University of Washington

Physics Colloquium Schedule

Spring Quarter 2006

Mondays, 4:00 P.M. Ronald Geballe Auditorium, Rm. A102
Coffee & cookies at 3:45 P.M. in the lobby

www.phys.washington.edu/colloquia.htm
~Spring Quarter Colloquium Chair: Professor Boris Spivak~

March 26:

Alejandro Garcia, UW Physics
Title: *"Weak decays of quarks in the nucleus"*
Abstract: According to the Standard Model quarks decay via the weak interaction into linear combinations of the mass eigenstates. This idea was proposed by Cabibbo to explain the difference in lifetimes between kaon and nuclear weak decays. In order to provide with a simple framework to explain CP violation this idea implied other generations of quarks that were later found. In the Standard Model the relationship between the weak eigenstates and the mass eigenstates are represented with a unitary matrix: the Cabibbo-Kobayashi-Maskawa matrix. However, it is not clear that the matrix is really unitary. I will present progress in the last few years on different experiments to test the unitarity of the matrix and understand nuclear physics issues that play a role in these tests.

April. 2:

Dietrich Habs, University of Munich, Germany
Title: "*Brilliant Photon and Particle Beams"*
Abstract: The Petawatt-laser PFS (5J/5fs) with 10 Hz repetition rate and a focused intensity of 10^{22}W/cm^2 is setup at the MPQ till 2010. We are actively planning the Exawatt-laser Eli (10J/10fs) with 0.03 Hz and a focused intensity of 10^{26}W/cm^2 in Europe to be built starting in 2010.Via nonlinear relativistic effects the high intensities can be increased much further in a small space-time volume, becoming more efficient the higher the starting intensity. E.g. by coherent harmonic focusing the PFS, its intensity can be focused to 10^{29}W/cm^2 in a small volume ($^{o}A^{3}$) for a short time. Extrapolating for the Exawatt-laser 10^{37}W/cm^2 can be reached. A second way for high intensities is building a compact x-fel using an undulator and laser-driven monochromatic electron beam. I show the new techniques to get a GeV electron beam

and discuss our table top xfel setup. With such techniques we can reach electrical field strength of 10^{18}-10^{22}V/m beyond the Schwinger limit ($1.8*10^{18}$V/m) where the vacuum becomes unstable against e^+e^- decay. Studying pair decay above or below the Schwinger limit is an experimental challenge. By the strong fields an electron is accelerated with a = 10^{28}-10^{32}g resulting in an Unruh temperature of (100 keV-1 GeV)/k. We want to measure the Unruh effect for the first time and study the entangled EPR-photons, which is a new approach to general relativity and quantum mechanics in the laboratory. We also study the Unruh effect for oscillating accelerations.

April 9:

Elliot Lieb, Princeton University

Title: "*The Dilute, Cold Bose Gas: A truly quantum-mechanical many-body problem*"

Abstract: The peculiar quantum-mechanical properties of the ground states of Bose gases that were predicted in the early days of quantum-mechanics have been verified experimentally relatively recently. The mathematical derivation of these properties from Schroedinger's equation has also been difficult, but progress has been made in the last few years (with R. Seiringer, J-P. Solovej and J. Yngvason) and this will be reviewed. For the low density gas with finite range interactions these properties include the leading order term in the ground state energy, the validity of the Gross-Pitaevskii equation in traps (including rapidly rotating traps), Bose-Einstein condensation and superfluidity, and the transition from 3-dimensional behavior to 1-dimensional behavior as the cross-section of the trap decreases. The latter is a highly quantum-mechanical phenomenon.

April 16:

Tom Lubensky, Department of Physics and Astronomy, University of Pennsylvania

Title: *"Liquid Crystals: What they are and why you should know about them"*

Abstract: Liquid crystals are soft materials with macroscopic symmetries that fill the gap between the highest-symmetry state of isotropic and homogeneous fluids and the lowest-symmetry state of periodic crystalline solids. They provide us with the language for describing partial rotational and positional order whatever their context. This talk will consider examples from the world of liquid crystals that illustrate both the power of phenomenological reasoning and how symmetry determines long-wavelength, low-frequency, and topological-defect properties of physical systems. It will, in particular, consider twist-grain boundary phases, the liquid crystal analogs of the Abrikosov vortex lattice in superconductors, sliding columnar phases in DNA-lipid complexes, which have quantum analogs in Sliding-Luttinger-liquid phases, and liquid crystalline elastomers, whose remarkable elastic properties are a consequence of a broken symmetry.

