The State of Department
the view from Bottom Foggy

- Welcome to those joining us
- Accomplishments of the past year
- Our goals and aspirations

Paul Grannis, Sept. 10, 2002
http://sbhep1.physics.sunysb.edu/~grannis/dept.html
Department Staff

Paul Grannis*, Chairman
Pam Burris, Assistant to Chairman

Peter Stephens, Director of Graduate Studies
Pat Peiliki, Assistant Director of Graduate Studies

Chris Jacobsen*, Director of Undergraduate Studies
Elaine Larsen, Assistant Director of Undergraduate Studies

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

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

Joe Feliciano & Frank Chin, Instructional Labs.
Chuck Pancake, Electronics Center
Rich Yoepp, Machine Shop
Sal Natale, Receiving
Important People for Grad Students to know of:

Graduate School (located in Computer Science Building)
  Lawrence Martin, Dean
  Jeanne Reiersen, Assistant to Dean

Foreign Study Office (located in Computer Science Building)
  Elizabeth Barnum
  Rose Cohen-Brown
  Elsy Padro

Campus Residences (located in O’Neill & Irving College Quad)
  Al Devries
  Anne Blair

Bursar’s Office (located on 2nd Floor, Administration Building)
  Kathy Raimond
  Mark Ippolito

Student Accounts (located on 2nd Floor, Administration Building)
  Kathy Czak-Malone
  Mary Ramsland

Central Mailroom (located in Central Receiving)
  Tom Larusso

Graduate Student Stony Brook VP for Stony Brook GSO
  Ramon de Castillo (ramon@math.sunysb.edu)

Physics and Astronomy Department Reps to GSO
  Angeliki Field-Pollatou
  Shawn Pottorf

Grad Student on Physics & Astronomy Graduate Committee
  Ashfia Huq
News of the Department

**New faculty:**  
*Concha Gonzales-Garcia* (joint YITP/Phys & Astron)  
Theoretical particle physics (arrive Jan. ‘03)

*Tom Weinacht*  
Experiments in coherent control of atoms and molecules

**Departing faculty:**  
*Igor Aleiner* - to Columbia University  
*Ralph Wijers* - to University of Amsterdam  
*Luis Orozco* - will move to Univ. Maryland next year

**Faculty Promotions:**  
*Axel Drees* (to Associate Professor),  
*Ken Lanzetta* (to Professor)
News of the Department in 2001-2

Faculty on leave: Phil Allen to Columbia, Dima Averin in Stony Brook, Fred Goldhaber at Stanford (& elsewhere), Concha Gonzalez-Garcia in CERN (fall), Janos Kirz to Berkeley, Jim Lukens in Stony Brook, Michael Marx at BNL, Hal Metcalf in Utrecht (spring), Peter van Nieuwenhuizen moving rapidly (in fall), Fred Walter where telescopes are.

Jack Marburger Science Advisor to the President

Peter Paul serving as interim Director at BNL

New staff: Sal Natale - receiving clerk (open 10AM to 3PM)

Retired staff members Audra Weiser and Roy Small died in the past year

Staff honors etc:

Elaine Larsen, Undergraduate Program Coordinator

Pat Peiliker, Graduate Program was awarded the Excellence in Service Award
Faculty prizes/honors:
David Fossan named the winner of the newly formed Chancellors' award for Excellence in Research and Scholarly Activities.
Barbara Jacak given Chancellor's Special Research award; gave Provost’s lecture on relativistic heavy ions
Tom Kuo won the Chancellors Award for Teaching
Peter van Nieuwenhuizen made Distinguished Professor
Phil Allen one of 4 Guggenheim Fellows for 2002-3 in Physics

Mountain in Antarctica named 'deZafra Ridge'; there was also a special American Geophysical Society meeting session in his name.
Faculty prizes/honors, cont’d:
Barry McCoy was Visiting Miller Professor UC Berkeley
Luis Orozco is Distinguished Travelling Lecturer: Div. Laser Science, APS
and Arfken Scholar in residence, Miami University
Chris Jacobsen won the Kurt Heinrich Award, Microbeam Analysis Society;
co-PI of $5.7M NSF Center for Environmental Molecular Sciences
Madappa Prakash, Steve Peggs*, Jack Marburger became APS fellows
Lou Dimauro* made Optical Society of America Fellow
Aaron Evans won a NASA fellowship
Thomas Schaefer given DOE Outstanding Junior Investigator award
Ilan Ben Zvi* received Brookhaven Science and Technology Award
Sasha Abanov to be 2002-3 Simons fellow
Emilio Mendez as the Department’s outstanding teacher
* = adjunct
Some of the Conferences organized by our faculty

