

From muons to gravitational lensing via microwave weapons research: a non-canonical path

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Overview

Boston University roots

The graduate school years

The military

Some more grad school years

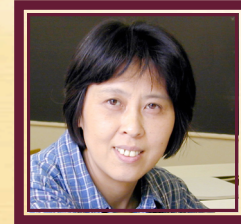
Postdoc at last !

Reflections



Boston University Roots

✠ Why start in physics? US Military said so...



✠ Why stay in physics? BU Professors:

- Karl Ludwig - Mechanics
- Steve Ahlen - E & M
- Lee Roberts - Waves
- Rama Bansil - Stat Mech
- Bennett Goldberg - Lab

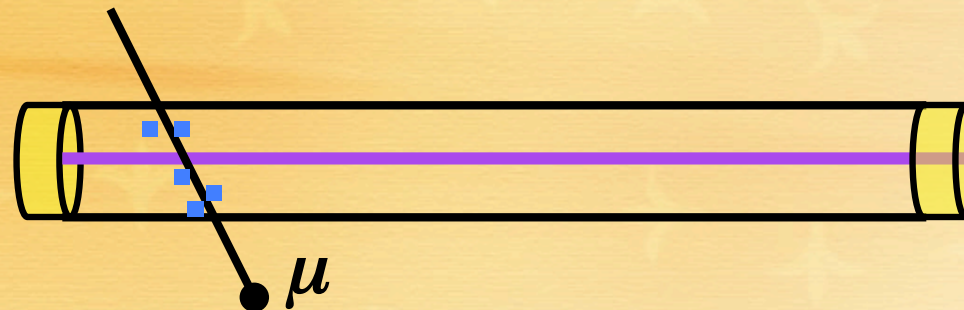


Boston University Undergraduate Research

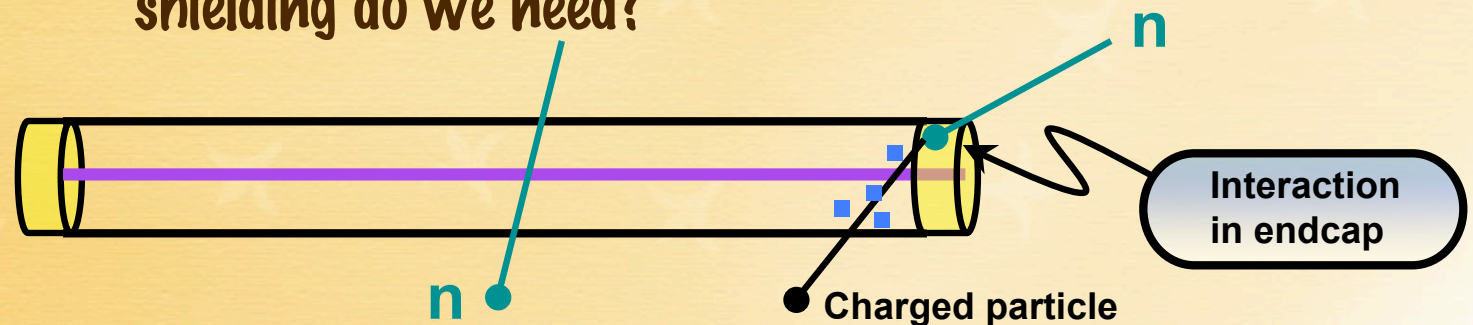
Bing Zhou



- ✦ Particle Experiment: Atlas Collaboration
- ✦ Advisor: Bing Zhou
- ✦ Investigated drift tube sensitivity to neutrons
 - A drift tube measures a muon track



- Neutrons can make a fake muon track - how much shielding do we need?



Steve Ahlen



Jim Shank



The Graduate School Years: Harvard



✦ More ATLAS work with John Huth

✦ Melissa Franklin: “With Paul Horowitz’s Lab Electronics, you can conquer the world”

✦ Lab Electronics turns out to be my arch-nemesis
▪ (even though it’s a truly awesome class)



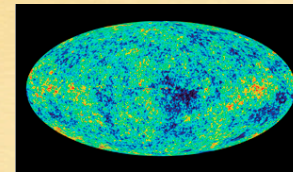
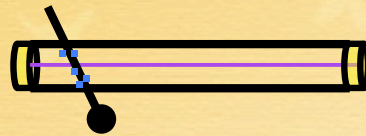
✦ Me: “How can I be an experimentalist if simple circuits defeat me? Better switch to theory!”

