

## Robert Hofstadter Memorial Lectures Planned for March 29 and 30, 2004

We are very pleased to announce that the 12th Annual Robert Hofstadter Memorial Lectures have been scheduled for Monday, March 29, 2004 (*see below*). Both lectures will be held at Stanford University, and we hope that you will plan to attend. This year we are honored that our distinguished lecturer will be Professor Carl Wieman, who received his B.S. from the Massachusetts Institute of Technology in 1973 and his Ph.D. from Stanford University in 1977. He has been at the University of Colorado since 1984, where he is currently a Distinguished Professor of Physics and a Fellow of JILA. He has carried out research in several areas of laser spectroscopy, including using laser light to cool atoms. This led



Carl Wieman

PHOTO: Univ. of Colorado at Boulder, Office of News Services

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### EVENING PUBLIC LECTURE

**8:00 pm – Monday, March 29, 2004**

#### **BOSE-EINSTEIN CONDENSATION: QUANTUM WEIRDNESS at the LOWEST TEMPERATURE IN THE UNIVERSE**

In 1924 Einstein predicted that a gas would undergo a dramatic transformation at a sufficiently low temperature (now known as Bose-Einstein condensation or BEC). In 1995, my group was able to observe this transformation by cooling a gas sample to the unprecedented temperature of less than 100 billionths of a degree above absolute zero. The BEC state is a novel form of matter in which a large number of atoms lose their individual identities and behave as a single quantum entity, the "superatom". This entity is the atom analogue to laser light, and, although large enough to be easily seen and manipulated, exhibits the nonintuitive quantum behavior normally important only at much smaller scales. The study and use of the curious properties of BEC has now become an important subfield of physics. I will discuss how we create BEC and some of the subsequent research we have done on it. Interactive applets as a tool for teaching science will be demonstrated in the presentation.

### AFTERNOON COLLOQUIUM

**4:15 pm – Tuesday,  
 March 30, 2004**

#### **RESONANT BEC: A NEW MACROSCOPIC QUANTUM SYSTEM**

Bose-Einstein condensation in Rubidium 85 is a macroscopic quantum system where the self interactions can be rapidly adjusted over a very large range. This is done simply by changing a magnetic field near a Feshbach resonance. Condensates near such a resonance show a variety of interesting features, a few of which are actually understood. These include BEC supernova-like explosions ("Bosenovas") and exotic coherent superpositions of atomic and molecular BECs.

Both lectures will be held on campus in our Teaching Facility on Serra Street (TCSEQ, Room 201). If you have questions, please contact us by telephone: (650) 723-4347, fax: (650) 723-1821 or email: [tice@stanford.edu](mailto:tice@stanford.edu). We hope you'll plan to join us for these exciting talks.

*February, 2004*

## A Letter from the Chair

*Dear Physics  
 alumni and friends,*

The year 2004 promises to be one of dynamic changes in the Physics Department. Our plans are progressing for KIPAC, the Kavli Institute for Particle Astrophysics and Cosmology. We also have plans to build a companion physics building next to Varian (*see articles on page 3 for details*). Professors Roger Blandford and Steven Kahn are leading two faculty searches for junior appointments in experimental and theoretical astrophysics; we look forward to strengthening our faculty in those areas. I am pleased to report that Steven Kivelson will be joining the Physics faculty next fall. Kivelson has taken a leading role in the theoretical physics of correlated electron systems. His presence on our faculty will undoubtedly put Stanford at the forefront of this most intellectually demanding and exciting area of condensed matter physics.

*I am also happy to report on some recent accolades received by our Physics faculty. Blas Cabrera was named Deputy Director of the W. W. Hansen Experimental Physics Laboratory (HEPL), and has been*

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## Chairman — from page 1

leading the effort in the new construction of Varian II. This is a substantial undertaking, and we anticipate great potential for research activities in this new facility. Last March, I was appointed to serve on the board of the team investigating the February 1, 2003 loss of the space shuttle Columbia. This investigation was a fascinating (and time-consuming) endeavor. A report on my experience and our findings is included in this newsletter. Also, this past year Prof. David Goldhaber-Gordon received both a Sloan Research Fellowship and a Terman Fellowship.

