin-Madison)

Neutrino flavor oscillation induced by neutrino mass eigenstate mixing has become the most plausible explanation of the results of solar, atmospheric, long-baseline and reactor neutrino experiments. Despite these results in recent years, we still know very little about the third angle, $\theta 13$, in the PMNS neutrino mixing matrix. The current best upper limit is $\sin^2 2\theta 13 < 0.17$ at 90% C.L. The Daya Bay reactor neutrino experiment in China is designed to reach a sensitivity of 0.01 at 90% C.L. in $\sin^2 2\theta 13$, independent of the

Dirac CP phase value. It has the best designed sensitivity among the current reactor neutrino experiments under construction. Determining the value of $\sin^2 2\theta 13$ to 0.01 sensitivity level independent of the Dirac CP phase is important for the planning of the next generation of appearance neutrino oscillation experiments for exploring CP symmetry. The Daya Bay experiment will start taking data with the first two near detectors in Summer 2011. Data taking with the full complement of eight detectors will start by Summer/Fall 2012. In this talk, we present the design, the installation and the current status of the Daya Bay neutrino experiment.

15:10 3E-6 DAEdALUS : Kate SCHOLBERG (Duke University)

DAEdALUS (Decay At rest Experiment for $\delta_{\rm CP}$ studies At the Laboratory for Underground Science) is a new approach to measuring CP violation in the neutrino sector using few-tens-of-MeV neutrinos from decay at rest of pions created by multiple cyclotrons, in conjunction with a large water Cherenkov detector at DUSEL. The DAEdALUS high-intensity stopped-pion neutrino sources would also enable exploration of low-energy neutrino physics at short baseline. This talk will describe the DAEdALUS physics program, and its status and prospects.

Parallel 3F - Dark Matter II - 4-153 (13:30-15:30)

Chair: Jocelyn Monroe (MIT)

13:30 3F-1 Towards Direct Detection of Dark Matter with SuperCDMS : Enectali FIGUEROA-FELICIANO (Massachusetts Institute of Technology)

The Cryogenic Dark Matter Search collaboration seeks to detect Weakly Interacting Massive Particle (WIMP) dark matter using germanium crystal targets instrumented with phonon and charge sensors and cooled to milliKelvin temperatures. The recently completed CDMS II experiment set an upper limit on the WIMP-nucleon elasticscattering spin-independent cross-section of $3.8\times10^{(-44)}\text{cm}^2$ for a WIMP mass of 70GeV/c^2 at the 90% confidence level. The first phase of our new SuperCDMS experiment, using more massive detectors with greatly enhanced discrimination is currently taking calibration data. We will describe the SuperCDMS experiment and our plans toward a ton-scale dark matter search using this exciting technology.

13:50 3F-2 Status and Prospects of the MiniCLEAN Dark Matter Experiment : Keith RIELAGE (LANL)

The MiniCLEAN dark matter direct detection experiment is a single-phase liquid argon detector, instrumented with photomultiplier tubes to observe scintillation light from a 150kg fiducial mass. This detector design strategy emphasizes scalability to target masses of order 10 tons or more. The projected light yield is > 5 photo-electrons per keV, which allows pulse shape discrimination to separate the electron background from a WIMP-induced nuclear recoil signal. MiniCLEAN is also designed for a liquid neon target, which in the event of a positive signal will provide a unique test of the expected A2 dependence of the WIMP interaction rate. This talk will review the experimental technique and current status of MiniCLEAN.

14:10 3F-3 Current Status of LUX Dark Matter Experiment. : Alexey LYASHENKO (Yale University)

The Large Underground Xenon (LUX) experiment is a dual phase xenon time projection chamber, designed for direct detection of Weakly Interacting Massive Particles (WIMPs), a leading dark matter candidate. The overall liquid xenon mass is 300 kg. A 100 kg fiducial mass is monitored with 120 photomultiplier tubes. LUX will be deployed at the Sanford Underground Science and Engineering Lab at the Homestake Mine in Lead, South Dakota at 4850 feet underground. The main goal of the LUX detector is to clearly detect (or exclude) WIMPS with a spin independent cross section per nucleon of $7\times10^{-46}\text{cm}^2$ at 100 GeV, equivalent to 1 event/100 kg/month in an inner fiducial volume. The overall background will be reduced to < 1 background events characterized as possible WIMPs in the fiducial volume in 4 months of live operation. We report on the current status of LUX detector and plans for future operation.

14:30 3F-4 SNOLAB: A Review of the Facility and Experiments : Richard FORD (SNOLAB)

I present a report on the status of SNOLAB and the experiments planned or under construction. SNOLAB is Canada's new international underground science laboratory specializing in neutrino and dark matter physics, funded by the Canada Foundation for Innovation (CFI) and by the Ontario Provincial Government. The laboratory is sited two kilometers below the surface at the 6800-foot level of Vale's Creighton Mine located near Sudbury, Ontario, Canada. This depth provides the equivalent of 6010m of water shield, and the location below horizontal grade in the granite of the Canadian Shield adds a further significant geometric shielding enhancement compared to mountain or near-coastal locations. The underground space contains 53,000 sq-ft for experiments and supporting infrastructure, and the entire facility is operated as a clean-room to achieve a low radioactive environment. The depth underground is unprecedented for a facility of this size, and results in a comic ray flux of less than 0.27 μ/m2/day, to allow the detection of rare particle physics interactions. The scientific program at SNOLAB emphasizes topics in particle astrophysics requiring this increased sensitivity due to the depth and the clean environment. These topics include measurements of low energy solar neutrinos, cosmic dark matter searches, neutrino-less double beta decay, and the detection of geoneutrinos, supernova neutrinos and reactor neutrinos. Other interdisciplinary fields also make use of the facility, including seismology, studies in geophysics, and the biological study of underground life forms. The underground infrastructure includes climate control with 320-ton chiller capacity (1.1 MW), HEPA filtered clean-room throughout, high-capacity ultra-pure water plant, boil-off nitrogen cover gas, compressed air, chemistry lab, high-speed 1-Gb/s single-fiber bundle network link to surface, and mine railcar system from surface building to underground. Other facilities underground include a safety refuge, personnel showers and laundry, sewage treatment plant, backup power generator, low background counting detectors, meeting rooms, and building automation and plant control systems. The SNOLAB facility also includes a surface building to provide chemistry and development laboratories, clean room areas, a computing facility, receiving, warehouse and storage, machine shop, auditorium, offices, administration, and meeting rooms. This depth underground is required for higher sensitivity Dark Matter experiments, such as DEAP, MiniCLEAN and COUPP, to reduce the cosmic-ray induced fast-neutron background interfering with the nuclear-recoil WIMP signal. For neutrino experiments, such as SNO+, the reduced cosmic ray flux reduces spallations, secondaries, and activation of the target (eg. C-11), all essential for detection of low energy solar pep and CNO neutrinos. The science and status of the experiments at SNOLAB is reviewed.

14:50 3F-5 Dark matter seeding in neutron stars : M Angeles PEREZ-GARCIA (Departamento de Fisica Fundamental and IUFFyM, University of Salamanca, Spain)

The energy release due to neutralino WIMP self-annihilation in the thermalization volume inside a compact object is shown to be comparable to the energy needed to create a long-lived lump of strange quark matter, or *strangelet*, for WIMP masses above a few GeV. Since strange matter is the most stable state of matter, accretion of self-annihilating dark matter onto neutron stars provides a mechanism to seed compact objects with lumps of strange quark matter and this effect may trigger a conversion of most of the star into a strange star. Using an energy estimate based on the Fermi gas model combined with the MIT bag model for the long-lived strangelet, a new limit on the possible values of the WIMP mass can be set that is competitive with those from direct searches. Our limit is especially important for subdominant species of massive neutralinos.

15:10 3F-6 Quantum Cold Dark Matter : Shane SPIVEY (University of Texas at Arlington)

It is well-established that the observed flat rotation curves of galaxies require either a modification to Newtonian dynamics or a roughly spherical massive halo of dark matter. Of the many proposed candidates, cold dark matter (CDM) models have achieved the most success in explaining the formation of galaxies and clusters, though observations have belied predictions of CDM in two important ways. First, CDM simulations produce halos that are sharply peaked in the center, while observations tell us this should not be the case. Second, CDM predicts a far larger number of dwarf galaxies in the Local Group than are actually found. These problems might be circumvented if the dark matter particle is a scalar boson with an extremely small mass on the order of 1e-25 eV. Such a particle has a Compton wavelength greater than 100 pc, and the high particle density of the resulting halo ensures that the wavefunctions overlap. Each particle is thus bound to a gravitational potential created by the luminous matter and by the halo itself, and its wavefunction can be described by a nonlinear Schrodinger equation. In this talk, we examine several possible equations describing such a particle, including the Gross-Pitaevskii equation for Bose-Einstein condensates, and estimate the range of masses allowed by observational data and recent halo simulations.

Parallel 3G - Parity-Violation in Neutral Currents - Kresge - Rehearsal A (13:30-15:30)

Chair: Jeffery Martin (University of Winnipeg)

13:30 3G-1 The Qweak Experiment at Jefferson Laboratory : Roger CARLINI (Jefferson Laboratory)

The Qweak Collaboration at Jefferson Lab will perform the first direct measurement of the proton's weak charge, to a precision of 4% by measuring the parity-violating asymmetry in elastic electron-proton scattering. This asymmetry is expected to be small, 250 ppb and is proportional to the proton's weak charge. At tree level, this correspond to a 0.3% measurement of the weak mixing angle, making this the best low energy measurement to date. This measurement will test the Standard Model prediction for the running of the weak mixing angle and be sensitive to new parity violating physics at the TeV scale. In combination with previous precision parity violation measurements an extraction of the neutral-weak effective couplings C1u and C1d can be performed. The experiment is currently running in Hall C at JLab, with a projected completion date of May 2012. The status and methodology of the experiment will be discussed in this talk. Preliminary measurements may be presented.

13:50 3G-2 Towards a Precise Measurement of Atomic Parity Violation in a Single Ra^+ Ion : Klaus JUNGMANN (University of Groningen)

Precise measurements of atomic parity violation (APV) provide access to the the Weinberg angle in the region of the lowest experimentally accessible momentum transfer. The information collected in such experiments can be exploited together with the Weinberg angle determined in parity violation experiments at intermediate energies and from high energy collider experiments to test the running of this quantity. The goal is to test the standard theory at high precision and to find eventual hints of (or to limit) physics beyond the standard theory as described in models that involve, e.g. extra Z' bosons or leptoquarks. The Radium ion is an ideal test object for high precision APV experiments due to the rather high nuclear charge of of Ra (Z=88). The measurements can be conducted in single trapped and laser cooled Ra^+ ions. The weak mixing angle can be measured via a laser intensity dependent shift of the $7S_1/2$-$6D_3/2$ transition. Due to parity violation there is a small E1 admixture to the E2 transition amplitude. At the TRImP facility [1] of the Kernfysisch Versneller Instituut in Groningen excited-state laser spectroscopy has been conducted [2] using trapped short-lived $^{209214}Ra^+$ ions as an important step towards high precision APV experiments. Measurements of ground and excited state hyperfine structure in the odd isotopes and isotope shifts of the ground and excited states in all investigated isotopes as well as the atomic excited state lifetimes provide important benchmarks for the necessary atomic theory [3]. For a successful extraction of the low energy value of the weak mixing angle with unprecedented accuracy the atomic physics calculations of Ra^+ [3] need to be better than 1%. The required theoretical understanding of Ra^+ atomic structure is therefore tested independently in such measurements. In particular, the hyperfine structure tests atomic wave functions at the origin and lifetime measurements probe them at larger distances from the nucleus. The next steps in this project will be experiments on laser cooling of the trapped Ra^+ ions and the trapping of a single radium ion. Its localization within a fraction of an optical wavelength in a radio frequency (Paul) trap is under way and will be described. As a particular attractive additional benefit of the experiment, it turns out that the ultra-narrow transitions in this system can also be exploited to realize a high stability optical frequency standard.

1. G.P. Berg et al, Nucl.Instr.Meth. 550, 169 (2006)
2. O.O. Versolato et al., Phys.Rev. A 82, 010501 (2010)
3. L.W. Wansbeek et al. Phys. Rev. A78, 050501 (2008)

14:10 3G-3 The FrPNC Experiment at TRIUMF: Atomic Parity Non-Conservation in Francium : Seth AUBIN (Dept. of Physics, College of William and Mary)

We present the plans and progress of the FrPNC collaboration to measure atomic parity non-conservation (PNC) and the nuclear anapole moment in a string of francium isotopes at TRIUMF. Atomic PNC experiments provide unique high precision tests of the electroweak sector of the standard model at very low energies. Furthermore, precision measurements of spin-dependent atomic PNC can determine nuclear anapole moments and probe the weak force within the nucleus. The anapole moment is a parity-violating static electromagnetic moment induced by the weak interaction between nucleons. Francium is an excellent candidate for precision measurements of atomic PNC due to its simple electronic structure and enhanced parity violation: Both the optical PNC and anapole moment signals are expected to be over an order of magnitude larger than in cesium.

The FrPNC collaboration is constructing an apparatus for laser cooling and trapping of francium atoms produced from an actinide target and directed to an on-line shielded laser laboratory. The weak mixing angle will be determined from an optical PNC measurement of the parity forbidden E1 transition amplitude for the 7s-8s transition, originally pioneered by Wieman and co-workers in cesium. The anapole moment can be measured through microwave spectroscopy of forbidden E1 transitions between hyperfine ground states or through the dependence of the optical PNC method on the hyperfine states.

The planned francium PNC measurements are sensitive to extensions of the standard model in the electroweak sector and can constrain PNC electron-quark couplings complementary to electron scattering. Measurements of francium anapole moments in a string of isotopes will help separate the isovector and isoscalar parts of the weak nucleon-nucleon interaction: At present, low-energy nuclear parity violation experiments and nuclear anapole moment measurements are at odds and do not produce a consistent set of weak nucleon-nucleon couplings.

Work supported by DOE, NSF, NSERC, TRIUMF.

14:30 3G-4 Nuclear Spin-Dependent Parity Violation in Diatomic Molecules : Sidney CAHN (Yale University)

Nuclear spin-dependent parity nonconservation (NSD-PNC) effects arise from exchange of the Z0 boson (parameterized by the electroweak coupling constants C2{P,N}) between electrons and the nucleus, and from the interaction of electrons with the nuclear anapole moment, a parity-odd magnetic moment. The latter scales with the nucleon number A of the nucleus as A3/2, while the Z0 coupling is independent of A; the former will be the dominant source of NSD-PNC in nuclei with A $\geq$ 20. NSD-PNC effects can be dramatically amplified in diatomic molecules by bringing two levels of opposite parity close to degeneracy in a strong magnetic field. This opens the prospect for measurements across a broad range of nuclei. As a precursor to the measurement of in the nuclear anapole moment of 137Ba, we have experimentally observed and characterized opposite-parity level crossings in 138BaF. These are found to be in excellent agreement with parameter-free predictions and indicate that the sensitivity necessary for NSD-PNC measurements should be within reach.

Supported by a grant from the National Science Foundation

14:50 3G-5 The NPDGamma Experiment at the SNS : Christopher CRAWFORD (University of Kentucky)

The weak interaction between nucleons induced by quark-quark weak interaction can be isolated by measuring PV observables. The hadronic weak interaction depends on poorly understood nonperturbative aspects of QCD. The low energy amplitudes can be classified in chiral effective field theory in terms of the spin and isospin dependence of transition amplitudes involving S and P waves. There is an active program to determine the EFT parameters by measuring hadronic PV in few body systems using slow neutron beams at the Spallation Neutron Source (ORNL) and the NCNR reactor (NIST). The NPDGamma experiment in preparation at the SNS will measure the gamma asymmetry relative to the neutron spin in the reaction $n + p \rightarrow d + \gamma$. This asymmetry is only sensitive to the 3S1$\rightarrow$3P1 isovector transition amplitude, usually modeled in terms of weak pion exchange. Experiments in other systems have not yet isolated this amplitude, which should be dominated by quark-quark neutral currents. I will describe the experimental setup for the SNS run, show commissioning data, and discuss our plans to achieve a sensitivity of 10 ppb in the asymmetry.

15:10 3G-6 Hadronic Parity Violation in Effective Field Theory : Matthias R SCHINDLER (University of South Carolina)

The weak interaction between quarks induces a parity-violating component in the low-energy interaction between nucleons. Due to the non-perturbative nature of QCD at these energies, an understanding of how the weak quark-quark interactions manifest themselves in nucleon interactions remains elusive. Few-nucleon experiments utilizing polarized neutrons are being performed at the SNS, NIST, and other neutron facilities to map out this weak component of the nuclear force. I will describe a theoretical program to analyze and interpret the obtained data based on effective field theory. This approach allows for a systematic and model-independent description of few-nucleon observables. Results for parity-violating observables in the two- and three-nucleon sectors will be presented, including a discussion of the relevance of parity-violating three-nucleon interactions. Recent progress in the application of effective field theory methods in few-nucleon systems will allow us to extend these calculations to observables involving four and more nucleons.

Parallel 3H - Accelerator Physics - Kresge - Rehearsal B (13:30-15:30)

Chair: William Barletta (MIT)

13:30 3H-1 The Belle-II Experiment at SuperKEKB : Gary VARNER (University of Hawaii)

We will describe the upgraded Belle-II detector and the new accelerator , SuperKEKB, which are under construction by an international collaboration at KEK in Tsukuba, Japan. SuperKEKB will have a luminosity about 40 times higher than KEKB and reach peak luminosities of $8 \times 10^{35}/\text{cm}^2/\text{sec}$ with integrated luminosities of 50 ab^{-1} by 2020. Detector and accelerator commissioning are expected to begin late 2014.

13:50 3H-2 Development of a Polarized He-3 Ion Source for RHIC : Charles EPSTEIN (MIT)

J. Alessi[1], E. Beebe[1], C. Epstein[3], W. Heil[2], S. Karpuk[2],

R. Milner[3], E. Otten[2], A. Pikin[1], A. Zelenski[1]

[1]Collider-Accelerator Division, Brookhaven National Laboratory, Upton, NY 11973-5000

[2]Institut fuer Physik, Universitaet Mainz, D 55099

[3]Laboratory for Nuclear Science, MIT, Cambridge, MA 02139

A polarized 3He beam in RHIC would enable new, unique, high energy QCD studies of neutron structure with existing polarized proton beams. In addition, it could be used for important tests of the Standard Model in a future electron-ion collider. A source of polarized 3He++ ions utilizing the new Electron Beam Ionization Source (EBIS) at BNL is under development. 3He atoms can be polarized using metastability exchange optical pumping and the atoms transferred to EBIS. Fully stripped 3He++ ions would be extracted from EBIS and their polarization measured at low energies. The concept for the ion source will be presented and the plan for the development described. Research supported by DOE Office of Nuclear Physics

14:10 3H-3 Accelerator Design of High Luminosity Electron-Hadron Collider eRHIC : Vadim PTITSYN (Brookhaven National Laboratory)

The design of future high-energy high-luminosity electron-hadron collider at RHIC called eRHIC is presented. We plan adding energy recovery linacs to accelerate the electron beam to 20 (potentially 30) GeV and to collide the electrons with hadrons in RHIC. The center-of-mass energy of eRHIC will range from 30 to 200 GeV. The luminosity exceeding $10^{34}\text{cm}^{-}2\text{s}^{-}1$ can be achieved in eRHIC using the low- beta interaction region with a 10 mrad crab crossing. The important eRHIC R items include the high- current polarized electron source, the coherent electron cooling and the compact magnets for recirculating passes. A natural staging scenario is based on step-by-step increases of the electron beam energy by building-up of eRHIC's SRF linacs.

14:30 3H-4 Injection Study of the Radiance 330 Synchrotron with a 1.6 MeV RFQ Linac : Fuhua WANG (MIT Bates Linear Aceelerator Center, Middleton, MA 01949, USA 01949)

The ProTom Radiance 330 proton radiotherapy system[1] provides the most advanced proton delivery capability to date. It supports true 3-dimensional beam scanning with dynamic energy and intensity modulation.

All of the protons extracted from the synchrotron are used to treat the patient, which results in minimal neutron background in the treatment room. The patient dose rate depends upon the number of protons injected and the acceleration cycle time. Therefore, one can boost the dose rate by increasing the beam intensity at injection. Improvements to the existing tandem accelerator injector are already underway. However, an alternative way to attain higher intensity beam is to use an RFQ linac as an injector. To this end, a novel 1.6 MeV RFQ linac has been designed to specifically satisfy the small energy acceptance limits of the synchrotron.[2] Simulations of the beam line optics and injection matching to the synchrotron have been performed using the computer codes PARMILA and TRACE-3D[3] to determine if an additional bunching cavity is needed. Assessments of the space charge limit at the relatively low injection energy of 1.6 MeV and RF capture simulations have also been performed. Results of these studies will be presented.