SUPERGRAVITY AT 25
Stony Brook, 2001
Dec. 1, 2 2001
Martin Rocek, Warren Siegel, George Sterman

James H. Simons Workshop on Random Matrix Theory, Stony Brook, Feb. 20 - 23, 2002
Jac Verbaarschot

NANOSCIENCE AND NANOTECHNOLOGY AT STONY BROOK
July 11, 2001
Phil Allen, Perena Gouma

International Workshop on Physics and Experiments with Future e+e Linear Colliders
August 26 - 30, 2002  Jeju Island, Korea
Paul Grannis et al.
Conferences coming up

Impressive scientific opportunities - and some nice places to confer!

International Conference on Low Energy Electrodynamics in Solids October 13-18
Montauk Yacht Club
László Mihály et al.

László Mihály, Phil Allen et al.

Neutrinos and Implications for Physics
Beyond the Standard Model
Stony Brook, Oct. 11-13, 2002
Robert Shrock

Quantum Electronics and Laser Science Conference Baltimore MD, June 1-6, 2003; Luis Orozco, Michael Downer

James H. Simons Conference on Quantum and Reversible Computation
Stony Brook, May 28-31, 2003
Vladimir Korepin
## Graduate Students

**Graduate Degrees awarded in the past year (Aug '01 thru Aug '02):**

<table>
<thead>
<tr>
<th>Name</th>
<th>Advisor</th>
<th>Degree</th>
<th>Where now?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tigran Bacarian</td>
<td>Dilmanian</td>
<td>PhD</td>
<td></td>
</tr>
<tr>
<td>Tracy Beck</td>
<td>Simon</td>
<td>Ph.D.</td>
<td>Gemini Observ.</td>
</tr>
<tr>
<td>Jane Burward-Hoy</td>
<td>Jacak</td>
<td>Ph.D.</td>
<td></td>
</tr>
<tr>
<td>Scott Bogner</td>
<td>Kuo</td>
<td>Ph.D.</td>
<td></td>
</tr>
<tr>
<td>Matt Cashen</td>
<td>Metcalf</td>
<td>Ph.D.</td>
<td>NIST</td>
</tr>
<tr>
<td>Shu-Chiuan Chang</td>
<td>Shrock</td>
<td>Ph.D.</td>
<td></td>
</tr>
<tr>
<td>Chris Chiara</td>
<td>Fossan</td>
<td>Ph.D.</td>
<td>Washington Univ</td>
</tr>
<tr>
<td>Olindo Corradini</td>
<td>Kakushadze</td>
<td>Ph.D.</td>
<td></td>
</tr>
<tr>
<td>Ruben Costa-Santos</td>
<td>McCoy</td>
<td>Ph.D.</td>
<td></td>
</tr>
<tr>
<td>Kunal Das</td>
<td>Bergeman</td>
<td>Ph.D.</td>
<td>Univ. Arizona</td>
</tr>
<tr>
<td>Jay Dickerson</td>
<td>Mendez</td>
<td>Ph.D.</td>
<td>Columbia</td>
</tr>
<tr>
<td>Pietro Faccioli</td>
<td>Shuryak</td>
<td>Ph.D.</td>
<td></td>
</tr>
<tr>
<td>Michael Feser</td>
<td>Kirz</td>
<td>Ph.D.</td>
<td>BNL</td>
</tr>
<tr>
<td>Antonio Garcia-Garcia</td>
<td>Verbaarschot</td>
<td>Ph.D.</td>
<td></td>
</tr>
<tr>
<td>Joshua Grossman</td>
<td>Orozco</td>
<td>Ph.D.</td>
<td>NIST</td>
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</tbody>
</table>
## Graduate Students