April 23:

Jim Lattimer

Title: *"Neutron Star Observations and the Prognosis for Equation of State Constraints"*

Abstract: Current and proposed observations of neutron stars can lead to an understanding of the state of their interiors and the key unknowns: the typical neutron star radius and neutron star maximum and minimum masses. Precise determinations of these neutron star properties would lead to significant eestrictions on the poorly understood equation of state near and beyond the equilibrium density of nuclear matter. Recent developments include observations of pulsars (leading to mass, spin period, and crustal thickness estimates), optical and X-ray emissions from cooling neutron stars (which lead to estimates of core temperatures and ages and inferences about the internal composition), and X-rays from accreting and bursting sources (which shed light on both crustal properties and internal compositions). Proposed measurements of additional properties, such as neutron star moments of inertia, will also be important.

April 30:

Seth Putterman, UCLA
Title: "*Energy Concentrating Phenomena: From Sonoluminescense To Crystal Fusion*"
Abstract: Fluids and solids that are driven off equilibrium do not relax smoothly to equilibrium. Instead they display a wide range of energy focusing phenomena. In sonoluminescence a pulsating bubble concentrates the ambient acoustic energy density by 12 orders of magnitude to create picosecond flashes of broadband ultraviolet light. At the minimum bubble radius where the contents have been compressed to their van der Waals hard core the acceleration exceeds 1011g and a Mega-Bar level shock wave is emitted into the surrounding fluid. For single bubbles driven at 30KHz SL is nature's smallest blackbody. At 1MHz the spectrum resembles Bremstrahlung from a transparent plasma with a temperature ~1MK and a nanometer radius. Whether cavitating systems will reach energy densities that initiate thermonuclear fusion is an open question. Ferroelectric crystals, however, can be configured to create nuclear fusion in a palm-sized apparatus. When the temperature of a ferroelectric crystal [e.g. Lithium Tantalate] is slightly varied, electrons are expelled with energies that can exceed 100KeV. By configuring the crystal surface with a field ionization tip, pyroelectricity can be used to generate and accelerate ions to energies where nuclear fusion occurs. Hoped-for applications range from miniature x-ray devices to neutron cameras to ion thrusters. In seeking to improve these devices one faces the question: what physics processes limit the spontaneous polarization [and resulting internal field] that can be produced with a ferroelectric crystal? For ~50 years Lithium Niobate has exhibited the highest ratio of spontaneous polarization to dielectric constant? Why haven’t superior materials been discovered? Is there a fundamental limit set by the laws of physics?

May 7:

Stanislas Liebler, The Rockefeller University
Title: "*Fluctuations, information, and survival: some lessons from bacteria*"
Abstract: Growing (micro) organisms are subject to different types of environmental changes. Some of these are regular - for instance, daily variations of light intensity. Others are stochastic, such as the random appearance of predators or toxins. Bacteria have developed an astonishing panoply of survival strategies in varying environments. I will describe some recent experimental and theoretical studies of bacterial behavior. Connections with information theory and statistical mechanics will be discussed.

May 14:

Steve Girvin, Yale University

Title: " *Circuit QED: Atomic Physics and Quantum Optics with Superconducting Electrical Circuits*"

Abstract: Recent experimental breakthroughs have led to the construction of artificial superconducting 'atoms': nanoscale objects containing nearly one trillion aluminum atoms coherently acting in concert. When placed inside a resonant cavity, these 'atoms' can strongly interact with microwaves and can be used to detect and generate individual microwave quanta. This talk will give an elementary introduction to recent remarkable experiments in the Schoelkopf and Devoret labs at Yale. In addition to being a new test bed for quantum mechanics and quantum optics in the ultra-strong coupling regime, this system has many promising features for quantum computation.

May 21:

Fred Reike, UW

Title: "*No flash required: How the retina adjusts its sensitivity when the light inputs change*"

Abstract: Perception of sights, sounds, and smells requires sensory systems to accommodate enormous changes in the input signals. For example, we can see over a range of light levels more than a billion times greater than the range of output signals visual neurons can produce. This requires that neurons in the retina adapt or adjust their gain to match the input signals. Such adaptation can occur in multiple locations, including the receptors themselves and sites within the circuitry that reads out the receptor signals. I will describe recent experimental and computational work aimed at understanding how vision accommodates daily changes in light level.