1. www.protominternational.com

2. "RFQ injector and Beam Line Design for the Protom Synchrotron," R Technical Enterprises, Inc., 4725 Arlene Place, Pleasanton, CA 94566

3. LANL reports LA-UR-98-4478 & LA-UR-97-886.

14:50 3H-5 The first muon beam from the new high-intense DC muon source, MuSIC : Nam Hoai TRAN (Osaka University)

A new DC muon source, MuSIC, is now under construction at Research Center for Nuclear Physics (RCNP), Osaka University, Japan. The MuSIC adopts a new pion/muon collection system, which is one of the important technique to realize future muon program such as the muon to electron conversion experiment (COMET/Mu2e), neutrino factories, and a muon collider. A thick pion production target is located on a proton beam line with a strong solenoidal magnetic field produced by a superconducting magnet, pion capture magnet. The pions and muons are captured by the solenoidal field and transported to backward by a transport solenoid line. The pion capture magnet and a part of transport have been build and beam tests were carried out using a DC proton beam to the production target. Muons produced were observed by plastic scintillation counters, and the number of muons per proton was estimated. The result indicate that the MuSIC will be the most intense DC muon beam in the world.

15:10 3H-6 The EMMA Non-Scaling FFAG Project and Its Implications for Intensity Frontier Accelerators : Hywel OWEN (University of Manchester)

EMMA (Electron Model for Many Applications) is a proof-of-principle demonstration of a non-scaling, fixed-field, alternating gradient accelerator (nsFFAG). Although nsFFAGs are related to cyclotrons and scaling FFAGs the normal requirement that the orbit radius is proportional to beam energy is broken, meaning that a large energy variation can be provided in a small magnet aperture; this has the potential to reduce the cost, and increase the reliability and flexibility of future intensity-frontier accelerators. We present results of commissioning of this accelerator at Daresbury Laboratory and discuss its merits compared to alternative approaches to delivering high-intensity hadron beams, in particular for use as low-cost c. 1 GeV proton drivers for accelerator-driven subcritical reactors and for the DAEDALUS neutrino project.

Parallel 3I - Charm and Semileptonic Decays - Kresge - Little Theatre (13:30-15:30)

Chair: Tobias Hurth (Johannes Gutenberg University, Mainz)

13:30 3I-1 Charm Physics Results at Belle : Eric WHITE (University of Cincinnati)

We will describe the latest results on charm physics from the Belle experiment at KEKB in Tsukuba, Japan. Results include measurements of $D^0{-}D^0$ bar mixing parameters, CP violating asymmetries in neutral and charged D mesons and properties of new particles.

13:50 3I-2 Recent BABAR Charm Physics Results : Ray COWAN (MIT)

We report recent BABAR charm physics results, including CP violation studies in $D^+ \to K_s 0\pi^+$ and $D^+ \to K_s 0h^+h^+h^-$, a study of the Dalitz plot of $Ds+ \to K^+K^-\pi^+$, measurements of the mass and width of the Ds1(2536)+, measurements of charm semileptonic and leptonic branching fractions, and searches for non-hadronic rare D decays.

14:10 3I-3 Semileptonic B Decays into Orbitally Excited Charmed Mesons : Jorge SEGOVIA (University of Salamanca)

Accuracy on the measurement of the Cabbibo-Kobayashi-Maskawa matrix elements demands a detailed knowledge of semileptonic decays of b-hadrons. In particular, decays involving orbitally excited c-mesons provide an important contribution to the total semileptonic width. Therefore, a better understanding of these processes will reduce the uncertainties in the above mentioned matrix elements. Recently, BaBar Collaboration has reported in Ref. [1] a study of B semileptonic decays into final states containing charged and neutral $D_1(2420)$ and $D*_2(2460)$, the two narrow orbitally-excited charmed light mesons.

From a theoretical point of view these processes involve two steps: a weak decay of the B meson and a strong decay of the charmed meson. The matrix elements for semileptonic decays can be parametrized in terms of form factors which, within the spectator approximation, can be evaluated from the wave functions of the mesons involved in the decay [2]. We evaluate these wave functions using the Constituent Quark Model of Ref. [3] which successfully describes hadron phenomenology and reactions. Strong decay widths are calculated consistently within the same model using a 3P0 and a microscopic model, where the strong decay is driven by the same interquark potential which determines the meson spectrum. The theoretical results agree reasonably with the experimental values. The prediction obtained with the microscopic model is closer than those obtained with the 3P0 model.

[1] B. Aubert et al. (BaBar Collaboration), Phys. Rev. Lett. 103, 051803 (2009).

[2] E. Hernandez, J. Nieves and J. M. Verde-Velasco, Phys. Rev. D 74, 074008 (2006).

[3] J. Vijande, F. Fernandez and A. Valcarce, J. Phys. G 31, 481 (2005).

14:30 3I-4 Like-sign dimuon charge asymmetry at DØ: Penny KASPER (Fermilab)

We present a measurement of the like-sign dimuon charge asymmetry in $p\bar{p}$ collisions at $\sqrt{s} = 1.96$ TeV using a dataset corresponding to an integrated luminosity of ≈ 9 fb^{-1} collected with the DØexperiment. This represents an increase of 50% relative to the dataset used to obtain first evidence for an anomalous source of CP violation in the B_s^0 system. New techniques are used to further reduce the dependence on MC models and related systematic uncertainties and lifetime tagging is employed to enhance the heavy flavor content of the sample. Additional constraints on the CP violation in the B_s^0 system are derived from a measurement of the flavor-specific semileptonic asymmetry in the $B_d^0 \to \mu D + X$ channel.

14:50 3I-5 Measurements of the Bs mixing phase at CDF : Robert HARR (Wayne State University)

Several recent results from the Tevatron hint at a Bs mixing phase larger than SM expectation. We present a new measurement of the semileptonic decay asymmetry A_{SL} using a sample of dimuons collected in 6/fb of CDF data. A measurement of the time-integrated mixing probability chi-bar will also be presented, along with measurements involving the b→ c-cbar-s transition.

15:10 3I-6 Results and prospects for Charm Physics at LHCb : Michael ALEXANDER (Glasgow)

Precision measurements in charm physics offer a window into a unique sector of potential New Physics interactions. LHCb is well equipped to take advantage of the enormous production cross-section of charm mesons in pp collisions at $\sqrt{s} = 7$ TeV. The measurement of the $D^0 - \bar{D}^0$ mixing parameters and the search for CP-violation in the charm sector are key physics goals of the LHCb programme. Results will be shown, based on the data collected in 2010, and the first few months of the 2011 run.

Parallel 3J - Standard Model Higgs Boson - Kresge Auditorium (13:30-15:30)

Chair: Iain Stewart (MIT)

13:30 3J-1 Higgs Production with a Central Jet Veto at NNLL+NNLO : Frank TACKMANN (MIT)

A major ingredient in Higgs searches at the Tevatron and LHC is the elimination of backgrounds with jets. In current H $\rightarrow$ WW $\rightarrow \nu\nu$ searches, jet algorithms are used to veto central jets to obtain a 0-jet sample, which is then analyzed to discover the Higgs signal. Imposing this tight jet veto induces large double logarithms which significantly modify the Higgs production cross section. These jet-veto logarithms are presently only accounted for at fixed order or with the leading-logarithmic summation from parton-shower Monte Carlos. Here we consider Higgs production with an inclusive event-shape variable for the jet veto, namely beam thrust $\tau_{\rm cm}$, which has a close correspondence with a traditional p_T jet veto. $\tau_{\rm cm}$ allows us to systematically sum the large jet-veto logarithms to higher orders and to provide better estimates for theoretical uncertainties. We present results for the 0-jet Higgs production cross section from gluon fusion at next-to-next-to-leading-logarithmic order (NNLL), fully incorporating fixed-order results at next-to-next-to-leading order (NNLO). At this order the scale uncertainty is 15-20%, depending on the cut, implying that a larger scale uncertainty should be used in current Tevatron bounds on the Higgs.

13:50 3J-2 Tevatron Results on the Search for a High Mass Higgs Boson : Romain MADAR (CEA/Irfu/SPP)

We present the current status for searches for the standard model Higgs boson in proton-antiproton collisions at a center-of-mass energy of 1.96 TeV at the Fermilab Tevatron collider. The search covers the Higgs boson production mechanisms gluon fusion ($gg \rightarrow H$), associated production (WH, $V = W, Z$) and vector boson fusion ($q\bar{q}H$), as well as the main high mass decay modes $H \rightarrow WW \rightarrow \ell^+\nu\ell^-\nu, \ell\nu jj$, and $H \rightarrow ZZ \rightarrow \ell^+\ell^- jj$. We present an upper limit on Higgs production obtained using all available search channels, which results in an exclusion of the SM Higgs boson in a region around M_H=160 GeV. We also interpret the results of these searches in the framework of 4^{th} generation models.

14:10 3J-3 Tevatron Results on the Search for a Low Mass Higgs Boson : Jesus VIZAN (Universidad de Oviedo/Fermilab)

We present a search for the Standard Model Higgs boson in via the low mass region, where the higgs is produced with an asssociated vector boson and decays into bbar, tau-antitau, or two photon final states. In order to discriminate between potential Higgs signal and large backgrounds, sophisticated, optimized multivariate techniques are required.

14:30 3J-4 Higgs Bosons at CMS : John CONWAY (UC Davis)

Certainly prominent on the LHC “to do” list is the elucidation of the nature of Electroweak Symmetry Breaking. We report on the search for the Higgs Boson with the CMS detector using the 2010 dataset, in the context of both the high mass final states with Weak Bosons and the low mass final states with photons or taus, as well as preliminary results with the early 2011 data set.

14:50 3J-5 ATLAS Higgs Boson Search : Joost VOSSEBELD (University of Liverpool)

The ATLAS data collected in 2010 and 2011 is analyzed looking for a Higgs boson with mass between 110 and 600GeV. The signal is searched for via gluon fusion, vector boson fusion and associated production modes. Several decay modes are considered: ZZ, WW, bb, tautau and gamma gamma, and a variety of leptonic and hadronic W and Z boson decays is considered. Sensitivity surpasses existing results across a domain hundreds of GeV wide.

15:10 3J-6 Geneva: A new event generator : Saba ZUBERI (LBL)

Geneva is a new event generator that can combines NLO calculations, logarithmic resummation and parton shower algorithms. In this talk I will describe the theoretical concepts behind Geneva, and give the current status of the code development.

Parallel 3K - Jet Substructure I - W20-407 (13:30-15:30)

Chair: Jesse Thaler (MIT)

13:30 3K-1 Peeking Inside Jets for Clues of New Physics : Christopher LEE (MIT)

Modern strategies to distinguish jets produced by boosted heavy particles from those produced by “ordinary” QCD take advantage of their characteristic substructure. I give an introduction to the available theoretical tools to predict analytical measures of such substructure precisely, and explore the modification of jet shapes in dense media as probes of the quark-gluon plasma produced in heavy ion collisions.

14:00 3K-2 Jets and Jet Substructure : Salvatore RAPPOCCIO (Johns Hopkins University)

Advanced jet reconstruction and jet substructure techniques have been implemented and studied extensively at colliders. These studies have been done in a range of environments, including proton-antiproton, proton-proton, and heavy ion collisions. A review of these techniques and the experimental challenges associated with them is presented.

14:30 3K-3 Full Jet Reconstruction in Heavy Ion Collisions with the STAR Detector at RHIC : Gabriel DE BARROS (University of Sao Paolo)

Jet quenching measurements provide unique and important probes of the hot QCD matter generated in high energy nuclear collisions. While full jet reconstruction in the complex environment of such collisions is challenging, it promises a much more complete picture of jet interactions in the medium than measurements of inclusive hadron distributions and hadronic correlations. In this talk I present the status of measurements utilizing full jet reconstruction in heavy ion collisions by the STAR Collaboration at RHIC. I emphasize recent progress made in measuring the inclusive jet cross section and related jet observables that are sensitive to jet quenching effects.

15:10 3K-4 Medium Induced Collinear Radiation from Soft Collinear Effective Theory (SCET) : Francesco D’ERAMO (MIT)

The propagation of hard partons through the strongly interacting matter created in high energy heavy-ion collisions involves widely separated scales. The methods of Effective Field Theories (EFT) can provide a factorized description at lowest nontrivial order, and a formalism where the correction to this factorization are calculable systematically order by order in the small ratios between the different scales. In this talk I will present our recent results on the calculation of the spectrum of the gluons emitted by the hard parton, where the radiated gluons are collinear with the incoming hard parton and with arbitrary energy (not necessarily much softer than the energy of the hard parton). I will also briefly discuss how to extend the analysis to include the emission of gluons collinear in arbitrary directions and gluons with all the components of their momentum scaling as the medium characteristic energy scale (soft gluons). In particular I will show how powerful concepts like collinear gauge invariance and reparameterization invariance simplify the derivation of the effective Lagrangian.

Parallel 3L - Heavy Ion Collisions III - W20-491 (13:30-15:30)

Chair: George Stephans (MIT)

13:30 3L-1 Transport Coefficients of the Quark-Gluon Plasma: From Weak to Strong Coupling : Marcus BLUHM (Subatech)

The knowledge about the transport coefficients of deconfined strongly interacting matter (Quark-Gluon Plasma, QGP) gives fundamental insights into the nature of QCD matter under extreme conditions. By means of relativistic heavy-ion collisions, these properties are intended to be experimentally revealed, providing also information about the structure of the produced hot matter. One of the remarkable findings is that the QGP created in experiments at RHIC is an almost ideal fluid obeying, apart from ultra-cold fermionic systems near unitarity, the smallest shear viscosity to entropy density ratio observed in nature. As the transport coefficients enter as parametric input into the phenomenological description of the heavy-ion collisions at RHIC and LHC, a guiding theoretical determination is mandatory.

By means of a quasi-particle model for QCD thermodynamics, which is related to QCD via the twoloop phi-functional formalism, featuring dynamically generated self-energies of the excitation modes and being extended to non-equilibrium systems self-consistently within an effective kinetic theory approach, the temperature dependence of shear and bulk viscosity coefficients of the QGP is investigated [1, 2]. Showing the parametric dependencies on coupling and temperature known from perturbative QCD at large temperatures, their extrapolation into the non-perturbative regime near the deconfinement transition temperature exhibits fairly nice agreement with available lattice QCD results for the pure gluon plasma. In particular, we find a minimum in the shear viscosity to entropy density ratio near the deconfinement transition, while the bulk viscosity to entropy density ratio increases rapidly in this region. The ratio of bulk to shear viscosity depicts at large temperatures the quadratic dependence on the conformality measure known from perturbative QCD, while in the vicinity of the deconfinement transition the linear dependence known from specific strongly coupled theories based on gauge/string duality is recovered [3]. This is, a quasi-particle picture, in which the excitations arise non-perturbatively from the fundamental quanta of QCD, is compatible with the apparent low specific shear viscosity observed for the strongly coupled deconfined medium and, furthermore, provides a systematic interpolation between the regimes of weak and strong coupling. Based on weak coupling arguments, an interrelation between the specific shear viscosity and the jet quenching parameter can be derived [4]. The jet quenching parameter obtained in this way exhibits a pronounced temperature dependence, which serves as possible explanation for the observed centrality dependence of the azimuthal anisotropy coefficient.

[1] M. Bluhm, B. Kampfer, K. Redlich, Nucl. Phys. A 830 (2009) 737C [2] M. Bluhm, B. Kampfer, K. Redlich, arXiv:1011.5634 [3] M. Bluhm, B. Kampfer, K. Redlich, arXiv:1101.3072 [4] A. Majumder, B. Muller, X.-N. Wang, Phys. Rev. Lett. 99 (2007) 192301

13:50 3L-2 Evaluation of Viscous Hydrodynamic Models in Relativistic Heavy Ion Collisions : Ron SOLTZ (Lawrence Livermore National Laboratory)

We have developed a set of Comprehensive Heavy Ion Model Evaluation and Reporting Algorithms (CHIMERA) for determining the set of physical parameters in viscous hydrodynamic calculations that best describe soft physics observables in Relativistic Heavy Ion Collisions. Using this tool we evaluate the results of the VH2 2+1D viscous hydrodynamic code with eccentricity fluctuations and pre-equilibrium flow coupled to the UrQMD microscopic transport code. In addition, we evaluate the performance of this model for different initial start times, density profiles, temperatures, viscosities and several choices of the equation of state. In our framework chi-squared comparisons between model and data for spectra, flow, and femtoscopic correlations are evaluated in a manner accounting for both statistical and systematic uncertainties in the data sets. Future directions of this research will also be discussed.

14:10 3L-3 Heavy Flavor Measurements in Heavy Ion Collisions by PHENIX at RHIC : Darren MCGLINCHEY (Florida State University)

The measurement of heavy flavor production, both open and closed, has been an important goal of PHENIX at RHIC. Measuring heavy flavor production in Au+Au collisions provides insight into the nature of the QGP medium produced in heavy ion collisions. However, recent measurements in d+Au collisions show that understanding heavy flavor production in cold nuclear matter without the formation of a hot dense final state is critical to the interpretation of the heavy ion data. This talk will present the latest results from open and closed heavy flavor from PHENIX, highlighting the new d+Au measurements and their implications for Au+Au collisions.

14:30 3L-4 The High Transverse Momentum Non-Photonic Electron Measurements in Au+Au Collisions at Center-of-Mass Energies of 200GeV at RHIC/STAR : Wenqin XU (University of California Los Angeles)

WENQIN XU, UNIVERSITY OF CALIFORNIA LOS ANGELES (UCLA), FOR THE STAR COLLABORATION Due to their large masses, heavy favor quarks are believed to be unique probes to the strongly-coupled QCD matter created in high energy Au+Au collisions at the Relativistic Heavy Ion Collider (RHIC). They are mainly produced in the initial hard scatterings, so the production can be well studied by perturbative-QCD(pQCD). When heavy favor quarks traverse the QCD medium, they are expected to lose less energy than light favor quarks due to the dead-cone effect, if the dominant energy loss process is gluon radiation. However, recent experimental studies found that the productions of non-photonic electrons (NPE) from the semi-leptonic decays of charm and bottom hadrons are strongly suppressed at high transverse momentum (pT) in Au + Au relative to number of binary collision scaled p+p and the NPE-hadron azimuthal correlations show a broadening on the away side. These results suggest some significant contributions from other processes to heavy favor quark energy loss, which stimulated various theoretical reconsideration. In order to differentiate model calculations, high precision measurements of NPE production in both Au+Au and p+p collisions, with disentangled charm and bottom contributions, are needed. In addition, model calculations with correct dynamics should be able to predict the elliptic flow of heavy flavor quarks at the same time. Simultaneous measurements of NPE production suppression and elliptic flow have better discriminating power on energy loss dynamics than individual measurement alone. We will present preliminary results of NPE production, NPE-hadron azimuthal correlation as well as NPE elliptic flow studies at midrapidity using a data set with high statistics and low photon conversion background from Au + Au collisions at at center-of-mass energies of 200 GeV collected at RHIC in Run 2010.

14:50 3L-5 Open Heavy Flavor Production at LHC p−p & Pb−Pb Collisions as seen by ALICE : Zaida CONESA DEL VALLE (CERN)

The ALICE experiment has the ability to measure, between others, open heavy flavor production in different colliding systems. Charm and beauty production in proton proton collisions are an important tool to test pQCD calculations in a new energy domain. Their spectra in heavy ion interactions is influenced by the formation of hot and dense QCD matter. Due to their relative large mass, the medium effects differ from those of light quarks. RHIC results show that they effectively loose energy in the medium through (elastic and/or inelastic) interactions, but a possible quark-mass hierachy has not yet been disentangled. LHC measurements at higher energies, with more statistics and better capabilities to separate charm and beauty production, will help to answer these questions. The status of open heavy flavor measurements in proton proton collisions at 7 TeV and lead lead collisions at 2.76 TeV with the ALICE experiment will be presented. The results of the single lepton analysis (electrons at mid-rapidity, muons at large-rapidities) and D mesons reconstruction in their hadronic decays will be discussed.

Poster Session - Stratton Student Center - Sala de Puerto Rico (15:30-17:30)

Public Lectures - Kresge Auditorium (19:00-20:50)

19:00 Glimpsing the Fly in the Cathedral: Ernest Rutherford and the Atomic Nucleus : Brian CATHCART (Kingston University)

A century ago the physicist Ernest Rutherford surprised a colleague with the announcement that he knew what the atom looked like. By this he meant that, on the basis of experiments in his laboratory in Manchester, England, he had formed a picture in his mind of the interior of the atom. It was almost entirely empty, but deep in the void was an entity which accounted for almost all of the atoms mass but was so small in relation to its surroundings that it was like a fly in a cathedral. We now call that fly the atomic nucleus and it is at the heart of our understanding of all matter. It is hard to imagine a more fundamental scientific discovery, and the story of how Rutherford achieved his great insight is a fittingly remarkable one. It has been told as a tale of serendipity an out-of-the-blue revelation born of the unexpected results of experiments conducted by a mere undergraduate. Rutherford himself gave some encouragement to this perception, and to modern eyes it is certainly astonishing that such primitive conditions, such crude apparatus and such feeble theoretical knowledge could have provided the foundations for so ground-breaking a discovery. But this is to underestimate Ernest Rutherford. A New Zealander whose bluff, rough manner occasionally led people to mistake him for a farmer, he was in truth a scientific research machine perfectly tuned to surprise the world. He had vast energy, a gift for motivating others, a penetratingly clear vision and a vivid imagination all evident in the discovery of the nucleus. Beside those, however, was a quality less regarded: his sheer will to make discoveries happen by bending everyone and everything around him to the task. If luck was involved in the discovery of the nucleus, it was luck for which Rutherford had made careful provision. The discovery of the nucleus was so unexpected, so far ahead of its time, that at the time hardly a scientist in the world trusted it or grasped its significance. My talk will look both at how it was achieved the means by which men of 1912 could detect something so unimaginably small – and at how Rutherford brilliantly laid the groundwork for it.