✦ Maximum Melodrama

- From particle experiment to theoretical cosmology
- Joined Martin White (Graduate Thesis Advisor)



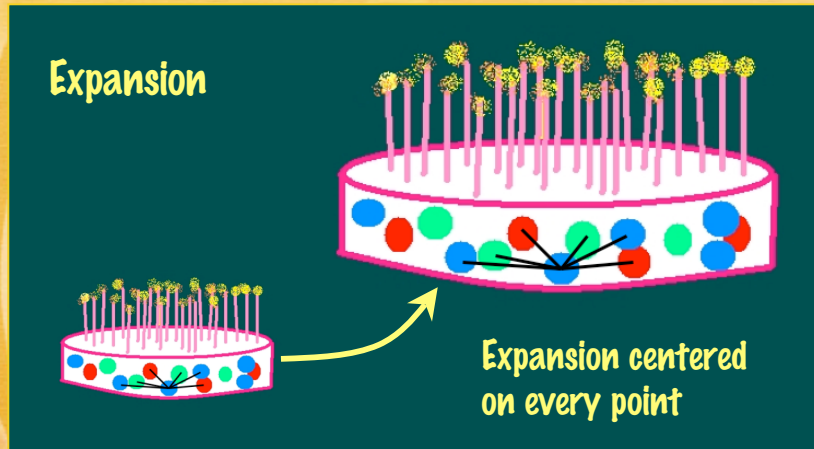
Little Particles



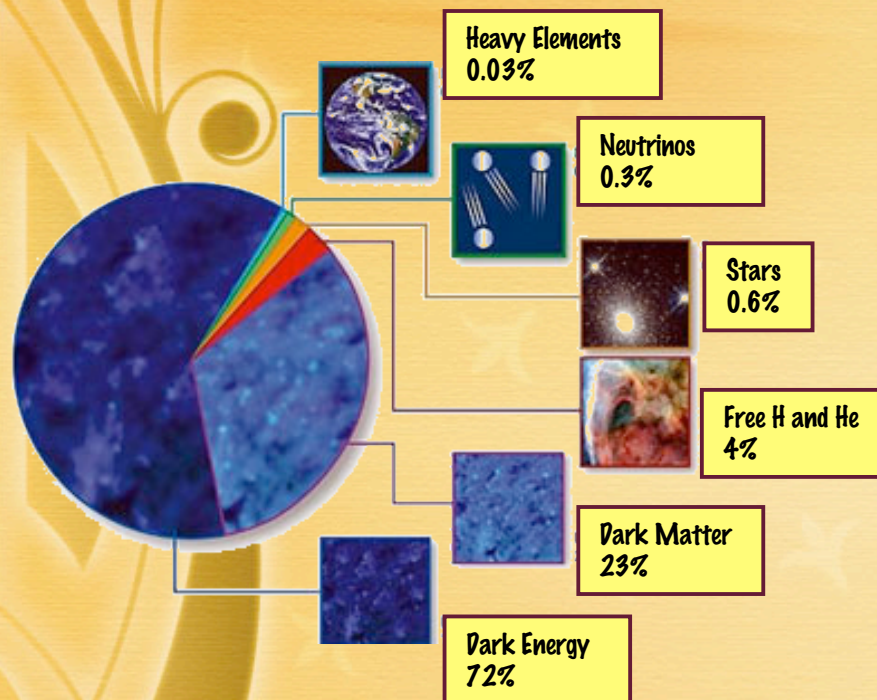
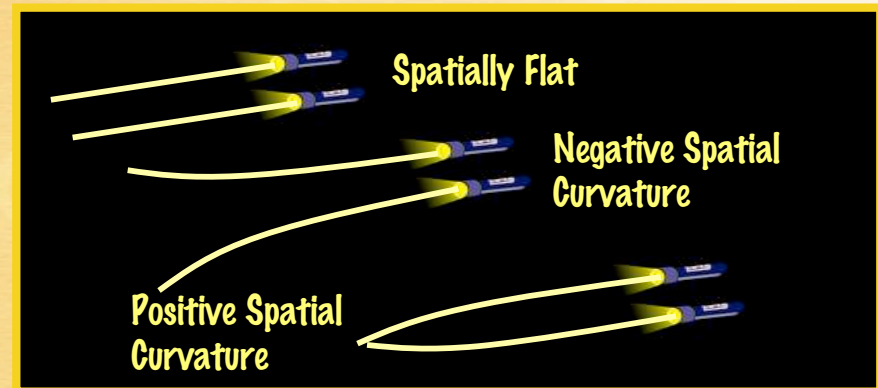
Universe

✦ Taught for 7 (Seven) (VII) semesters in a row proving definitively that even theorists have to work for a living!!

