Physics & Astronomy – Our Community

A summer Friday afternoon (7 July)

New grad students have arrived (29 August)
Department Staff

Peter Koch, Chair
Pam Burris, Assistant to the Chair

Laszlo Mihaly, Graduate Program Director
Pat Peiliker, Assistant Graduate Program Director

Emilio Mendez, Undergraduate Program Director
Elaine Larsen, Assistant Undergraduate Program Director

Bob Segnini, Director of Physical Laboratories
Rich Berscak, Building Manager

Sara Lutterbie, Business Officer
Diane Siegel, Main Office
Maria Hofer, Main Office

Joe Feliciano and Frank Chin, Instructional Laboratories
Chuck Pancake and Gene Shafto, Electronics Center
Walt Schmeling and crew, Machine Shop
Sal Natale, Receiving
We have been “fenced in” to our building since 1999 when some bricks fell off the façade. This addition to our building costs the university ~ 20 k$ per year. The ~2 M$ fix is (now) supposed to start next spring.
PHYSICS AND MATH BUILDING MASONRY REPAIR STATUS

Masonry probes in 2003 determined the condition of the masonry facade, corner soldier brick courses, masonry column enclosures, and relieving angle structures by all the windows.

Scope of Work for the masonry repairs was defined. Budgetary Cost estimates for masonry repair and new roof were completed: 1.96 M$ (more since then).

The 5-year Capital Plan for the campus was funded last year (2005); the repair job for our building was originally supposed to start in May of this year. The current estimate is it will begin next spring (2007) and take two years.

We will be working with all of you in the Physics and Astronomy community to phase the sub-projects to minimize the interruption to your research and work. We ask now for your understanding and good will as we move forward.

The interruptions will be temporary. The improvements will endure.

Rehabs of P-level lighting and some restrooms were completed this spring.

This lecture hall was just “rehabbed” – completed 2 weeks ago!
Four views of this room (Harriman 137) on 7 July 2006
Scenes from the grand opening of the Graduate Student Lounge, 17 March 2006, already with a gourmet coffee machine ($0.75/cup) and soon to have a computer data projector and screen for practicing talks and viewing movies. Thank you Paul Grannis, Bob Segnini, Rich Berscak, and President Kenny (rehab $$)
Where our faculty received their doctorates
Thanks to Sara Lutterbie for making this figure
New faculty

Leonardo Rastelli, foundations of string field theory. After a postdoc at Princeton, Leonardo joined us as Assistant Professor in the YITP in January 2006 and promptly won an Outstanding Junior Investigator (OJI) Award from the US Department of Energy.

Main focus: different aspects of open/closed duality.
Also phenomenological interests (the “LHC Olympics”).

Strings can be open or closed. Open strings are a generalization of Yang-Mill theory, closed strings a generalization of gravity.

In recent years, we have learnt that in several models the open and closed descriptions are really equivalent (dual) to each other.

- Aspect of AdS/CFT: renormalization group flows and boundary conditions
  L.R., T. Hartman

Other case study: in open string field theory, only open strings are dynamical, yet closed strings emerge as bound states.

- Exact solitonic solutions in OSFT decribing D-branes.
  L.R., B. Zwiebach

Towards a reformulation of string theory based only on open strings?
Michael Zingale, computational astrophysics. After a postdoc at the Supernovae Science Center at UC Santa Cruz, Mike joined us as Assistant Professor in January 2006. He promptly won an Outstanding Junior Investigator (OJI) Award from the US Department of Energy and a President’s Early Career Award in Science and Engineering (PECASE).

Astrophysics, abstract astro-ph/0606496
From: Michael Zingale Date: Wed, 21 Jun 2006 16:52:08 GMT (436kb)
Low Mach Number Modeling of Type Ia Supernovae. II. Energy Evolution
Authors: A. S. Almgren, J. B. Bell, C. A. Rendleman, M. Zingale
Comments: 30 pages; accepted to the Astrophysical Journal

The convective period leading up to a Type Ia supernova (SN Ia) explosion is characterized by very low Mach number flows, requiring hydrodynamical methods well-suited to long-time integration. We continue the development of the low Mach number equation set for stellar scale flows by incorporating the effects of heat release due to external sources. Low Mach number hydrodynamics equations with a time-dependent background state are derived, and a numerical method based on the approximate projection formalism is presented. We demonstrate through validation with a fully compressible hydrodynamics code that this low Mach number model accurately captures the expansion of the stellar atmosphere as well as the local dynamics due to external heat sources. This algorithm provides the basis for an efficient simulation tool for studying the ignition of SNe Ia.
New faculty

Gilad Perez, theoretical particle physics, just joined us as Assistant Professor in the Yang Institute for Theoretical Physics after a postdoc at Berkeley.

(He and Yasmin are expecting their first child in November)

The Standard Model of particles and interactions leaves essential questions unanswered: What gives masses to the fundamental particles? We believe that it is related to electroweak symmetry breaking which raises the hierarchy problem, the huge gap between the weak and Planck scales. The LHC experiments will address these questions. I am involved in studies of signatures through which new physics may reveal itself and help to solve the above. Recent cosmological-observation raised additional puzzles: What can induce the matter-anti-matter asymmetry of our Universe? What is the source of dark matter and energy? We explore experimental and theoretical methods to improve our knowledge regarding these issues.
Meigan Aronson, experimental condensed matter physics, will join us as Professor of Physics in January 2007 (joint appointment with Brookhaven National Laboratory). She is now Professor of Physics at the University of Michigan.