19:45 Rutherford's Legacy in Particle Physics - Exploring the Proton : Jerome FRIEDMAN (MIT)

Rutherford's legacy of employing scattering experiments to probe structure has been crucial to advancing our understanding of sub-atomic physics. This talk will describe the role of inelastic electron and neutrino scattering in uncovering the quark sub-structures of the proton and neutron.

Wednesday 27 July 2011

Plenary 3 - Kresge Auditorium (08:30-10:15)

Chair: Frithjof Karsch (Brookhaven National Laboratory)

08:30 P3-1 Recent Progress in Applying Gauge/Gravity Duality to Quark-Gluon Plasma and Nuclear Physics : Andreas KARCH (University of Washington, Seattle)

I will give a brief overview of the basic philosophy behind applying gauge/gravity duality (or holography for short) to problems in nuclear and heavy ion physics, highlighting the differences between phenomenological models and the so called "top-down" approach. Recent progress regarding viscosities, energy loss, as well as hadronic physics will be reviewed.

09:05 P3-2 Light Baryon Spectroscopy : Volker CREDE (Florida State University)

Nucleons are complex systems of confined quarks and gluons and exhibit the characteristic spectra of excited states. These serve as an excellent probe of Quantum Chromodynamics (QCD), the fundamental theory of strong interaction. In particular, highly-excited states are sensitive to the details of quark confinement, which is only poorly understood within QCD. This is the regime of non-perturbative QCD and it is one of the key issues in hadronic physics to identify the corresponding relevant degrees of freedom and the effective forces between them. In recent years, lattice-QCD has made significant progress toward understanding the spectra of hadrons. On the experimental side, high-energy electrons and photons are a remarkably clean probe of hadronic matter, providing a microscope for examining atomic nuclei and the strong nuclear force. For more than a decade, laboratories worldwide have accumulated data for such investigations, resulting in a number of surprising discoveries and contributing to our understanding of the nucleon, its underlying quark structure, and the dynamics of the strong interaction. Current experimental efforts at many laboratories utilize highly-polarized frozen-spin (butanol) targets and deuterium targets in combination with polarized photon beams. These are important steps toward so-called complete experiments that will allow us to unambiguously determine the scattering amplitudes in the underlying reactions and to identify resonance contributions. In my talk, I will give an overview of the excited baryon program and will discuss recent results from spectroscopy experiments at Jefferson Laboratory, ELSA, and MAMI.

09:40 P3-3 Neutron Star Mass and Radius Measurements and the Equation of State of Cold Dense Matter : Scott RANSOM (National Radio Astronomy Observatory)

Over the past several years, astrophysical observations of neutron stars using X-rays and radio wavelengths have made significant progress towards determining the Equation of State of neutron star matter. X-ray observations of thermonuclear burst oscillations from the surfaces of actively accreting neutron stars seem to provide ways to measure the masses and radii of the neutron stars, albeit currently not with extreme precision. Radio timing observations of binary millisecond radio pulsars cannot constrain neutron star radii, but can occasionally provide very precise mass measurements. One of the most exciting of those is a 2 Solar Mass pulsar as determined via a high signal-to-noise measurement of relativistic Shapiro delay last year. These observations are providing quite significant constraints on possible Equations of State.

Plenary 3 – Kresge Auditorium (10:45-12:10)

Chair: Donald Geesaman (Argonne National Laboratory)

10:45 P3-4 Connecting the LHC to ultra-high energy cosmic rays: from 10 to 100 TeV CMS : Ralph ENGEL (Karlsruhe Institute of Technology)

Cosmic rays of ultra-high energy produce gigantic secondary particle cascades in the Earth atmosphere. These extensive air showers not only allow us to learn more about their very rare primary particles coming from extragalactic sources, but also offer a window to studying hadronic interactions at energies up to 400 TeV CMS. After a brief introduction to the physics of cosmic rays of ultra-high energy, the relation of the characteristics of hadronic multiparticle production to observables of air showers is discussed. The importance of measurements at the LHC is emphasized and the impact of first LHC data on the interpretation of air showers is reviewed. The talk concludes with a discussion of the current status and first results on deriving constraints from air shower measurements on hadronic particle production at energies far beyond man-made colliders.

11:20 P3-5 A Progress Report on the AMS Experiment : Andrei KOUNINE (MIT)

Alpha Magnetic Spectrometer (AMS-02) is a general purpose high energy particle detector which was successfully deployed on the International Space Station (ISS) on 19 May 2011 to conduct a unique long duration mission of fundamental physics research in space. Among the physics objectives of AMS are a search for an understanding of Dark Matter, Antimatter, the origin of cosmic rays and the exploration of new physics phenomena not possible to study with ground based experiments. This report overviews performance of the AMS-02 detector on ISS as well as the first results based on data collected during first two months of operations in space.

11:40 P3-6 J-PARC Status after the Earthquake on March 11 : Kazuhiro TANAKA (J-PARC)

At 2:46pm on March 11 in 2011, Tohoku Region Pacific Coast Earthquake hit J-PARC. Approximately 40 minutes later, tsunami of a height of about 4m and the maximum run-up of about 6m attacked the shore of the J-PARC site. When the mark of the tsunami was verified later, it was understood that it had been exactly a near miss though the worst situation that the tsunami flows in the J-PARC site had been, thanks to geographical features around the J-PARC, fortunately avoided. Finally it was found that no one was injured by the earthquake and tsunami at the J-PARC site. In addition, no radiation problem happened in J-PARC. After the earthquake, we could perform the first inspection throughout the J-PARC facilities on March 17. At that time electricity was not recovered at all and no detailed inspection was possible. Then we found, fortunately, there was almost no obvious structural damage in the accelerators and experimental facilities due to many underpins underneath the buildings. However, all roads around the buildings and the utilities such as water pump stations and electric transformer yards had severe damages. After those inspections we started recovery works of our J-PARC facilities promptly. Japanese Government supports us strongly, too. In early June, electricity and cooling water were fully recovered at the 50GeV-MR and the Hadron and Neutrino Experimental Facilities and were partly recovered at the LINAC, the 3GeV RCS and the Material and Life-science Facility (MLF; spoliation neutron source and pulsed muon source with the 3GeV beam). Test operation of the magnets has already been started at the 50GeV-MR and the Hadron and Neutrino Facilities. Though we need some time for re-alignment of all the experimental devices such as magnets, monitors, detectors, etc., which slipped off in the range of mm to cm from their appropriate positions, now we believe we can complete the rebuilding of our experimental facilities by the end of this year and our accelerator complex can start the beam acceleration at the same time. Experimental programs will be re-started in the spring run time (January-March) in 2012. At the PANIC2011 Conference, updates of our J-PARC status will be reported as well as our scientific activities, which were demonstrated partly by the announcement of the electron neutrino appearance in the long-baseline oscillation experiment, T2K.

12:00 Awards for Best Posters

The awards for best posters will be presented by MIT professors Markus Klute and Steven Nahn.

Thursday 28 July 2011

Plenary 4 - Kresge Auditorium (08:30-10:15)

Chair: Jean-Paul Blaizot (CEA (France))

08:30 P4-1 Collective Behavior in Heavy Ion Collisions : Constantin LOIZIDES (LBNL)

Nuclear collisions at the Relativistic Heavy Ion Collider (RHIC) and the Large Hadron Collider (LHC) occur at energies that enable the creation of a new state of matter, called the quark-gluon plasma, with energy density similar to that achieved in the early universe shortly after the Big Bang.

The medium generated in such collisions exhibits collective behavior characteristic of a strongly coupled, near-inviscid fluid, which undergoes rapid three-dimensional expansion. I will present a review of the most striking observations made with heavy ion collisions at RHIC and LHC. The new data from RHIC and the LHC explore the evolution of the quark-gluon plasma state over two orders of magnitude in collision energy, allowing significant tests of phenomenological models that have successfully described earlier data.

09:05 P4-2 Hard Probes of Quark-Gluon Plasma in Heavy Ion Collisions : Carlos SALGADO (University of Santiago de Compostela)

High-energy collisions among nuclei are the experimental tools to access some of the properties of QCD in which collective behavior is a main ingredient. High temperatures and high density states of deconfined matter are created in experiments at RHIC in Brookhaven and at the LHC in CERN. The reach of collider energies give access to processes determined by large scales or small distances where perturbative QCD can be applied. Medium-modifications of these hard probes provide the most diverse tools to characterize the properties of the created matter. Indeed, jet quenching, the suppression of particles produced at high transverse momentum, has been established at RHIC almost a decade ago as one of the main tools in heavy-ion collisions. The melting of quarkonia is expected toF provide also information about the temperature and the properties of the produced medium. The beginning of the LHC era for hot QCD studies starts with the first nuclear beams in 2010. The amount of information produced by this first run is overwhelming: The three experiments with nuclear program (ALICE, ATLAS and CMS) have provide new results in basically all subjects considered in previous experiments and have also shown the potential to make nuclear collisions at the TeV scale for the first time. I will review what these new results from both RHIC and LHC imply for our understanding of hot and dense QCD matter from a theorists' perspective and how these new results change some of the concepts we developed in the last years.

09:40 P4-3 Recent Results in Particle and Nuclear Physics from Lattice QCD : Tetsuo HATSUDA (University of Tokyo)

Lattice QCD now became a powerful tool to analyses the properties of many-body systems of quarks and gluons such as single hadrons, multi-hadrons and the quark-gluon plasma. I will summarize some recent results of full lattice QCD simulations for light hadron masses, nucleon-nucleon and hyperon-nucleon and hyperon-hyperon forces, di-baryon systems, and the QCD phase transition at high temperature and baryon density. Future direction of lattice QCD applied to particle and nuclear physics will be also discussed.

Plenary 4 - Kresge Auditorium (10:45-12:00)

Chair: Pervez Hoodbhoy (Quaid-e-Azam University (Pakistan))

10:45 P4-4 W, Z, and top : Joao GUIMARAES DA COSTA (Harvard University)

Abstract not received

11:20 P4-5 Jets in Standard Model and Beyond Standard Model Physics : Gavin SALAM (CERN; Princeton; LPTHE/CNRS (Paris))

Jets are the closest we come to observing free quarks and gluons in high-energy collisions. As such they play a central role across the full spectrum of collider studies, from searches for physics beyond the standard model, to investigations of the medium produced in heavy-ion collisions. Our understanding of the behavior of jets can be crucial both in interpreting data and in proposing ways to better discover new physics. This talk will give an overview of the latest theoretical developments in the field, including a discussion of how they relate to recent results and possible future analyses at RHIC, Tevatron and the LHC.

Parallel 4A - QCD & Hadron Structure - W20-307 (Mezzanine Lounge) (13:30-15:30)

Chair: Rolf Ent (JLab)

13:30 4A-1 Electromagnetic Polarizabilities: Lattice QCD in Background Fields : Brian TIBURZI (CTP, MIT)

The response of hadrons to electromagnetic probes is highly constrained by chiral dynamics; but, in some cases, predictions have not compared well with experimental data. Electromagnetic properties of hadrons can be computed by lattice simulations of QCD in background fields. Focusing on calculations in background electric fields, we demonstrate new techniques to determine electric polarizabilities and baryon magnetic moments. We argue that the lattice can be used to test the chiral electromagnetism of hadrons, and ultimately confront experiment.

13:50 4A-2 Precision Measurement of the Neutron d_2: Probing the Lorentz Color Force : David FLAY (Temple University)

The quantity d_2, known as the twist-three matrix element, is a measure of the average restoring Lorentz color force experienced by a quark inside a polarized nucleon after it is struck by a virtual photon in electron Deep Inelastic Scattering (DIS). With its information encoded in both spin structure functions g_1 and g_2 in the quark valence region at large Bjorken x, this confining local force is a result of the remnant di-quark system attracting the struck quark. While bag- and chiral soliton-model calculations for the neutron d_2 are consistent with those of lattice QCD, current experimental data differ by approximately two standard deviations from those theoretical results. To address this issue, the experiment E06-014 was carried out from February to March of 2009 at Jefferson Lab. It consisted of measuring double-spin asymmetries and the total cross section via scattering a longitudinally polarized electron beam off of a longitudinally or transversely polarized He-3 target, allowing for the construction of the neutron d_2. The experiment covered excitation energies in the resonance and DIS valence quark regions. Preliminary results concerning the asymmetries and cross sections will be presented.

14:10 4A-3 Diquark Correlations in a Hadron From Lattice QCD : Jeremy GREEN (Center for Theoretical Physics, Massachusetts Institute of Technology)

Using lattice QCD, a diquark can be studied in a gauge-invariant manner by binding it to a static quark in a heavy-light-light hadron. We compute the simultaneous two-quark density of a diquark, including corrections for periodic boundary conditions. We define a correlation function to isolate the intrinsic correlations of the diquark and reduce the effects caused by the presence of the static quark. Away from the immediate vicinity of the static quark, the diquark has a consistent shape, with much stronger correlations seen in the good (scalar) diquark than in the bad (axial-vector) diquark. We present results for pion masses 293 MeV as well as 940 MeV, and discuss the behavior as the pion mass changes.

14:30 4A-4 Calculation of Nucleon Structure in Lattice QCD with Almost-physical Light Quarks : Sergey SYRITSYN (Lawrence Berkeley National Laboratory)

One of the main themes of nuclear physics today is whether the structure of hadrons can be understood in terms of QCD. QCD in nonperturbative, low-energy regime can be solved only numerically on a lattice. It is an increasingly hard computational problem at lighter quark masses, and only recently simulations of the full QCD with real-world quark masses have become possible. To claim that we understand how hadron structure follows from QCD, we have to reproduce basic hadron observables such as nucleon radius and axial charge. These quantities are known very well from experiments, and can be used as a benchmark for lattice QCD as a framework to study nucleon structure. Once we control the systematic effects of our simulations, lattice QCD will be able to reveal the detailed picture of the nucleon.

I will report recent calculation of nucleon form factors, charge radius and axial charge performed in full QCD with twice the physical pion mass and newer, more exciting calculation with pion masses very close to physical. The same simulation yields values for the nucleon momentum fraction carried by quarks, quark spin and orbital angular momentum (OAM) contribution to the nucleon spin. The quark OAM is a particularly interesting observable exhibiting quarks motion in the nucleon, and it is hard to measure in experiments, making lattice QCD a necessary tool of nuclear physics. The origin of the nucleon spin is a central focus of contemporary nuclear physics experiments at Jefferson Lab, RHIC spin, and a future electron-ion collider.

14:50 4A-5 Perturbative and Non-Perturbative Origins of the Proton Sea : Mary ALBERG (Seattle University and University of Washington)

Deep Inelastic Scattering and Drell-Yan experiments have measured a light flavor asymmetry in the proton sea. The excess of dbar over ubar antiquarks can be understood in many models, but the ratio dbar(x)/ubar(x) measured by Fermilab E866 has not been successfully described. Fermilab E906 will probe the kinematic dependence of this ratio with better resolution and extend it to higher x. We have developed a hybrid model that includes both perturbative and non-perturbative contributions to the proton sea. A meson cloud formalism is used to represent the non-perturbative fluctuation of the proton into meson-baryon states. Our Fock state expansion includes the dominant pion-nucleon terms and all higher meson-baryon terms that provide significant contributions to the proton sea. We include perturbative processes by using a statistical model that uses Fock states of quarks, antiquarks and gluons to represent the parton distributions of the "bare" hadrons in the meson cloud. This model uses detailed balance between the Fock states, and transfer between states is assumed to take place through quark-gluon splitting and recombination, quark-antiquark creation and annihilation, and gluon splitting. The resulting parton distributions, though perturbative in origin, contribute an additional asymmetry to the sea. We compare our results to the E866 data and make predictions for the E906 measurements. This work has been supported in part by the Research in Undergraduate Institutions program of the National Science Foundation, Grant No. 0855656.

15:10 4A-6 The E-906/SeaQuest experiment at Fermilab : Markus DIEFENTHALER (University of Illinois at Urbana-Champaign)

The E-906/SeaQuest experiment at Fermilab will continue a series of Drell-Yan measurements to explore the antiquark structure of the nucleon and nuclei. To extend existing measurements to larger values of Bjorken-x, a 120 GeV proton beam extracted from Fermilab's main injector is used, resulting in a factor of 50 more luminosity than previous experiments and enabling access to values of x up to 0.9. An overview will be presented of the key physics goals of the E-906/SeaQuest collaboration. These include investigation of the dramatic dbar/ubar flavor asymmetry in the nucleon sea and its behavior at high x; study of the EMC effect in Drell-Yan scattering and the unexpected absence of any antiquark excess in existing data; and measurements of the angular dependence of the Drell-Yan process, sensitive to spin-orbit correlations within the nucleon. The talk will conclude with a status report on the ongoing commissioning of this new experiment.

Parallel 4B - Helicity Structure of the Nucleon - W20-306 (20 Chimneys) (13:30-15:30)

Chair: Christine Aidala (LANL)

13:30 4B-1 New COMPASS Results on Longitudinal Spin Effects : Marcin STOLARSKI (LIP-Lisboa)

A short review of the COMPASS results obtained in polarized deep inelastic scattering of polarized muons off longitudinally polarized proton and deuteron targets is given. Two new measurements of the gluon polarization DG/G are discussed. A new LO result from the analysis of high-pT hadron pairs for Q2 > 1 $(\text{GeV/c})^2$ and separated into three experimental points as a function of x-g is shown. A new open charm value for DG/G obtained at NLO, and which combines both proton and deuteron data and includes several D0 decay channels is presented. The cross-section for the D* production is given and kinematic distribution of the D* are compared with the AROMA generator. Finally results for the LO flavor separation of the three lightest quark polarized parton distributions as well as Bjorken sum rule test are also shown.

14:00 4B-2 Spin Physics with the PHENIX detector at RHIC : Abhay DESHPANDE (Stony Brook University)

In addition to colliding a variety of nuclei in a range of energies, the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory (BNL) is also capable of colliding polarized protons in transverse and longitudinal spin orientations. High energy collisions of polarized protons at 62.4, 200 and (most recently) 500 GeV Center-of-Mass have enabled some of the most unique studies of the spin structure of the proton. In this talk we present an overview of measurements from the PHENIX Collaboration which constrain the gluon's contribution (Δg) and the anti-quark contribution $\Delta\overline{q}$ to the nucleon spin, and explore the transverse spin structure of the proton.

14:30 4B-3 Exploring Gluon Polarization in the Proton with Inclusive and Correlation Measurements at STAR : Carl GAGLIARDI (Texas A&M University)

One of the primary goals of the RHIC spin program is to determine the gluon polarization distribution within the proton. At leading order, pp collisions involve a mixture of quark-quark, quark-gluon, and gluon-gluon scattering. In RHIC kinematics, the quark-gluon and gluon-gluon contributions dominate, which makes RHIC an ideal tool to explore gluon polarization. The STAR experiment has measured the longitudinal double-spin asymmetry, A_{LL}, for inclusive jet and pion production at $\sqrt{s}$ = 200 GeV. The results provide valuable constraints on the gluon polarization in the proton when included in a next-to-leading-order global analysis. STAR has also measured A_{LL} for di-jet and $\pi^{\pm+}$ jet production at 200 GeV. At leading order, the latter processes provide access to the incident parton kinematics, allowing a direct determination of the momentum dependence of the gluon polarization, $\Delta g(x, Q^2)$. During the current RHIC run, STAR is investigating these same observables in pp collisions at $\sqrt{s}$ = 500 GeV, which will expand the kinematic reach to lower-x gluons. The STAR measurements at 200 GeV will be discussed, including the current status of the data that were recorded in 2009. The anticipated sensitivity of the 2011 500 GeV data set will also be discussed.

14:50 4B-4 Recent STAR results on W boson production in polarized $p + p$ collisions at $\sqrt{s} =$ 500 GeV : Jan BALEWSKI (MIT)

The STAR experiment has collected W-boson events from collisions of longitudinally polarized protons at $\sqrt{s} = 500$ GeV in 2009 and 2011. In the standard model leading-order $W^{\pm}$ production is through $u+\bar{d} \rightarrow W^+$ and $d+\bar{u} \rightarrow W^-$. These interactions are ideal tools to study the spin-flavor structure of the proton, because the spin-dependent W production cross section $\Delta\sigma = \sigma(\overrightarrow{p}p)-\sigma(\overleftarrow{p}p)$ depends strongly on the polarization of the quark and anti-quark in the proton, with $\overrightarrow{p}(\overleftarrow{p})$ representing a proton with its spin aligned with (against) its momentum direction. The STAR Electromagnetic Calorimeter triggered on electrons/positrons from the weak decay of the W boson and provided information about energy of the lepton, while the STAR Time Projection Chamber allowed reconstruction of the lepton track and its charge sign. QCD physics background was suppressed by isolation cuts around a candidate lepton track as well as vetoing on transverse energy opposite in azimuth. We will present results of the single-spin asymmetry, $A_L = \Delta\sigma/(\sigma(\overrightarrow{p}p) + \sigma(\overleftarrow{p}p))$, for mid-rapidity charge separated W^+ and W^- production from 2009 data set and a progress report on the 2011 set.