### Graduate Degrees continued:

<table>
<thead>
<tr>
<th>Name</th>
<th>Advisor</th>
<th>Degree</th>
<th>Where now?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jeffery Hack</td>
<td>Metcalf</td>
<td>Ph.D.</td>
<td></td>
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<tr>
<td>Prashantah Jaikumar</td>
<td>Zahed</td>
<td>Ph.D.</td>
<td></td>
</tr>
<tr>
<td>Jingyoung Serena Kim</td>
<td>Walter</td>
<td>Ph.D.</td>
<td></td>
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<tr>
<td>Mikhail Kopytine</td>
<td>Jacak</td>
<td>Ph.D.</td>
<td>Kent State</td>
</tr>
<tr>
<td>Slava Kulik</td>
<td>Grannis</td>
<td>Ph.D.</td>
<td>Fermilab</td>
</tr>
<tr>
<td>Bogdan Kulik</td>
<td>Rocek</td>
<td>Ph.D.</td>
<td>DESY/Berlin</td>
</tr>
<tr>
<td>Robert LaFon</td>
<td>DiMauro</td>
<td>Ph.D.</td>
<td>Sandia Lab</td>
</tr>
<tr>
<td>Andrei Litvintsev</td>
<td>vanNieuwenhuizen</td>
<td>Ph.D.</td>
<td></td>
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<tr>
<td>Chris Mauger</td>
<td>Jung</td>
<td>Ph.D.</td>
<td></td>
</tr>
<tr>
<td>Irina Mocioiu</td>
<td>Shrock</td>
<td>Ph.D.</td>
<td></td>
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<tr>
<td>Abid Patwa</td>
<td>Rijssenbeek</td>
<td>Ph.D.</td>
<td>BNL</td>
</tr>
<tr>
<td>Eugenio Rivera</td>
<td>Lissauer</td>
<td>Ph.D.</td>
<td>Carnegie Inst.</td>
</tr>
<tr>
<td>Radu Roiban</td>
<td>Rocek</td>
<td>Ph.D.</td>
<td>Santa Barbara</td>
</tr>
<tr>
<td>Achim Schwenk</td>
<td>Brown</td>
<td>Ph.D.</td>
<td></td>
</tr>
<tr>
<td>Eric Sharkey</td>
<td>Ben-Zvi</td>
<td>Ph.D.</td>
<td>BNL</td>
</tr>
<tr>
<td>William Sherry</td>
<td>Walter</td>
<td>Ph.D.</td>
<td></td>
</tr>
</tbody>
</table>
# Graduate Students

## Graduate Degrees continued:

<table>
<thead>
<tr>
<th>Name</th>
<th>Advisor</th>
<th>Degree</th>
<th>Where now?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aaron Stein</td>
<td>Jacobsen</td>
<td>Ph.D.</td>
<td></td>
</tr>
<tr>
<td>Andrew Steiner</td>
<td>Prakash</td>
<td>Ph.D.</td>
<td></td>
</tr>
<tr>
<td>Chun Mei Tang</td>
<td>Rijssenbeek</td>
<td>Ph.D.</td>
<td></td>
</tr>
<tr>
<td>Derek Teaney</td>
<td>Shuryak</td>
<td>Ph.D.</td>
<td>BNL</td>
</tr>
<tr>
<td>Diana Vaman</td>
<td>vanNieuwenhuizen</td>
<td>Ph.D.</td>
<td>Princeton</td>
</tr>
<tr>
<td>Juhao Wu</td>
<td>L.H. Yu</td>
<td>Ph.D.</td>
<td>SLAC</td>
</tr>
<tr>
<td>Noriaki Yahata</td>
<td>Lanzetta</td>
<td>Ph.D.</td>
<td></td>
</tr>
</tbody>
</table>

38 Ph.Ds from Aug. 2001 through Aug. 2002 -- ~29 per 12 months

<table>
<thead>
<tr>
<th>Name</th>
<th>Advisor</th>
<th>Degree</th>
<th>Company/Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mary Stone</td>
<td>Metcalf</td>
<td>MSI</td>
<td></td>
</tr>
<tr>
<td>Chandraika-John Sugrim</td>
<td>Hemmick</td>
<td>MSI</td>
<td>Jabil Electronics</td>
</tr>
<tr>
<td>Andre Butz</td>
<td>Koch</td>
<td>MA</td>
<td></td>
</tr>
<tr>
<td>Christian Traeger</td>
<td></td>
<td>MA</td>
<td></td>
</tr>
</tbody>
</table>
Graduate Program

<table>
<thead>
<tr>
<th></th>
<th>Ph.D. degrees awarded over three year period</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIT</td>
<td>43</td>
</tr>
<tr>
<td>Texas/Austin</td>
<td>34</td>
</tr>
<tr>
<td>Illinois/Urbana</td>
<td>33</td>
</tr>
<tr>
<td>California/Berkeley</td>
<td>32</td>
</tr>
<tr>
<td>Cornell</td>
<td>27</td>
</tr>
<tr>
<td>Maryland</td>
<td>27</td>
</tr>
<tr>
<td>Cal. Inst. Technology</td>
<td>23</td>
</tr>
<tr>
<td>Univ. Chicago</td>
<td>23</td>
</tr>
<tr>
<td><strong>Stony Brook</strong></td>
<td><strong>22</strong></td>
</tr>
<tr>
<td>Colorado/Boulder</td>
<td>21</td>
</tr>
<tr>
<td>Wisconsin/Madison</td>
<td>21</td>
</tr>
<tr>
<td>Princeton</td>
<td>21</td>
</tr>
<tr>
<td>UCLA</td>
<td>20</td>
</tr>
<tr>
<td>California/San Diego</td>
<td>20</td>
</tr>
</tbody>
</table>