Meigan’s group studies magnetism and magnetic phase transitions with neutron scattering, magnetic, thermal, and electrical transport measurements. Current projects include the explication of the critical phenomena which accompany phase transitions occurring at zero temperature, where order is stabilized not by reducing temperature, but by tuning an external variable such as pressure, composition, or magnetic field. The fully quantum mechanical modes which accompany the zero temperature phase transition result in unusual properties near the quantum critical point, and often lead to secondary instabilities such as magnetically mediated superconductivity or even more exotic collective states. A second project studies the magnetic and electronic structure of magnetic nanoparticles, where the combination of particle shape, spatial confinement, and novel extended structures can lead to behaviors which are impossible for bulk magnets. For instance, it is possible to modify both the strength and the spatial variation of the internal magnetic field in the nanoparticles using chemical modulation, creating new hybrid systems with high degrees of crystalline perfection. Thus, the dynamics and stability of the nanoparticle moment can be controlled, of particular interest if the particles are assembled into extended structures.
New faculty

Steven Dierker, experimental condensed matter physics, is currently Associate Lab Director for Light Sources and Project Manager for the NSLS-II Project at Brookhaven National Laboratory, where he has been on leave since 2001 from his position as Professor of Physics at the University of Michigan. His home academic appointment has now moved to our department. He expects to continue to devote his full-time efforts to administrative and managerial duties at BNL directed toward making the new synchrotron radiation facility operational around FY 2013.
Aneesh Deshpande, son of Arati and Abhay
Born 12 December 2004, 7 lbs. “Sleeps through the night, hyperactive during the day at 9 months!”

Adélia Schneble, daughter of Elisa and Dominik
Born 5 September 2004, 8 lbs. “Sometimes, but not always, sleeps through the night.”

Ina Lee Evans, daughter of Yulin Dudley and Aaron
Born 23 January 2005, 9 lbs. “She’s almost there. She wakes up twice.”

Rebecca Sydney Durst, daughter of Sarah and Adam
Born 30 June 2005, 8 lbs 10 oz. “(Mostly) sleeping through the night.”

recent arrivals in faculty families
A few months later, Dec. 2005, at our holiday party – All come next December

Sarah, Adam, and Rebecca

Dominik, Elisa, and Adélia

Yulin, Ina, and Aaron

(there seems to be a non-negligible interaction between Elisa and Ina)

Aneesh, 1 year old, December 2005

Arati, Aneesh, and Pooja

Where is Abhay in the pictures? He was busy 24/7 as Run 6 Coordinator at RHIC!
Welcome back to faculty members on leave during last academic year:

Concha Gonzalez-Garcia (fall)       Chang Kee Jung (spring)       Mike Marx
Laszlo Mihaly                        Martin Rocek (spring)         Jack Smith (fall)
                                        Phil Solomon (spring)

Bon (or continuing) voyage to faculty members on leave during this academic year:

Sasha Abanov (spring)    Dima Averin (spring)    Concha Gonzalez-Garcia (fall)
Paul Grannis             John Hobbs              Janos Kirz (fall)
Jim Lattimer (spring)    Peter Paul (fall)       Michael Rijssenbeek (fall)
Jac Verbaarschot        Mike Simon              Amos Yahil (fall)

Good luck to our colleagues departed for other positions or retired:

Norbert Pietralla – Universität zu Köln (February 2006)
Urs Wiedemann – CERN (July 2006)
Bill Weisberger – became Professor Emeritus after the 2005-6 academic year
Sasha Abanov was promoted to Associate Professor with tenure and received the departmental Outstanding Teacher Award for 2005-6

Abhay Deshpande was Run 6 Coordinator at RHIC, Dec. ’05 – June ’06 (very successful: 7-fold increase of integrated PHENIX data compared to 2001-5)

Marvin Geller awarded the NASA Distinguished Public Service Medal

Paul Grannis continues on leave with DOE Office of Science, working to develop International Linear Collider Project

John Hobbs is serving as Physics Coordinator of D-Zero (on leave at Fermilab)

Chang Kee Jung leads the HUSEP collaboration in the competition for NSF DUSEL (deep-underground scientific laboratory)

Michael Marx named Associate Dean of the College of Arts and Sciences

Janos Kirz served as Interim Director of Advanced Light Source at Lawrence Berkeley National Lab (through 6/06)

Hal Metcalf is Chair of Division of Laser Science of the APS until 10/06
Laszlo Mihaly was elected Fellow of the American Physical Society

Peter van Nieuwenhuizen was co-winner of 2006 Dannie Heineman Prize for Mathematical Physics of the APS for the discovery of supergravity (at Stony Brook)

Leonardo Rastelli received DOE Outstanding Junior Investigator Award (OJI)

Gene Sprouse was named (yesterday) Editor-in-Chief of the APS effective ~1 March 2007 -- one of the top three leadership positions of the APS. A College Board study calls Gene’s PHY 141/2 course a “top example” and “exemplary.”

Jac Verbaarschot is Villum Kann Rasmussen Foundation Visiting Professor at the Niels Bohr Inst. and Guest Professor at the Niels Bohr Intl. Academy, Copenhagen 2006-7. Jac also received an Alexander von Humboldt Award, May 2006.