15:10 4B-5 Single spin physics with W bosons in 500 GeV $p^{\uparrow} + p$ collisions in PHENIX experiment. : Edouard KISTENEV (BNL)

Electrons from $W^{\pm}$ decays into $e^{\pm}$ have been observed in collisions of longitudinally polarized (approximately 39% polarization) protons at $\sqrt{s} = 500$ GeV in the PHENIX detector at RHIC. W production in polarized pp collisions delineates by flavor the quark spin contributions to the proton spin and provides way to probe the flavor-dependence of sea antiquark polarization in the nucleon. Lepton level asymmetries measured by detecting leptons from W-decay are easily predicted by the electroweak theory and are free from uncertainties in fragmentation functions. This study is based upon approximately 8.6 pb^{-1} integrated luminosity acquired in 2009. The background subtracted lepton energy spectrum is used to determine the $W^{\pm}$ production cross section in the PHENIX central arms, which cover $\mid \eta \mid \leq 0.35$. Results on extracting an electron single spin asymmetry which probes the spin structure of the nucleon will be reported.

Parallel 4C - Charm and Strange Spectroscopy - W20-201 (West Lounge) (13:30-15:30)

Chair: Kei Moriya (Indiana University)

13:30 4C-1 Charmonium and Charmonium-like States with BABAR : Torsten SCHROEDER (Ruhr Univ. Bochum)

We present a search for the X(3872) produced in $B \rightarrow \psi\pi+\pi-K$ and $B \rightarrow \psi\pi+\pi-\pi0\,K(\,psi = J/\psi \text{or} \psi(2S))$ using 427 fb−1 of BaBar data. We present updated mass and width measurements for the Y(4260)–¿ J/psi $\pi + \pi-$ produced in Initial State Radiation events using 454 fb−1 of data. We report the study of the B meson decays $B+ \rightarrow J/\psi\phi K + \text{and} B0 \rightarrow J/\psi\phi K_S$, and of charged and neutral B decays to $\chi_{c1}K$ pi. We describe a detailed study ofcharmonium states produced in two-photon collisions and decaying to $K_S K\pi$ and $K\,K\pi\pi\,\pi0$. We present a high statistics measurement of the mass and width of the $\eta c(2S)$ state.

14:00 4C-2 New results for charmonium spectroscopy from lattice qcd : Liuming LIU (Trinity College Dublin)

The spectrum of charmonium states up to and beyond the open charm threshold is explored. Techniques which have enabled high statistical precision light spectroscopy calculations are exploited for the first time. A variational calculation with a large operator basis is presented, which enables reliable spin determination and precision hybrid spectroscopy.

14:30 4C-3 Charm spectroscopy at the PANDA experiment : Thomas WURSCHIG (HISKP, Universitaet Bonn)

The PANDA experiment will be hosted at the future FAIR facility which is currently under construction at GSI, Darmstadt. It is one of the key projects of this facility featuring an intense hadron physics program. Studies will be performed with antiprotons using a fixed target setup. The antiproton beam is delivered by the HESR which will provide high intensities resulting in a luminosity of up to 2 × 1032 cm-2s−1 and an excellent momentum resolution of better than p/p = 10R−4. The beam momentum will range between 1.5 GeV/c and 15 GeV/c thus covering the complete charmonium sector. Due to the usage of different targets starting from hydrogen to heavier nuclei it will be possible to investigate antiproton-proton reactions and the reactions of antiprotons within nuclear matter. The unique experimental conditions render possible a high precision spectroscopy of unrivalled quality in the entire charm quark sector. PANDA is designed as a multi-purpose detector with a full angular coverage for both charged and neutral particles thus aiming on fully exclusive measurements. It will include suited sub-detectors to perform particle identification, high momentum resolution, precise calorimetry and high vertex resolution.

One major part of the PANDA physics program is high-precision spectroscopy of QCD bound systems with charm quark content. In this context, charmed mesonic systems are of particular interest because the charm quark is sufficiently heavy to be treated in non-relativistic perturbation calculations much better than light up, down or strange quarks. The spectra of charmonium and systems with open charm represent a QCD analogue to the positronium and hydrogen in QED and can thus deliver a deeper insight into the long-range features of QCD. Besides, discoveries of new states during the last decade revived the interest in the charm sector because they do not seem to fit into conventional models. The presentation will start with a short review of the current experimental status within the charm sector. The particular impact of PANDA expected to improve the knowledge in this regime will be elaborated on starting from an overview of the planned research program to the description of the experimental setup allowing a detailed study of the relevant mass region. Finally, detailed simulations will be summarized.

14:50 4C-4 Evidence for a Bound H-dibaryon from Lattice QCD : William DETMOLD (Thomas Jefferson National Accelerator Facility/College of William Mary)

The H-dibaryon, an I=0, J=0, s=-2 state with valence quark structure uuddss, is investigated in lattice QCD. Calculations are performed on four ensembles of anisotropic clover gauge-field configurations, with spatial extents of L $\sim$ 2.0, 2.5, 3.0 and 3.9 fm, at a spatial lattice spacing of b $\sim$ 0.123 fm, and at a quark masses where the pion mass is 389 MeV. Strong evidence is presented for the existence of a bound state in this channel with a binging energy of $E_B = 16.6 + -2.1 + -4.6$ MeV. This represents the first calculation of a bound multi-baryon system in QCD but further work at lighter quark masses is needed to understand implications for experiment.

15:10 4C-5 Bound H-dibaryon in the Flavor SU(3) Limit from a Full QCD Simulation on the Lattice : Takashi INOUE (Nihon University, College of Bioresource Sciences)

The flavor-singlet H-dibaryon, which has strangeness −2 and baryon number 2, is studied by the approach recently developed for the baryon-baryon interactions in lattice QCD. The flavor-singlet central potential is derived from the spatial and imaginary-time dependence of the Nambu-Bethe-Salpeter wave function measured in Nf= 3 full QCD simulations with the lattice size of L about 2, 3, 4 fm. The potential is found to be insensitive to the volume, and it leads to a bound H-dibaryon with the binding energy of 30–40 MeV for the pseudo-scalar meson mass of 673–1015 MeV.

Parallel 4E - Neutrinoless Double Beta Decay - 4-163 (13:30-15:30)

Chair: Kimihiro Okumura (Institute for Cosmic Ray Research, University of Tokyo)

13:30 4E-1 The Enriched Xenon Observatory (EXO) : Liang YANG (SLAC National Acclerator Laboratory)

The Enriched Xenon Observatory (EXO) is an experimental program designed to search for the neutrinoless double beta decay (0nbb) of Xe-136. Observation of 0nbb would determine an absolute mass scale for neutrinos, prove that neutrinos are massive Majorana particles (indistinguishable from their own antiparticles), and constitute physics beyond the Standard Model. The current phase of the experiment, EXO-200, uses 200 kg of liquid xenon with 80% enrichment in Xe-136, and also serves as a prototype for a future 1-10 ton scale EXO experiment. The double beta decay of xenon is detected in an ultra-low background time projection chamber (TPC) by collecting both the scintillation light and the ionization charge. The detector is now operational at Waste Isolation Pilot Plant (WIPP) in New Mexico. It was first run with natural xenon to fully commission it and study its performance. Preparation for physics data taking is underway. The projected two-year sensitivity for neutrinoless double beta decay half-life is 6.4E25 y at 90% confidence level. In view of a future ton scale experiment, the collaboration is performing R to realize an ideal, background-free search for which the daughter nucleus produced by the double beta decay is also individually detected. In this talk, the current status and preliminary results from EXO-200 will be presented, and prospects for a ton scale EXO experiment will be discussed.

13:50 4E-2 Search for Neutrinoless Double Beta Decay with CUORE : Laura KOGLER (UC Berkeley)

The Cryogenic Underground Observatory for Rare Events (CUORE) is an experiment to search for neutrinoless double beta decay (0nuDBD) in Te-130 and other rare processes. The observation of 0nuDBD would indicate that neutrinos are Majorana particles and would provide information about the absolute neutrino mass scale. CUORE is a bolometric detector composed of 988 TeO2 crystals, with the total mass of about 750 kg of natural Tellurium. We will discuss the status of the CUORE experiment, including recent R efforts, anticipated sensitivity, and present the most recent results from Cuoricino, the predecessor experiment operated in Gran Sasso National Laboratories in Italy.

14:10 4E-3 The MAJORANA DEMONSTRATOR: A Search for Neutrinoless Double-Beta Decay of Germanium-76 : Alexis SCHUBERT (University of Washington)

The observation of neutrinoless double-beta decay could determine whether the neutrino is a Majorana particle and may provide information on the absolute scale of neutrino mass. The MAJORANA Collaboration [1] will search for neutinoless double-beta decay in an array of germanium detectors enriched to 86% in 76-Ge. Germanium detectors are a well-understood technology and have the benefits of excellent energy resolution, a high Q-value of the candidate isotope, and the ability to act as source and detector. The MAJORANA Collaboration has chosen to use p-type point contact germanium detectors, which have the advantages of low noise, low energy threshold, and the ability to identify background events through the use of pulse-shape analysis. MAJORANA is constructing the DEMONSTRATOR, which will be used to conduct research and development toward a future tonne-scale Ge experiment. The DEMONSTRATOR will be installed deep underground and will contain 40 kg of Ge deployed in an ultra-low-background shielded environment. For a tonne-scale experiment, MAJORANA has a background goal of one count per tonne-year in a 4-keV region of interest surrounding the 76-Ge beta decay endpoint.

Research supported by DOE under contracts DE-AC05-00OR22725 and DE-FG02-97ER41020.

[1] V.E. Guiseppe (2010) arXiv:1101.0119

14:30 4E-4 Status and Perspective of the GERDA Neutrinoless Double Beta Decay Experiment : Karl Tasso KNOEPFLE (MPI Kernphysik)

The study of neutrinoless double beta decay (DBD) is the most powerful approach to the fundamental question if the neutrino is a Majorana particle, i.e. its own anti-particle. The observation of neutrinoless DBD would not only establish the Majorana nature of the neutrino but also represent a determination of its effective mass if the nuclear matrix element is given. So far, the most sensitive results have been obtained with Ge-76, and the group of Klapdor-Kleingrothaus has made a claim of discovery. Future experiments have to reduce radioactive backgrounds to increase the sensitivity. The GERmanium Detector Array, GERDA [1], is a new DBD experiment which is currently being commissioned at the INFN Gran Sasso National Laboratory, Italy. It is implementing a new shielding concept by operating bare Ge diodes - enriched in Ge-76 - in high purity liquid argon supplemented by a water shield. The aim of GERDA is to verify or refute the recent claim of discovery, and, in a second phase, to achieve a two orders of magnitude lower background index than recent experiments. The paper will discuss design, physics reach, and the commissioning of GERDA with a string of three natural low-background Ge diodes; it will also present results from various R efforts that are relevant for phase II of the experiment.

[1] http://www.mpi-hd.mpg.de/GERDA/

14:50 4E-5 NEXT: Searching for Double Neutrinoless Beta Decay with 136Xe TPCs : Roberto SANTORELLI (CIEMAT Madrid)

The most promising method to reveal the neutrino nature is the search for neutrinoless double beta decay ($\beta\beta 0v$), an extremely rare decay process (t1/2 $> 10^{25}$ yr) forbidden in the standard model and possible only if neutrinos are Majorana particles, that can also directly determine the absolute neutrino mass scale. A pressurized gaseous TPC (time projection chamber) with 136Xe can take advantage of both good energy resolution and the presence of the $\beta\beta 0v$ decay topological signature of the $\beta\beta 0v$ decay. As a result, the background rate can be expected to be one of the lowest among the new generation of $\beta\beta 0v$ experiments. The NEXT collaboration is developing a high-pressure gaseous xenon chamber (HPGXe) aiming to reach a sensitivity better than 10^{26} yr for the $\beta\beta 0v$ decay mode of 136Xe (corresponding to an effective Majorana mass of $\sim$50 meV), providing, at the same time, a precise measurement of the decay mode with two neutrinos in the final state, not yet observed in xenon. The details of the HPGXe technology will be discussed with the results of different xenon prototypes currently operated.

15:10 4E-6 Status and Perspectives on COBRA, a Neutrinoless Double-Beta Decay Experiment : Jerrad MARTIN (Washington University in Saint Louis)

COBRA is a low-background experiment using Cadmium Zinc Telluride (CZT) semiconductor detectors to search for the neutrinoless double-beta decay of cadmium-116. While the experiment has produced globally competitive half-life limits with prototype detectors, a future large-scale iteration could set limits constraining the effective Majorana neutrino mass to less than 100 meV. This contribution provides a general discussion of COBRA's science goals, as well as a report on the status of ongoing R Current projects include CZT detector growth and characterization, radioassaying laboratory materials, large-scale system design, a suite of Monte Carlo studies, and pixel detector development.

Parallel 4F - Lepton Flavor Violation - 4-153 (13:30-15:30)

Chair: Jim Miller (Boston University)

13:30 4F-1 Recent results from the MEG experiment : Alessandro BALDINI (INFN)

The $\mu \to e\gamma$ decay, which is absent in the Standard Model, is instead foreseen to occur in several new physics models with a branching ratio which might be detectable by the MEG experiment. In this talk, after a brief overview of the experimental methods employed, the most recent analysis results of the 2008–2010 MEG data taking period will be shown and the foreseen experimental sensitivity to the $\mu \to e\gamma$ decay will finally be presented.

13:50 4F-2 A New High-Sensitivity Muon-Electron Conversion Search at Fermilab : David BROWN (Lawrence Berkeley National Lab)

Mu2e will search for coherent, neutrino-less conversion of muons into electrons in the field of a nucleus, with a sensitivity improvement of a factor of 10,000 over existing limits. Such a lepton flavor-violating reaction probes new physics at a scale unavailable by direct searches at either present or planned high energy colliders. The physics motivation for Mu2e will be presented, as well as the design of the muon beamline and spectrometer. A scheme by which the experiment can be mounted in the present Fermilab accelerator complex will be described. Prospects for increased sensitivity from the Project X linac that is being proposed by Fermilab will be discussed.

14:10 4F-3 DeeMe – An Experimental Search for Muon-Electron Conversion in Nuclear Field at Sensitivity of 10^{-14} with Pulsed Proton Beam : Masaharu AOKI (Osaka University)

DeeMe An Experimental Search for Muon-Electron Conversion in Nuclear Field at Sensitivity of 10-14 with Pulsed Proton Beam Masaharu Aoki on behalf of DeeMe Collaboration All the known processes involving charged leptons, such as electron, muon and tau, conserve lepton flavor. Thus, it is embedded in the Standard Model (SM) a priori, and the processes violating the flavor invariance of the charged leptons (charged lepton flavor violation: CLFV) are totally forbidden in the SM. There might be a higher order effect coming from the neutrino oscillation, but the amplitude is suppressed by a GIM-like mechanism to the level of 10-50, which is far beyond the experimental accessibility.

On the other hand, there are numerous theoretical models giving predictions for the CLFV processes: SUSY-GUT, SUSY-Seesaw, extra dimension, and so on. A CLFV signal may be seen by experiment that improves the current experimental upper limit only a few orders of magnitudes. It is conceivable that the CLFV signal lies waiting to be discovered right under the current limit.

DeeMe collaboration had proposed a new experiment to search for the muon-electron conversion at J-PARC by using 3-GeV pulsed proton beam from a booster synchrotron (RCS). It utilizes muonic atoms formed in a primary proton target, and extracts 105-MeV/c electrons from the muon-electron conversion by using a large-acceptance secondary beamline. The number of muonic atoms formed in the primary target is estimated to be 1010/sec for 1 MW operation of the RCS. DeeMe aims to reach 10-14 of the single event sensitivity for silicon nuclei in a silicon-carbide production target. The detailed design of DeeMe is currently on going. It is relatively simple experiment compared to the other muon-electron conversion experiments proposed in J-PARC MR and Fermilab, and we aim to deliver the physics result within several years. The DeeMe beamline is designed so that it can be used for not only DeeMe but also other experiments such as muon g-2, muonium byperfine structure measurement and so on. Fruitful outcomes of the muon fundamental science will be expected from J-PARC in near future. In this presentation, the idea, design and status of DeeMe will be explained.

14:30 4F-4 Search for Muon to Electron Conversion at a sensitivity better than 10^{-16} at J-PARC : Hiroki NAKAI (Osaka University)

After the discovery of neutrino oscillation, a search for lepton flavor violation of charged leptons has attracted much interest from theorists and experimentalists. A process of muon to electron conversion in a muonic atom is one of the most important process to search for charged lepton flavor violation with muons. The experimental proposal to search for this process with single event sensitivity of 3×10^{-17} was proposed to J-PARC in Japan. The proposal has been "stage-1" approved in 2009 as J-PARC E21. This experiment is called COMET (COherent Muon to Electron Transition). We have made many R such as proton extinction measurements at the J-PARC accelerator, R on tracking chambers and electron calorimeter. Now we are working to prepare technical design report to get the final approval as soon as possible. In this paper, we would like to present physics motivation of charged lepton flavor violation, and the present status of the COMET experiment preparation and future prospect at J-PARC.

14:50 4F-5 Belle Results on Lepton Flavor Violation : Kenji INAMI (Nagoya University)

We report results from the Belle experiment at KEKB on Lepton Flavor Violation (LFV) in tau lepton decays. Modes include $\tau \to 1V^0$, where V^0 is a vector meson, t$\tau \to 111$ and $\tau \to 1\gamma$. These decay modes are highly suppressed in the Standard Model and are sensitive to new physics. Belle has the world most sensitive limits for many of these LFV modes.

Parallel 4G - Jets at the Frontiers of QCD - Kresge - Rehearsal A (13:30-15:30)

Chair: Sal Rappoccio (Johns Hopkins University)

13:30 4G-1 N-subjettiness : Jesse THALER (MIT)

Many beyond the standard model scenarios predict that the LHC will produce new heavy particles with decay channels involving top quarks, W/Z bosons, and Higgs bosons. If these top quarks and electroweak bosons are sufficiently boosted, then their decays can be misreconstructed as a single fat jet. In this talk, I describe a new jet shape, N-subjettiness, designed to tag boosted hadronically-decaying objects and reject the background of QCD jets with large invariant mass. I will argue that N-subjettiness combines the advantages of jet shapes with the discriminating power seen in previous jet substructure algorithms. I will also suggest that techniques learned from N-subjettiness may be applicable to entire events, pointing toward new algorithms for jet reconstruction.

13:50 4G-2 The Soft Function for Exclusive N-Jet Production at Hadron Colliders : Teppo JOUTTENUS (Massachusetts Institute of Technology)

Jet vetoes are essential in many Higgs and new-physics analyses at the LHC and Tevatron. The signals are typically characterized by a specific number of hard jets, leptons, or photons, while the backgrounds often have additional jets. Vetoing additional jets strongly restricts the phase space of the underlying inclusive N-jet cross section and causes large double logarithms in perturbation theory that must be summed to obtain theory predictions. A global event shape "N-jettiness" vetoes undesired jets and defines an exclusive N-jet cross section in a manner that can be well-controlled theoretically. N-jettiness divides phase space into N+2 regions, each containing one jet or beam. Using a geometric measure these regions correspond to jets with circular boundaries. We give a factorization theorem for the cross section fully differential in the (transverse) mass of each jet, and compute the corresponding soft function at next-to-leading order (NLO). This method can be applied in general to N-jet soft functions, including other observables. All ingredients are now available to extend NLO cross sections to resummed predictions at next-to-next-to-leading logarithmic order.

14:10 4G-3 Test of QCD in multijet final states at Tevatron : Ashish KUMAR (SUNY Buffalo)

We present studies of differential distributions for various final states involving jet production in $p\bar{p}$ collisions at $\sqrt{s} = 1.96$ TeV at the Tevatron, using data collected with the DØdetector. We investigate the inclusive jet production, differential distributions for final states with 2 or 3 jets, and ratios of differential distributions. The measurements are compared with NLO QCD calculations and with recent determination of parton distribution functions. From the data we also derive a determination of the strong coupling constant over a large kinematic range.

14:30 4G-4 ATLAS Measurements of Jet Cross Sections : Stephanie MAJEWSKI (BNL)

Jet cross sections have been measured in proton-proton collisions at a centre-of-mass energy of 7 TeV using the ATLAS detector. Inclusive single-jet differential cross sections are presented as functions of jet transverse momentum and rapidity. Dijet cross sections are presented as functions of dijet mass and angle. The measurements extend the previously measured kinematic region to higher rapidities, and to both higher and lower values of transverse momentum. The results are compared to next-to-leading-order QCD calculations matched to leading- logarithmic parton showers. In addition, measurements are presented of multijet cross sections, and of the azimuthal correlation between dijets, and of dijets separated by large intervals of rapidity where a veto is applied based on the presence of further jets with the rapidity interval. These measurements are sensitive to higher order QCD effects in new kinematic regimes.