9th position; looks like it is rising
### Admitted students

- **Total**: 53
- **Ph.D.**: 47
- **MSI**: 3
- **MA**: 3
- **Women**: 10

Total 53 acceptances = 35% of admits. (5 could not come due to visa problems)

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**New Graduate Students - Fall 2002**

<table>
<thead>
<tr>
<th>Name</th>
<th>University</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tan Ahn</td>
<td>Stony Brook</td>
</tr>
<tr>
<td>Shivani Ahuja</td>
<td>St. Stephens College</td>
</tr>
<tr>
<td>John Antonakakis</td>
<td>Stony Brook</td>
</tr>
<tr>
<td>Timothy Avery</td>
<td>SUNY Cortland</td>
</tr>
<tr>
<td>Sahap Aybat</td>
<td>Bogazici Univ</td>
</tr>
<tr>
<td>Matthaeus Bartsch</td>
<td>University Munich</td>
</tr>
<tr>
<td>Robert Bennett</td>
<td>MIT</td>
</tr>
<tr>
<td>Kieran Boyle</td>
<td>Vassar College</td>
</tr>
<tr>
<td>Sarah Campbell</td>
<td>Grinnell College</td>
</tr>
<tr>
<td>Jun Chen *</td>
<td>Peking Univ</td>
</tr>
<tr>
<td>Xin Chen</td>
<td>Shanghai Jiao Tong Univ</td>
</tr>
<tr>
<td>Sung Tae Cho</td>
<td>Seoul Natl Univ</td>
</tr>
<tr>
<td>Alin Costin</td>
<td>Univ. Bucharest</td>
</tr>
<tr>
<td>Debra DePietro</td>
<td>Univ. of Rhode Island</td>
</tr>
<tr>
<td>Frank Dimler</td>
<td>Univ. of Wurzburg</td>
</tr>
<tr>
<td>Alan Dion</td>
<td>Univ. of Georgia</td>
</tr>
<tr>
<td>Renaud Gauthier</td>
<td>Columbia Univ</td>
</tr>
<tr>
<td>Simone Giombi</td>
<td>Universita Di Bologna</td>
</tr>
<tr>
<td>Stefan Gromoll</td>
<td>MIT</td>
</tr>
<tr>
<td>Feng Guo</td>
<td>USTC</td>
</tr>
<tr>
<td>Jun Guo</td>
<td>USTC</td>
</tr>
<tr>
<td>Jeremy Holt</td>
<td>Univ. of Michigan, Flint</td>
</tr>
<tr>
<td>Benjamin Hornberger</td>
<td>Univ.Wurzburg, Stony Brook</td>
</tr>
<tr>
<td>Peng Jiang *</td>
<td>Shandong Univ</td>
</tr>
<tr>
<td>Keun YoungKim</td>
<td>Sogan Univ.</td>
</tr>
</tbody>
</table>

* = not awarded visas -- deferred
New Graduate Students - continued

Bjorg Larson
Dan Li
Jingbin Li
Ivar Lyberg
Xiaolong Ma
Carlos Martinez-Torteya
Viktoria Martynenko*
Huijie Miao
Matthew Nguyen
Patrick Nuernberger
Daniel Pertot
Jonathan Rameau
James Reilly
Sebastian Reyes
Claire Shean
Lichi Shi*
Lai-Wa Siu
Mark Stanford
Ryan Terri
Diego Trancanelli
Le Trung
Yanjun Tu*
Dylan Walker
Lisa Whitehead
Koon-Kiu Yan
Jinmi Yoon
Wei Zhou

Univ. of Iowa
Peking Univ
USTC
Univ. of Warwick
USTC
Instituto Tecnologico
St. Petersburg State Univ
Fudan Univ
Vassar College
Univ. of Wuerzburg
Univ. Stuttgart
Vassar College
Univ. of Rhode Island
Catholic Univ. of Chile
Univ. of Virginia
Peking Univ
Univ of Hong Kong
U Mass-Amherst
Occidental College
Univ. of Perugia
College Natural Sciences
USTC
Sarah Lawrence College
Vanderbilt Univ.
Univ. of Hong Kong
Seoul Natl Univ
Peking Univ

Where do the incoming grad students come from?

LATIN AMERICA
EUROPE
ASIA
US

We are delighted with this group of excellent new students - the life blood of the department!