Michael Zingale received DOE Outstanding Junior Investigator Award (OJI) and President’s Early Career Award in Science and Engineering (PECASE)
Recently appointed adjunct faculty

The department has a large number of adjunct faculty who teach occasional courses and support and supervise graduate students (both Ph.D. and MSI), thereby enriching our intellectual and scholarly life.

Recent additions are

**Anand Sivaramakrishan** – AMNL Dept. Astrophysics (astronomical instruments)

**Yimei Zhu** – BNL (experimental condensed matter physics)
Stony Brook is one of the leading universities in number of physics Ph.D. degrees granted.

At Stony Brook
in 2003-4: 32 PhDs
in 2004-5: 24 PhDs
in 2005-6: 20 PhDs

(number of our PhDs/year should rise again because of large recent classes)
# Ph.D. and MSI degrees awarded in 2005-6

## December 2005 Ph.D. degrees (6)

<table>
<thead>
<tr>
<th>Last name</th>
<th>first name</th>
<th>advisor</th>
<th>present location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carmell</td>
<td>Matthew</td>
<td>Prakash</td>
<td>unknown</td>
</tr>
<tr>
<td>Chang</td>
<td>Xiangyun</td>
<td>Ben-Zvi (BNL)</td>
<td>BNL</td>
</tr>
<tr>
<td>Egdemir</td>
<td>Jamil</td>
<td>Averbach</td>
<td>Wake Forest University</td>
</tr>
<tr>
<td>Rabenstein</td>
<td>Kristian</td>
<td>Averin</td>
<td>City Group</td>
</tr>
<tr>
<td>Requist</td>
<td>Ryan</td>
<td>Allen/Abanov</td>
<td>University of Erlangen</td>
</tr>
<tr>
<td>Sickles*</td>
<td>Anne Marie</td>
<td>Jacak</td>
<td>BNL</td>
</tr>
</tbody>
</table>

* Winner of 2005 Gertrude Scharff-Goldhaber Prize from Brookhaven Women in Science

## May 2006 Ph.D. degrees (3)

<table>
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<tr>
<th>Last name</th>
<th>first name</th>
<th>advisor</th>
<th>present location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calaga#</td>
<td>Rama</td>
<td>Peggs/Ben-Zvi (BNL)</td>
<td>BNL</td>
</tr>
<tr>
<td>Christensen</td>
<td>Neil</td>
<td>Shrock</td>
<td>Michigan State University</td>
</tr>
<tr>
<td>Sobczyk</td>
<td>Alexander</td>
<td>Svoboda (CSHL)</td>
<td>unknown</td>
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## May 2006 MSI degree

<table>
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<th>Last name</th>
<th>first name</th>
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<th>present location</th>
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<tbody>
<tr>
<td>Brown</td>
<td>Richard</td>
<td>Weinacht</td>
<td>unknown</td>
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</table>

# Winner of a 2006 President’s Award to Distinguished Doctoral Students
### Ph.D. and MSI degrees awarded in 2005-6

**August 2006 Ph.D. degrees (11)**

<table>
<thead>
<tr>
<th>Name</th>
<th>First Name</th>
<th>Last Name</th>
<th>University</th>
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</thead>
<tbody>
<tr>
<td>Cardoza</td>
<td>David</td>
<td>Weinacht</td>
<td>Stanford University</td>
</tr>
<tr>
<td>Casalderrey-Solana</td>
<td>Jorge</td>
<td>Shuryak</td>
<td>Lawrence Berkeley Natl. Lab.</td>
</tr>
<tr>
<td>Desai</td>
<td>Satish</td>
<td>Hobbs</td>
<td>Fermilab</td>
</tr>
<tr>
<td>Holt</td>
<td>Jason</td>
<td>Kuo</td>
<td>TRIUMF</td>
</tr>
<tr>
<td>Lee</td>
<td>Seung Hyun</td>
<td>Metcalf</td>
<td>Korean Air Force Academy</td>
</tr>
<tr>
<td>Lima*</td>
<td>Enju</td>
<td>Kirz (SBU and ALS/LBNL)</td>
<td>European Synchr. Rad. Facility</td>
</tr>
<tr>
<td>Lu</td>
<td>Ming</td>
<td>Jacobsen</td>
<td>Argonne National Laboratory</td>
</tr>
<tr>
<td>Miao</td>
<td>Xiyue</td>
<td>Metcalf</td>
<td>Stony Brook University</td>
</tr>
<tr>
<td>Newaz</td>
<td>A.K.M.</td>
<td>Mendez</td>
<td>Washington University</td>
</tr>
<tr>
<td>Shifrin</td>
<td>Leonid</td>
<td>Verbaarschot</td>
<td>Brunel University (London)</td>
</tr>
</tbody>
</table>

Note the opportunities to do Ph.D. research “elsewhere”, supervised by research mentors affiliated with our faculty. Ask about such opportunities.