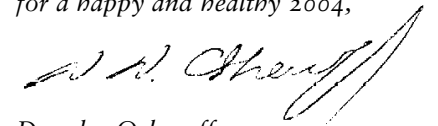
We look forward to this year's Robert Hofstadter Memorial lectures, which will be given by Carl Wieman, a Stanford graduate who is now a Distinguished Professor of Physics at the University of Colorado and a co-recipient of the 2001 Nobel Prize in Physics. Prof. Wieman received the prize for his work on the Bose-Einstein Condensate. The lectures will again be held at Stanford University on March 29 and 30, 2004 in the Teaching Center (TCSEQ), Room 201 (see article).

A diverse new group of twenty-five students entered our Ph.D. program in 2003. The incoming graduate students include five women and twelve foreign students. Two of our new graduate students have NSF Fellowships, one has a Stanford Graduate Fellowship, and

one has a Hertz fellowship. We are very pleased to welcome these new students to our department.

I wish to thank all of you who have made donations to the Physics Department this past year. Your contributions have created many opportunities and events for our students and for the larger physics community. On behalf of everyone in the department, I thank you again for your continued support and interest.

With best wishes  
for a happy and healthy 2004,



Douglas Osheroff  
Chair and Professor of Physics

## Memorial lectures — from page 1

to cooling atoms sufficiently to attain Bose-Einstein condensation in a vapor, for which he was awarded the Nobel Prize in Physics in 2001, as well as numerous other awards. He has worked on a variety of innovations in teaching physics to a broad range of students, including the Physics Education Technology Project, which creates online interactive simulations for learning physics (<http://www.colorado.edu/physics/phet>). He is a 2001 recipient of the National Science Foundation's Distinguished Teaching Scholar Award and a member of the National Academy of Sciences, the Board of Physics and Astronomy, the Committee on Undergraduate Science Education and the National Task Force on Undergraduate Physics. ❧

## The New Faces of the Society of Physics Students

### Andrew Chen, SPS Vice President

The Society of Physics Students (SPS) is responsible for organizing the Wednesday Noon Lecture Series given by Stanford faculty. From the physics of the eye to the effects of asteroid impacts on the earth, this eclectic series of noon lectures aims to acquaint students with not only the fields they might become interested in researching, but also the abundant faculty resources available to them in the Physics, Applied Physics, and Geophysics Departments. The attendance at these lectures has been growing significantly, and we expect this trend will continue.

In the spirit of fostering relationships between students and faculty, SPS will hold several informal advisor-advisee events this year, providing students and faculty with an opportunity to mingle and exchange ideas. There will also be informational panels during the coming quarters regarding the graduate school application process and summer research program opportunities.

Last, but not least, SPS organizes a number of social functions for students, providing more opportunities to network and develop friendships. We have been very encouraged by the students' and faculty's level of enthusiasm and participation so far this year, and we look forward to a great year ahead! ❧

## Student Awards Presented at Commencement, 2003

David S. Levine Award for  
Outstanding Junior Physics Major:

**Colin Connolly and  
Evan Kirby**

Jeffrey Willick Memorial Award  
for Outstanding Scholarship  
in Astrophysics:

**Joel Hartman**

Paul Kirkpatrick Award for  
Outstanding Teaching Assistants:

**Lynford Goddard and  
Paul SanGiorgio**

# New Construction Projects Around Varian Physics

by Blas Cabrera

**D**uring 1997, the Physics Lecture Hall, built in 1958 and fondly called the Tank, was torn down to make way for the new Science and Engineering Quad. The teaching functions are now carried out in the TCseq (now the Hewlett Teaching Center for the S & E Quad). That facility services all of the science departments, but is still most heavily used by the Physics Department.


The construction of a new laboratory building opposite the current Moore Laboratory for Advanced Materials (shown in the photo below on the left) will soon become a reality. This construction project has been made possible by two significant events. One is the decision by the University to relocate the north end of HEPL (the Hansen Experimental Physics Laboratory) and the second, a major collaborative effort between campus Physics and SLAC to create the new KIPAC (Kavli Institute for Particle Astro-



*Photos of Tank deconstruction.*

physics and Cosmology). We are extremely fortunate that our top choices for Director, Prof. Roger Blandford, formerly from Caltech, and for Associate Director, Prof. Steven Kahn, formerly from Columbia University, accepted our offers.

The funding for the new building has recently been finalized, with a major University contribution for the relocation of north HEPL and the support of a donor, John Arrillaga, whose support was also instrumental to the Alumni Center and the sports complex at Stanford. The project is now on a fast track, with construction slated to start in October, 2004 and be completed by the end of 2005.

A doctored photograph, by our Department Chair Doug Osheroff, shows the approximate appearance of the new building. It will have two floors above ground and two basements, providing excellent experimental research space. 



