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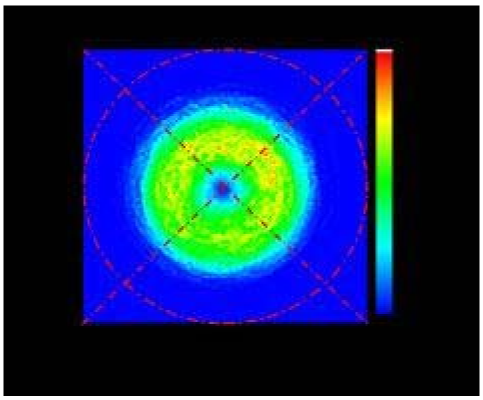

Dr. Steven Anlage wrote this month's Research Spotlight regarding wave chaos in electromagnetism and quantum mechanics.

On April 29, 2006, we celebrated Maryland Day with several events, demos and experiments.

DEPARTMENT OF PHYSICS
UNIVERSITY OF MARYLAND

Alumnus Youngchan Kim credits some of his success to a biography of Madame Curie that he read as a child. Find out how a book led Dr. Kim to life as a physicist in our Alumni Spotlight section.

Andrew York wrote this month's Graduate Blog and explains his current work on experimental Physics.

Dr. Mohapatra and Jawahery attended the Flavor Physics & CP Violation International Conference from April 9 - 12. View the Recent Events section to read about other past events.

Dr. Min Ouyang is the 2006 recipient of the Ralph E. Powe Junior Faculty Enhancement Award. View the News section to find out more about this honor and other Physics' awards and honors.

The CMPS commencement will be held on Monday, May 22, 2006, at 10 a.m. in the Reckord Armory. The speaker will be Dr. Robert F. Brammer, Vice President and Chief Technology Officer of Northrop Grumman Corporation. View more upcoming events in the Up Next section.

NEW HIRES:
We would like to welcome the Physics Department's newest faculty members. They will all start as Assistant Professors this Fall.

Dr. Paulo Bedaque - Theoretical Quarks, Handrons & Nuclei research group.
Dr. Arthur La Porta- Joint appointment with the Physics Department and the Institute for Physical Sciences and Technology (IPST).
Dr. Arpita Upadhyaya - Joint appointment with the Physics Department and IPST.

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Wave Chaos in Electromagnetism and Quantum Mechanics

By: Dr. Steven Anlage

Chaos is a ubiquitous phenomenon in everyday life. It is seen in dripping faucets, population dynamics, the weather, electrical circuits, heart arrhythmia, and many other places. These are all manifestations of what we might call “classical” chaos, because they involve the evolution of classical deterministic quantities, like atmospheric pressure, electric currents, or the trajectory of a gas particle. Chaos is defined as the extreme sensitivity to initial conditions (for example the initial position and momentum of an atom in a gas). This is manifested in the “butterfly effect” in which a butterfly flapping it's wings in Brazil can eventually affect the weather here in College Park.

However, many other interesting things involve waves, such as quantum mechanics, concert hall acoustics, electromagnetism, and electrical transport properties of nanoscale quantum dots. An interesting question for physicists is whether or not chaos plays a role in the properties of these wave systems. At first it seems that chaos should not apply at all to wave phenomena since one cannot define simultaneously the position and momentum of a wave to test the “extreme sensitivity to initial conditions.” Instead one has to consider wave systems that have high-energy (short wavelength) properties that display “ray chaos” – the extreme sensitivity of system evolution to initial ray directions. Ray chaos turns out to be quite common, as it is found in atomic nuclei and quantum dots, as well as concert halls and electromagnetic resonators.

What are the unique properties of wave chaotic systems? It has been hypothesized that they have many “universal” properties that are amazingly insensitive to details such as whether one is talking about an acoustic wave in air or a quantum mechanical wave in a nucleus! This means that simple physical processes, like the interference of waves, manifest themselves in essentially identical ways in vastly different systems.