* Winner of 2006 Gertrude Scharff-Goldhaber Prize from Brookhaven Women in Science
## Incoming graduate class for 2006-7

(intentionally smaller because of unusually large incoming classes in previous two years)

<table>
<thead>
<tr>
<th>Last Name</th>
<th>First Name</th>
<th>Previous university</th>
<th>Home</th>
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<tbody>
<tr>
<td>Albert</td>
<td>Stephan</td>
<td>Tech. Univ. Munich</td>
<td>Germany</td>
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<tr>
<td>Caputo</td>
<td>Regina</td>
<td>Colorado School of Mines</td>
<td>US</td>
</tr>
<tr>
<td>Chen</td>
<td>Ning</td>
<td>University of Science and Technology</td>
<td>China</td>
</tr>
<tr>
<td>Dong</td>
<td>Huan</td>
<td>Nanjing University</td>
<td>China</td>
</tr>
<tr>
<td>Gadde</td>
<td>Abhijit</td>
<td>Indian Inst. of Technology</td>
<td>India</td>
</tr>
<tr>
<td>Geissler</td>
<td>Dominik</td>
<td>University of Wuerzburg</td>
<td>Germany</td>
</tr>
<tr>
<td>Greif</td>
<td>Daniel</td>
<td>University of Wuerzburg</td>
<td>Germany</td>
</tr>
<tr>
<td>Hlaing</td>
<td>Htay</td>
<td>Bates College</td>
<td>Myanmar</td>
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<tr>
<td>Irizarry</td>
<td>Melvin</td>
<td>Univ. Puerto Rico- Mayaguez</td>
<td>US</td>
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<tr>
<td>Kaufman</td>
<td>Johnathan</td>
<td>University of Pittsburgh</td>
<td>US</td>
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<tr>
<td>Kowalczyk</td>
<td>Szczepan</td>
<td>University of Amsterdam</td>
<td>Netherlands</td>
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<td>Li</td>
<td>Li</td>
<td>University of Science and Technology</td>
<td>China</td>
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<tr>
<td>Meijer</td>
<td>Melvin</td>
<td>University of Nijmegen</td>
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<tr>
<td>Mueller</td>
<td>Michael</td>
<td>University of Bonn</td>
<td>Germany</td>
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<tr>
<td>Novak</td>
<td>Julia</td>
<td>Purdue University</td>
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### Incoming graduate class for 2006-7, cont.

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<td>Proissl</td>
<td>Manuel</td>
<td>University of Tuebingen</td>
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<td>Scharfenberger</td>
<td>Benedikt</td>
<td>University of Wuerzburg</td>
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<td>Schlieder</td>
<td>Joshua</td>
<td>Bloomsburg University of Pennsylvania</td>
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<tr>
<td>Springmann</td>
<td>Marco</td>
<td>Heinrich-Heine-Univ. Duesseldorf</td>
<td>Germany</td>
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<tr>
<td>Strehlau</td>
<td>Tobias</td>
<td>University of Bonn</td>
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<td>Jiaoyin</td>
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<td>Jan</td>
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<td>Wang</td>
<td>Jue</td>
<td>Nanjing University</td>
<td>Germany</td>
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<tr>
<td>Webb</td>
<td>Stephen</td>
<td>Georgia Institute of Technology</td>
<td>US</td>
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<td>Wu</td>
<td>Liusuo</td>
<td>University of Science and Technology</td>
<td>China</td>
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<tr>
<td>Zhang</td>
<td>Zhengwen</td>
<td>Zhongshan University</td>
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</tbody>
</table>
Where our graduate students received their undergraduate degrees

Thanks to Sara Lutterbie for making this figure
Physics NSF-REU Program
Erlend Graf, Karen Kernan

**Mentors:** Aaron Evans, Tom Hemmick, Chris Jacobsen, Ken Lanzetta, Michael Marx, SB-LTC

**Participants from:** College of New Jersey, Principia College, Harvard, Western Washington, Tufts, UConn, University of Rochester, WPI, University at Buffalo, Columbia, Stony Brook
<table>
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<th>1 yr. ago</th>
<th>now (9/11/06)</th>
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<tr>
<td>PHY121</td>
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<tr>
<td>PHY303</td>
<td>28</td>
<td>38</td>
<td>38</td>
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PHY introductory course enrollments continue to climb. Junior levels fluctuate some.

We continue to need to improve in finding opportunities for research projects for undergraduates. This will help to increase the number of majors.
<table>
<thead>
<tr>
<th>Month</th>
<th>Number</th>
<th>Name</th>
<th>Status/Institution</th>
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<tbody>
<tr>
<td>December</td>
<td>2</td>
<td>Basil Bannister</td>
<td>seeking employment</td>
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<tr>
<td></td>
<td></td>
<td>Mohammad Khan</td>
<td>Harvard University</td>
</tr>
<tr>
<td>May</td>
<td>8</td>
<td>Kyung Soo Choi</td>
<td>Caltech</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Melissa Friedman</td>
<td>Oxford University (Marshall Scholarship)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Seong Kim</td>
<td>seeking employment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Eric Kuflik</td>
<td>University of Michigan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tak Chu Li</td>
<td>University of Maryland</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ka Ho Lo</td>
<td>University of Illinois, Urbana-Champaign</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Brian Martin</td>
<td>Harris Corp., Rochester, NY</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Larne Pekowsky</td>
<td>Syracuse University</td>
</tr>
</tbody>
</table>
Laser Teaching Center
Marty Cohen, Harold Metcalf, John Noé

Recent areas of research
• Optical vortices
• Optical tweezers
• Acousto-optics
• Photorefractive optics
• GRIN optics
• Sonoluminescence
• Laser modes and stabilization
• Polarized light
• Ray optics with matrices

Activities [past year participants]
• Optics Rotation PHY-582 [6]
• WISE High School [10] & College [1]
• NSF-REU Summer Program [3]
• SBU undergraduate research [3]
• High School summer research [6]
• Tours, demonstrations, recruitment

Work presented at
• URECA Research Celebration
• OSA/DLS meeting (Tucson)
• DAMOP meeting (Knoxville)

Summer 2006 group
The bequest by the Simons Foundation sponsored two special lecturers to visit the department for about a week and give a combination of colloquium and seminar-level talks. Each lecturer was available for discussions and interactions with students and faculty. Make suggestions for more visiting lecture series!