* = not awarded visas -- deferred
Effective Sept. 2002, the comprehensive exam for advancement to candidacy was modified:

**Part I** (Classical Mechanics, Electrodynamics, Quantum Mechanics, Statistical Mechanics) is given in September for entering students. Passing the sections of this exam will exempt students from the corresponding courses; not passing means students must complete the corresponding course with grade of B or better.

**Part II** (Breadth) remains as the comprehensive exam to be passed by all Ph.D. (Masters) students. It is given in September and January.

The rationale is that we want to assure that all of our students have clear mastery of the core subjects of Physics, and the courses are the preferred way to achieve this.
Graduate Students honors (recognized in May 2002 colloquium)

Jay Dickerson - Special award for a graduating PhD Turner Fellow
Matthew Cashen, Shu-Chiuan Chang - 2 of 5 President’s Awards for Distinguished Doctoral Students.
Jerry Francischelli - ASNY Graduate Research Prize
Yiing-Rei Chen - Gertrude Goldhaber prize for outstanding woman student at SB or working at BNL
Seth Aubin - ($10K) Grand Prize of Optical Society of America New Focus Award
Xiyue Miao - Di Tian Prize for the outstanding Asian student
Andrew Steiner - Max Dresden Prize for outstanding theoretical dissertation research
Sasa Ratakovic - David Fox prize for outstanding TA
Tirthabir Biswas, Matt Cashen, Loic Grandchamp, Yildirim Mutaf - Peter Kahn prize for research travel
Jorge Casalderrey - T.A. Pond prize for best performance on comprehensive exam
Neil Christenson - Henry Silsbee prize for academic achievement
Jay Dickerson - Soroff prize recognition for outstanding student recognition
Michael Feser, Abid Patwa - Lee Wilcox prize for outstanding experimental thesis
Undergraduate program

17 undergraduate BS in Physics and Astronomy in the last year.

Undergraduate research – John Noe taking the direction of undergraduate research projects department-wide. Last year, 16 students took part in the undergraduate research symposium. There was a special university-wide award to Doug Broege.

Undergraduate curricular issues – we think it should be possible to increase the number of undergraduate majors; a combination of a 'general' program, a 'technical' program (e.g. engineering physics) in addition to a 'professional' program. Chris Jacobsen and Phil Allen have been working in these directions. We should do better here.

Work to develop our new 'research directions' courses at several levels. New initiative for “Nanoscience Perspectives” for incoming students (Phil Allen, Chris Jacobsen, Chris Berndt of Engineering). New course development “Physics of Sport” (Chang Kee Jung).
The Grad Physics Building exterior: Albany has allocated funding for an engineering design study to determine the extent of damage to the building facade and a means to accomplish the repair. The Attorney General's Office sign the contract to the engineering firm for a start date in early September.

The department has undertaken a variety of infrastructure improvements, including the new network hubs. We believe we have won the right to get our plumbing, electrical, carpentry jobs let to outside contractors rather than waiting for WCPP. This should speed up our renovations.

Space rehab in S240A for the Math Learning Center is starting. Will free 2 lab modules on A-level for consolidation of our teaching labs. Will move Junior Lab to A-level.
**Outreach**

**Laser Teaching Center** - in addition to serving Stony Brook undergraduates, has provided research experience for dozens of area high school students. *(John Noe, Hal Metcalf)*

**Quarknet** - An NSF-sponsored program to bring particle physics to high school teachers, involving them in ongoing experiments and devising projects for the high schools. *(Michael Rijssenbeek)*

Annual **Physics Challenge Exam** which brings nearly 2000 students to campus. The winners of this exam receive a substantial scholarship for study at Stony Brook.

**Long Island Physics Olympics** in which 75 outstanding high school students are brought to campus to compete in a variety of areas.

About 20 high school students tutored for **Intel Science Talent Search**; seven were semi-finalists.
The popular Open Night Friday night series for the general public continues. The talks last semester: Deane Peterson and Emilio Mendez are planning a star-studded roster for 2003.

Astronomy Open Nights Spring 2002:
Doug Swesty “Explosions in the Sky: Understanding Supernovae”
Deane Peterson: “Measuring Distances in Astronomy: It's Harder Than You Think”
Michal Simon “Weighing the Young Stars”
Aaron Evans “Kuiper Belt Objects: Remnants of the Early Solar System”

Worlds of Physics Spring 2002
Janos Kirz “Just How Dangerous IS Radiation??”
John Hobbs “What's the matter? A story of the smallest objects in the universe.”
Luis Orozco “Waves and Particles in Light”
Fred Goldhaber “Einstein the Radical vs Einstein the Conservative”
Some sample highlights:

For 43 respondents to annual addendum, 263 papers published (6.1 per person), 51 in Science or PRL. These faculty gave 193 seminars and colloquia (4.5 per person).