Prof. Steven Anlage investigates these universal properties through a unique experiment. He uses a flat two-dimensional microwave cavity (metallic box) to simulate the properties of a two-dimensional square well quantum mechanical system. The electric field of the microwave signal acts like the wave function of the Schrödinger equation of quantum mechanics. The resonant frequencies of the metallic box are equivalent to the eigen-energies, and the standing wave resonance patterns are equivalent to the eigenfunctions, of the quantum problem. The box has a shape that produces “ray chaos” at high frequencies, and can be used to study quantum chaos in great detail on a table-top without all the complications of fabricating and measuring real quantum structures.

In collaboration with theorists Edward Ott and Thomas Antonsen of the Physics department, the Anlage group has developed a novel way to measure the universal scattering properties of quantum chaotic systems (like nuclei and two-dimensional quantum dots). They study the scattering of microwaves from the box and have developed a very complete picture of how the universal properties depend on loss or “de-phasing” of the quantum system. Besides testing fundamental issues in quantum mechanics, this research also establishes the foundation for a quantitative statistical model of absorption of wave energy in electromagnetic and acoustic systems, which is of some practical interest.

Prof. Anlage's student on this project, Sameer Hemmady, recently won the Student Speaker Award from the Group on Statistical and Nonlinear Physics of the American Physical Society (http://www.physics.umd.edu/news/GSNP_Award.htm).

Dr. Anlage is a professor of Physics at the University of Maryland . He is a member of the Center for Superconductivity Research. Visit his research website at : http://www.csr.umd.edu/anlage/AnlageHome.htm or contact him at, anlage@umd.edu .

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Alumnus Admires the Success of Madame Curie

"When I was a child, probably 11 or 12, I read a biography on Madame Curie," said alumnus Youngchan Kim. "I don't remember the author, but her story inspired me. Her dedication to Physics (and science in general) impressed me a lot. I didn't know what Physics was about, but after reading it, I found that I was better at math and science than at literature or something else. So I decided to study physics."

Youngchan Kim was born and raised on Jeju Island , Korea . After receiving his bachelor's degree, in Physics and Mathematics, from Korea Advanced Institute for Science & Technology, he came to the University of Maryland to obtain his Ph.D.

Prior to attending UMD, Kim had never left Korea . The transition was frightening; however, he found comfort from the friendly people in the department. It was also a benefit to be in an area with such a large Korean community. He applied to Maryland because of his interest in studying Nonlinear Dynamic and Chaos. However, he worked under Dr. Michael Fisher on Phase Transitions.

"Working under Dr. Fisher, was probably the best situation I could have imagined to have had," said Kim. "I was fortunate to have him as my advisor. From his courses and advice, I learned a lot of physics, how to conduct research and how to be a good physicist."

After receiving his Ph.D. in 2002, Kim worked as a postdoc, at Maryland , for three years. An important and original chapter of Dr. Kim's thesis was published three years ago in Physical Review Letters in an article titled, Precise Simulation of Near-critical Fluid Coexistence (YC Kim, M.E. Fisher and E Luijten) *91* 065701:1-4 (2003). The original paper reported on a scaling technique for extracting results of unprecedented precision and detail from finite-size Monte Carlo simulations. The article has now been highlighted, in the second edition of David P. Landau and Kurt Binder's "Guide to Monte Carlo Simulations in Statistical Physics." It appeared as a case study in chapter six, section 6.1.4, titled, Near Critical Coexistence .

"One of my professors of Chemical Engineering, whom I collaborated with during my Ph.D., has used my thesis for his current research," said Kim. " He asked me for comments and some advice and honestly, it made me feel good to know that someone appreciated my work."

Last summer he accepted a position as a research fellow at the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), for the National Institute of Health, working for Dr. Gerhard Hummer. He is currently working on understand the mechanism of proton pumping by an enzyme called Cytochrome c oxidase inside mitochondrial or bacterial membranes. This enzyme pumps protons, which are later used to produce food molecules for various proteins. He is also working on a project to build a simple model for simulating protein-protein interactions.

Year's later, after achieving some success of his own, Kim's decision to study Physics has proven to be the best one.

"I love what I do," said Kim. " It is always exciting and challenging to find out that you don't know much about Nature."

If you are interested in contacting Dr. Youngchan Kim, please send your messages to the Editor, who will be happy to forward your questions and comments.