**Uzi Landman** of Georgia Tech is an expert on science at the nanoscale. His 25 October Simons lecture was *Small is Different: Emergent Physics and Chemistry in the Nonscalable Regime.*

**Frank Wilczek** of MIT shared the 2004 Nobel Prize in Physics for co-discovery of asymptotic freedom in the strong force. He visited and lectured during 17 – 21 April 2006. His colloquium title was “The Origins of Mass and the Feebleness of Gravity.”
SIMONS LECTURE SERIES ON THERMAL GAUGE FIELD THEORIES
Anton Rebhan
Institute for Theoretical Physics, Technical University, Vienna
20 Sept. – 7 October 2005

A Symposium on General Relativity
C.N. Yang Institute for Theoretical Physics
20-21 October 2005
One of the themes of the fourth workshop was the String Landscape and the Swampland -- what are the general constraints on low energy physics that follow from string theory? Martin Rocek reports 4 posted preprints have already acknowledged the workshop.
Press Release

Contact: Patrick Calabria • 631.632.6310 • FAX: 631.632.6313
Stony Brook University • 310 Admin • Stony Brook, NY 11794-0605

Stony Brook Announces $25 Million Gift From Renowned Former Math Chair Jim Simons
Is Largest Single Cash Donation in SUNY History

Mon, 8 May 2006, 09:17:00

STONY BROOK, N.Y., May 8, 2006 -- Jim Simons, a world-renowned mathematician who as Chair built Stony Brook University’s Mathematics Department into one of the best in the nation, announced today that the Simons Foundation is donating $25 million to the University — the largest single cash gift in its history and, in fact, the largest single cash gift ever given to any SUNY institution.

Simons, President of Renaissance Technologies, a private investment firm located in East Setauket, N.Y., has undertaken numerous philanthropic causes related to math, science and autism. Together with his wife, Marilyn, he manages the Simons Foundation, a charitable organization devoted to scientific research.

"Marilyn and I have a relationship with Stony Brook University which stretches back to 1966, when I arrived to chair the Department of Mathematics," Simons said. "A few years later I met, courted and married Marilyn, who had completed her undergraduate studies at Stony Brook and went on to receive her Ph.D. from their Department of Economics. Since that time we have remained involved and watched the institution develop into a first class public research university. Among the University's strongest areas are mathematics and physics, and it is on these that our gift will be focused."

"During the past thirty years mathematics and physics have grown increasingly intertwined. This is particularly true in the cases of string theory, quantum field theory and cosmology, which have all depended upon and stimulated advanced work in geometry and topology. Sustained by its close relationship with Brookhaven National Laboratory and building on a fine faculty already in place we believe our gift can help propel Stony Brook into the very top rank in these central fields."

"Jim has extraordinary vision," said Stony Brook President Shirley Strum Kenny. "He understands the critical need for support of education, particularly in science and mathematics, in America. His generosity paves the way for Stony Brook to explore new frontiers in education and research, now and in the future."

Dr. Simons was Chair of Stony Brook's Department of Mathematics from 1966-76 and was largely responsible for shaping its reputation as one of the best departments of its kind in the nation; the graduate math program was ranked 28th in the US News & World Report ratings released last month. He also has supported several academic initiatives at Stony Brook, including an annual workshop in mathematics and physics, and a lecture series related to those topics.
Attending colloquium – The many research areas in Physics and Astronomy connect in deep and interesting ways. The weekly colloquium is your opportunity to learn about the richness of physics and to expand your horizons. It is responsibility of all of us to join in this central activity of our department. Please come each week. Students: make sure your advisor comes! Advisors: make sure your students come!

Colloquia, Dept. Physics & Astronomy, Stony Brook University
Colloquium committee: Chris Jacobsen, Aaron Evans, Kostya Likharev, and Tom Weinacht
Coffee & Tea served at 3:45 pm. Talk begins at 4:15 pm.

Schedule:

<table>
<thead>
<tr>
<th>Date</th>
<th>Speaker</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>September 12, 2006</td>
<td>Peter Koch, Stony Brook University</td>
<td>Chair's colloquium</td>
</tr>
<tr>
<td>September 19, 2006</td>
<td>Clark McGrew, Stony Brook University</td>
<td>Neutrino Oscillations: the Next Generation</td>
</tr>
<tr>
<td>September 26, 2006</td>
<td>Chris Monroe, University of Michigan</td>
<td>Towards the artificial cell: progress and difficulties</td>
</tr>
<tr>
<td>October 3, 2006</td>
<td>Laszlo Mihaly, Stony Brook University</td>
<td>Ferromagnets, antiferromagnets, and materials beyond</td>
</tr>
<tr>
<td>October 10, 2006</td>
<td>Albert Bartlett, University of Colorado</td>
<td>Future Population and Resource Trends</td>
</tr>
</tbody>
</table>

from P&A web pages: first five weeks
To give students a flavor for the research opportunities that the Department offers, I asked each research area to prepare summary slides. Disclaimer: Any errors in description are mine. The speed of presentation is unavoidable. Hold on!