In the national Citation index, Stony Brook ranks 13th nationally in Physics, & 22nd in Astrophysics.

In Vol. 51 (2001) of the prestigious Annual Review of Nuclear & Particle Science, 3 of the 13 articles are authored by Stony Brook faculty: Gerry Brown; Madappa Prakash, James Lattimer et al.; Chang Kee Jung, Clark McGrew et al.


Chris Jacobsen & collaborators create coherent extreme ultraviolet radiation laser (\(\lambda = 36\) nm, few femtosecond pulse) and made high resolution hologram images of nm objects (Physics World, Aug. 2002)
Research expenditures

**Physical Sciences and Math**
Physics and Astronomy ~ $13M (14th in the nation)

**Major Schools, Colleges & Centers**

- School of Medicine
- Arts and Sciences
- CEAS
- Marine Science

**Major units of University**

- Phys/Astro merger

**Graphs:**
- Physical Sciences & Math RF Expenditures FY 80 - FY 02
- MAJOR SCHOOLS, COLLEGES & CENTERS RF Expenditures FY 80 - FY 02
Many of our students and faculty work closely with many scientists at BNL; world class facilities in our back yard!

Our collaborations extend to most prominent US universities, and many leading institutes and laboratories around the world.

Some of the labs/telescopes where we work:
The Research accomplishments of the Department

Physics and Astronomy as a field has overarching ‘Big Questions’ as enunciated in a recent National Academy of Sciences report:

1. Developing Quantum Technologies
2. Understanding Complex Systems
3. Applying Physics to Biology
4. Creating New Materials
5. Exploring the Universe
6. Unifying the Forces of Nature

We should, and do, participate in all of these Grand Challenges! They are highly interrelated, and our faculty frequently move from one area to another as opportunities and new connections arise. We are the largest department in the College in large part because we value the unity of physics more than the differences. (Unlike Biological Sciences which is split into four departments)
A poor man's view of the multiple connections in our research.
connections ...

The timeline of the universe (the ultimate physics laboratory) again demonstrates the interconnectedness of physics and astronomy.
I asked each of the research groups in the department for a succinct, accessible account of the most interesting new science in the past year. No physicist is shy, and so in true academic fashion, I got a factor of two more pages than requested with amazing density of material:

I used to do this to Chairs too - and now I apologize!

There is much I don't understand that I am reporting ... but I am sure it's truly interesting! I apologize for mistakes, but I'll try. Proceed from the largest to smallest objects in the universe
Astronomy/Astrophysics

The deepest views of the cosmos from the Hubble Space Telescope indicate an epoch of rapid star formation just 100 million years after the Big Bang, much earlier than earlier thought. The analysis uses Lyman $\alpha$ absorption lines due to intervening dust, red-shifted into the visible inferring the intensity of distant sources. Such early ignition of stars disagrees with previous theory. (NASA press conference, Jan 8, 2002) - Ken Lanzetta

Aaron Evans uses infrared measurements to study active galaxies and galactic mergers.

Phil Solomon has pioneered the study of galactic molecular clouds using radio telescopes.

Amos Yahil has made a variety of contributions to cosmology and dark matter.
**Formation of binary systems**

What is the difference between formation of massive planets and low mass stars?

Mike Simon and colleagues are measuring the fractions of binaries with low mass companions using IR more sensitively than before, in an attempt to study this question. They are now able to detect binaries at the threshold where planets should be sensed.

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**How far away is anything in the universe?**

If we don't know the distance to our nearest neighbors, our yardstick for the universe is skewed. Deane Peterson's research (with REU student K. Hinterbichler) has refined this basic distance scale calibration, based on a new analysis of star clusters.
To be a quark star or not to be, that is the question. The nearby neutron star found by Fred Walter et al. was the subject of controversy this year. Based on estimates of luminosity and parallax, some suggested that it is a 'quark star'. The diameter measurement rests on the spectral measurement which seems to have two blackbody components, indicating a 'hot spot'. Recent distance measurements by Walter and Lattimer suggests it's further away, bigger, and not quark matter.
Supernovae, Neutron Stars, and Black Holes

- F. Douglas Swesty
- James M. Lattimer
- Madappa Prakash
- Gerald E. Brown

TeraScale Simulations of Neutrino-Driven Supernovae and Their Nucleosynthesis

- Relativistic Multi-Dimensional Hydro
- Neutrino Radiative Transport
- Nuclear Equation of State
- Neutrino Interactions in Matter