NEWS

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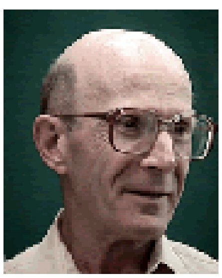
Congratulations

Dr. Min Ouyang is the 2006 recipient of the Ralph E. Powe Junior Faculty Enhancement Award. This award is intended to enrich the research and professional growth of young faculty.



The Council for International Exchange of Scholars has announced that Dr. O.W. Greenberg is the Fall 2006 recipient of the Fulbright Award for the Dublin Institute for Advanced Studies.

The CMPS Spring Academic Festival was held on April 28, 2006, at the rotunda in the Math Building. Several Physics' alumni, faculty, staff and students were awarded.

In the News

Joe Redish was quoted in an article that appeared in the Denver Post, on March 20, 2006. He was providing information regarding reform to physics education and the impact of the University of Colorado physics professor, and Noel Prize winner, Carl Wieman, on Physics education.
To view the article, visit : http://www.denverpost.com/news/ci_3617118

Ellen Williams was profiled in the Gazette Newspaper on March 9, 2006

RECENT EVENTS

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- Michael Fisher was invited to give a lecture at the American Physical Society Meeting in the forum for the History of Physics session on “A Century of Critical Phenomena,” held in Baltimore on March 16, 2006. Professor Fisher also gave a public lecture in the Oppenheimer series at UC Berkeley on March 20, 2006.

- On April 12, 2006, Hassan Jawahery gave the summary talk, at the Flavor Physics and CP Violation International Conference. The conference was held from April 9-12 at the Costal Plaza Hotel in Vancouver, Canada.

- Rabi Mohapatra presented the Neutrino Theory talk on Implication of Neutrino Mixing Beyond Neutrinos at the Flavor Physics and CP Violation International Conference held in Vancouver, Canada.

- Robert Park attended Programs for Judges 2006, at George Mason University School of Law, from April 21-27. He presented a talk regarding science in the courts, where he demystified scientific issues that arise in the courtroom.

- On Apr 17 the Physics Walking Club reached its 1000-mile mark since charting began in January. Founded in 1999, by then Kari Knouse, in memory of her husband, Ernie Knouse, the management of the Club was shortly turned over to Xiao-ning Zhao who has kept the club walking at various speeds and distances ever since. With membership now at 14, one can almost always find others to walk with whether he/she might like to walk the Lake Artemesia trail, the Golf Course Trail, the treadmills at HHP, the Campus or inside Comcast, Cole or Armory during severe weather. Each day a person walks, they receive a check-mark on a chart that Bill Norwood keeps. As Xiao-ning says, "Just show up in the Physics Lobby at noon, and others will walk with you." Individuals preferring a shorter walk because of convenience, special health issues, or whatever, can show up at 1:00 and walk for just 1/2 hour with Jesse and/or Grace, Jesse@umd.edu or sewlallg@umd.edu. It's a great way to maintain or improve health and to interact with others. (Submitted by Bill Norwood, Physical Science Technician III)

GRADUATE BLOG

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Andrew York-Atomic Molecular and Optical Physics

Experimental physics loves the extreme. Maryland research thrives on the coldest atoms the fastest particles and the smallest electronic devices. When you have a new toy that lets you do something that was impossible twenty years ago, it's a lot easier to come up with exciting and original ideas. Our lab is no different.

The heart of our lab is a pulsed laser amplification chain that lets us generate some of the most intense electric fields in the world. Our main laser produces pulses of light 50 femtoseconds long containing 100 millijoules, and can be focused to a spot smaller than 10 microns. The electric field of one of our focused pulses is more than ten times stronger than the field that binds an electron to a hydrogen nucleus, but each pulse contains so little energy it would take more than 20,000 of them to boil a gram of water. If you accidentally block our beam with your hand, you don't feel your hand heat up, you just hear a snapping sound as you smell what used to be a thin layer of your skin.