*Current building site*



*Varian 2 – to be completed by the end of 2005*

# The Columbia Accident Investigation: Following in Feynman's Footsteps

by Douglas Osheroff

I remember the Challenger accident and its investigation vividly, particularly the part played in the investigation by Richard Feynman. How could NASA have been so blind to the risks associated with leaking o-rings on the SRB's? These are the solid rocket boosters strapped to the sides of the external fuel tank that holds the liquid hydrogen and oxygen for the orbiter's main rocket engines. Each SRB contains a million pounds of solid rocket propellant, and generates three million pounds of thrust. Little did I realize then that I would ultimately be following in Feynman's footsteps (but never filling his shoes) in a remarkably similar investigation.

The Columbia space shuttle orbiter broke up while re-entering the earth's atmosphere on February 1, 2003 at an altitude of 200,000 feet and a velocity of 12,000 mph. All aboard perished. Within a few hours, NASA had asked Hal Gehman, a recently retired four star admiral, to chair a board to investigate the disaster. Most of the members of that board were defined by their positions in NASA's by-laws. These included safety experts from the Navy, Air Force, FAA, and DOT. The addition of several 'university types' was later mandated by several members of Congress to prevent the investigation from being an 'inside job'. As a result, I did not begin participating in the investigation until March 13. On that day I walked into NASA headquarters and had a long chat with Sean O'Keefe, the NASA administrator. Members of the 'CAIB', the Columbia Accident Investigation Board, had enormous power within NASA.

I next traveled to Houston, where CAIB had its headquarters on Saturn Lane, adjacent to NASA's Johnson Space Center. I was immediately impressed by the quality of the other board members, especially Hal Gehman. Luckily for me, they were at least moderately impressed by the Nobel Prize, so the fact that I was clueless in the procedures of an accident investigation did not seem to matter. However, it soon became



*Chef Osheroff*

clear to me that all the important jobs had been grabbed up by the other board members, long before I arrived on the scene. I was a member of Team 3, whose job it was to establish the physical origins of the accident. Everyone suspected that the breakup of Columbia was initiated by a hole in the leading edge of the left wing, caused by a piece of insulating foam that had fallen off the external fuel tank 82 seconds into launch. It was our job to decide if the evidence supported this as the initiating event, which ultimately was indeed the case. However, every time I tried to request information or ask that a test be performed, I found myself stepping on someone else's turf.

Ultimately I realized that no one was asking the obvious question: What made the foam fall off in the first place? Foam frequently fell off the external tank, and NASA had an accepted mechanism to explain why, but one which had never been tested. In their model, it was assumed that liquid air would collect in voids inside the cold foam around the bipod spindle, where the chin of the orbiter was anchored to the external tank. During ascent, aero-heating would occur once the shuttle velocity became supersonic, and this heat would cause the condensed nitrogen to boil rapidly. The ensuing pressure build-up would then blow apart the bipod foam ramp. I looked at this scenario and lots of data on the thermal properties of the foam. I concluded that the NASA model was most probably wrong. But to convince NASA of this I needed to do an experiment. I asked myself the following simple question: How does fluid pressure propagate through the closed-cell structure of the insulating foam? To

answer this question, I glued a piece of foam to a brass plate with a hole in its center. This hole was connected to a tube that I could fill with red ink, and then pressurize with compressed air. What I found from numerous experiments was that the pressure always produced a planar fracture of the foam that intersected normal to the foam's outer surface. Such a fracture could not cause foam ejection, as the foam on both sides of the fracture was still attached to the plate. NASA was proceeding with their own tests of the cryo-expulsion model for foam separation, and I predicted that all their tests would fail. This was indeed the case.

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# Kavli Institute for Theoretical Astrophysics and Cosmology

By Roger Blandford

KIPAC Director and Professor of Physics and SLAC

2003 marked the Inauguration of the Kavli Institute for Particle Astrophysics and Cosmology (KIPAC) at Stanford. KIPAC is a major initiative by the Physics Department and SLAC to expand theoretical and experimental research into exciting new areas that exist at the interface between physics and astronomy. As readers of this newsletter may know, we have recently discovered that almost all of the Universe comprises dark matter and energy whose nature and provenance is far from clear. We have also observed, from a great distance, giant explosions that are over in seconds. These explosions are probably associated with the birth of black holes. Cosmic rays can now be measured with energies as large as that of a well-hit baseball. Magnetic field strengths over a billion times stronger than those that can be sustained in the laboratory are now measured around neutron stars. These and other discoveries are of great interest to Stanford physicists and astronomers. Members of KIPAC are working closely with the pre-existing research groups to develop new experimental projects, to solve fundamental theory problems and open up new areas of astrophysical phenomenology.