Cliff's Notes Cosmology



- ✠ The universe is expanding
- ✠ The expansion is accelerating
- ✠ The universe is spatially flat



- ✠ There's other kinds of stuff than us in the universe
 - Dark Matter: stuff like us but dark
 - Our stuff is not heavy enough to form structures we see like galaxies and galaxy clusters
 - Dark Energy: stuff very unlike us
 - Does not clump gravitationally
 - Drives the accelerated expansion

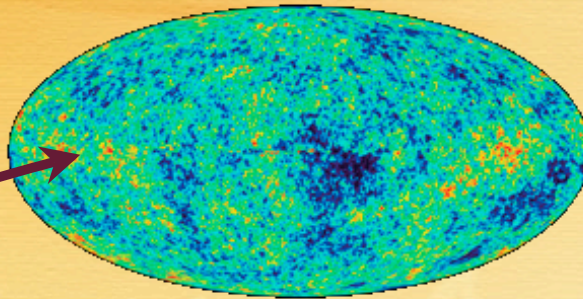
Graduate Research: Astrophysical Probes of Dark Energy

⌘ Dark energy has an observable impact on

- The volume and expansion rate of the universe
- The growth of large scale structure in the universe

⌘ Volume (or distance)

Cosmic Microwave Background

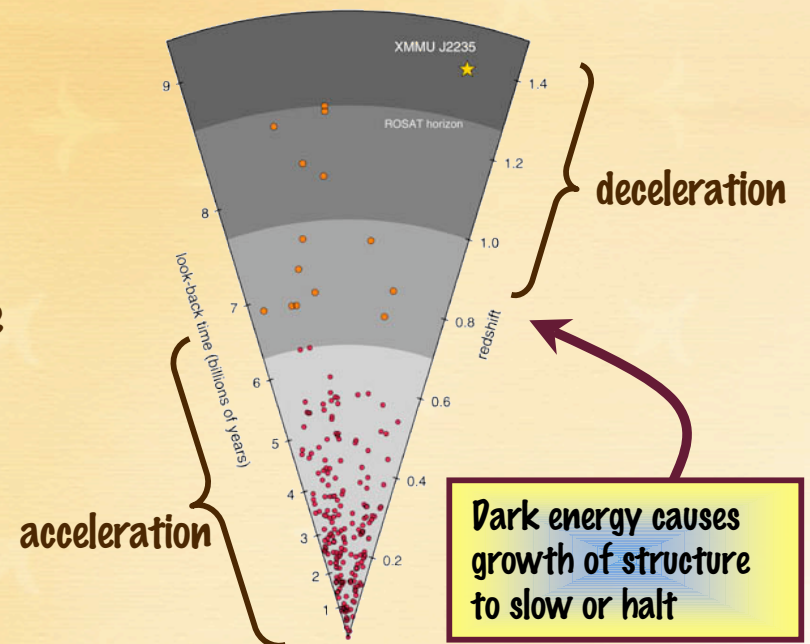


Physical size of spots is known

- We know the characteristic spot size on the CMB
- Accelerated expansion increases the distance to the CMB surface
- Spots appear smaller

⌘ Structure

Galaxy Cluster Abundance



Dark energy causes growth of structure to slow or halt



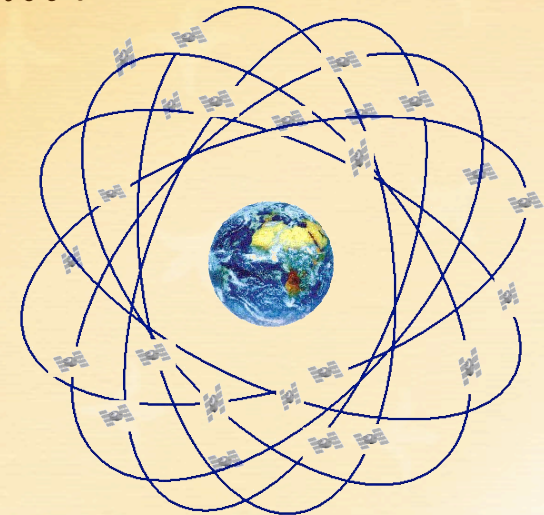
The military - break GPS



✠ Space Countermeasures Hands On Program (Space-CHOP)

