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Quantitative Ultrasonic Properties of Prostate Cells

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In the United States, prostate cancer is the second leading cause of cancer death and the most diagnosed form of cancer in men. It has been shown that healthy and malignant cells have differences in their quantitative ultrasonic (QUS) properties. This study explored the fundamental QUS properties of healthy prostate cells by determining attenuation, speed of sound, and backscatter, with the object of comparing the QUS differences between cancerous and non-cancerous prostate cells in the future. Ultimately, these findings could lead to a non-invasive way of detecting cancer through quantitative ultrasound. It was found that in the higher frequencies, the cells reflected more of the waves leading to higher backscatter coefficients generally matching the theoretical fit for a spherical scatterer, attenuation also increased with frequency following a power law of $f^{0.7}$. Speed of sound was determined to be frequency independent." Sarah Iacoviello Assumption
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A Novel Drone-based Application to Monitor and Determine Air and Soil Temperature Distributions in Indoor Farming Environments

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Indoor farms require frequent monitoring of environmental parameters. This is done manually today and is infrequent and error-prone. Drone-based monitoring can be employed to substantially increase productivity. Various sensors can be mounted on drones, and their flight paths can be programmed to automate the process, allowing direct measurements of parameters. This idea was explored for a mushroom farm. Mushrooms require uniform temperature distributions of ambient air and soil. With drone-based monitoring, temperature measurements can be frequent rather than employing a single thermometer for each large room, giving poor estimates of the temperature distribution. A drone was flown, and air temperatures were collected at designated points. Computational kriging was used to impute missing values and obtain near-continuous distributions that showed a 0.41% error upon validation. Using the air temperatures, a convective-diffusive heat flow model provided soil temperature estimates at boundaries of soil beds. These were then used in a Laplace heat conduction equation to obtain soil temperature distributions. Upon validation, a 1.02% error was observed. Results show that drone-based monitoring can be deployed in indoor farms to increase efficiency and reduce operation costs.

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Combining Laser Radar and Radiosonde Measurements to Study the Planetary Boundary Layer

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Laser radar, or LIDAR, an acronym for light detection and ranging, is a remote sensing technique which, when applied to the atmosphere, can provide continuous observations of atmospheric structure over a range of altitudes. Camera-based Lidar, or CLidar, is a lidar system specifically developed and optimized for near-ground atmospheric studies including those of the lowermost layer of the atmosphere, the planetary boundary layer (PBL). It consists of a laser which is transmitted into the atmosphere and imaged from the side with a CCD camera. The side-scatter of the laser beam is used to derive the extinction caused by suspended particulates in the atmosphere, also called aerosols. This extinction was plotted to help provide a picture of atmospheric behavior in the Bahamas, and results were compared with nearby balloon-borne radiosonde measurements. The radiosonde apparatus rises through the atmosphere measuring many atmospheric properties, such as relative humidity and potential temperature, which provide insights into the dynamics of the PBL. Using these two techniques, the structure of the planetary boundary layer was studied for multiple nights. PBL behavior informs our understanding of weather, climate, and the dispersion of pollutants such as dust or smoke.

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A new explanation for Redshift/Blueshift

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When an object moves relative to an observer who is stationary or moving, changes in sound and light are observed, which is called the Doppler phenomenon. When the light source or the receiver moves, the color of receiving light will change. When an object moves away from receiver we have redshift. It means the light is shifted to the redspectrum. And if comes towards, we have Blueshift. Given the physical for the law in light ($V=\theta/\lambda$) . In the Redshift/Blueshift phenomena, speed is the main parameter. If the speed does not meet its specific threshold, a fraction of the speed of light, the Redshift cannot be seen clearly. We have taken the concept of frequency from another point of view, Impulse. This means, although the speed of blue light is identical to that of red light and there is no difference, as the frequency of blue light is equal to 700 THz, the blue light beats the detector $700*10^{12}$ times in the unit of time; or the red light with a frequency equal to 400 THz means the red light beats the detector $400*10^{12}$ times in a second. This definition will help us to explain many related phenomena such as Redshift/Blueshift. In this paper, we have defined the frequency as an impulse and based on this definition we have explained the basic reason of Redshift/Blueshift phenomena in detail.

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The Development of Machine-Learning Models to Forecast Energy Output of Wind Turbines

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Fossil fuels are currently being depleted at a rate faster than can be formed, creating the need for alternative energy sources. The main limitation in implementing renewable energy is currently its high cost and unpredictability. The main goal of this project was to explore underlying patterns in wind turbine power generation in order to identify potential improvements to forecasting. Five models were studied in this project: the linear regression model, random forest regressor, multilayer perceptron, XGBoost regressor, and support vector machine. The primary feature selections used to predict power output were wind speed, wind direction, ambient temperature, turbine features, and a combination of all four. Using k-fold cross-validation (k=10), it was found that the XGBoost regressor was the optimal model, with minimal errors. Then, time-series k-means, an unsupervised learning algorithm, was used to cluster data, and was found to significantly improve predictions compared to supervised learning. Manual seasonal clustering was also performed but failed to improve accuracy at all. A hybrid of the top two models, XGBoost and random forest, was created and tested. The hybrid was found to have fewer errors either separately.

