# Spring 2007 Colloquium Series
# Physics Department
# University of Oregon

## 4:00pm Thursdays, 100 Willamette
## (Reception at 3:45pm in the Atrium)

| | | |
|---|---|---|
| April 5 | Umar Mohideen<br><br>University of California, Riverside | Title: Probing the Quantum Vacuum with the Casimir Effect<br><br>Abstract:<br>A brief review of the many facets of the Casimir effect, its place in quantum physics and its importance to applications will be provided. Following which, the experimental status and our precision measurements using microfabricated cantilevers will be discussed. Finally, some outstanding questions and corresponding experiments will be presented.<br><br>(Host: van Enk) |
| April 12 | Graham Kribs<br><br>University of Oregon, Eugene | Title: Dimensionful Constants and the Anthropic Principle<br><br>Abstract:<br>What determines the size of the fundamental constants of Nature? Modern particle theory has established that constants are not constant, fundamental is relative, and what constitutes a scientific explanation is rationally debatable. This talk will be a tale of two constants, the cosmological constant and the Higgs mass, whose rather different character leads to support for and against the application of the anthropic principle to explain their size.<br><br>(Host: van Enk) |
| April 19 | Hailin Wang<br><br>University of Oregon, Eugene | Title: Cavity QED with silica microresonators<br><br>Abstract: A quantum system, whose dynamics can be manipulated and controlled at the level of a single photon, is of both fundamental and practical interest. In this talk, I will discuss two promising systems that are based on the use of silica optical resonators. The first system consists of artificial atoms, such as nanocrystals or defect centers, coupling to a resonator mode via a dipole optical transition. The second system exploits the interaction between a mechanical excitation and a resonator mode via radiation pressure. Both of these systems take advantage of the ultrahigh quality factor inherent in silica microresonators. |

| | | |
|---|---|---|
| | | (Host: van Enk) |
| April 26 | Jun Ye<br><br>JILA, NIST, Boulder | Title: The art of light-based precision measurement<br><br>Abstract: Improvements in spectroscopic resolution have been the driving force behind many scientific and technological breakthroughs over the past century, including the invention of the laser and the realization of ultracold atoms. Creating and preserving optical phase coherence are one of the two major ingredients (the other being the control of matter) for this scientific adventure. Lasers with state-of-the-art frequency control can now maintain phase coherence over one second, that is, 10^15 optical waves can pass by without losing track of a particular cycle. Translating into distance, such a coherent light wave can traverse the circumference of the Earth 10 times and still interfere with the original light. The recent development of optical frequency combs has allowed this unprecedented optical phase coherence to be established across the entire visible and infrared parts of the electromagnetic spectrum, leading to direct visualization and measurement of light ripples. A new generation of atomic clocks using light has been developed, along with new forms of optical interferometry, with an anticipated measurement precision reaching 1 part in 10^18. These developments will have impact to a wide range of scientific problems such as the possible time-variation of fundamental constants and gravitational wave detection, as well as to a variety of technological applications including global position systems and deep space navigation.<br><br>(Host: van Enk) |
| May 3 | Michael Raymer<br><br>University of Oregon | Title: Photon Wave Mechanics: How to Think and Teach About Photons<br><br>Abstract: In a first quantum physics course in the second or third year of university study, a student is usually introduced to the concept of photons in the context of old (pre-wave-mechanics) quantum theory. After introducing Planck's relation between the frequency and energy of a quantized harmonic oscillator, and Einstein's famous use in 1905 of this relation for light oscillators, the formal study of quantized light is usually dropped until the student enters the second year of graduate studies, if indeed that ever happens. The reason for this delay is that light is composed of an infinite number of oscillators, and therefore is usually treated using quantum field theory, with all of its complexities. Using wave mechanics, which treats the photon as a quantum 'particle' we have found that it is easy to introduce a formal, if approximate, theory of the photon in an introductory quantum physics course in which the students are assumed to have only a rudimentary knowledge of electromagnetism and waves. In fact, the juxtaposition of the wave mechanics of the electron and of the photon, through their respective wave equations, serves to clarify at the outset that quantum theory is not only about the Schroedinger equation for the electron. Rather, that equation is just one of the many quantum wave equations that appear in |