14:50 4G-5 Forward jets and forward-central dijets at CMS : Niladri SEN (DESY)

We report on a measurement of the cross section of inclusive forward jets in pp collisions at sqrts = 7 TeV, based on a data sample collected in 2010 and corresponding to an integrated luminosity of 171 nb1. Jets are reconstructed with the anti-kT (R = 0.5) algorithm in the Hadronic Forward (HF) calorimeter at pseudorapidities $3.2 <| \eta |< 4.7$, in the transverse momentum range pT = 35 – 140 GeV/c. The single differential cross section as function of the jet transverse momentum is presented and compared to next-to-leading order perturbative QCD calculations, PYTHIA and HERWIG parton shower event generators, as well as to the CASCADE Monte Carlo. In addition, a measurement is presented of dijet production with one jet in the forward region ($3.2 <| \eta |< 4.7$, where eta denotes pseudorapidity) and one jet in the central region ($| \eta |< 2.8$). Differential cross sections are obtained as function of the transverse momentum of the jets. The measurements are compared to perturbative QCD calculations, PYTHIA and HERWIG parton shower event generators, as well as by the CASCADE Monte Carlo.

15:10 4G-6 Event Shape Distributions and Precision alphas(MZ) Determination at NNNLL Order : Iain STEWART (MIT)

Event shapes are observables for jet production that can be computed theoretically to high precision combining perturbative and nonperturbative methods and that can be measured with high precision experimentally. Plenty of data exists from electron-positron colliders (e.g. JADE, LEP I, LEP II) allowing for accurate tests of our understanding of quantum chromo dynamics in the perturbative as well as in the nonperturbative regime. These results are of importance for the LHC where an accurate understanding of quantum chromodynamics is crucial for identifying effects from beyond the Standard Model. Recently, using effective field theory methods based on Soft-Collinear-Effective Theory (SCET) is has become possible to treat the eventshape distributions thrust (T) and heavy jet mass (HJM) at next-to-next-to-next-to-leading (NNNLL) order systematically summing large logarithms, accounting for fixed-order matrix element corrections and the parametrization of nonperturbative power corrections. An important outcome of using the SCET formalism for event shapes is that non-perturbative effects in the different event shapes distributions can be defined field theoretically and related to each other in systematic manner. In this talk I report on the most recent results on thrust and our new theoretical implementation of heavy jet mass at the NNNLL order level. We show how the theory predictions compare to the experimental data and determine the strong coupling αs(MZ) from fits to experimental data in the tail region.

Parallel 4H - Quarkonia - Kresge - Rehearsal B (13:30-15:30)

Chair: Penny Kasper (Fermilab)

13:30 4H-1 Recent Charmonium Results at BESIII Experiment : Cong GENG (University of Science and Technology of China)

In this talk, we will report the results on charmonium physics obtained at the BESIII experiment at the BEPCII collider. The analyses are based on the world largest ψ(2S) data sample with 106 M ψ(2S) decays. The talk includes the study of the S-wave and P-wave spin-singlet states h_c, η_c, and $\eta_c(2S)$; evidence for ψ(2S)$\gamma\pi$0 and $\gamma\eta$; observation of χ_c decays into vector meson pairs, or a photon with a vector meson; and the improved measurement of the three-photon decays of the J/ψ.

13:50 4H-2 Belle Results on B_s Decays and A Search for the h_b particle : Kay KINOSHITA (University of Cincinnati)

We report results on B_s decays from an analysis of Belle's full Upsilon(5S) data sample. Measurements include branching fractions for CP eigenstates of the B_s meson such as $B_s \to J/\psi f_0(980)$. We also report results of a search for the h_b particle using the Υ(5S) data sample.

14:10 4H-3 Upsilon production and polarization from CDF : Matthew JONES (Purdue University)

We present a new measurement of Upsilon(1S), (2S), and (3S) polarization in dimuon events from p-pbar collisions at 1.96 TeV, using the CDF detector at the Tevatron. The measurement is conducted over a pT range of 2-40 GeV/c, based on data comprising an integrated luminosity of 6 fb-1.

14:30 4H-4 Quarkonia Results from ATLAS : Kendall REEVES (UT Dallas)

The inclusive J/Psi production cross-section and fraction of J/Psi produced in B-hadron decays are measured in proton-proton collisions at sqrt(s)=7 TeV with the ATLAS detector at the LHC, as a function of the transverse momentum and rapidity of the J/Psi. From the inclusive production cross-section and fraction of J/Psi produced in B-hadron decays, the differential production cross-sections of prompt and non- prompt J/Psi are determined separately. The Upsilon(1S) production cross-section is also measured. All results are compared to predictions from perturbative QCD calculations.

14:50 4H-5 Quarkonia results from CMS : Roberto COVARELLI (University of Rochester)

This talk presents the J/psi and psi(2S) differential cross sections in pp collisions at 7 TeV, as a function of transverse momentum and in several rapidity ranges, on the basis of the 2010 data collected by CMS, corresponding to an integrated luminosity of 40 inverse picobarns. The B to J/psi and B to psi(2S) fractions will also be presented, and compared to other measurements as well as to theory calculations. The Y production cross section in proton-proton collisions at $\sqrt{\text{s}} = 7$ TeV is measured using a data sample collected with the CMS detector at the LHC. We also report the measurement of the Y(1S), Y(2S), and Y(3S) differential cross sections as a function of transverse momentum and rapidity.

15:10 4H-6 Studies with onia at LHCb : Joel BRESSIEUX (EPFL- Lausanne)

LHCb results will be presented of studies made of the production of $c\bar{c}$ and $b\bar{b}$ states in pp collisions at $\sqrt{s} = 7$ TeV. The range and precision of these measurements will be invaluable in discriminating between theoretical models. Results and prospects will also be shown for so-called exotics, such as the X(3872).

Parallel 4I - Collider Searches Beyond the Standard Model - Kresge - Little Theatre (13:30-15:30)

Chair: Tulika Bose (Boston University)

13:30 4I-1 Searches for new physics in top decays at DØ: Marc-Andre PLEIER (Brookhaven National Laboratory)

We present results on the search for new physics using the sample of top quarks identified in up to 5.4 fb^{-1} of DØdata, using different types of measurements. We present constraints on the production of new 4th generation quarks, of charged Higgs bosons and $t\bar{t}/t\bar{b}$ resonances, as well as constraints on anomalous couplings of the top quark which could lead to new decay channels (FCNC) or to modifications of the production cross sections or the decay distributions (anomalous couplings).

13:50 4I-2 Mass Measurements at the LHC : K.C. KONG (University of Kansas)

I would like to discuss recent development in mass determination in the presence of missing energy, focusing on MT2 based variables. I will also argue that many of the existing mass-measurement variables proposed for hadron colliders (MT , Meff , MT2 , HT , Smin, etc) are far more closely related to each other than is widely appreciated, and indeed can all be viewed as a common transverse quantity specialised for a variety of purposes.

14:10 4I-3 Search for a heavy neutrino and right-handed W of the left-right symmetric model with CMS detector : Alexander GUDE (University of Minnesota)

The left-right (LR) symmetric model explains the origin of the parity violation in weak interactions and predicts the existence of additional heavy right-handed W and Z' gauge bosons. In addition, heavy right-handed neutrino states arise naturally within the LR symmetric model. These neutrinos can be partners of light neutrino states, related to their non-zero masses through the see-saw mechanism. This makes the searches of heavy right-handed W and neutrino interesting and important. This talk is about the first search for signals from the heavy W and N production with the CMS Experiment at the LHC.

14:30 4I-4 Search for New Physics in the Top Sector : Benjamin AUERBACH (Yale University)

The Tevatron has now delivered over 10 fb-1 of data. With the Tevatron schedule to shut down in October, the CDF experiment is now utilizing close to the full final dataset in measurements of the properties of the top quark and searches for new physics in the top sector. Searches for 4th generation quarks, measurements of the top quark forward backward asymmetry, and new searches in alternative channels will be presented.

14:50 4I-5 Exotics Searches for New Physics with the ATLAS Detector : Jalal ABDALLAH (Universitat Autonoma de Barcelona)

Studies of high energy leptons at the Large Hadron Collider is one of the most direct and sensitive ways to search for new physics phenomena. The Standard Model predicts relatively low backgrounds to processes with high-pt leptons making them strong candidates for early discoveries. We present the results based on first data collected with the ATLAS detector at the LHC and discuss current sensitivities and future discovery prospects. We summarize the search for new physics in the diphoton final state in pp collisions recorded with the ATLAS detector. The data are confronted with Standard Model predictions. We summarize the analysis of the dijet angular distributions and invariant mass in pp collision data recorded with the ATLAS detector. The data are confronted with Standard Model predictions with the goal of searching for new phenomena: new resonances, contact interactions and gravitationally mediated effects in large extra dimensions, including gravitational scattering, quantum micro-black holes. We summarize the analysis of top and top-like final states in pp collision data recorded with the ATLAS detector. The data are confronted with Standard Model predictions with the goal of searching for new phenomena: new resonances, 4th generation quarks and heavy gauge bosons.

Parallel 4J - Top Quark Physics - Kresge Auditorium (13:30-15:30)

Chair: Steve Nahn (MIT)

13:30 4J-1 Tevatron Results on Top Quark Physics : Zhenyu YE (Fermilab)

We present measurements of the cross sections for top-antitop production via the strong interaction and of the electroweak production of single top quarks in proton-antiproton collisions at a center-of-mass of 1.96 TeV at the Fermilab Tevatron. In addition to presenting results for the total cross sections we also investigate differential distributions, present results on the forward-backward asymmetry and on the correlations of the spins of the two top quarks, the helicity of W bosons from top decays, and color flow studies in ttbar events. For the electroweak production, we investigate separately different classes of diagrams leading to the single top final state. Finally we present new methods for measuring the top quark mass and width.

14:00 4J-2 Top quark cross section measurements with CMS : Jan STEGGEMANN (RWTH)

We present precise measurements of the top quark pair production cross section at 7 TeV, performed using CMS data collected in 2010-2011. The total cross section is measured in the lepton+jets, dilepton and fully hadronic channels, including the tau-dilepton and tau+jets modes. The results are combined and confronted with precise theory calculations. We also obtain an indirect constraint on the top quark mass through its relation to the cross section. Various differential cross sections are measured as well and compared with theoretical models. Measurements of the top pair invariant mass distribution are used to search for new particles decaying to top pairs. Further results include measurements of the top pair charge asymmetry.

14:30 4J-3 Top Quark Production Measurements at ATLAS : Robert CALKINS (Northern Illinois)

We present measurements of the top-quark pair-production cross-section and studies of single-top quark production in proton-proton collisions at $\sqrt(s) = 7$ TeV with the ATLAS detector at the Large Hadron Collider using the full 2010 data sample. A variety of channels is considered.

14:50 4J-4 Top Quark Mass and Properties at ATLAS : Duc Bao TA (University of Amsterdam/NIKHEF)

We present results obtained in the lepton+jets and dilepton channels, with emphasis on the current understanding of the systematic uncertainties.

15:10 4J-5 Top Quark Mass from Reconstruction : Andre HOANG (University of Vienna)

Quark masses are scheme-dependent quantities and the well-known pole mass is not well-defined at the strict field theoretic level, so careful thought has to be applied to answer the question of what top quark mass is measured at the Tevatron and LHC when its invariant mass is reconstructed using Monte Carlo generators. I explain the problem and show how the issue is resolved for electron-positron collisions via a factorization theorem that can be derived from Soft-Collinear-Effective Theory. The implication of these results for interpreting Tevatron and LHC top mass measurements are described.

Parallel 4K - Heavy Ion Collisions and the QCD Phase Diagram - W20-407 (13:30-15:30)

Chair: Sevil Salur (UC Davis)

13:30 4K-1 Two Critical Points in the NJL Model Phase Diagram for QCD : Marcus PINTO (Dept of Physics, Universidade Federal de Santa Catarina, Brazil)

Although most of the results obtained up to now seem to support the QCD critical point, an interesting observation against its existence comes from the work by de Forcrand and Philipsen who, from numerical simulations of QCD at imaginary chemical potential, observed that the region of quark masses where the transition is presumably of the first order (for quark masses smaller than the physical ones), tends to shrink for small positive values of the chemical potential. Conversely, according to models supporting the critical point, the first order region should expand when the chemical potential increases, so that the physical quark mass point hits the critical line at some finite value of the temperature and chemical potential. A possible explanation for this discordance has been given by Fukushima who pointed out that a strong (repulsive) vector coupling may account for the initial shrinkage of the first order region, that would then start expanding again at larger values of the chemical potential. As a result, two critical points might appear for a given range of (small) quark masses, as argued by Bowman and Kapusta who investigated the Linear Sigma Model including thermal fluctuation and considered small values for the pion mass. These points are located at the end of two first order transition lines. One of them is the usual line which starts at zero temperature and chemical potential of the order of the constituent quark mass while the other is an unusual line which starts at zero chemical potential and high temperature. Interestingly enough, these findings suggest the possibility of a rich structure for the QCD phase diagram in a situation which is similar to the one which arises in metamagnetic systems whose phase diagram may display two critical points in the magnetic field versus temperature plane. Here, we exploit the two flavor Nambu—Lasinio beyond the large-N approximation when small finite pion (and quark current) masses are considered. Then, vector contributions, which are 1/N suppressed naturally appear on the thermodynamical potential leading to the appearance of two critical points. Our findings indicate that the first order line observed at low chemical potential and high temperature has a more "chiral" character while its low temperature and high chemical potential counterpart displays characteristics typical of a "liquid-gas" phase transition. We investigate different observables near these critical points. Our results also seem to support the back-bending of the critical line in the chemical potential-current mass which could reconcile the lattice findings by de Forcrand and Philipsen with most model predictions. It is also shown that the large-N approximation completely misses the possibility of more than one critical point.

14:00 4K-2 Fermion spectrum at ultrasoft region in a hot QED/QCD plasma : Satow DAISUKE (Kyoto University)

We discuss that the fermion spectrum at an ultrasoft-momentum region in quantum electrodynamics (QED) and quantum chromodynamics (QCD) at high temperature T. We show that the fermion propagator has a pole at the ultrasoft-momentum region, $\omega << g^2$T, where ω is the energy. The dispersion is ω= v$|\ p\ |$ $-i\gamma$, where v= 1/3is the velocity, γ is the damping rate of order g^2T log(1/g) in the leading order of the coupling constant g. The residue of the pole is weak of order g^2. When a system has conserved charges, soft modes called hydrodynamic modes appear. These hydrodynamic modes are zero mode, i.e., the dispersion of the poles is $\omega = 0$ at $p = 0$. The question is whether such a soft mode exists in the fermionic sector, when the system has a peculiar symmetry of the fermions. We show that the pole at the ultrasoft region is related to chiral symmetry, although it is not the exact zero mode. In order to obtain the correct pole, one have to sum over relevant diagrams beyond the hard thermal loop approximation even in the leading order. This is similar to the calculation of transport coefficients [1]. We analytically obtain the pole of the fermion propagator and its residue in the leading order by summing over the relevant diagrams. Such pole was also suggested in Ref. [2], in which the self-consistent equation was shown; however it has not been solved. We also discuss whether this phenomena is robust in the fermion-boson system in the chiral limit in the weak coupling theory.

[1] S. Jeon, Phys. Rev. D52, 3591 (1995); Y. Hidaka and T. Kunihiro, arXiv:1009.5154. [2] V. V. Lebedev and A. V. Smilga, Annals Phys. 202, 229 (1990).

14:30 4K-3 Facets of the QCD Phase diagram : Jochen WAMBACH (TU Darmstadt)

I discuss recent developments in the theoretical exploration of the phase diagram of strong interaction matter. Special emphasis is put on the possible existence and size of the so-called 'quarkyonic phase' as well as the occurrence of inhomogeneous chiral phases at large quark chemical potentials and moderate temperatures.

14:50 4K-4 Production of Strange Baryons in Au+Au collisions at RHIC from $\sqrt{s_{NN}}$ 7.7 to 200 GeV : Feng ZHAO (University of California, Los Angeles)

Strange baryon production has been suggested to be sensitive to the dynamics of the Quark-Gluon Plasma in heavy ion collisions. The strange baryon spectra and antibaryon to baryon ratios provide information on the chemical freeze-out parameters of final state, such as temperature (T), baryon chemical potential (μ_B) and strangeness chemical potential (μ_S). In 2010, the Solenoidal Tracker at RHIC (STAR) took Au+Au data at beam energies of 7.7 GeV, 11.5 GeV, 39 GeV and 200 GeV. The production of Λ, Ξ^-, Ω^- and their antiparticles at mid-rapidity from these colliding energies is studied. The strange baryon spectra and antibaryon to baryon ratios will be reported. The physics implications, in particular the constraints on chemical freeze-out parameters, will also be discussed.

15:10 4K-5 Charge Asymmetry Measurements at ALICE : Jim THOMAS (Lawrence Berkeley National Lab)

Parity-odd domains, corresponding to nontrivial topological solutions of the QCD vacuum, may be created during relativistic heavy-ion collisions. These domains are predicted to lead to charge separation of quarks along the system's orbital momentum axis. We investigated a three-particle azimuthal correlator which is a P even observable, but directly sensitive to the charge separation effect. We have made measurements with charged hadrons near center-of-mass rapidity with this observable in Pb-Pb collisions at rootS 2.76 TeV using the ALICE detector at the LHC. The observed signals will be compared to the results obtained at RHIC and to different model predictions. We will review what we know about the energy scaling properties of the proposed phenomena and discuss possible contributions from other effects that are not related to parity and CP violation.

Parallel 4L - Hard Probes, AdS/CFT and Heavy Ion Collisions - W20-491 (13:30-15:30)

Chair: Constantin Loizides (LBNL)

13:30 4L-1 Hard Probes and the AdS/CFT Correspondence: Theory and Predictions : Jorge NORONHA (Universidade de Sao Paulo)

In this talk I will review the recent theoretical developments concerning the application of the AdS/CFT correspondence to the study of highly energetic probes in the quark-gluon plasma. I will present not only the novel generic properties displayed by jets at strong coupling but also some detailed predictions involving the attenuation of jets that can be falsified at RHIC and LHC.

14:00 4L-2 Gravitational collapse and far from equilibrium dynamics in holographic gauge theories : Paul CHESLER (MIT)

In recent years holography has emerged as a powerful tool to study non-equilibrium phenomena in certain quantum theories, mapping challenging quantum dynamics onto the classical dynamics of gravitational fields in one higher dimension. One interesting process accessible with holography is the formation of a quark-gluon plasma in strongly coupled non-Abelian gauge theories. In the dual gravitational description, the formation of a quark-gluon plasma maps onto the process of gravitational collapse and black hole formation. I will describe how one can use techniques from numerical relativity to study this process.

14:30 4L-3 Testing pQCD and AdS/CFT Energy Loss at RHIC and LHC : William HOROWITZ (University of Cape Town)

The stunning quantitative success of perturbative QCD (pQCD) calculations of high-pT light leading particle suppression in heavy ion collisions at RHIC is called into question by its inability to simultaneously describe the normalization and azimuthal anisotropy of this pattern, the suppression of the decay fragments of heavy quarks, or the suppression of triggered away-side yields at RHIC nor quantitatively the suppression at both RHIC and LHC. Surprisingly, strong coupling methods based on the AdS/CFT correspondence currently provide the best qualitative understanding of both light parton and heavy quark quenching and their correlations in the quark gluon plasma (QGP) created at RHIC. While neither approach is falsified or verified conclusively by the current data, future measurements from RHIC and LHC should resolve the puzzle. Transitioning then to quantifying the properties of the QGP medium will be difficult due to the simplifying approximations made in order to maintain analytic control over the calculations; however much progress is being made in identifying and eliminating the major sources of theoretical uncertainty in these energy loss models.

14:50 4L-4 Jet Modification Via The LPM Effect In Infinite Quark Matter : Christopher COLEMAN-SMITH (Duke Physics)

Recent results for Pb+Pb collisions at centre of mass energies of 2.76 TeV from the LHC have shown dramatic di-jet asymmetry, implying a strong medium modification of jets as they pass through the QGP. A fully-relativistic Monte-Carlo Boltzmann transport code, the Parton Cascade Model (PCM), is used to simulate the development of a jet in a partonic medium. The PCM includes collisional and radiative processes and a local probabilistic implementation of the Landau-Pomeranchuck-Migdal (LPM) effect. The PCM is particularly suitable for the examination of jet modification as it treats both medium and jet partons on an equal footing, allowing for full tracking of the process. We present the first infinite matter results, including an accurate treatment of the LPM effect, for the energy flow within the jet cone alongside results for the rate at which energy lost from the jet is deposited back into the medium. We also apply our simulation to the observed ATLAS dijet asymmetry.

15:10 4L-5 Momentum Broadening in Weakly Coupled Quark-Gluon Plasmas : Mindaugas LEKAVECKAS (MIT)

Jet quenching parameter is an important quantity in order to understand energy losses in heavy ion collisions and to get insights into properties of deconfined quark-gluon plasmas. Soft Collinear Effective theory provides framework to define momentum broadening of probing quark/gluon and thus define jet quenching parameter as the expectation value of two space-like separated light-like Wilson lines which can be evaluated for the desired medium. In this work we evaluate jet quenching parameter at weak coupling for quark-gluon plasmas in thermal equilibrium using Hard Thermal Loop resummed effective thermal field theory.

