Dimensions . . . The Physics & Astronomy Newsletter

Summer 2010

Faculty News

Anupam Garg: After 25 years, an experimental realization of the Leggett-Garg test
Quantum mechanics does not in general permit microscopic objects such as electrons and atoms to be in a definite state at all times. But does this indefiniteness also extend to macroscopic objects? Or, as Einstein so pungently asked, "Is the moon there when nobody looks?" In 1985, Professor Anupam Garg and Anthony Leggett proposed a quantitative test to address this question. Their test has now been experimentally realized in the work of Palacios-Laloy and colleagues, recently published in Nature. At least at the level of macroscopicity realized in the experiment, quantum mechanical indefiniteness is found to prevail.

Adilson Motter has received the inaugural Northwestern-Argonne Early Career Investigator Award for Energy Research, which will fund his work into improving the U.S. electric power grid. He was selected for his proposal, "Optimization of Power-Grid Dynamics for the Development of Smart Grids." The award is funded by the Initiative for Sustainability and Energy at Northwestern (ISEN) and Argonne.

Brian Odom was recently interviewed by National Public Radio, and discussed a recent European measurement suggesting that the radius of the proton might be 4% smaller than previously thought. (Link: http://www.npr.org/templates/story/story.php?storyId=128568237)
Prof. Odom speculated in the interview that perhaps protons really are the same size as we thought before, but that there is new physics beyond the Standard Model affecting the new measurement.

James A. Sauls was invited to give a talk on "Spin Supercurrents in Superconducting-Ferromagnetic Josephson Junctions" at the International Symposium on Quantum Fluids and Solids held in Grenoble, France (August 1-7).

Michael Smutko has been awarded the Charles Deering McCormick University Distinguished Lecturer Prize for 2010, Northwestern's highest teaching award. He was also elected to the Associated Student Government's Faculty Honor Roll for the fourth time.

Welcome, Frank!

Frank Petriello will formally join our faculty in January, 2011. Frank received his PhD in physics at Stanford University in 2003, with his thesis titled *Topics in Collider Physics*. His adviser was Prof. Jo Anne Hewett. He went on to do Postdoctoral Research at Johns Hopkins University, and then was a Visiting Scientist at the Fermi National Accelerator Center. He is currently an Associate Professor with the Department of Physics at the University of Wisconsin, Madison. His research interests include perturbative QCD; physics at the TeV scale; and new calculational techniques for quantum field theory.

Selected New Publications

Adilson E. Motter
"(Non)Invariance of Dynamical Quantities for Orbit Equivalent Flows", Katrin Gelfert and Adilson E. Motter, Communications in Mathematical Physics (in press - 2010). The transformation of dynamical quantities established in this paper addresses a long-standing problem in general relativity and cosmology, namely, of whether chaos is a property of the physical system or a property of the coordinate system. At the center of this discussion is the mixmaster cosmological model, a spatially homogeneous anisotropic solution of Einstein's equations that has been conjectured to describe the dynamics of the early universe. This model can be described as a geodesic flow on a Riemannian manifold with negative curvature, which

nevertheless has been shown to have positive or vanishing largest Lyapunov exponent depending on the time coordinate adopted. This problem has resisted rigorous solution because the transformations used in cosmology are not guaranteed to preserve the normalization property of the invariant measure and because the identification of truly invariant indicators of chaos is often elusive. To this regard, the results in this paper show once and for all that Lyapunov exponents, entropies, and dimension-like characteristics can be used to make invariant assertions about chaos. However, the same results also show that the values of some quantities that have been previously conjectured to be invariant, such as the information dimension and topological entropy, are not invariant in general.

Pulak Dutta
"How water meets a very hydrophobic surface", Sudeshna Chattopadhyay, Ahmet Uysal, Benjamin Stripe, Young-geun Ha, Tobin J. Marks, Evguenia A. Karapetrova and Pulak Dutta, Phys. Rev. Lett., 105, 37803 (2010). Blow gently on a bead of water sitting on a water-repellent (hydrophobic) surface, and it slides away easily. Is that because the droplet hovers slightly above the surface, leaving an intervening low-density "cushion"? There have been many previous attempts to answer this question experimentally, but the results are contradictory because the effect is too weak to be clearly seen on the wax-like (hydrocarbon) surfaces studied. We have used synchrotron x-rays to probe the interface between water and much more hydrophobic (fluorocarbon) surfaces.

CIERA News and Events

The CIERA GK-12 program "Reach for the Stars" is now in full swing. The teachers and graduate fellows were chosen and paired up this summer. They spent an extraordinarily productive week working together and learning the basics of science education and the research being done by each of the fellows. The fellows are becoming quite active in the classroom, serving as "resident scientists" within the classroom of their partnering teacher.