Neutron Stars from Their Birth to Old Age

- Proto-Neutron Stars & Neutrinos
- Neutron Star Cooling & Superfluidity
- Quark Phases & Quark Stars

Connection to SB neutrino experiments capable of seeing supernova neutrinos
Stony Brook telescopes

Ken Lanzetta, Aaron Evans, Gene Sprouse & visitor Paul Hickson are developing a prototype rotating, liquid mirror telescope that would lead to building a 50m diameter equivalent telescope (LAMA) that would be the largest in the world. Collaboration with Columbia Univ., American Museum of Natural History, Rochester Inst. Technology for Phase 1.

Stony Brook has joined the SMARTS consortium that operates 3 telescopes at the Cerro Tololo observatory in Chile (Fred Walter and Mike Simon). These relatively modest telescopes will allow new studies of star forming regions, studies of transient events (γ ray bursters, supernovae), stellar interferometry, etc.
Reconstructed pre-explosion orbital periods vs. black hole masses of soft X-ray transients. The He star progenitors of the black hole lie between 7 and 11 solar masses. The green theoretical curves are in good agreement with the observations when projected back to the time of explosion.

Loop rotating with black hole cuts B field lines associated with accretion disk; generates current of $\sim 10^{25}$ A. The resistance in the BH gives power loss that generates gamma ray burster along rotation axis.

Field lines anchored in the disk couple the BH rotation to the disk, torquing it to high $\Omega$. Viscous losses result in hypernova explosion.

Black holes, hypernovae and gamma ray bursters  
Gerry Brown, Chang-Hwan Lee,  
(Hans Bethe, Ralph Wijers)
Atmospheric Sciences -

Institute for Terrestrial and Planetary Atmospheres
(Marvin Geller)

Numerical Weather Prediction and Climate Modeling

Opportunities for Research

- Atmospheric Dynamics and effects on climate
- Radiative transfer of solar energy through atmosphere (clouds, aerosols, molecular ...)
- Short and long-term climate change
- Atmosphere-ocean interactions (heat exchange, circulation, sources/sinks for atmospheric gases)
- High resolution molecular spectroscopy for atmospheric parameters
- Atmospheric chemistry and regulation of stratospheric ozone, H$_2$O, etc.
- Local and mesoscale meteorology

Bob deZafra continues his studies to identify and track the ozone hole in Antarctica and the Arctic.
Nanofabrication of diffractive x-ray optics

50 nm zones in nanoimprint replica (also 30 nm by direct e-beam write).

With Bell Labs, U. Texas

*BNL Nanocenter ($80M): Jacobsen co-leader of nanofab lab*

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**X ray optics and spectromicroscopy**

Beetz, Feser, Fleckenstein, Hornberger, *Jacobsen, Kirz, Lima, Lu, Shapiro, Stein, Wirick*

Scanning microscopy lab at National Synchrotron Light Source, Brookhaven

Support: NIH, NSF, NSF Center for Environmental Molecular Science

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**Spectromicroscopy**

Chemical state mapping (XANES) at 50 nm

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Human sperm

Lu and Haematite
Condensed matter physics

Vladimir Goldman’s group has fabricated quantum antidots (S) that collect either electrons or fractional charge quasiparticle states; a sensitive capacitor shows the existence of fractional charge collective states, as predicted by theory.

Use BNL NSLS infrared light to excite electron spin resonance at very high magnetic fields (15T) to probe the collective electron interactions vs. temperature. The clear departures seen by Laszlo Mihaly’s group from $\hbar \nu = \mu_B B_{\text{EXT}}$ indicate the presence of very strong local temperature dependent B fields due to the electron system.
Condensed matter physics

How do you raise $T_c$ for the Buckyball fullerene superconductors? The lore was that if one inserts filler (chloroform etc.), the expanded lattice gives a higher density of states and larger $T_c$. Peter Stephens’ group says it is not so - the fillers don’t expand the lattice!

Emilio Mendez’ group has constructed semiconductor microcavities that can be tuned by applied E field. Mixed states arise from photon/exciton interference & probe the modes of the cavity. The technique gives a very broad band semiconductor laser.