Parallel 5A - Diffractive and small-x - W20-307 (Mezzanine Lounge) (16:00-17:40)

Chair: Rolf Ent (JLab)

16:00 5A-1 Diffractive Measurements in ATLAS : Kate SHAW (Universita di Udine, INFN)

Kinematic regions with an enhanced sensitivity to diffraction are defined, and events are selected in the ATLAS detector either by vetoing events either with signals in scintillators in the forward region, or by requiring regions in the calorimeter with low or no energy deposited. The measured cross sections and distributions are compared to available models of diffractive processes in proton-proton collisions.

16:20 5A-2 Hard diffraction at CMS : Antonio VILELA PEREIRA (Univ. di Torino e Sez. dell'INFN)

The observation of jet production at the LHC in pp collision events with a large rapidity gap is presented. Using data collected by the CMS experiment in 2010, corresponding to an integrated luminosity of 3 pb-1, an acceptance corrected measurement of the ratio of diffractive to inclusive dijet production is obtained for proton momentum losses smaller than 0.00316. The rapidity gap survival probability is estimated from the comparison of data to predictions of the POMPYT generator. The observation of the production of W and Z bosons at the LHC in pp collision events with a large rapidity gap is presented. Using data collected by the CMS experiment in 2010, corresponding to an integrated luminosity of 35 pb-1, a detailed study of the event structure and the energy distribution in the forward region of w and Z events is presented. These contain also event samples which are dominated by diffractive interactions.

16:40 5A-3 Soft QCD measurements in the forward direction with the LHCb experiment : Sebastian SCHLEICH (University of Dortmond)

LHCb presents studies of particle production in minimum bias events in pp collisions at $\sqrt(s) = 7$ TeV. These studies include measurements of strangeness production, particle ratios, baryon-antibaryon ratios and charged particle production. The forward coverage and low p_T acceptance of the experiment makes these measurements very complementary to those performed by the central detectors at the LHC. Further benefits arise from the powerful particle identification capabilities provided by the LHCb RICH system. The measurements are compared with theoretical predictions.

17:00 5A-4 W and Z Production Measured Using the ATLAS Detector, and Impact on Partons Densities of the Proton : Sofia CHOURIDOU (UC Santa Cruz)

Differential and inclusive cross sections for W and Z production are presented, as well as the lepton charge asymmetry as a function of lepton rapidity. The data from pp collisions at 7 TeV were collected during 2010 using the ATLAS detector, are compared to the predictions of next-to-leading-order QCD with a variety of parton density fits. The impact of these measurements on the knowledge of the structure of the proton is discussed.

17:20 5A-5 Combined Measurement of the Inclusive Diffractive Cross Sections at HERA : Valentina SOLA (Torino)

A combination is presented of the inclusive diffractive cross section measurements made by the H1 and ZEUS collaborations at HERA. The analysis uses all available data which employed the Large Rapidity Gap technique on deep inelastic scattering data recorded between 1997 and 2007. Correlations of systematic uncertainties are taken into account by the combination method, resulting in improved precision.

Parallel 5B - Outlook - W20-306 (20 Chimneys) (16:00-17:40)

Chair: Christine Aidala (LANL)

16:00 5B-1 Opportunities in ep Physics at an Electron-Ion Collider : Marco STRATMANN (Brookhaven National Laboratory)

The Electron-Ion Collider (EIC) is proposed to deliver electron-nucleon and electron-nucleus collisions at unprecedented luminosities, allowing for precision studies of the spatial, momentum, and spin structure of hadronic matter well beyond the limits of any existing facility. In my talk I shall focus on the compelling case for spin physics at an EIC. I will discuss some of the anticipated key measurements to unravel the helicity structure of the proton down to small momentum fractions x including novel electroweak probes and the path leading to a $2 + 1$ dimensional image of the nucleon in momentum space as obtained from transverse momentum dependent (TMD) parton densities. TMDs encode the intrinsic transverse motion and spin-orbit correlations of partons, are deeply linked to the physics of Wilson lines, and exhibit non-trivial factorization properties.

16:30 5B-2 Imaging of Sea Quarks and Gluons with an Electron-Ion Collider : Tanja HORN (Catholic University of America)

Hadrons in QCD are relativistic many-body systems, with a fluctuating number of elementary quark/gluon constituents and a very rich structure of the wave function, for instance, distinct components in different kinematic regions. The 12 GeV upgrade at Jefferson Lab will bring many new opportunities to probe the valence quark structure of strongly interacting systems, which can be described with methods of nuclear physics. These include searches for exotic bound states and 3D imaging of the three valence quarks inside the nucleon. An Electron-Ion Collider (EIC), a next generation facility, will allow for studies of the fundamental structure of matter by directly probing the force carriers of QCD, the gluons, and the sea of virtual quarks inside both nucleons and nuclei. In this talk I will discuss the exciting prospects of studying the landscape of nucleon structure using exclusive reactions, and in particular the gluon and sea quark imaging of the nucleon.

17:00 5B-3 Small-x physics opportunities with a Large Hadron-electron Collider at CERN : Nestor ARMESTO (Universidade de Santiago de Compostela)

I will show the possibilities for small-x physics studies offered by the proposed electron-proton and ion collider at CERN, the Large Hadron-electron Collider [1]. After a short introduction on open problems at small x, I will present the machine and detector. Then I will focus on small-x aspects in both ep and eA, first on inclusive measurements and then on diffraction. I will finish by discussing some opportunities for final state and photoproduction studies.

[1] M. Klein et al., Prospects for a Large Hadron Electron Collider (LHeC) at the LHC, EPAC'08, 11th European Particle Accelerator Conference, 23-27 June 2008, Genoa, Italy; http://cern.ch/lhec.

Parallel 5C - Meson Decays - W20-201 (West Lounge) (16:00-17:40)

Chair: Eugene Pasyuk (JLab)

16:00 5C-1 Precision Measurement of Gamma(Ke2)/ Gamma (Kmu2) Ratio using Stopped Positive Kaons at J-PARC : Suguru SHIMIZU (Osaka University)

The TREK collaboration is proposing a precise measurement of Rk= $\Gamma(K^+ \to e^+\nu)/\Gamma(K^+ \to \mu^+\nu)$ ratio to test lepton universality at J-PARC. The experiment will be performed with a stopped K^+ technique using the TREK detector system based on the 12-sector iron-core toroidal superconducting spectrometer and the CsI(Tl) calorimeter, which has been developed to search for the experiment to search for T-violating transverse muon polarization in the $K^+ \to \pi^0\mu^+\nu$ decay. The Standard Model (SM) prediction for the Rk value is highly precise (δ Rk/Rk= 0.5×10^{-3}), and a deviation from this value could very clearly indicate the existence of New Physics beyond the SM. A possible mechanism how SUSY Lepton Flavor Violation can affect lepton universality has been discussed. The non-vanishing e-τ lepton mixing can change the Rk value from the SM prediction at the percent level.

We aim at achieving an uncertainty for Rk of better than δ Rk/Rk= 2×10^{-3}, which is about half of the current uncertainty from the NA62 and KLOE experiments. Since the NA62 and KLOE groups adopted an in-flight-kaon decay method, the systematic uncertainties are from the proposed J-PARC experiment and it is worth checking the Rk value using a different kinematical approach. Such independent measurements are complementary, and comprehensive studies are very important to increase the experimental reliability. Taking into account these points, we aim at achieving an uncertainty for Rk of better than δ Rk/Rk= 2×10^{-3} at J-PARC.

In this talk, an overview of the Rk experiment, results from recent R activities, and the current project status will be presented. Also, the performance of the recently commissioned K^+ beamline K1.1BR at the new J-PARC Hadron Facility will be reported.

16:20 5C-2 Test of Chiral Perturbation Theory with ke4 decays at NA48 : Cristina BIINO (Turin University)

The NA48/2 collaboration has accumulated ∼45000 semi-leptonic K charged decays to pi0 pi0 e+- neutrino (Ke400), increasing the world available statistics by more than two orders of magnitude. Low background contamination and very good pi0 reconstruction bring the first precise measurement of the Branching Fraction and decay Form Factor at the percent level. Concurrently, more than one million K charged decays to pi+ pi- e+- neutrino (Ke4+-) have been analyzed, leading to an improved determination of the Branching Fraction by a factor of 3 and detailed Form Factor studies. Comparison of both Ke4 modes decay properties allows a test of chiral symmetry relations and ChPT predictions at unprecedented level.

16:40 5C-3 A New Determination of the Kpipi Matrix Element of the Electroweak Penguin Operator in the Chiral Limit : Kim MALTMAN (York University)

The Standard Model SU(3) chiral limit K pi pi matrix element of the electroweak penguin operator, Q_8, is related by chiral symmetry to the vacuum expectations of the dimension D=6 operators appearing in the OPE expansion of the difference of the flavour ud (isovector) vector (V) and axial vector (A) current-current correlators [1]. The matrix element of Q_8 is an important ingredient in assessing Standard Model expectations for epsilon'/epsilon. A number of determinations of the relevant D=6 condensates exist in the literature, obtained using dispersive and/or sum rule approaches [2]. To date none of these includes studies of the impact of possible "duality violations" (OPE breakdown) sufficient to allow one to reliably quantify the systematic errors resulting from the neglect of such effects. In this paper we report on the results of an investigation of the impact of duality violating (DV) effects based on a physically well-motivated model for

DV contributions to the V and A correlators [3]. The model has been tested in an analysis used to extract α_s from hadronic tau decay data and found to allow accurate theoretical representations of, not just the physical V and A spectral functions, but also of weighted integrals of the V and A spectral distributions involving "unpinched" weights, none of which can be well produced using the OPE representations of the V and A correlators alone [4]. Here we show, first, that the theoretical spectral representations produced by the fitted values of the V and A channel DV parameters obtained in the earlier analysis beautifully satisfy the classical chiral sum rules, which must be obeyed by the physical ud V-A correlator, providing a further test of the input V and A channel analyses. With the V and A channel DV contributions so constrained, we proceed to perform a dedicated analysis of the ud V-A channel. The analysis is designed specifically to optimize the accuracy of the extraction of the V-A D=6 condensates and employs carefully chosen finite energy sum rules involving the ud V-A correlator, using (i) experimental spectral data and (ii) the DV contributions, as constrained by the earlier V and A analyses, as input. We report in this presentation on the results of this analysis.

* Contribution presenter

[1] J.F. Donoghue and E. Golowich, Phys. Lett. B478 (2000) 172

[2] For some details, discussions of several of the other analyses, and comments about the issue of DV, see V. Cirigliano, E. Golowich and K. Maltman, Phys. Rev. D68 (2003) 054013

[3] For a description of the DV model, and its application to the V and A spectral functions, see, e.g., O. Cata, M. Golterman and S. Peris, Phys. Rev. D79 (2009) 053002

[4] A discussion of the analysis strategy, as well as preliminary results of the α_s extraction, can be found in D. Boito et al., arXiv: 1011.4426 [hep-ph] and the slides of M. Goltermans talk at the Workshop on Precision Determinations of α_s, Munich, Feb. 9-11, 2011.

17:00 5C-4 Hadron Physics at KLOE-2 : Federico NGUYEN (Roma Tre University; INFN)

The KLOE experiment has collected 2.5 fb^1 at the peak of the phi resonance at the e+e- collider DAPHNE in Frascati. The whole data set includes 100 million eta's produced through the radiative decay $\phi \rightarrow \eta\gamma$ and tagged by means of the monochromatic recoil photon. Measurements of η decay channels, such as $\pi+\pi-\gamma, e+e-e+e-$, are in progress. Pseudoscalar production at the phi-factory associated to internal conversion of the photon into a lepton pair allows the measurement of the form factor $F(q1^2 = M(\phi)^2, q2^2 > 0)$ of pseudoscalar mesons in the kinematical region of interest for the VMD model. The only existing data on $\phi \rightarrow \eta e + e-$ are based on 213 events. At KLOE, a preliminary study of this decay has been performed on 739 pb-1 using the $\eta \rightarrow \pi + \pi - \pi\ 0$ final state. Simple analysis cuts provide about 7000 signal events with very small residual background contamination. From a sample of 240 pb-1 taken off the phi resonance, a preliminary analysis of the $e+e- \rightarrow e+e-\eta$ process, without tagging e+e- in the final state is presented. Using two different decay channels, $\eta \rightarrow \pi+\pi-\pi 0 and \eta \rightarrow \pi^0\pi^0\pi^0$, the cross section of the process $e+e- \rightarrow e+e-\eta$ is extracted. The same data set has been used to search for the f0(600) that can be produced in gamma-gamma interactions and observed in the reaction $e+e- \rightarrow e+e-\pi 0\pi 0$. The preliminary $\pi 0\pi 0$ mass spectrum show an excess of events with respect to the expected background in the f0(600) mass region. A new beam crossing scheme allowing for a reduced beam size and increased luminosity is operating at DAPHNE. The KLOE-2 detector is successfully rolled in this new interaction region and is ready to acquire collision data. At the moment, the detector is being upgraded with small angle tagging devices, to detect both high and low $e+e$- energy in $e+e- \rightarrow e+e-$ X events. The inner tracker and small angle calorimeters are scheduled to be installed in a subsequent step, providing wider acceptance for both charged particles and photons. The main goal of KLOE-2 is to collect an integrated luminosity of about 20 fb^-1 in 2-3 years in order to refine and extend the KLOE physics programme.

17:20 5C-5 DN Interaction from Meson Exchange : Laura TOLOS (ICE (CSIC-IEEC))

We present a model for the interaction of D-mesons with nucleons which has been developed in close analogy to the meson-exchange antikaon-nucleon (KbarN) potential of the Juelich group using SU(4) symmetry constraints. The interaction model generates the $\Lambda_c(2595)$ resonance dynamically as a DN quasi-bound state. Results for DN total and differential cross sections as well as DN scattering lengths are presented and compared with predictions of two recent interaction models that are based on the leading-order Weinberg-Tomozawa term. Some experimental features of the $\Lambda_c(2595)$ resonance are discussed. Selected predictions of the original KbarN model are reported too. Specifically, it is pointed out that the model generates two poles in the partial wave corresponding to the $\Lambda_c(1405)$ resonance, the counterpart of the $\Lambda_c(2595)$ in the strange sector.

Parallel 5D - Nuclear Astrophysics II - 4-149 (16:00-17:40)

Chair: Igor Shovkovy (Arizona State University)

16:00 5D-1 Nucleation of antkaon condensed matter in hot neutron stars : Sarmistha BANIK (Saha Institute of Nuclear Physics)

A first order phase transition from nuclear matter to antikaon condensed matter may proceed through thermal nucleation of a critical droplet of antikaon condensed matter during the early evolution of proto neutron stars. Droplets of new phase having radii larger than a critical radius would survive and grow, if the latent heat is transported from the droplet surface to the metastable phase. We investigate the effect of thermal conductivity and shear viscosity on the thermal nucleation time of the droplets of antikaon condensed matter.

These transport properties might play important role in the thermal nucleation of a new phase. We calculate the shear viscosity and thermal conductivity of neutron star matter composed of n, p, e^-, μ, using Boltzmann kinetic equation in the relaxation time approximation. The calculation of shear viscosity and nucleation time involves the equation of state (EoS) as an input, that we construct for neutron star matter undergoing a first order antikaon condensation within the framework of relativistic field theoretical model.

It is noted that thermal nucleation time is strongly dependent on the surface tension. We also observe that the prefactor in the nucleation rate, which includes the shear viscosity and thermal conductivity, is enhanced by several orders of magnitude compared with the T 4 approximation of earlier calculations. Consequently the thermal nucleation time in the latter case overestimates our result.

Further, we study the thermal nucleation in the neutrino trapped case. At a temperature 10 MeV, the trapped neutrinos transport most of the energy and momentum, and might contribute considerably towards the transport coefficients. We report the effects of shear viscosity and thermal conductivity on the nucleation of antikaon condensed phase in neutrino-trapped matter.

16:20 5D-2 The Lattice QCD study of the Three Nucleon Force : Takumi DOI (University of Tsukuba)

Recently, it has been realized that the three nucleon forces play an important role in various nuclear/astro physics, e.g., light nuclear systems, neutron rich nuclei, the equation of state of the symmetric/asymmetric nuclear matter and the phenomena in the neutron star core. In this talk, we present the lattice QCD calculation of the three nucleon force, utilizing the Nambu-Bethe-Salpeter (NBS) wave function. The calculation of the three nucleon system is, however, quite challenging: enlarged degrees of freedom make the calculation cost divergent, and the identification of genuine three nucleon force is also nontrivial. We present a new formulation to determine the genuine three nucleon force, and the result of the three nucleon force in triton channel from dynamical clover fermion lattice QCD is presented.

16:40 5D-3 The Lead Radius Experiment PREX : Dustin MCNULTY (Thomas Jefferson National Accelerator Facility)

The PREX experiment at Jefferson Lab has measured the parity-violating electroweak asymmetry in the elastic scattering of polarized electrons from 208Pb at an energy of 1.06 GeV and a scattering angle of 5◦. Since the Z0 boson couples mainly to neutrons, this asymmetry provides a clean measurement of the neutron RMS radius Rn of the lead nucleus. In addition to being a fundamental test of nuclear models, a precise measurement of Rn pins down the density dependence of the symmetry energy of neutron rich nuclear matter, which has impacts on neutron star structure, heavy ion collisions, and atomic parity violation experiments. The results from the first measurements performed in 2010 will be presented. Prospects for follow-up experiments with 208Pb and 48Ca will be discussed.

17:00 5D-4 EMC Effect, Short-Range Correlations in nuclei and Neutron Stars : Mark STRIKMAN (Penn State University)

Photons, as well as quarks and gluons, are constituents of the infinite momentum frame (IMF) wave function of an energetic particle. They are mostly equivalent photons whose amplitude follows from the Lorentz transformation of the particle rest frame Coulomb field into the IMF and from the conservation of the electromagnetic current. Recently we evaluated in a model independent way the dominant photon contribution to the nuclear structure [1]. In addition we shown that the definition of x consistent with the exact kinematics of eA scattering (with exact sum rules) works in the same direction as the nucleus field of equivalent photons. Combined, these effects account for the bulk of the EMC effect for $x \leq 0.55$ where Fermi motion effects are small. In particular, for these x the hadronic mechanism contribution to the EMC effect does not exceed $\sim$3% for all nuclei. Also the A-dependence of the hadronic mechanism of the EMC effect for $x > 0.5$ is significantly modified making it consistent with the A-dependence of the average kinetic energy of nucleon in nuclei which is dominated by the contribution of the short-range correlations (SRC). Our analysis implies that hadronic non-nucleonic effects are much smaller than was previously thought. They are concentrated at larger $x > 0.55$ which matches well expectations of the minidelocalization model [2] of the EMC effect in which only small size rare configurations of bound nucleons are strongly deformed. The deformation is expected to be proportional to the average virtuality of nucleons, which is also consistent with the data. Smallness of the admixture of the non-nucleonic degrees of freedom in nuclei is also indicated by the theoretical analysis of the recent BNL and Jlab data which directly observed the pn and pp SRCs in nuclei [3]. Smallness of the non-nucleonic degrees of freedom in nuclei matches well the recent observation of a two-solar mass neutron star. We discuss also implications of these recent developments for direct searches of non-nucleonic degrees of freedom in nuclei, and the tagged EMC effect.

References

[1] L.Frankfurt, M.Strikman, Phys. Rev. C82, 065203 (2010). [2] L.L.Frankfurt, M.I.Strikman, Nucl. Phys. B250, 143-176 (1985) [3] L.Frankfurt, M. Sargsian, M.Strikman, Int.J.Mod.Phys. A23, 2991-3055 (2008).

Parallel 5E - Neutrino Experiments II - 4-163 (16:00-17:40)

Chair: Kimihiro Okumura (Institute for Cosmic Ray Research, University of Tokyo))

16:00 5E-1 The Nucifer Experiment: Non Proliferation with Reactor Antineutrinos : Andi Sebastian CUCOANES (IRFU/SPP, CEA Centre de Saclay)

Nuclear reactors are the most intense sources of terrestrial antineutrinos. This characteristic made them interesting for neutrino physics since the early times of the first antineutrino detection. Antineutrinos are generated in the decay chains of the of the fission products, thus a survey of the neutrino flux close to a reactor provides information related to the core content and the thermal power. This application arouses the International Atomic Energy Agency (IAEA) interest in using antineutrino detectors as a potential safeguard tool. A dedicated working group, which coordinates the simulation effort of various reactor types and defines the end product to be used by the agency, has been created in 2010. The detectors included in the safeguard program should be a good compromise between detection performances and design constrains related to safety, low cost and size reduction.

After a brief review of the existing projects in the field of reactor monitoring with antineutrino, we present the Nucifer experiment, under development at Saclay, France. The detection mechanism is based on the inverse beta reaction in a volume of one cubic meter of liquid scintillator viewed by 16 photomultiplier tubes. An antineutrino event is characterized by two energy depositions: a prompt one from the positron annihilation gammas and a delayed one from the neutron capture. In order to reduce the time of coincidence, the scintillator is loaded with gadolinium. The detection efficiency for antineutrino events is $\sim$50%. An important challenge of the Nucifer detector design is the minimization of the background influence. An active veto made by plastic scintillator plates will tag cosmic rays and a passive shielding will reduce dramatically the background coming from external neutrons and gamma rays.