Ultraintense fields have gotten a lot cheaper in the past twenty years. The technique of chirped-pulse amplification, pioneered in the mid-eighties, allows small labs like ours to generate huge field strengths on a reasonable budget. The same intensities produced by a $176 million football-field-size government project in 1984 can now be purchased off the shelf for about $1 million, and fits on a tabletop. Because so many labs can afford femtosecond-scale millijoule-level lasers, new ideas for applications can spread rapidly. Quite a few applications have been found, including micromachining, coherent x-ray generation, terahertz generation, nonlinear microscopy, electron acceleration, and photochemistry. One of our lab's projects is to improve the efficiency and peak intensity of coherent x-ray generation by femtosecond lasers. The difference between a coherent x-ray beam and an incoherent one is the same as the difference between a light bulb and a laser: hard to explain quickly, but very important to scientists. Bright sources of coherent x-rays are useful for medical imaging, lithography, biology research, and plasma physics. Bright sources of coherent x-rays are also traditionally large and expensive shared facilities like synchrotrons or free electron lasers.

Femtosecond lasers offer an appealing alternative that brings coherent x-rays into small labs. When you focus an intense laser pulse into a low-pressure gas, coherent ultraviolet and x-ray radiation is produced at the focal spot of the beam . The mechanism is simple: the intense electric field of the laser rips electrons away from gas atoms and slams them back into the parent atom half an optical cycle later. The violent acceleration of the electron during recombination can produce very short-pulse, high-frequency radiation. The drawback of the method in , however, is efficiency.

Only a very small spot at the focus of the beam is intense enough to produce x-rays, so the resulting beams are very weak. Our group has demonstrated extending the size of the intense focal region by guiding laser pulses in hollow optical fibers made of plasma and has also proposed several schemes for efficiently generating coherent x-rays using these fibers. These optical plasma fibers are specially shaped sparks that guide light exactly like glass fiber optics. Plasma fibers, however, can guide ultraintense laser pulses that would destroy any glass fiber in a single shot. Since the plasma fiber could be extended to huge lengths, the size of the focal region doesn't limit conversion efficiency any more. A new problem arises, however: phase matching. In general, infrared laser pulses and the x-rays they generate don't go the same speed in a mixture of neutral and ionized gas. If the x-rays slip ahead of the generating laser pulse by half a wavelength, they destructively interfere with any new x-rays generated by the laser. For a given mismatch in speed, the "dephasing length" is how far the laser and the x-rays can go before they slip out of phase. Making the fiber any longer than the dephasing length is pointless and actually decreases total efficiency. By carefully manipulating the size and composition of the spark in , we could minimize the x-ray/laser pulse speed mismatch and thus make the dephasing length as long as possible. This requires careful microscopic control of the spark shape and the injection of the laser pulse, and is annoying to do in practice.

Recently, we decided to try to make a diameter-modulated plasma fiber, and we succeeded. The modulated waveguide abandons dispersion-based speed-matching and allows the x-rays and laser pulse to drift in and out of phase with each other. The spacing of the modulations is carefully chosen to be one dephasing length long. This way, when the pulse interferes constructively with the x-rays, the fiber diameter is small and the laser energy is crunched into an intense spot. When the pulse is destructively out of phase with the x-rays, the fiber diameter is large and the laser is spread out into a large, weak beam. Unlike the unmodulated case, each dephasing length generates net x-rays, so extending the fiber for many dephasing lengths increases total efficiency. We're currently working on generating x-rays in the modulated plasma fiber. Since a plasma fiber has no damage threshold, we should be able to use a laser pulse that is arbitrarily intense. More intense pulses can produce much shorter wavelengths and higher conversion efficiencies, so this is a very exciting experiment. Check in with us at lasermatter.umd.edu in a few months to find out how it turns out!