| | | |
|---|---|---|
| | | physics. In this talk, I will also review the more-or-less rigorous theory of photon wave mechanics, including the spin or vectorial nature, which is useful for describing one-photon states or two-photon entangled states. It turns out that J.C. Maxwell himself discovered the first fully relativistic quantum theory of a particle. I will also review experiments we have carried out to determine photon wave functions.<br><br>(Host: van Enk) |
| May 10 | Dave Bacon<br><br>University of Washington, Seattle | Title: When Physicists Build Quantum Algorithms<br><br>Abstract: Our universe is a quantum universe, obeying the laws of quantum theory to high precision. Thus it makes perfect sense to base the most fundamental model of a computer (which is, of course, nothing more than a physical device obeying the laws of physics) upon gadgets which respect the laws of quantum theory. Such "quantum computers" have attracted widespread attention over the last decade, in large part due to the ability of these computers to break modern cryptosystems and to outperform classical computers at certain algorithmic tasks. An important grand challenge for quantum computing these days is to find new quantum algorithms which outperform their classical counterparts. As a physicist, however, you may wonder, "what role can I play in coming up with new quantum algorithms, I'm just a pragmatic physicist?" In this talk I will give examples of new quantum algorithms inspired and devised by physicists, using tools and techniques which are near and dear to most physicists. These new quantum algorithms suggest that there is much that physics can contribute to the theory of quantum computing algorithms.<br><br>(Host: van Enk) |
| May 17 | Stan Micklavzina and the Society of Physics Students<br><br>University of Oregon | Title: Physics Clicker Test and Ice Cream Social<br><br>Abstract: Undergraduate students have requested a social hour to meet the faculty and graduate students within the department. They also requested research space to perform low temperature experiments utilizing cream, sugar, and assorted flavorings and a large number of participants to taste and consume the results. But what do you talk about? How dow we "break the ice"? We will do what we do best, we give a test! An interactive Physics IQ test! We will have various demonstrations set-up and ask questions about what will occur when the demonstration is performed. We will utilize a "clicker" system where all participants will be able to anonymously respond to the questions and immediately display the results. We will demonstrate how an interactive activity using these response devices could be utilized in the classroom as well as display some new physics demonstrations one can use in their teaching. Faculty and grad students are encouraged to bring name tags from a meeting you have attended. This can help identify what area you do research in. (Another way to help initiate conversation).<br><br>(Host: van Enk) |

| | | |
|---|---|---|
| May 24 | Martin Schmaltz<br><br>Boston University | Title: New Physics at the LHC, maybe the Little Higgs?<br><br>Abstract: With the start of the Large Hadron Collider in 2008 particle physics is likely to enter its most exciting period in over three decades. The physics of the TeV scale will begin to be uncovered, and whatever is found will have profound implications. In this talk I review the argument for why we expect to see new physics at the LHC and present one of the leading proposals for what this new physics might be.<br><br>(Host: Kribs) |
| May 31 | John Harris<br><br>Yale | Title: Evidence for a Quark-Gluon Plasma in the Laboratory<br><br>Abstract: Ultra-relativistic collisions of heavy nuclei are being investigated for the first time at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory and will soon be investigated at the Large Hadron Collider at CERN. These collisions heat nuclear matter to energy densities previously reached only within the first few microseconds after the Big Bang. Temperatures of 2 x 1012 K are achieved, melting the vacuum into a plasma of quarks and gluons. The goal of physicists in this field is to re-create and to uniquely identify the properties of the primordial quark-gluon plasma in order to understand Quantum Chromodynamics at high energy densities. After six years of operation, RHIC and its experiments have established the presence of such extreme energy densities, temperatures and pressures. The system that is created behaves somewhat unexpectedly as a strongly-interacting, low viscosity liquid of quarks and gluons and is opaque to energetic quark and gluon probes. I will present an overview of the results establishing the creation and behavior of a hot (T = 2 x 1012 K) quark-gluon liquid at RHIC and its quenching of energetic probes. The quark-gluon liquid has behavior and properties similar to those of strongly-interacting classical fluids that are studied in atomic physics. Remarkably, a theoretical approach to black holes involving strings in five dimensions can describe the unique properties of this quark-gluon liquid.<br><br>(Host: Hsu) |
| June 7 | Frans Pretorius<br><br>Princeton | Title: Simulations of Binary Black Hole Coalescence<br><br>Abstract: The collision of two black holes is thought to be one of the most energetic events in the universe, emitting in gravitational waves as much as 5-10% of the rest mass energy of the system. An international effort is currently underway to detect gravitational waves from black hole collisions and other cataclysmic events in the universe. The early success of the detectors will rely on the matched filtering technique to extract what are, by the time the waves reach earth, very weak distortions in the local geometry of space and time. In the case of black hole mergers numerical simulations are needed to obtain predictions of waveforms during the final stages of coalescence. 2005 was a watershed year for numerical simulations of black holes, and we are now beginning to explore the fascinating landscape of black hole collisions in |

the fully non-linear regime of Einstein's theory. In this talk I will give an overview of the recent successes and what we have learned about the merger process, for both astrophysically relevant binaries and, time permitting, more esoteric configurations. The latter include hyperbolic encounters fine-tuned to an approximate threshold of merger, exhibiting behavior similar to "zoom-whirl" geodesics in a black hole background. These types of orbits may have some relevance to speculative black hole formation by parton collisions at the LHC in large extra dimension scenarios.

(Host: Imamura)

---

Last modified: Tue Apr 3 10:32:04 PDT 2007