I attempt to organize the presentation from largest to smallest scales, but even this has problems: unity of physics!

Physics and Astronomy + YITP research expenditures
~ 13.9M$ in FY '05 (highest in the university, ¼ of total for College of Arts and Sciences)
D. Peterson & collaborators, using the Navy Prototype Optical Interferometer, discovered Vega, *THE* absolute standard, is rotating very near breakup.

M. Simon, T. Beck (PhD 2003) and L. Prato (PhD 1998) are using Gemini North and Keck Interferometer at Mauna Kea to determine the masses and distances of very young binary systems.

Vega as seen from Earth. Blue is hot, red cool.

Orbit of Haro 1-14c measured by the Keck Interferometer
First Author
Vega is the second brightest star in the northern hemisphere and is used by astronomers as a benchmark for assessing the brightness and colour of other stars. But on page 896 of this issue, it is Vega itself that gets assessed, with some surprising results. In the course of testing a new instrument, Deane Peterson at Stony Brook University in New York and his team discovered that Vega rotates rapidly, is slightly tilted on its axis, and is older than was previously thought. Peterson talks to Nature about the effect these results may have.

As Vega is a benchmark, how will this affect understanding of other stars?
It will ripple through the system. It's like a small tremor; it will be felt everywhere but it won't break anything.

Why look at Vega?
Vega is the absolute standard: you classify other stars using it. It is also a photometric standard — when you want to measure how much light you're getting from an object you compare its brightness with that of Vega.
But there have been some niggling problems: calibrations for Vega in the visible spectrum that have been extrapolated to the infrared don't quite fit. But these issues have been around for some 30 years and they weren't what motivated our work.
So what did motivate you? …
J. Faherty (graduate student) and F. Walter measured a new distance to the isolated neutron star, Geminga, 250 (+120, -62) pc compared to 159 previously. This changes its parameters substantially.

F. Walter and S. Howell (AZ), monitoring accretion onto EF Eri, a magnetic (80 MG) white dwarf, with the SMARTS telescopes, found they were able to measure the mass of the companion, which is substellar.
Cosmic rays initiate showers when they collide with the atmosphere. Radio waves from distant sources (i.e. TV) may be reflected by the ionization created by the shower particles. This technique is already used to study micrometeors (Radio Meteor Scatter) higher in the atmosphere, and can also study lightning.

To confirm that observed signal originate from UHECR we need to independently observe shower debris – will do this with simple counters built, installed, and operated by local high school teachers and students.
Nuclear Astrophysics

- Faculty: Jim Lattimer, Doug Swesty, Mike Zingale
- Senior Research Scientist: Eric Myra
- Postdoc: Ken DeNisco
- 5 graduate student researchers

Swesty
- Radiation-hydrodynamics in stars and laboratory high-energy density physics applications
- Highest resolution studies of core-collapse supernovae 2-D convection ever done
  - Convective structure exists at much smaller scales than previously thought
  - Large scale eddies penetrate into the proto-neutron star
Nuclear Astrophysics

Zingale

- Modeling turbulent thermonuclear burning in Type Ia supernovae.
- Developing a new-generation low Mach number hydrodynamics code (with LBL).
  - Allows for long time evolution of full stars.
  - Will be applied to X-ray bursts, Classical novae, and the ignition of Type Ia supernovae.

Lattimer

- Limits to dense matter from neutron star observations
- Computations of Equations of State for supernovae and neutron stars

PSR J1748-2446ad

green area is excluded
1.4 solar mass star has radius < 14.5 km
Quantum Computer: Need--To Reduce Decoherence ⇒ Great Josephson Junctions Required

Lukens Group
Stony Brook Superconducting Devices
Design and Fabrication
Vijay Patel & Wei Chen

Superconducting Qubit

• 1/f fluctuations in $I_c$ lead to decoherence.
• Stony Brook junctions are 100 times quieter than typical—the best available.

Data from Shawn Pottorf
Coulomb-blockade of anyons: Coherent transport of FQHE quasiparticles in multi-antidot systems

Quantum antidots make it possible to manipulate individual FQHE quasiparticles of fractional charge and statistics, and hold promise for development of qubits based on the quasiparticle transport:

\[
\frac{\delta/\Delta}{T/\Delta} = 0.0 \quad \text{and} \quad a = 3.0
\]

Dmitri Averin and Jim Nesteroff work on the theory of correlated transport of FQHE quasiparticles in multi-antidot structures. The theory predicts the signatures of anyonic statistics in resonant peaks of quasiparticle tunneling through the antidots.
Durst Group
Scattering of Dirac Quasiparticles from Magnetic Vortices in Cuprate Superconductors

Allen Group
Physics of “Nanowires”