In addition, special precautions are taken in order to reduce the internal background given by the radioactivity in the detector materials. The Nucifer detector is going to be deployed at the CEA-OSIRIS research reactor (70MW). First antineutrino event is expected by summer 2011.

The future plans are to deploy Nucifer at the ILL nuclear research reactor, and then close to a commercial power reactor.

16:20 5E-2 Project 8: Using Radio Frequency Techniques to Measure the Neutrino Mass from Beta Decay : Benjamin MONREAL (University of California - Santa Barbara)

We propose a novel technique by which the energy spectrum of low energy electrons can be extracted. The technique relies on the detection and measurement of coherent radiation created from the cyclotron motion of electrons in strong magnetic elds. Since the frequency of cyclotron radiation emitted by the particle depends inversely on its Lorentz boost, the detection and measurement of the coherent radiation emitted is tantamount to measuring the kinetic energy of the electron. As the technique inherently involves the measurement of a frequency in a non-destructive manner, it can, in principle, achieve a high degree of resolution and accuracy. One immediate realization of this technique is in the measurement of the endpoint spectrum from tritium beta decay, which is directly sensitive to the absolute mass scale of neutrinos. In this poster, we discuss a new experimental effort, known as Project 8, to utilize this technique towards a sensitive beta decay neutrino mass experiment.

16:40 5E-3 The JEM-EUSO Mission and Its Potential for Neutrino Observation at Extreme High Energies : Piero GALEOTTI (University of Torino)

JEM-EUSO (Extreme Universe Space Observatory on-board Japanese Experiment Module of the International Space Station) is a science mission planning to observe particles with extreme energies above few times 1019 eV. This observation will be performed by the detection of the fluorescence light emission, time and space-resolved, following the traces of the particles in the Earth atmosphere. Its privileged position at about 400 km above the Earth surface, combined with a large field of view, innovative optics and a high efficiency focal surface, results in an unprecedented atmospheric target volume ($\sim$1012 ton), three orders of magnitude higher than the current or foreseen projects in South Pole or in the Mediterranean sea, opening the possibility of neutrino observation and high energy neutrino astronomy, at least above energies of the order of few 1019 eV or so. In this contribution the mission itself and the potential of JEM-EUSO for neutrino observation will be described.

17:00 5E-4 A Quantum Sensor for Applications in Neutrino Mass Spectrometry : Daniel RODRIGUEZ (University of Granada)

The most-suited instrument for high-accuracy mass and therefore for high-accuracy Q-value- determinations is the Penning trap. However, the most-advanced type of Penning trap mass spectrometer up to date needs a drastic improvement in order to contribute from a Q-value measurement to the mass determination of the electron antineutrino at the level of 10-11 as pursued by the international MARE collaboration measuring the end-point of the decay 187Re to 187Os.

In this contribution, a novel device, called quantum sensor, is proposed to measure the mass of a single ion with ultimate accuracy and unprecedented sensitivity while it is stored and cooled in a trap. The quantum sensor is made of a “reference” ion suspended in vacuum by the electric and magnetic field of a Penning trap, and laser cooled to very low temperatures. By “wiring” this ion with the ion of interest, the mass of the later can be determined from its cyclotron frequency using the fluorescence of the reference ion. The method will be presented and the proposed experiment in order to determine the Q-value in the decay 187Re to 187Os will be described in detail. Other applications of the quantum sensor will be underlined.

17:20 5E-5 Search for Neutrino-less Double Beta Decay with CANDLES : Saori UMEHARA (Osaka University)

Neutrino-less double beta decay ($0\nu\beta\beta$) is acquiring great interest after the confirmation of neutrino oscillation which demonstrated nonzero neutrino mass. Measurement of $0\nu\beta\beta$ provides a test for the Majorana nature of neutrinos and gives an absolute scale of the effective neutrino mass. Among double beta decay nuclei, 48Ca has an advantage of the highest $Q\beta\beta$-value (4.27 MeV). This large $Q\beta\beta$-value gives a large phase-space factor to enhance the 0 rate and the least contribution from natural background radiations in the energy region of the $Q\beta\beta$-value. Therefore good signal to background ratio is ensured in the measurement of $0\nu\beta\beta$. In order to search for $0\nu\beta\beta$of 48Ca, we proposed CANDLES system by using CaF2 scintillators. The CANDLES system aims at a high sensitive measurement by a characteristic detector structure and 48Ca enrichment. The detector structure realizes a complete 4π active shield by immersion of the CaF2 scintillators in liquid scintillator. The active shield leads to a low background condition for the measurement.

On the other band, 48Ca enrichment is also effective for the high sensitive measurement, because natural abundance of 48Ca is very low (0.19%). This means that an improvement of sensitivity by enrichment is a maximum of 20 times for the neutrino mass. However 48Ca enrichment is generally difficult and expensive. Therefore we started the study of 48Ca enrichment of our own and succeeded in obtaining enriched 48Ca although it is a small amount. Now we installed the CANDLES III system, which contained 350 g of 48Ca without enrichment, at the Kamioka underground laboratory. For the performance check, we performed a pre-measurement with the system. And we will start a $0\nu\beta\beta$ measurement in 2011. The sensitivity of the CANDLES III system is 0.5 eV for neutrino mass. Here we will report the current status and future prospects of CANDLES.

Parallel 5F - Neutrino Oscillations II - 4-153 (16:00-17:40)

Chair: Mike Shaevitz (Columbia University)

16:00 5F-1 Neutrino-Long-Baseline Experiments and Nuclear Physics : Ulrich MOSEL (Universitaet Giessen)

Present neutrino long-baseline experiments all use nuclear targets. This makes it mandatory to understand the interactions of neutrinos with nuclei, e.g., for the energy reconstruction. In this talk I will discuss in detail how much information the two generic detector types, Cherenkov and tracking counters, give on the underlying microscopic event. As examples, the MiniBooNE and T2K detectors will be used. I will also discuss how much the uncertainties in the energy reconstruction can affect the flux reconstruction and, correspondingly, the extraction of neutrino oscillation parameters.

16:20 5F-2 Results from MINOS : Lisa WHITEHEAD (Brookhaven National Laboratory)

MINOS is a long-baseline neutrino oscillation experiment situated along Fermilab's high-intensity NuMI neutrino beam. In this talk, I will present the most recent results from MINOS. I'll report on the muon neutrino and anti-neutrino disappearance measurements. I will also discuss the search for muon neutrino to electron neutrino transitions, observation of which would indicate a non-zero value for the neutrino mixing angle $\theta_1 3$.

16:40 5F-3 Hadron Production Measurement in NA61/SHINE Experiment at CERN SPS for the Neutrino and Cosmic Ray Experiments. : Tomasz PALCZEWSKI (Soltan Institute for Nuclear Studies, Warsaw, Poland)

Results on hadron production in p+C interactions at 31 GeV/c obtained from data collected in 2007 by NA61/SHINE detector at the CERN SPS [1-4] are presented. These data are necessary for the improvement of the accuracy of neutrino flux simulations of the T2K neutrino experiment [5]. Knowledge of the pion and kaon production in this region is also important for cosmic ray simulation upgrades needed by the Pierre Auger and KASKADE experiments. For predictions of the T2K neutrino beam parameters, the measurements of the NA61/SHINE experiment were performed on a thin Carbon target as well as on a replica of the target installed at JPARC, Tokai. For neutrino and cosmic ray experiments, dedicated data taking periods were performed during 2007, 2009, and 2010 runs. Final charged pion production cross sections obtained from 2007 pilot run data [6] are discussed. Three different methods of charged pion yields extraction are shown. First, dedicated low momentum dE/dX analysis (below 1GeV/c and 3GeV/c for negatively and positively charged particles, respectively) based on log-likelihood approach. Second, combined dE/dx and Time Of Flight (TOF) information analysis, which can be done in 1-15 GeV/c momentum region. Third, analysis of negatively charged pions in wide momentum range ($0.2 - 15$ GeV/c), which can be performed using Monte Carlo information for global corrections even without detailed particle identification studies. Differential cross sections of charged pions in momentum and polar angle variables are shown. Systematic error analyses and comparison with existing Monte Carlo Models are described. In addition the NA61 collaboration aims at producing new measurements of charged and neutral kaon production for the summer. For completeness the NA61 sub detectors are described and it is shown that detector has a full coverage of T2K phase space region and good particle identification.

[1] N. Antoniou et al. [NA61 Collaboration], CERN-SPSC-2006-034. (2006).

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[5] Y. Hayato et al. [T2K Collaboration], T2K at J-PARC, Nucl. Phys. Proc. Suppl. 143, (2005).

[6] N. Abgrall et al. [NA61 Collaboration]. CERN-PH-EP-2011-005. (2011).

17:00 5F-4 Massive Neutrino Search in the Decay $\pi^+ \rightarrow e^+\nu$: Chloe MALBRUNOT (University of British Columbia)

A natural extension of the Standard Model that includes neutrino mass and possibly explains the origin of dark matter is inclusion of sterile neutrinos mixing with the ordinary neutrinos. Evidence of massive neutrinos in the $\pi^+ \rightarrow e^+\nu$ decay spectrum was sought with the background $\pi^+ \rightarrow \mu^+ \rightarrow e^+$ decay chain highly suppressed. Upper limits (90 % c.l.) on the neutrino mixing matrix element —Uei—2 in the mass region 65-130 MeV/c2 were set at a few $^{\times}10-8$ level, improving the previous results by a factor of two. We are also looking for a signature of massive neutrinos in the decay $\pi^+ \rightarrow e^+\nu\nu$ for the mass region 40-80 MeV/c2, where tight limits may not exist when the massive neutrino decays radiatively to a lighter neutrino with a short lifetime.

17:20 5F-5 Lorentz- and CPT-violating Texture for Neutrino Oscillations : Jorge S DIAZ (Indiana University)

A three-parameter model of neutrino oscillations based on a simple Lorentz- and CPT-violating texture is presented. The model is consistent with oscillatory signals observed in atmospheric and reactor experiments as well as the MSW-LMA solution of the solar neutrino problem. Some of the features that naturally arise include the observed mixing in reactor and atmospheric experiments, and a low-energy signal in MiniBooNE in both neutrinos and antineutrinos consistent with recent observations. Simple extensions of the model that preserve the texture can accommodate the recent MINOS anomaly and the LSND signal.

Parallel 5G - Lepton Universality and Forward Jets - Kresge - Rehearsal A (16:00-17:40)

Chair: Masaharu Aoki (Osaka University)

16:00 5G-1 Test of lepton flavour universality in kaon leptonic decays at CERN NA62 experiment : Cristina LAZZERONI (University of Birmingham)

The ratio of charged kaon leptonic decay rates BR(K $\rightarrow$ e ν)/BR(K $\rightarrow \mu\nu$) is suppressed and predicted to excellent precision within the Standard Model. A precision test of lepton flavour universality by measurement of this ratio at the NA62 experiment at CERN, based on a dedicated sample collected in 2007, is reported. A record accuracy of 0.5% has been achieved. This result constrains the parameter space of new physics models with extended Higgs sector (including supersymmetry).

16:20 5G-2 Measurement of the Pion Branching Ratio at TRIUMF : Chloe MALBRUNOT (University of British Columbia, TRIUMF)

Study of rare decays is an important approach for exploring physics beyond the Standard Model (SM). The branching ratio of the helicity suppressed $\pi \rightarrow$ e v decay, is one of the most accurately calculated decay process involving hadrons and has so far provided the most stringent test of the hypothesis of electron-muon universality in weak interactions. The branching ratio has been calculated in the SM to better than 0.01% accuracy to be R= $1.2353(1).10^4$.

The PIENU experiment at TRIUMF, which started taking physics data in September 2009, aims to reach an accuracy five times better than the previous PSI and TRIUMF experiments so as to confront the theoretical calculation at the level of 0.1%. If a deviation from the SM branching ratio is found, “new physics” beyond the SM, at potentially very high mass scales (up to 1000 TeV), could be revealed. Alternatively, sensitive constraints on hypotheses can be obtained for pseudoscalar or scalar interactions, or on the mass and couplings of heavy neutrinos.

So far, around five millions pion to electron decay events have been accumulated by the PIENU experiment. Data taking will continue in 2011 to increase the statistics to the 10^7 level. The presentation will outline the physics motivations, describe the apparatus and techniques designed to achieve high precision and present the status of the analysis.

16:40 5G-3 Search for Non-Standard Model Physics Using the Transverse Muon Polarization in Stopped K+ Decay : Sebastien BIANCHIN (TRIUMF)

We have proposed a search for new physics beyond the Standard Model (SM) by measuring the transverse muon polarization, P_T, in the decay of stopped K+ mesons. This experiment will be carried out at the new high intensity 30 GeV proton synchrotron at J-PARC in Tokai, Japan. P_T is a T-odd triple product correlation defined as $P_T = s_\mu(p_\mu * p_\pi)$ where s_μ is the muon polarization vector in the muon spin direction and p_μ and p_π are unit vectors along the μ^+ and $\pi 0$ momentum directions, respectively. P_T in K+ decay is particularly sensitive to new physics since the SM contribution occurs only in higher orders ($\sim 10^-7$) and the final state interaction is predicted to be $\sim 10^-5$. Various extensions to the SM such as multi-Higgs doublets, leptoquarks, R-Parity violating or Squark-family mixing SUSY allow P_T values as high as 410^-3, just below the current experimental limit. The physics potential of this experiment in terms of the discovery of new physics along with the power to constrain the many various proposed extensions of the SM is both competitive and complementary to other experiments such as the next generations EDM experiments and B-decays at the Super-B factory. In fact, since the effect of any new interaction arises in P_T as an interference with the dominant SM process, it appears directly proportional to the amplitude rather than proportional to the square of the amplitude, as it is the case in direct production processes. The low-energy kaon beamline (0.8 GeV/c), a branch of the K1.1 beamline will be used. The proposed detector system will be an upgraded version of our previous KEK-PS-E246 detector system. The major changes to the hardware are: i) the introduction of a new active polarimeter system to track the muon decay positrons, ii) a new preamplifier and readout system for the CsI(Tl) calorimeter, iii) a new scintillating fibre target with finer segmentation, iv) an improved charged particle tracking system incorporating new state-of-the-art GEM detectors near the target, and v) a new polarimeter magnet to provide a uniform magnetic field in the muon stopping region. This new experimental arrangement, along with the increased kaon beam intensity at J-PARC ($2 * 10^6$ K+/sec) and a runtime of 10^7 seconds, will allow us to improve our E246 result by at least a factor of 20, down to $\delta_{(P_T)} \sim 10^{-4}$. This will severely limit the range of the various new physics models currently allowed. Details of the new experiment will be presented.

17:00 5G-4 BABAR Results on Lepton Universality and Lepton and Baryon Number Conservation : Matthew BELLIS (Stanford University)

We present recent BABAR results on lepton universality, and lepton and baryon number conservation in Upsilon, B, charm and tau decays.

17:20 5G-5 Forward Jet-like Event Spin-dependent Properties in Polarized p+p Collisions at The Center of Mass Energy of 200 GeV : Nikola POLJAK (University of Zagreb)

The STAR collaboration has reported precision measurements on the transverse single spin asymmetries for the production of forward neutral pions mesons from polarized proton collisions at the center of mass energy of 200 GeV. Disentangling contributions to forward asymmetries requires one to look beyond inclusive neutral pion production to the production of forward jets or direct photons. Present forward detector capabilities are not well matched to the complete reconstruction of forward jets, but do have sufficient acceptance for jet-like events. A jet-like event is a clustered response of an electromagnetic calorimeter that is primarily sensitive to incident photons, electrons and positrons.

During the RHIC running in the year 2006, STAR with the Forward Pion Detector (FPD++) in place collected 6.8 inverse picobarn of data with an average polarization of 60%. FPD++ was a modular detector prototype of the Forward Meson Spectrometer (FMS) that consisted of two detectors placed symmetrically with respect to the beam line at a distance of 7.4m from the interaction point. Readout of the FPD++ was triggered when the sum of energies in the central module of the calorimeter used for neutral pion measurements was larger than a threshold. This trigger minimizes the bias for jet-like events, making it appropriate to disentangling contributions to the forward transverse spin asymmetries.

For the jet-like events, we have reconstructed the angle of the outgoing leading neutral pion with respect to the fragmenting parton, thus enabling us to disentangle the contributions to the forward neutral pion asymmetries. The simulated data set shows that on average there are approximately 2.5 fragmenting mesons per one jet-like event. The investigation of background in the sample, as well as of systematic effects is under way. The jet-like event analysis is being applied to the FMS data in order to intercompare the results with those obtained with the FPD++. Preliminary FPD++ results, to within the precision of the data, provide no evidence of measured contributions to the asymmetry from jet fragmentation (Collins effect), thus isolating contributions from the distribution functions (Sivers effect).

Parallel 5H - EDMs and other T-Violation Searches - Kresge - Rehearsal B (16:00-17:40)

Chair: Makoto Fujiwara (University of Calgary)

16:00 5H-1 A New Facility for Fundamental Particle Physics: The High-Intensity Ultracold Neutron Source at the Paul Scherrer Institute : Bernhard LAUSS (Paul Scherrer Institute)

At the Paul Scherrer Institute (PSI), Switzerland, construction of the new high intensity ultracold neutron (UCN) source was completed in 2010. First ultracold neutrons have been produced in late December. The design goal is to surpass by a factor 50 to 100 the current ultracold neutron densities available for fundamental physics research such as the search for a neutron electric dipole moment or the precise determination of the lifetime of the free neutron. The PSI UCN source is based on neutron production via spallation of 590 MeV protons on lead, followed by neutron thermalization in heavy water and subsequent cooling in a solid deuterium crystal to cold and finally ultracold neutron energies below about 300 nano-eV. The produced UCN are stored in a 2m3 large UCN storage volume from where they can be distributed on demand to 3 experiment beam ports. The key features of the UCN source include:

i) Use of PSIs full 1.3 MegaWatt proton beam for optimal neutron production from a lead spallation target.

ii) The growing and maintaining of a suitable (ortho-)deuterium crystal at a temperature of 5K close to this spallation target.

iii) Storage and guiding of the ultracold neutrons from production to experiments over several meters passing through the radiological shield.

Commissioning of the UCN source was done in several steps up to the final successful vacuum tests and cool-down of the system in fall 2010. A total of 27 cube meters of deuterium gas were solidified within a short time and the first ultracold neutrons were detected at all beam ports before the winter shutdown of the PSI accelerator.

The installation is now being prepared for production optimization followed by user operation. We will give an overview of the source and present the first ultracold neutron measurements performed at this new facility.

16:20 5H-2 New Search for the Neutron Electric Dipole Moment : Klaus KIRCH (PSI - ETHZ)

Permanent electric dipole moments (EDM) of fundamental systems like the neutron, the electron or muon, atoms or molecules violate parity and time reversal symmetries and, invoking the CPT theorem, also CP symmetry. While no finite EDM value has been established so far, these experiments present one of the most promising routes to establish new physics beyond the standard model. Especially searches for the neutron EDM have a long tradition in successfully excluding theories and models of CP-violation. Several new neutron EDM searches are being prepared by various collaborations around the world.

Our experiment to search for a neutron EDM with improved sensitivity is set up at the new source for ultracold neutrons (UCN) at the Paul Scherrer Institute (PSI). The apparatus which provided the present best limit on the neutron EDM ($d < 2.9 \times 10^{-26}$ ecm 90% CL, Baker et al., Phys. Rev. Lett. 97 (2006)

131801) was moved from the Institute Laue-Langevin to PSI beginning of 2009. Since then the system has been carefully investigated and upgraded, especially in terms of high rate UCN counting, high voltage and leakage current control, removing and avoiding magnetic impurities, improved demagnetization and field reproducibility, improved magnetic field homogeneity and multi-channel optical magnetometry with gradient control. Towards the end of 2010 first UCN have been stored and detected with the apparatus. All subsystems have been commissioned and the setup is complete and presently being used in measurements aiming at limiting various systematic false effects.

For the dominant systematic effects, counter measures have been found and established allowing going for a first EDM measurement in 2011 and exceeding in sensitivity the previous result. Data taking in 2012 and 2013 with 200 nights per year should then yield $d < 5 \times 10^{-27}$ ecm (95% CL) in case no signal is found. A neutron EDM of 1.3×10^{-26} ecm could be discovered at 5 sigma confidence. While running the present experiment we are designing a next apparatus in order to gain another order of magnitude in sensitivity down to a few 10^{-28} ecm. This new experiment is expected to start data taking around 2015.

16:40 5H-3 Model Dependence of the Deuteron Electric Dipole Moment : Benjamin GIBSON (Los Alamos National Laboratory)

Direct measurement of the electric dipole moment (EDM) of the neutron lies in the future; measurement of a nuclear EDM may well be obtained first. The deuteron is the one nucleus for which exact model calculations can easily be performed. In this report we explore the model dependence of deuteron EDM calculations. Using a separable potential formulation of the Hamiltonian, we examine the sensitivity of the deuteron EDM to variations in the nucleon-nucleon interaction, including contemporary potential models. We write the EDM as the sum of two terms, the first of which depends on the target wave function with plane-wave intermediate states, and the second of which depends on intermediate multiple scattering in the 3P1 channel, the latter being sensitive to the off-shell behavior of the 3P1 amplitude. We compare the full calculation with the result in the plane-wave approximation, explore the tensor force contribution to the model results, and examine the effects of short range repulsion that characterizes realistic, contemporary potential models of the deuteron. Because one-pion exchange dominates the EDM calculation, separable potential model calculations will provide an adequate description of the deuteron EDM until such time as a measurement of better than 10% is achieved.

