Physics Colloquium
Graduate Posters

Michigan Technological University
Thursday, April 16. 2015
1:00 – 3:00 pm
Aftermath Atrium in Fisher Hall

Search for Sub-Planckian Length Scales in GRB 090510A and GRB 130427A

Chad Brisbois
Advisor: Dr. Robert Nemiroff

Abstract: The ability of the photons detected from GRB 090510A and GRB 130427A by the LAT instrument aboard NASA's Fermi satellite to constrain the spectrally dispersive properties of cosmological spacetime as predicted by some theories of quantum gravity is assessed. The most constraining photons continue to be, as reported previously, three super-GeV photons detected in GRB 090510A, separated by about 30 GeV in energy, that all arrived within about one millisecond. This suggests that spacetime is not only smooth across the universe at scales below the Planck length, but at scales even 1/500th of the Planck length. Here we report on a search conducted using all Fermi-LAT detected photons from these GRBs -- including those below 1 GeV -- for independent evidence that the universe is smooth at any scale below the Planck length.

Quantum Inspired Non-reciprocal waveguide arrays on Garnet deposited Silicon-On-Insulator Platform

Dolendra Karki
Advisor: Dr. Miguel Levy

Abstract: On-chip Optical isolators on silicon platform are the recent quest in integrated photonic circuits to allow light transfer in the desired direction and prevent any reflected feedback from optical interfaces. By introducing the magneto-optic non- reciprocity in waveguide arrays, quantum inspired state transfer of light in the forward direction and surface Bloch oscillation induced blocking of reflected light in the backward direction could be employed in the photonic devices. Here, the development towards fabrication of such devices for the realization of such effect will be presented.

Freezing Water with Ionic Salts

Joseph Niehaus
Advisor: Dr. Will Cantrell

Abstract: Although salt is typically used to lower the melting and freezing point of water, we demonstrate that is possible to trigger ice formation by dropping simple ionic salts such as sodium chloride onto supercooled water. More surprisingly, sodium hydroxide, a highly exothermic salt, also triggers freezing upon impact. The probability of freezing roughly scales with the amount of mass that impacts the droplet, and more directly with the density of the salt.

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Ab Initio Study of the Structural and Electronic Properties of MgV2O4

Kevin Waters
Advisor:

Abstract: MgV2O4 is a Mott insulator with applications in magnetism and superconductivity. We performed a theoretical study to determine its mechanical and electronic properties. Our study is based on density functional theory for which an extensive search was performed to determine Hubbard parameter. The calculated results find the cubic MgV2O4 to be metallic with the bulk modulus of 190 GPa.

Barium Concentrations in Rock Salt by Time-Resolved Laser-Induced Breakdown Spectroscopy

Kiley Spirito
Advisor: Dr. Jacek Borysow

Abstract: Time-Resolved Laser-Induced Breakdown Spectroscopy (TRELIBS) was used to determine the elemental concentration of barium in Texas Dome rock salt. TRELIBS allows for an efficient, in situ, and minimally destructive concentration analysis technique that detects a wide range of elements with no sample preparation.
TRELIBS measurements were made in the 545nm to 594nm range. The proximity of a strong barium emission line (553.5481 nm) to the sodium doublet (588.9950 nm and 589.5924 nm) allowed for measurement within a single frame of the spectrograph.
This barium emission line was compared to the sodium doublet for relative intensity. A homemade calibration sample containing known amounts of barium and sodium was used to determine the relative concentrations. By approximating the sodium content in the rock salt as 50%, we determined the absolute concentration of barium in the salt to be 0.13+0.03 percent.

Effect of Turbulence on Droplets in Precipitation

Neel Uday Desai
Advisor: Dr. Raymond Shaw

Abstract: How does water in the atmosphere go from cloud droplets (1-10 um) to rain (0.5-5 mm)? Currently, it is believed that droplets grow initially by condensation and later by collisions during gravitational sedimentation. However, these processes assume droplets to be evenly distributed in space and to approach each other at terminal speed. Kostinski and Shaw, 2001 showed that droplets tend to be clustered instead. We believe turbulence also modifies the relative velocity. So turbulence plays an important part in this conversion. We investigate the role of turbulence by recreating turbulent cloud conditions in the presence of gravity in the laboratory. We analyze how quantities like radial distribution function and collision rate change with turbulence intensity using digital holographic particle tracking.

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Towards Using Smartphones to Refine Sunrise and Sunset Time Models

Teresa Wilson
Advisor: Dr. Robert Nemiroff

Abstract: Current models that predict the times of sunrise and sunset are only typically accurate to a few minutes. Variations in atmospheric refraction, which is affected by conditions such as pressure, temperature and humidity, contribute to the differences between computed and observed times. At high latitudes, slight changes in refraction can cause the Sun to remain continuously above the horizon instead of appearing to set. A substantial collection of observations would help constrain atmospheric models, which should, in turn, complement astronomical observations through improved understanding of air stability, refraction, and transparency. Smartphones have a number of sensors that can provide us with such a data collection.

Using LiDAR and RaDAR to Calculate Drizzle Rates in Marine Stratocumulus Clouds

M. Amanda Shaw
Advisor: Alexander Kostinski

Abstract: If measuring by fractional coverage, stratocumulus clouds cover more of the Earth than any other cloud type, shielding up to 20% of Earth's surface from direct solar radiation and producing a net cooling effect. Small changes in the fractional coverage and thickness of stratocumuli have the ability to influence the Earth's radiative budget as much as increasing greenhouse gases do. As a consequence of this influence, the characterization of and the ability to model stratocumuli have become important objectives. Our research aims to improve the characterization of drizzling marine stratocumulus clouds since drizzle production affects marine stratocumuli lifetimes, fractional coverage, and albedo. Using data from the Marine ARM GPCI Investigation of Clouds (MAGIC) field campaign, we derive drizzle rate and liquid water content from the relationship between drizzle drop diameters and cloud depth.

Initials results for the liquid water content measurements are lower than those resulting from modeled marine (strato)cumulus clouds, 0.23 versus 0.44 respectively. While the drizzle rate appears to be higher than typical, other case studies illustrate that drizzle rates can differ by a factor of up to 20. Our case falls within this large range of drizzle rates, but more work needs to be done to factor in a drop size distribution given that marine stratocumulus clouds have broader distributions and fewer drops than continental (strato)cumulus clouds.

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