Abanov group
Applications of quantum hydrodynamics to the edge states of Fractional Quantum Hall Effect systems

molecular $\pi$ state on ZnO nanowire (Xiao Shen)
X-ray optics group

- NSF-funded Center for Environmental Molecular Sciences (CEMS) at Stony Brook
- Leading role in lensless x-ray imaging at Berkeley
- Spectromicroscopy for chemical state mapping at Brookhaven
- Phase contrast imaging methods at Argonne
- Enju Lima: Gertrude Goldhaber Award (Brookhaven Women in Science); now postdoc in Grenoble, France
- Funded programs from NIH, NSF, DoE

Benjamin Hornberger: highest resolution x-ray phase contrast image. Present efforts aimed at providing information on cell ultrastructure and mass along with trace element mapping in cells at Argonne Lab

Work with CEMS, Holger Fleckenstein, Bjorg Larson on chemical state mapping by combining imaging with spectroscopy. This example: Larson, Gillow et al. studies of spore formation in bacteria

Ming Lu, PhD Aug. 2006: 30 nm zone plates providing the best combination of resolution, working distance, efficiency for carbon edge spectromicroscopy. With BNL’s CFN
Electron Spin Resonance on LiCu$_2$O$_2$

Experiment in BNL: one branch

Theory: Strong, weak branches

Experiment in Lausanne:
Weak signal observed at 420GHz
AFTER theory predicted it

Electronic Noise in Mesoscopic Conductors

W. Song, A. K. M. Newaz, J. K. Son, E. E. Mendez


When a battery is connected to a long metallic wire the electric current fluctuates a bit with time, but at low temperature the squared fluctuations (shot noise) average to zero. Only recently has it been shown that when the wire is mesoscopic, that is, shorter than the collision length of the electrons, the low-temperature fluctuations, although small, do not average to zero.

Dependence of the noise in a superlattice on electric field, for structures in which one layer is varied from 1.5 to 3.5 nm. At low fields, the noise in the 1.5-nm structure is comparable to that in a metal but it is almost three times larger for the 3.5-nm structure. At high fields, all structures show the same noise as a vacuum tube.
Nucleon decay and Neutrino (NN) Group

Super-Kamiokande

- Reconstruction to restore the detector to the original photo-cathode coverage (40%) completed (June 2006)
  - Many Stony Brook NN Group members including three undergraduate students (B. Bell, B. Martin, S. Kim) participated in the reconstruction in Japan

- SKIII is being ready for T2K.

Nucleon decay and Neutrino (NN) Group

- Indication of tau neutrino appearance in the atmospheric neutrino data, analysis led by the Stony Brook group
- Paper submitted to PRL
T2K Long Baseline Neutrino Oscillation Experiment

• First long baseline neutrino oscillation experiment proposed to measure $\theta_{13}$
• Project approved by the Japanese Government in Dec. 2003
• Stony Brook led US proposal ($5M) received a strong recommendation from a national panel (NuSAG) and funded for FY06
• Data taking will start in Apr. 2009
Henderson DUSEL
(Deep Underground Science and Engineering Lab)
Empire, Colorado

- Project led by Stony Brook (Jung)
- Colorado State Senate Bill 06-229 providing $20M for Henderson DUSEL passed and signed, May 2006
- Media Coverage
  - Over a dozen media coverage prominently featuring Stony Brook
Measuring $\psi(R,t)$ for a Molecule Breaking Apart

Progress towards making Bose-Einstein condensates

Weinacht lab

Schneble lab

Laser cooling and trapping of rubidium

$1 \times 10^{10}$ atoms at ~ 200°K

Magnetic trapping and transport

Quadrupole trap, Axial field gradient ~ 150G/cm

(Absorptive imaging technique)

Next (and final) step: evaporative cooling to < 500nK
The usual optical forces on atoms have limits, but these can be overwhelmed by exploiting coherent exchange of momentum between atoms and light.

We use the coherent process of adiabatic rapid passage to do this very effectively.

Dr. Xiyue Miao – 17 August 2006
To excite atoms from state 1 to state 3 it seems intuitive to use **blue** light first, then **red** light.

The efficiency is **MUCH** higher if these are applied in the counter-intuitive order (STIRAP)

Dr. S.-H. Lee 25 May 2006
PHENIX Experiment at RHIC has finished its 6th run!
Time for Upgrades!!

- $\gamma^* \rightarrow e^+ e^-$ provides direct radiation from plasma phase
- Huge combinatorial background mostly due to $\gamma + X \rightarrow e^+ e^- + X$ & $\pi^0 \rightarrow \gamma + e^+ e^-$ (small angle pairs).

New detector vetoes small angle pairs to reduce background:
- Direction tagging Cherenkov detector reduces background by a factor of 10-30 X.
- Beyond present State of the Art...
- Triple-Stacked Gas Electron Multipliers (GEM) made photosensitive by evaporated CsI coating.