17:00 5H-4 Time-Reversal Violation in Heavy and in Few-body Nuclei : Vladimir GUDKOV (University of South Carolina)

Time reversal invariance violating (TRIV) effects in low energy physics could be very important for a search for new physics, being complementary to neutron and atomic electric dipole moment measurements. In this relation, a sensitivity of some TRIV observables to different models of time-reversal (CP) violation and their dependencies on nuclear structure are discussed.

17:20 5H-5 A New Limit on Time-Reversal-Invariance Violation in Beta Decay: Results of the emiT-II Experiment : Timothy CHUPP (University of Michigan)

We have measured the triple correlation Don·(ppxpe) by observing proton- electron coincidences in the decay of polarized neutrons. A non-zero value of D can arise due to parity-even-time-reversal-odd interactions that imply CP violation due to the CPT theorem. (Final-state effects also contribute to D at the level of 10-5 and can be calculated with precision of 1% or better.1) The D coefficient is uniquely sensitive to the phase, φAV, of the ratio of axial-vector (A) and vector (V) amplitudes: λ=gA/gV as well as to scalar and tensor interactions that could arise due to beyond-Standard-Model physics such as leptoquarks.2 The experiment was performed with the NG-6 cold-neutron beam at the NIST Center for Neutron Research in Gaithersburg, Maryland. The neutron beam is polarized, passes through a spin flipper and is collimated into a spectrometer, which measures proton-electron coincidences in an octagonal detector array concentric with the neutron beam. The recoil protons were accelerated to 28 keV and detected by surface barrier detectors. The electrons were detected in plastic scintillators. The detector is highly segmented, allowing the triple correlation to be isolated and separated from a variety of systematic effects due to the parity-odd-time-reversal even correlations.3 A 14-month run in 2002-2003 produced a sample of over 300 million proton-electron coincidence events. A blind analysis and extensive study of all significant systematic effects has recently been completed with the result D = (-0.96±1.89 (stat)±1.01(sys))x10-4. The corresponding upper limit on D is a factor of three improvement over the previous upper limit for neutron decay4,5 and over the upper limit measured in 19Ne decay,6 and thus our result represents the most sensitive test of time- reversal invariance in beta decay. Assuming only vector and axial vector interactions in beta decay, the result can be interpreted as a measure of the phase φAV = (180.013±0.028)°. This result also improves constrains on certain non-VA interactions.

Parallel 5I - Heavy Flavor Prospects - Kresge - Little Theatre (16:00-17:40)

Chair: Guy Wilkinson (University of Oxford)

16:00 5I-1 Charm program at BESIII : Chunlei LIU (Carnegie Mellon University)

BES-III has successfully accumulated about 2.5fb-1 $\psi(3770)$ data, which is about four times of the previous world's largest sample. The Long-term goals of BES-III include about 20fb-1 samples at psi(3770)and at higher psi states. With these data samples, BESIII will make it possible to study in detail, and with unprecedentedly high precision in the decays of charmed mesons. Many high precision measurements, including CKM matrix elements related to charm weak decays, decay constants f_D and f_{Ds}, Dalitz decays of D meson , searches for CP violation in the charmed-quark sector, and absolute decay branching fractions, will be accomplished.

16:20 5I-2 B and D Hadron Production and Prospects : Elvira ROSSI (Universita di Napoli 'Federico II' e INFN)

The production cross sections of the D*+−, D+− and Ds+− charm mesons are measured with the ATLAS detector in pp collisions at $\sqrt(s) = 7$ TeV . The differential cross sections as a function of transverse momentum and pseudorapidity as well as the total cross sections are measured for D*+− and D+− production. B-hadrons are observed in proton-proton collisions with the ATLAS detector and reconstructed in exclusive decay modes involving a J/Psi.

16:40 5I-3 New physics search potential of SuperB : Douglas ROBERTS (University of Maryland)

The study of $B_{u,d,s}$, D and τ decays at SuperB can provide both stringent constraints on new physics scenarios, and over constraints on the CKM description of quark mixing and CP violation in the Standard Model. In addition the billions of tau leptons accumualted at SuperB facilitate a comprehensive set of searches for lepton flavour and CP violation in tau decays. The rich landscape of new physics sensitive observables in both tree dominated and loop or flavor changing neutral current rare decays complements measurements possible at existing facilities. We discuss the physics potential of what can be learned from B, D and tau decays at SuperB.

17:00 5I-4 Hadronic b-hadron decays at LHCb : Andrew POWELL (Oxford)

We present studies from the LHCb experiment of decays of the type hb → hcX, where hb represents a beauty hadron (B±, B0 or Λb) and hc a charmed hadron (D0, D()+, Ds or Λc). Such decays are important for the determination of the CKM angle γ, a key goal of the LHCb physics programme. We report on the observation of new decay modes, and first measurements on the road to a precise determination of γ We also present measurements of decays to hadronic final states without charm. These charmless modes have a rich phenomenology and high sensitivity to possible contributions from New Physics. We exploit the data accumulated in 2010, and in the early months of the 2011 run.

17:20 5I-5 Physics at Belle-II/SuperKEKB : Kay KINOSHITA (University of Cincinnati)

Over the course of the last decade, the Belle detector at the KEKB collider has collected over 1 ab^{-1} of integrated luminosity, allowing for a number of precision measurements of the Standard Model, including confirmation of the Kobayashi-Maskawa mechanism of CP violation. In June of 2010, KEKB and Belle were shut down to begin upgrading both the accelerator and detector. The increased luminosity of the new accelerator, Super-KEKB, coupled with significant improvements in background rejection and sensitivity of the upgraded detector, Belle II, will ultimately provide a dataset approximately 50 times larger than that obtained with Belle. We will present the expected sensitivity of this dataset in selected decay measurements, including some that are unique to an e^+e^- collider environment.

Parallel 5J - Beyond the Standard Model Higgs Boson - Kresge Auditorium (16:00-17:40)

Chair: Steve Nahn (MIT)

16:00 5J-1 Search for exotic Higgs boson decays with ALEPH at LEP2 : Itay YAVIN (New York University)

We describe several searches for exotic Higgs boson decays in data taken by the ALEPH detector at LEP2. Specifically, we search for Higgs boson produced through the Higgstrahlung process with decays into a light neutral scalar that subsequently decays into a pair, a gluon pair, or a charm-quark pair. We present the combined exclusion on the different channels considered. We also present exclusion limits for alternative models based on the RECAST framework.

16:20 5J-2 Search for the MSSM Higgs boson in $p\bar{p}$ collisions at DØ: Nicolas OSMAN (Centre de Physique des Particules de Marseille)

We present searches for Higgs bosons (ϕ) in the framework of MSSM models using up to 8.6 fb^{-1} of data collected with the DØdetector in protonantiproton collisions at a center of mass energy of 1.96 TeV at the Fermilab Tevatron collider. Within the MSSM the production of the Higgs boson can be significantly enhanced compared to the standard model and there is a significant branching ratio to 3rd generation fermions (pairs of b quarks and τ leptons) at all masses. In addition to the gluon fusion ($gg \rightarrow \phi$), we also investigate the associated production with a b quark ($bg \rightarrow b\phi$) and present results for final states involving 3 or 4 b-jets, τ pairs and τ pairs produced in association with a b-quark. We interpret our results in the framework of the MSSM. In addition we discuss searches for a fermiophobic Higgs boson and NMSSM Higgs bosons.

16:40 5J-3 Physics with taus : Michail BACHTIS (University of Wisconsin)

The importance of decays of new particles to taus led to the development of innovative tau reconstruction programs by the CMS collaboration. The performance of tau reconstruction algorithms, their validation by the measurement of isolated taus from vector boson decays and searches for new physics processes, e.g., MSSM higgs decays to taus, will be discussed.

17:00 5J-4 ATLAS Searches for Higgs Bosons Beyond the Standard Model : Trevor VICKEY (University of the Witwatersrand)

The search for the neutral and charged Higgs boson(s) beyond the Standard Model is presented, based on the ATLAS data collected in 2010 and 2011. A wide region of the MSSM parameter space is excluded via searches for Higgs boson decays into two tau-leptons, with an additional sensitivity improvement from the di-muon decay channel. The di-muon final state is additionally explored in the region of invariant masses below 12 GeV, motivated by the search for the light CP-odd Higgs boson predicted by the Next-to-Minimal Supersymmetric Models. The experimental observation of charged Higgs bosons would provide a clear signature of the physics beyond the Standard Model. Several final state topologies are explored, with Higgs bosons originating from the top-quark decays in top pair events and subsequently decaying into $\tau + \nu$ or $c\bar{s}$.

Parallel 5K - Jet Substructure II - W20-407 (16:00-17:40)

Chair: Carlos Salgado (University of Santiago de Compostela)

16:00 5K-1 Scale choice for di-jet invariant mass : Hsiang-nan LI (Academia Sinica)

We construct an evolution equation for the distribution of light-quark and gluon jets in the jet invariant mass in the framework of QCD resummation. The solution of the evolution equation exhibits a behavior consistent with a PYTHIA simulations. We also construct an evolution equation for the energy profile within the light-particle jets in the similar framework. The solutions show that the energy accumulates faster within a light-quark jet cone than within a gluon jet cone. Comparison with the data implies that high (low) energy jets are mainly composed of the quark (gluon) jets. Our formalism is then applied to heavy-particle jets, which are factorized into convolutions of heavy-particle kernels and jet functions for light particles from the heavy particle decay. The jet profile for an energetic heavy particle is derived. The different energy profiles will be a useful feature for the jet identification at LHC.

16:20 5K-2 Jet shower evolution in medium and di-jet asymmetry in Pb+Pb collisions at the LHC : Qin GUANGYOU (Duke University)

We study the evolution of a partonic jet shower propagating through a hot quark-gluon plasma. A differential equation is derived the evolution of the radiated gluon distribution as the jet propagates through the medium. Combined with the in-medium evolution of the leading parton, we compute the depletion of the energy from the jet cone by dissipation through elastic collisions with medium constituents, by scattering of shower partons to larger angles, and by radiation outside the jet cone. Numerical results are presented for the nuclear modification of di-jet energy asymmetry in Pb+Pb collisions at the LHC.

16:40 5K-3 Jet Production and Jet Properties in $\sqrt{s_{NN}} = 2.76$ TeV Pb+Pb Collisions : Aaron ANGERAMI (Columbia University)

A broad program of measurements using heavy ion collisions is underway in ATLAS, with the aim of studying the properties of QCD matter at high temperatures and densities. With the factor of 14 increase in collision energy compared to RHIC data, significant insights have already been achieved. These include the observation of a centrality-dependent dijet asymmetry, which is strongly suggestive of “jet quenching” – strong energy loss of energetic jets in a hot, dense medium. Further results on jet modifications in heavy ion collisions will also be shown, both at the jet and fragmentation function levels. This talk describes measurements performed using up to 9 pb-1 of lead-lead collision data provided at a nucleon center-of-mass energy of 2.76 GeV by the Large Hadron Collider and collected by the ATLAS Detector during November and December 2010.

17:00 5K-4 Studies of jet quenching in PbPb collisions at $\sqrt{s} = 2.76$ TeV : George STEPHANS (MIT)

Jets are an important tool to probe the hot, dense medium which is produced in ultra-relativistic heavy ion collisions. Copious production of hard processes, well above the heavy ion background, occurs at the Large Hadron Collider due to the large increase in collision energy. The multipurpose Compact Muon Solenoid (CMS) detector is well designed to measure the hard scattering processes with its high quality calorimeters and high precision silicon tracker. Jet quenching has been studied in CMS in PbPb collisions at $\sqrt{s_{_{NN}}} = 2.76 \sim$TeV. As a function of centrality, dijet events with a high pT leading jet were found to have an increasing momentum imbalance that was significantly larger than those predicted by simulations. The angular distribution of jet fragmentation products has been explored by associating charged tracks with the dijets observed in the calorimeters. The calorimeter-based momentum imbalance is reflected in the associated track distributions, which show a softening and widening of the subleading jet fragmentation pattern. Studies of the missing transverse momentum projected on the jet axis have shown that the overall momentum balance can be recovered if tracks at low pT are included. In the PbPb data, but not in the simulations, a large fraction of the balancing momentum is carried by soft particles radiated at large angle relative to the jets.

17:20 5K-5 Reconstruction of Jet-Properties in Pb+Pb Collisions with the ALICE Experiment : Christian KLEIN-BOESING (Institut fuer Kernphysik Muenster/EMMI)

The quantification of the effect of parton energy loss, known as jet quenching, is one of the of the major goals of jet and high p_T measurements in heavy ion collisions. Here, the reconstruction of full jets, compared to single particle measurements, provides a more direct access to the original parton properties and the modification of the fragmentation process in heavy ion collisions. The reconstruction of jets with their longitudinal and transverse structure requires a careful subtraction of the underlying heavy ion event, as well as a precise knowledge of the background induced fluctuations of the reconstructed jet energy. The ALICE detector with its excellent tracking and PID capabilities provides an ideal tool for the studies of jet structure and composition over a large dynamic range from jet momenta of about 100 GeV/c during the first LHC run, down to particle p_T of 100 MeV. We will show the performance of the ALICE jet reconstruction in heavy ion collisions and the current status of the analysis of in medium jet modification in Pb+Pb collisions at the LHC.

Parallel 5L - Lattice QCD Thermodynamics - W20-491 (16:00-17:40)

Chair: Tetsuo Hatsuda (University of Tokyo)

16:00 5L-1 Fluctuations and Higher Moments of Conserved Charges from the Lattice : Prasad HEGDE (Brookhaven National Laboratory)

Fluctuations and higher moments of conserved charges such as the net baryon number, strangeness or electric charge are important observables that are influenced by non-trivial physics beyond simple thermalization i.e. criticality. They may allow to characterize thermal conditions met in heavy ion collisions at freeze-out. Moments up to fourth order are now measured in the low energy run at RHIC. Early lattice calculations of these moments had been performed within simple discretization schemes and/or on rather coarse lattices. Discretization errors thus were large. We present here new results from a calculation using the highly improved staggered fermion action (HISQ) on lattice of size $32^3 \times 8$. The HISQ action yields much better agreement with hadron resonance gas physics at low temperature and also leads to small discretization errors in the high temperature regime. We discuss results for up to fourth order moments of charge fluctuations on the phenomenologically determined freeze-out curve relevant for the low-energy run at RHIC as well as the LHC.

16:20 5L-2 O(4) Scaling, Pseudo-Critical Temperatures and Freeze-out in Heavy Ion Collisions : Frithjof KARSCH (Brookhaven National Laboratory)

In the chiral limit and at temperatures close to the QCD phase transition temperature physical observables are expected to show universal properties that are controlled by the symmetry class of a 3-dimensional O(4) spin model [1]. Higher moments of net baryon number as well as electric charge fluctuations are sensitive to these universal features of the chiral phase transition [2]. The sixth order moments are the first moments which will diverge in the chiral limit at the QCD phase transition temperature. At non-zero values of the light quark masses the sixth order moment of baryon number fluctuations has a pronounced minimum at a pseudo-critical temperature which is close to the temperature where fluctuations of the chiral order parameter are the largest. We present a calculation of the O(4) scaling functions that control scaling properties of the net baryon number fluctuations [3]. Using these universal scaling functions as well as PNJL model calculations [4] we show that the sixth order moment of baryon number fluctuations is negative in the vicinity of the pseudo-critical temperature for the chiral transition. This is in striking contrast to hadron resonance gas model calculations. We conjecture that higher order moments of net baryon number and electric charge fluctuations are well suited to characterize freeze-out conditions in heavy ion collisions. Their experimental analysis in low energy runs at RHIC as well as at LHC will allow to verify to what extent freeze-out occurs from a thermal medium close to criticality.

[1] O. Kaczmarek et al., Phase boundary for the chiral transition in (2+1) -flavor QCD at small values of the chemical potential Phys. Rev. D83, 014504 (2011).

[2] F. Karsch and K. Redlich, Probing freeze-out conditions in heavy ion collisions with moments of charge fluctuations, Phys. Lett. B695, 136 (2011).

[3] J. Engels and F. Karsch, The scaling functions of the free energy density and its derivatives for the 3d O(4) model, in preparation.

[4] J. Engels, B. Friman, F. Karsch, K. Redlich and V. Skokov, Fluctuations as probe of the QCD phase transition and freeze-out in heavy ion collisions at LHC and RHIC, in preparation.

16:40 5L-3 The QCD Phase Transition Region with Domain Wall Quarks : Zhongjie LIN (Columbia University)

Results will be presented from a study of the QCD transition region using 2+1 flavors of fermions and a dislocation supressing gauge action on a lattice with temporal extent of 8 and spatial extent 16 (1.9-2.7 fm). A series of temperatures from 140 through 200 MeV, separated by 10 MeV have been studied. All the simulations lie on a line of constant physics with 200 MeV pions, realized using domain wall fermion, a chirally symmetric fermion formulation. The chiral susceptibility, screening masses, anomalous symmetry breaking and a detailed study of the Dirac spectrum will be described and compared with earlier staggered results.

17:00 5L-4 QCD thermodynamics on the lattice : Alexei BAZAVOV (Brookhaven National Laboratory)

In this talk recent results from the HotQCD collaboration on 2+1 flavor QCD thermodynamics are presented. Using the p4, asqtad and HISQ actions on lattices with the temporal extent 6, 8 and 12 and several light quark masses, HotQCD has studied different thermodynamic quantities that characterize the transition region, including the renormalized Polyakov loop, chiral condensate and susceptibility, fluctuations and correlations of various conserved charges and the trace anomaly. Comparison to the Hadron Resonance Gas model, lattice cut-off effects and the approach to the continuum limit are also discussed.

17:20 5L-5 Bottomonium above deconfinement in lattice nonrelativistic QCD : Sinead RYAN (Trinity College Dublin)

The temperature dependence of bottomonium for temperatures above and below Tc is presented, using non-relativistic dynamics for the bottom quark and full relativistic lattice QCD simulations for two light flavors on a highly anisotropic lattice. We find that the S-wave (Upsilon) is insensitive to the temperature in this range, while the P wave propagators show a crossover from the exponential decay characterizing the hadronic phase to a power-law behaviour consistent with nearly-free dynamics at approximately twice the critical temperature.

18:30 Dinner Cruise (tickets required)

The buses will depart from Kresge Auditorium, on Amherst Alley. The buses will return at 22:30 from the boat and will drop off at Kresge Auditorium, Le Meridien Hotel (20 Sydney St), Hyatt Hotel (575 Memorial Dr), and Courtyard by Marriott Boston-Cambridge (777 Memorial Dr).

Friday 29 July 2011

Plenary 5 - Kresge Auditorium (08:30-10:15)

Chair: Giorgio Gratta (Stanford University)

08:30 P5-1 Latest Results in Heavy Flavour Physics : Guy WILKINSON (University of Oxford)

Precise measurements of the decays of hadrons containing heavy quarks (charm or beauty) provide high sensitivity to possible New Physics effects in a manner which is complementary to the direct search for new particle production. A summary will be given of the most recent results in quark flavour physics, focusing on the analysis of the datasets being accumulated at the LHC and Tevatron, but also reporting on the ongoing studies of B-factory data. Prospects for the coming couple of years will be reviewed.

09:05 P5-2 Dark matter: new results from direct detection : Laura BAUDIS (University of Zurich)

We have strong evidence that about 83% of matter in our Universe is dark, revealing its presence only by its gravitational attraction. If the dark matter is made of Weakly Interacting Massive Particles (WIMPs), it can be directly detected via elastic scattering from nuclei in ultra-low background, deep underground detectors. WIMPs arise naturally in many beyond standard model theories, a popular example being the neutralino, or the lightest supersymmetric particle. After an introduction to the direct detection method, I will review the current techniques to search for these hypothetical particles. The focus will be on recent results, and on the most promising techniques for the near future.

09:40 P5-3 Dark Matter in the Era of Data : Neal WEINER (NYU)

In the recent few years, a variety of data have arisen from experiments searching for signs of dark matter. These experiments have covered a wide range of sources, including direct detection searches, modulation studies, cosmic ray anti-matter, gamma rays, and more. I will discuss what the status of various theoretical interpretations, searches for new models of dark matter and dark forces, and what are the prospects for discovery in the next few years.

Plenary 5 - Kresge Auditorium (10:45-12:10)

Chair: Joachim Mnich (DESY (Germany))

10:45 P5-4 Future Directions of Accelerator-based HEP and NP Facilities : Thomas ROSER (BNL)

Progress in particle and nuclear physics has been closely connected to the progress in accelerator technologies — a connection that is highly beneficial to both fields. This paper presents a review of the present and future facilities and accelerator technologies that will push the frontiers of high-energy particle interactions and high intensity secondary particle beams.

11:20 P5-5 Closing Perspective : Steven E. KOONIN (Under Secretary for Science, DOE)

12:00 Conference Closing : Peter FISHER (MIT)

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