You can find out more about the program at:
http://gk12.ciera.northwestern.edu/.
The latest press release on Reach for the Stars is at:
http://www.northwestern.edu/newscenter/stories/2010/07/reach-for-the-stars-grant.html

Other upcoming CIERA events include:

CIERA Annual Public Lecture
Speaker: Kip Thorne (Caltech)
Title: Black Holes
Date: October 18, 2010
Time and Location: TBA

CIERA Quarterly Colloquium:
Speaker: Peter Goldreich (Institute for Advanced Study)
Title: Reading the Record of Ancient Impacts
Date: October 5, 2010
Time and Location: 4pm - Swift Hall

We Hear That . . . (Alumni News)

Jeffrey Klug (PhD 2010, Advisor: Prof. Michael Bedzyk) is now part of a collaboration that recently published the following article:

"Effects of Cantilever Buckling on Vector Piezoresponse Force Microscopy Imaging of Ferroelectric Domains in $BiFeO_3$ Nanostructures", Ramesh Nath, Seungbum Hong, Jeffrey A. Klug, Alexandra Imre, Michael J. Bedzyk, Ram S. Katiyar, and Orlando Auciello, Applied Physics Letters, 96, 163101 (2010). Systematic studies are presented on the effects of cantilever buckling in vector piezoresponse force microscopy V-PFM imaging of polarization domains in thin-film-based 001-oriented $BiFeO_3$ nanostructures, as observed through the coupling of out-of-plane and in-plane PFM images. This effect is a strong function of the laser spot position on the cantilever, being strongest at the free end, and insignificant at 60% of the cantilever length from the pivot point. This finding provides a unique approach to V-PFM imaging of ferroelectric polarization domains, yielding three dimensional PFM images without sample rotation in the plane.

Krishnaswamy Raghunathan (PhD 1978, Advisor: Prof. Ralph Segel) - Dr. Raghunathan worked in the aerospace industry following his graduation and has also worked on meteorological satellites as well as geo-synchronous communication satellites. Although he retired from full-time employment in 2006, he is still working part-time at Space Systems/LORAL as a staff assistant to the Chief Engineer.

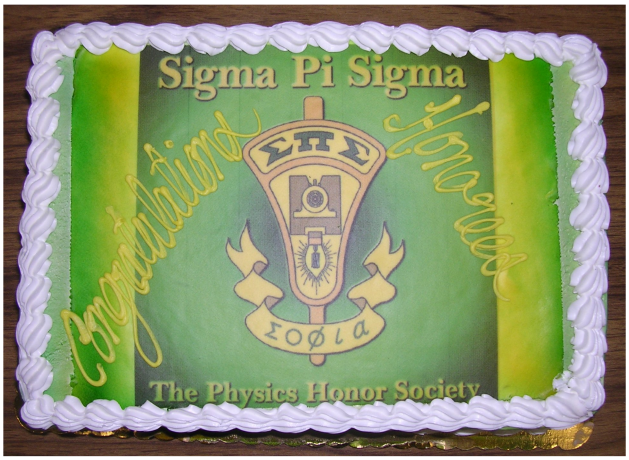
Joseph A. Schaefer (PhD 1972, Advisor: Prof. Jules A. Marcus) - From 1971 through 1999 Dr. Schaefer taught Physics and Engineering at Loras College in Dubuque Iowa, reaching the rank of Professor of Physics and Engineering Science. In the fall of 1999 he left Loras College, and began teaching in the Department of Aerospace Engineering at Iowa State University in Ames, Iowa, where he has the rank of Senior Lecturer. Currently, his primary teaching is the introductory course in Fluid Mechanics and the Strength of Materials laboratory course. He holds the title of Professor Emeritus at Loras College. In 1989, he was recognized by the Council for Advancement and Support of Education as the "1989 Iowa Professor of the Year." In 2008 the Loras College Alumni Association selected him for recognition for Outstanding Contributions by an Alumnus to Teaching at Loras College. His most recent research activities involve freeze-bonding of ice and the physics of ice jams, conducted at the Iowa Institute of Hydraulic Research at the University of Iowa.