Cherenkov light forms “blobs” on an image plane ($r_{\text{BLOB}} \sim 3.36\text{cm}$)
Relativistic Heavy Ion Group

On-Campus Production Facility:
- “Clean Tent” in Nuclear Structure Lab
- Ultrasound/high-vacuum cleaning
- CsI evaporations onto GEMs
- Performance testing
- GEM installation into final detector

Other PHENIX upgrades at SB:
- Silicon Vertex Detector
  --installation 2010

Laminar flow table: <1 particle/m³
Evaporator: 1.8 m³ at 1.2x10⁻⁸ mbar
Glovebox: <3 ppm H₂O
Clean tent: <40 particles (≤0.5 μm)/m³
Understanding the Proton Spin

Quark Model

$QCD + \text{Orbital motion}$

• RHIC Spin program at BNL:
  – The **first & the only** polarized proton collider in the world
  – Stony Brook Spin Group plays leading role in all aspects of experiment: beam polarization measurement in the collider rings, operation & upgrade of collisions with PHENIX detector and analysis

• Stony Brook Group: Prof. Abhay Deshpande
  – *Evidence for Orbital Angular Momentum*: Graduate Student **Nathan Means** (2009)
  – Additional members expected in 2006/7

$\frac{1}{2} = \frac{1}{2} \Delta \Sigma + \Delta G + I_{Q\&G}$

0.12 Significant(?) ???

“quarks” “gluons” ang.mom.

$\Delta G \propto A_{LL}(\pi^0)$

Run 5 (Preliminary)

$\Delta g = 0$

$\Delta g = -g$

$A_{LL}(\pi^0)$ is not included.
Teaney & (student) Casalderrey (2006): Computed diffusion constant $D$ of a heavy quark in a strongly coupled gauge theory using string theory and holographic duality. $D$ vanishes as coupling goes to infinity. Already 25 citations after being posted for only 2 months.

(postdoc) Gellmann, Shuryak, & Zahed (2005): Computed shear viscosity of strongly coupled QCD as a function of the plasma coupling. Minimum in viscosity coincides with the “perfect liquid” region of QCD being probed by RHIC experiments.

(student) Dusling & Zahed (2006): Calculation of dimuon spectrum using general principles of broken chiral symmetry, diluteness, and unitarity reproduces experimental spectra recently reported by the Na60 collaboration for indium on indium collisions.

Splittorf (NBI) & Verbaarschot (2006): Show how to evaluate the QCD partition function by squaring the fermion determinant and thereby turning fermions into “bosons”, perhaps avoiding the treacherous “sign problem”.

QCD News from the Nuclear Theory Group
High Energy Experiment: D0

- AY 05/06, \( \geq 40 \) journal pubs
  - 1(+2) w/current full data set
  - +31 preliminary w/full data set
- Data set large and growing
  - published using 20x top discovery sample
  - Record instantaneous beam luminosities in past month
- Running again after important but localized upgrades during spring
  - 2 SBU postdocs leading efforts
  - Impacts most of physics program

Highlight #1: (1st) ‘Direct Limits on \( B_s \) Oscillation Frequency’

- Position of minimum gives osc. frequency

![Diagram of \( B_s \) oscillation frequency](image)
High Energy Exp: D0 and Atlas

- D0 Higgs search closing in on unexplored region. Asks “How is there mass?”

- Atlas
  - Project of the near future
  - Significant data in ’08.
  - 7x higher center-of-mass (mass reach) than D0.
    - See Higgs boson if it exists
    - Should see SUSY if it exists
  - Good timing for incoming students

D0 Highlight #2: Gaining ground on Higgs searches

Plot shows ratio of current sensitivity to Standard Model prediction.

Expect to explore new territory in about one year!
Particle Phenomenology @ YITP

Professor Goldhaber was one of the key organizers of “Geometry and the Universe, A Symposium on General Relativity” held in Stony Brook on October 20 - 21 2005. All the talks are available on website http://insti.physics.sunysb.edu/itp/

Professor Shrock continued research on one of the most important questions in high energy physics, namely the source of electroweak symmetry breaking (EWSB). He studied models in which the EWSB is dynamically produced by a bilinear condensate of fermions interacting by a new strong force.

One of several recent papers by Shrock and his student Neil Christensenen, who was awarded a Dresden Prize, is

Professor Smith has been working on Higgs production cross sections and decay distributions for the upcoming experiments at the CERN LHC.

One paper “Higgs boson production from black holes at the CERN LHC” Phys. Rev. D74, 014007 (2006) by Gouranga Nayak and J. Smith was highlighted in an article in New Scientist (28th July 2006).

Professor Sterman worked with graduate student Mert Aybat on higher order processes in Quantum Chromodynamics. They performed the first calculation of the effects of two low-energy gluons in amplitudes for producing arbitrary numbers of final-state particles (jets).

S.M Aybat, L.J. Dixon and G. Sterman
• String field theory applying field theory methods to second-quantize strings

• Anti-de Sitter/Conformal Field Theory use duality between strings and 4-d QCD to get nonperturbative information about the latter

• Triangular-lattice gravity quantizing gravity on a triangular lattice

• (Hyper)Kähler manifolds geometry of spaces used in compactification of strings and nonlinear field theory

• Random lattice superstrings quantization of superstrings on worldsheet lattices and duality to nonperturbative QCD

• First-quantized particle/string loop amplitudes quantum mechanical methods for calculating string amplitudes, and applications to particles

• Anomalies for supersymmetric monopoles quantum corrections to mass relations for supersymmetric monopoles
Thank you all for the exciting results in physics and astronomy produced over the past year. Hear the details at our colloquia, seminars, Friday, and other presentations!

Our community of students, research associates, and faculty is justifiably recognized as being at the leading edge of many of the most important areas of science. Keep it up!

New students – we welcome you to our community and wish you every success. Use your time here to advantage!

Now please come to the reception in the keg circle

Thank you main office staff for arranging this!

I will put this talk on my web site after (inevitable) errors are corrected.