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Engineering of a Novel Plant Microbial Fuel Cell to Increase Electric Potential and Power Output Using Thinopyrum intermedium

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Plant-microbial fuel cells (P-MFCs) utilize plant exudates and microbes to power a series of redox reactions to generate electricity. The purpose of this experiment was to determine the effect of the addition of urea, spent coffee grounds, and phenylacetic acid and the increase of soil porosity on electrical potential, power output, and current density of the novel P-MFC. The first phase consisted of the determination of optimal concentrations of each substance using sediment MFCs called MudWatts. The second phase consisted of the creation of the novel P-MFC using the online software CAD (Computer-Aided Design) Onshape and the integration of the concentrations and soil porosities into each system. Data were analyzed using IBM SPSS Version 25 using a t-test with a confidence interval of 95% and a One-Way ANOVA followed by a Post-Hoc Scheffe ($p<0.05$). The urea and coffee grounds groups significantly increased electrical potential and power output, but no significance for the phenylacetic acid group was found. The alternate hypothesis was partially supported as the novel P-MFC design, urea, and coffee grounds significantly increased electrical potential and power output.

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Study on the Random Anomalies in the Stock Market

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This paper uses the rescaled range analysis (R/S analysis) method to examine the fractal characteristics of the Index. Due to the possibility of multiple bubbles in the stock market, the log-periodic power law (LPPL) model is used to identify the bubbles in different periods.

In order to conduct an investigation of this index, a calculation and analysis of the fractal dimension of the index was used along with LPPL modeling. The fractal dimension can be related to the nature of changes in the price of a stock, which allows for the detection of market bubbles. The LPPL modeling allows for the classification of bubbles as positive, negative, reverse, and reverse negative.

Financial bubbles generated by market jumps can result in tremendous economic damage. Given their catastrophic impacts, it is important to accurately detect and identify market jump anomalies and their underlying financial bubbles. Existing research on financial market bubbles can be broadly divided into four categories: herd behavior, bubble theory, LPPL analysis, and the market jump anomaly. Most of these studies analyzed the formation, development, and bursting of financial market bubbles retrospectively.

Analysis of "Non-Promt" Backgrounds in Lepton Events at the Large Hadron Collider

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In the search for new physics beyond the Standard Model (SM), the ATLAS detector at the Large Hadron Collider (LHC) is collecting an ever-growing collision dataset requiring a precise understanding of background sources. An ideal candidate for high-precision studies of the SM are four-lepton events, which have final states of two same-flavor opposite-charge lepton pairs. These events have contributions from interesting SM processes including single Z boson production, Higgs boson production, and on-shell ZZ production, as well as sensitivity to new physics beyond the SM. However, non-prompt leptons produced by secondary hadron decays or as artifacts of mis-reconstructions contaminate the dataset and must be suppressed. These backgrounds are subject to rare detector effects and are therefore preferentially studied using data driven methods. Through comparisons with Monte Carlo simulated data, I studied a sample of collision data in which the final states include a pair of leptons, and any additional third lepton is likely to be non-prompt. I investigated the non-prompt lepton suppression methods and refined the non-prompt lepton region to reduce systematic uncertainties on background measurements.

Temperature-dependent Characterization of GST225 using Ellipsometry

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With extensive developments over the past few decades, chalcogenide materials have developed from optical disk storage materials to leading candidates for electronic phase change memory (PCM), bridging the gap between the much slower flash memory, and the faster but volatile DRAM. PCM is based on the fast (1-100 ns) and reversible transitions between crystalline and amorphous states of chalcogenide compounds, with high contrast in electrical resistivity that is utilized for data storage. Switching between the stable crystalline state and the metastable amorphous state is done through suitable electrical pulses for crystallization or melt-quench amorphization. Ge2Sb2Te5 (GST) has been the most common PCM material due to its suitable properties but repeated cycling between states (>10^{10} cycles) tends to result in voids within the active region of a device, due to the mass density change between its amorphous and crystalline phases. Voids can leave a device in an irreversible high resistance state and are a main failure mechanism in PCM. We aim to study the amorphous-crystalline mass density change of GST films deposited by sputtering under different conditions, using *in situ* ellipsometry, to identify deposition conditions that can minimize void formation in the material.