- Leverage open source information
- assess vulnerability of the Global Positioning System (GPS)
- Design an attack strategy to destroy or disable GPS
- Focus on asymmetric threat (terrorist effort or rogue nation)
- Recommend strategies to harden the system

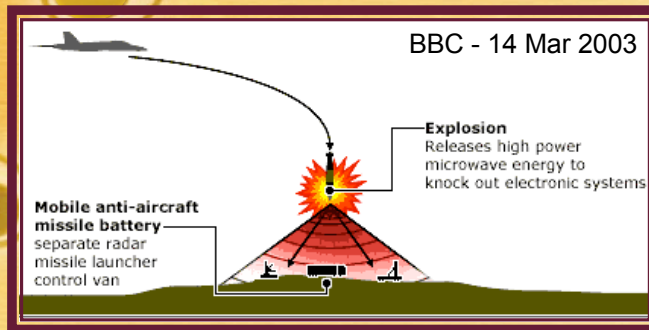
✠ Our design became quite well known because Iraq used a related technique on the first day of the war



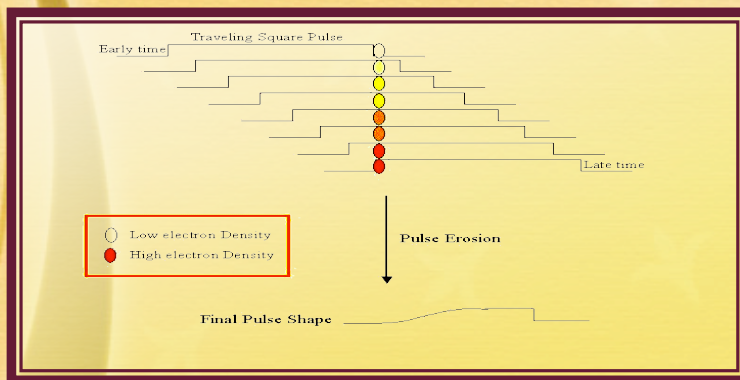
The military - computational plasma physics



- ✦ High powered microwave weapons technology
 - Active denial (crowd control)
 - Electronic disruption or destruction



- ✦ Non-lethal applications that preserve infrastructure and human life



- ✦ Microwaves cause air breakdown
 - Air plasma causes signal reflection
 - Computational simulations of plasma formation in air