UP NEXT

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May 2- Colloquium
Turbulent Heating and cascade Properties of Plasma Turbulence
William Dorland, University of Maryland

May 4-6 - Physics is Phun
When You're Hot, You're Hot
Thermodynamics with dangerous and exciting applications.
Program runs from 7:30-8:45 p.m.
Physics Lecture Halls, Physics Building

May 9- Colloquium
Exploring the Terascale with the International Linear Collider
Paul Grannis, SUNY at Stony Brook

May 11- Last days of classes

May 13-19 - Final Exams

May 21- UMD Commencement Ceremony
7:00 p.m. Comcast Center

May 22 - CMPS Recognition Ceremony
10:00 a.m. Reckord Armory

LETTER FROM THE CHAIR

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Dear Colleagues,

As I approach the final days of my term as Physics Chair, I would like to take some time to thank all those who helped me over the past seven years. Specifically, I have been fortunate to have a strong administrative team lead by my associate chairs, Fred Wellstood, Nick Chant, Drew Baden and Doug Roberts. Their hard work, innovative ideas and dedication has helped pushed the department in positive new directions and certainly made my job easier.

I have also been fortunate to have an extraordinary staff. Zack Robbins, my first hire as department coordinator, taught me a great deal and helped set the tone of my administration. He also helped me make the decision to hire, as my administrative assistant, a young woman who we were concerned might not be assertive enough to deal with the demands of the faculty. As it turns out our concerns about Reka were unfounded. She has since been promoted to the department's Director of Faculty Affairs & External Relations. Besides being known as the administrative team's “enforcer,” her efforts have revolutionized the way we do things in the department and the campus. She developed the system for electronic promotions that is now being used at all levels of the campus. Many of the innovations around here in the past seven years have been developed with Reka's help. We have also been privileged to have an outstanding communications staff with Hannah Wong, Sheldon Smith, Karrie Hawbaker and, now, Carole Cuaresma. My life has been organized, with skill, from Reka Montfort, David Watson and, now, Nick Hammer.

I'm confident that under new leadership this department will remain one of the top departments in the nation. This confidence comes for two reasons. First, because much of the hard work of making this the best run department at the University is done by the staff, the new chair will have the support of Dean Kitchen, Kari Aldrige and the superb supporting administrative staff in the financial and billing offices. I know that somehow, defying all odds, Lorraine will continue to keep the building limping along. I also know that Bernie, Tom, Linda and Jane will provide the best student support at the University.

The second reason is because of our extraordinary faculty who are always willing to do what it takes to make our department great. I knew the department was going to be in great hands when the search committee came up with Nick Hadley and Drew Baden as potential chairs. They are both great leaders and either would have done a great job. After a difficult decision, Dean Halperin chose Drew. As a Physics professor and Associate Chair of Facilities & Personnel, Drew has made extraordinary contributions to the field of physics as well as the department and university.

Drew has produced outstanding work in the field of high energy physics. His current research efforts have played a critical role in two of the most prominent experiments in high energy physics today, DZero and Compact Muon Solenoid (CMS). He is an exceptional professor who excels in research, teaching and service to the department.

As you all know, the Physical Sciences Complex (PSC) has been a major priority during my term as Chair. Drew was the point-person on the proposal for the building and he has played an integral role in making the PSC a reality. I am certain that the momentum that we have built over the past several years will continue under Drew's leadership. I hope you will all welcome him as the new chair and help make his transition as smooth as possible.

Regards,

Jordan Goodman
Professor and Chair

EDITOR’S NOTE

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Dear Readers,

I've always been impressed with this department and this past month has only increased my admiration of all of its hard workers. This issue of the Photon is filled with information about Physics staff, students and faculty.

Dr. Anlage wrote this month's Research Spotlight about his current research regarding wave chaos in electromagnetism and quantum mechanics. Andrew York, a graduate student, wrote this month's Graduate Blog and provides information about the research he is working on under Dr. Howard Milchberg.

There were also several events held this past month, including Maryland Day, where we displayed to the community why we're a top department. We offered visitors interactive activities, demos, talks, hotdogs and even a live band. In addition, the CMPS held its Academic Spring Festival, where several physics students, faculty, alumni and staff were awarded for their outstanding contributions to the department.

This was a great way to end another exciting semester!

Best Regards,
Carole

CONTACT US

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The Photon Online is the official University of Maryland-Physics online newsletter. We release an issue monthly to highlight researches, alumni, awards, honors and events. The views and opinions of our readers are valued; please contact us with any questions, ideas or comments.

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