Physics Graduate Student Poster Session

Michigan Technological University

Thursday, April 10, 2008

2:00 – 4:00pm

Fisher Hall Atrium (near the Aftermath)

Analysis of Climatic Data via Statistics of Record-Breaking Extremes
Amalia Anderson, PhD Physics
Advisor: Dr. Kostinski

Abstract: Climate patterns can be examined statistically by a study of record-breaking extremes. This is done by counting the number of record-breaking extremes, such as record-breaking high or low values, which occur in a time-series. Since the behavior of record-breaking events is known for a stationary series according to the statistics of extremes, an examination of records is a useful tool in picking out trends. This method of picking out trends is particularly suitable for extracting weak signals, like picking up mean and/or variance trends which are often difficult to extract from signals with strong noise.

I recently analyzed temperature time-series from the *Global Historical Climatology Network* (GHCN). Several groups have already reported trends for this data, usually reporting increases in the mean temperature over 100 years to be just less than 1°C. The International Panel on Climate Change has reported 0.7°C. I simulate data using this trend and compare the record-breaking highs and record-breaking lows for the simulations and the GHCN data.

Nonlinear Magnetophotonic Crystals
Pradeep Kumar, PhD Engineering Physics
Advisor: Miguel Levy

Abstract: The work presented here concentrates on the development of a new class of nonlinear magneto-optical materials possessing strong nonlinear magnetic susceptibility and photonic band gaps for nonlinear optical applications. The main focus is on enlarging the nonlinear performance of ferrite garnet films by stress generation and compositional gradients in the sputter-deposition growth of these films and by controlling the surface contribution to harmonic generation in the presence of photon trapping.

Surface second harmonic generation has emerged as an important tool for surface probing and characterization in the last two decades because it overcomes the selection rule prohibition of second-order nonlinear effects in the bulk media with inversion symmetry [1]. The nonlinear optical effects are generally forbidden in a medium with inversion symmetry. Since the inversion symmetry is necessarily broken at a surface, such effects appear to be highly surface-specific between two centro-symmetric media. The surface effect could be maximized by photon trapping in relatively small regions through photonic crystal technology and the confined μm-scale cross sectional dimensions of optical waveguide.

This work aims to establish the feasibility of harmonic generation as a tool for sub-micron magnetic analysis.

Photonic State Coupling and Magnetically-Tunable Photonic Bandgaps
Neluka Dissanayake, PhD Engineering Physics
Adviser: Dr. Miguel Levy

Abstract: Control of the optical signal through optical bandgap engineering can be put to use in optical filtering and switching. In this work, the formation of magnetically tunable optical bandgaps in nonreciprocal media is investigated. The simultaneous presence of optical gyrotropy (Faraday effect) and crystal anisotropy in a photonic crystal results in the formation of a band gap at frequency band cross over point inside the brillouin zone. The coupling between local optical normal modes with different polarization is responsible for this effect. These new type optical band gaps named gyrotropic degenerate bandgaps form functional photonic crystals which have applications in optical switches and magnetic sensors.

Lagrangian Properties of Cloud Particles in Turbulence Obtained by Holographic Particle Tracking
Jiang Lu, PhD Physics
Advisor: Dr. Raymond Shaw

Abstract: We have designed a laboratory system for studying Lagrangian statistics of particles in homogeneous, isotropic turbulence. The system is designed to match the flow and particle conditions governing the collision rate of droplets in atmospheric clouds (e.g., particle Stokes number and gravitational settling parameter). Two methods for particle tracking are used, both based on digital in-line holography. The first is a combination of stereo-imaging and holography using two cameras. The second uses a single holographic system with depth resolution improved by temporal averaging of particle position. These approaches provide a tool for quantifying the 3-D Lagrangian properties of inertial particles with finite settling speed in homogeneous isotropic turbulence. Lagrangian statistics relevant to the cloud coalescence problem are discussed.

RCI Techniques for Calculating Energy Levels in $4f^n$ Ions Applied to Gd IV
Eric Domeier, MS Physics
Advisor: Dr. Donald R. Beck

Abstract: Relativistic Configuration Interaction (RCI) techniques and results for the energy levels and Landé *g* values of Gd IV $4f^7$ J=7/2 are presented including energies of 14 new levels as well as improved *ab initio* results for previously treated levels. The average error between adjacent energy levels of 4.5% based on experimental results. Triple and quadruple excitations are examined. The current computational limitations of RCI are discussed as well as significant improvements made in computational efficiency and accuracy for the difficult $4f^n$ states are introduced including: a more systematic treatment of radial convergence, and neglecting off-diagonal matrix elements between quadruple excitations.

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