Raymond A. Spong (BS 1949, Advisor: Prof. Kaj Aage Gunnar Strand) graduated from Lane Technical High School in Chicago about a month after the attack on Pearl Harbor. He entered NU in the fall of 1942. He met his future wife in the Friday night lab sessions that Professor Oliver Lee held with his beginning astronomy class. At that time Dr. Strand headed the Astronomy Department, and Dr. Krogdahl was the only other permanent staff member. For several years after Raymond received his BS he worked as a graduate assistant, mostly reading glass plates on a measuring engine in conjunction with research on the double star system 70 Ophiuchi. The calculations were done on a Marchand calculator, and backed up by a mechanical Monroe adding machine to which someone had affixed a small motor so that at least simple addition could be done without extra keystrokes. Although IBM offered him a job as a time clock repair man, Raymond eventually accepted a position with the US Naval Underwater Sound Laboratory, and spent the remainder of his career working on underwater sound and anti-submarine warfare problems, 35 of those years in the Electric Boat Division of General Dynamics.

Tassos Fragos (PhD 2010, Advisor: Prof. Vicky Kalogera) is now working at the Harvard-Smithsonian Center for Astrophysics, sponsored by two postdoctoral fellowships joint for 4 years: one from the Harvard Institute for Theory and Computation (ITC) and one from the Smithsonian CfA.

Undergraduate News

Northwestern's Chapter of the Physics Honor Society Sigma Pi Sigma goes back to 1970 when the Chapter received its charter. Eight students were installed in the first ceremony. The chapter then became inactive till 1986. Since then it has had an Installment Ceremony every year with membership now numbering 171.



In 2010, the newest student members were inducted by Prof. Art Schmidt. They were: David Ackerman, Matthew (Emery) Goss, Julian Jacobson, Rachel Koltun, Zhaoyang (John) Liu, Ian Lizarraga, Andrew Loveridge, Michelle Miller, Dmitry Spivak, Michael Tremmel, and Wing Chi (Teresa) Wong.

New Sigma Pi Sigma members: Andrew Loveridge, David Ackerman, Michael Tremmel, and Ian Lizarraga.

Undergraduate Research Awards

Asna Ansari, **Ian Lizarraga**, and **Scott Phelan** have been awarded Summer Grants of $3,000 to pursue independent research projects this summer. Asna will work with Prof. Vicky Kalogera, Ian with Prof. Adilson Motter, and Scott with Prof. Farhad Yusef-Zadeh.

Graduate News

Joo Sang Lee, a graduate student working with Adilson E. Motter, has been selected to receive a Fellowship from the Biotechnology Cluster Program. Lee, who is also part of the NU Physical Science Oncology Center, studies relations between metabolism, gene expression, and cancer.

Francesca Valsecchi, a graduate student working with Vicky Kalogera, recently was part of a collaboration that published the following article:

"Formation of the Black-Hole X-Ray Binary M33 X-7 via Mass Exchange in a Tight Massive System", by F. Valsecchi, E. Glebbeek, W. Farr, T. Fragos, B. Willems, J. Orosz, J. Liu, V. Kalogera, Nature, (accepted for publication 2010). M33 X-7 is a recently discovered (2007) x-ray luminous binary system that hosts one of the most massive black holes among all x-ray binaries known at present, a 15.65 solar mass black hole orbiting a 70 solar mass stellar companion in a Keplerian orbit of 3.45 days. The massive components (the star is the most massive star ever discovered in this class of systems), and the tight orbit challenge our understanding of typically invoked black-hole x-ray binary formation channels. For the first time, we present a solution to the evolutionary history of M33 X-7 that is consistent with the complete set of observational constraints. [PRESS EMBARGOED UNTIL FURTHER NOTICE]

Thomas Wytock, a graduate student working with Adilson E. Motter, has been appointed to the NIH-sponsored Molecular Biophysics Training Program. Wytock's research will be focused on gene interaction networks.

Other News

Dr. Matthias Eschrig (former postdoctoral associate with James Sauls) has accepted a tenured faculty position at the Royal Holloway University of London. He also will hold a joint senior research position at the Rutherford-Appleton Laboratory.

As The Dust Settles . . . Our Construction Soap Opera

Construction of the long-planned infill between the chemistry and physics wings is well underway. For those of you with nostalgic memories of the old Physics Annex, the photo below shows all that is left of it now. It has been demolished down to bare mud, and pilings for the new infill are now being driven in. Meanwhile, there is scaffolding in the F-wing stairwell as workers prepare to build a fourth story on the F-wing directly above the existing third story. Stay tuned for more news as the work goes on . . .

Have News to Share??

The department newsletter is a means of reaching out to the alumni, students, faculty, and post-docs to keep them abreast of current research and developments in the Department of Physics and Astronomy. It is also a forum to keep the department informed of your accomplishments; the department welcomes submissions of newsworthy items for publication in the newsletter. Please feel free to send in items via email to Raymond Bailey at rgb@northwestern.edu.

In addition to your news item, please include:
- Name
- e-mail Address
- Phone Number
- If you are an alumnus, also include your degree and your graduation year.