As the first two of nine new faculty members, Steve Kahn and I have been delighted with the reception we have received by the whole Stanford community. The KIPAC group is growing rapidly — we already have three excellent senior staff members, eight outstanding postdocs, two administrators and a stream of visitors and students to get us off to a great start. In the summer of 2005, we intend to move into the Fred Kavli building at SLAC, made possible by a generous gift from Fred Kavli and the Kavli Foundation.



Fred Kavli and Persis Drell at the 2003 KIPAC Inauguration ceremony

Our final home on campus will be in a new physics building that is currently in the planning stage. Included among our major research initiatives are plans to build hardware for ground- and space-based optical telescopes as well developing an astrophysical computing center.

One of my ambitions as Director is to foster collaboration with other cosmologists and astrophysicists in the local area. We have already hosted a one day meeting that was well-attended by colleagues from the University of California and their research laboratories. We will host three more major research meetings over the coming year. Please follow our progress on our website: <http://www-group.slac.stanford.edu/kipac/> and feel free to visit when you return to Stanford. ~~~

## Investigation — from page 4

My experiment cost only about a hundred dollars for parts and perhaps a dozen hours of my time, yet it showed that a long-held NASA theory for foam expulsion could not be correct. This was not the same as Feynman's immersing a rubber o-ring in ice water and showing how it became stiff, but in a similar way it pointed to the fact that NASA was not doing its homework in adequately characterizing those components of the shuttle assembly that failed repeatedly. For this work, my fellow board members were sufficiently

impressed that they produced a fake press release suggesting that I had done the experiments in the kitchen at the student union cafeteria. The picture on page 4, showing me in my chef's attire, accompanied the text of that press release.

While this story is amusing, the investigation was deadly serious. Everyone worked long hours, and just when we began to think we really had nailed the cause, the fear that we might be wrong, and that our mistake might lead to the loss of another orbiter and seven more brave souls spurred us on. It was an amazing collaborative effort, and I believe our final report is a remarkable document.

The investigation forced me to spend much of my time at NASA centers or the CAIB headquarters, and it did not end until late August, when the final report was released. I believe I flew in excess of 60,000 miles for the investigation. However, people at Stanford were extremely supportive of my work on the board, and the department continued to run smoothly. Our plans to create KIPAC, the Kavli Institute for Particle Astrophysics and Cosmology, remain on-track, and our plans to build a companion physics building next to Varian are now moving forward. Is it that providence has rewarded my sacrifice, or is it that the Chair really isn't needed? ~~~



Anne Hall, Walter Meyerhof & Carol Wilkinson



Steve Grimes, Jane & Stanley Hanna

## PHYSICS ALUMNI REUNION

— October 17, 2003


**T**hanks very much to everyone who attended our Physics alumni reunion reception on October 17, 2003. Approximately thirty alumni attended, and they enjoyed visiting with classmates and former instructors, touring the physics labs and hearing about the latest research in our department. In addition to these photos from the event, more reunion photos can be found on our Physics Department website: <http://www.stanford.edu/dept/physics/index.shtml>. At right, you will find news from a few of our Physics alumni. Anytime you are in the Bay Area, please stop by the department to say hello.

## WHERE ARE THEY NOW?


**W. Gilbert Clark** (BS, 1952) obtained a Ph.D. in Physics from Cornell in 1961 and worked as a postdoc at UCSD until he joined the UCLA Physics department faculty in 1965. Since his early “retirement” from UCLA in 1994, he has continued to work there on condensed matter physics research. Prof. Clark was recently elected a Fellow of the American Physical Society.

**Cynthia Galovich** (Ph.D., 1987) became Chair of the Physics Department at the University of Northern Colorado in August 2002. Her

department is an undergraduate only department with 7 faculty members. They have an active undergraduate research program and encourage their students to present their research results at APS and AAPT meetings.

**Randall McEachern** (Ph.D., 1983) is a physicist at Lawrence Livermore National Laboratory. He is currently moving from a long-time position relating to target fabrication (materials science issues) to a different job in the NAI Directorate (Non-proliferation, Arms Control, and International Security). 

*Please send us news about yourself to the following email: [tice@stanford.edu](mailto:tice@stanford.edu). Include your address and information about your current employment and interests.*



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