The military - Additional Duties

⌘ Human Gate

Several weeks



⌘ Foam Cutter Extraordinaire

Several weeks



⌘ Adventures in security management

Rubber stamp top and bottom of front and back of every document in 11 of these

TOP SECRET

THIS IS A COVER SHEET
FOR CLASSIFIED INFORMATION



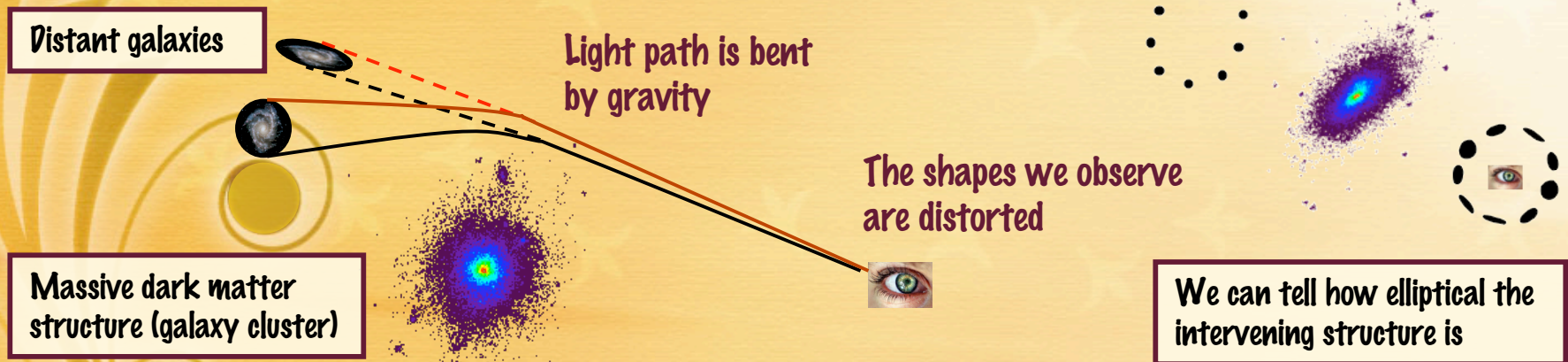
Two short weeks later

A large fraction (>50%) of what I had just stamped

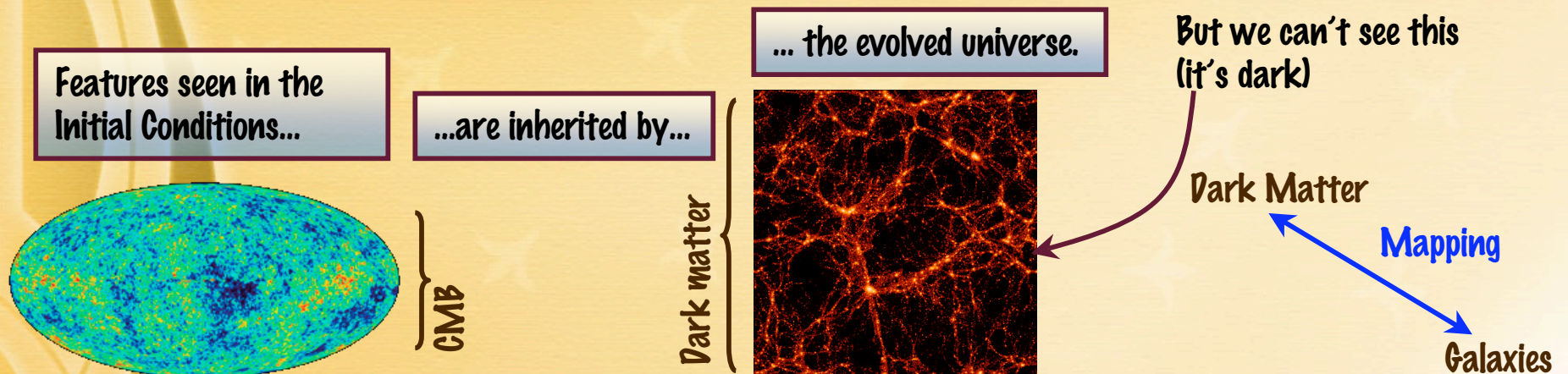


Some more years in graduate school: Berkeley

- ✠ Returned to my research on dark energy
- ✠ Gravitational lensing to study galaxy cluster shapes

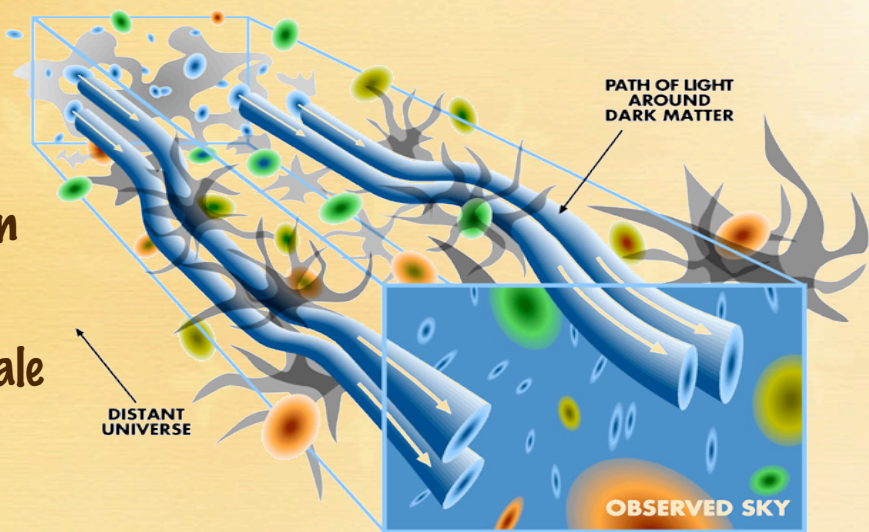


- ✠ Cosmology through the clustering of galaxies: baryon oscillations



Postdoc at last!

- ✠ 9 years later... moved to the Institute for Advanced Study
- ✠ Galaxy distributions in redshift space for gravitational lensing
 - Galaxies are lensed by *all* the dark matter in the line of sight
 - Breaking galaxies into nearby and distant samples probes dark matter in different parts of space
 - Sensitive to the growth of large scale structure
 - Need to know which fraction of galaxies lie in each sub-sample
- ✠ Entertaining myself with interdisciplinary discussions
 - Why cosmology is more like economics than like other branches of science



Reflections



✠ The people are important

- don't learn in a vacuum, ask questions
- practice communicating what you learn to others
- collaborate and share credit
- work with people you like

✠ Remain curious

- if you get bored then start asking a new question
- don't be afraid of "wasting" time and effort in learning new topics, your time is not that important

✠ Skill comes from diligence