New sensitive infrared photo-optic devices are investigated by Michael Gurvitch
Condensed matter physics

A SQUID device, with a Josephson junction in a gap, has two macroscopic quantized states, each with billions of electrons in currents. With quantum tunneling and small interaction with the environment, a superposition of symmetric and antisymmetric states can be formed with slightly different energies. These macroscopically large quantum systems enable one more 'Schrödinger's cat' experiment, and can form the basis for quantum computing. Lab of Jim Lukens.
Mesoscopic physics

Vasili Semenov and Dmitri Averin are working in the area of thermodynamics of computation. The unique combination of theory, experiment and industrial effort aims to demonstrate functional circuits with the energy dissipation below thermodynamic limit of $k_B T \ln 2$ per operation. The ultimate goal is demonstrate the large-scale quantum information processing.

Chemical self-assembly of molecular electron devices on prefabricated nanowire structures. The resulting circuits are expected to evolve into neural networks that simulate the cerebral cortex but work $\sim 10^5$ times faster. Work in progress by Kostya Likharev and Jim Lukens, in collaboration with Chemistry, Computer Science, BNL and ORNL.
Condensed matter theory  Sasha Abanov, Igor Aleiner, Phil Allen

Selected Publications


Atomic and optical physics

Quantum chaos: highly excited states of hydrogen, driven by microwave electric fields exhibit chaotic behavior involving collective behavior with hundreds of photons. Various circumstances (polarization, static and microwave fields, bichromatic fields) alter the outcome and display both classical and quantum characteristics. These lead to new theories of chaotic systems in the lab of Peter Koch.

Control of atomic motion using laser cooling is investigated in Hal Metcalf’s lab. Interference of deBroglie matter waves and optical light waves give a fascinating insight into fundamental interactions. The plot shows specially prepared atomic states whose wave functions are superpositions of different momenta, so parts of the atom are moving in different directions (again, the Schrödinger’s cat!).
Atomic and optical physics

Adjunct professor Lou DiMauro conducts experiments at BNL exploiting the light-matter interaction with hyperfast X-rays and attosecond laser pulses.

Coupled systems of a weak EM cavity field and trapped atoms are in a tangled wave function that can be disturbed by emission of a single photon. Emission of a photon at the coupling frequency disturbs the wave function, but carefully phased EM pulses can shape it. Control of the process with rapid feedback allows preparation of interesting states for quantum information systems. Luis Orozco and collaborators.
Atomic and optical physics

Tom Weinacht uses shaped ultrafast laser pulses to create and measure tailored wave packets in atoms and molecules. Controlling atomic and molecular motion may lead to coherent control over chemical reactions.

Gene Sprouse and Luis Orozco use the Stony Brook Linac to make Francium nuclei ($T_{1/2} = 3$ min) and put it in an atomic trap contained by lasers/fields. The very cold (10 m/s) atoms are stored for 30 sec, and the spectroscopy has been revealed for the first time. Fr decays should provide one of the most sensitive studies of Parity violation, and thus will shed light on the Electroweak symmetry breaking of particle physics.
**Nuclear Theory:** Gerry Brown, Tom Kuo, Madappa Prakash, Thomas Shaefer, Edward Shuryak, Jac Verbaarschot, Ismail Zahed

**Quantum Chromodynamics** - a quantum field theory of the strong nuclear interaction - 8 gluons of mixed color interact with $N_c=3$ pure colors of quarks, in analogy with $\gamma$ in EM. The force is weak at short distance (asymptotic freedom) and strong at long distance (confinement of quarks in nucleons). The long distance behavior, such as the existence of nuclei, can only be understood from first principles by large scale computer simulations.

**First principle studies:** to obtain analytic understanding of QCD, study theories in simplified parameter ranges:

- Limit of low mass and energy - at low quark masses and momenta, QCD becomes a theory of weakly interacting bosons
- Semiclassical limit ($\hbar \to 0$) - tunnelling becomes very rare, and such rare events (instantons) can be understood as a dilute gas of particles
- $N_c=2$: with 2 colors, “nucleon” contains 2 quarks and is a boson. For low quark masses, get a Bose-Einstein condensate
- $N_c=\infty$: in theory, physics simplifies when a parameter approaches $\infty$. We understand that $2 \ll 3 \approx \infty$!
- Mesoscopic limit: if pion wavelength $\gg$ size of box, QCD can be described by matrices of pure random numbers.
Nuclear Theory, cont’d:

Phenomenological Studies:
Renormalization group analysis of low momentum effective nuclear interaction
A theory with modified lifetime and mass of particles explains the production of $e^+e^-$ pairs in medium energy nuclear collisions
Description of initial stage of high energy nuclear collisions in terms of classical fields
Description of final stage of high energy nuclear collisions by relativistic hydrodynamics

Mathematical Physics:
Random Matrix Theory - with eigenvalues interpreted as the position of particles these theories are equivalent to one-dimensional exactly soluble systems

Non-linear systems: Peter Kahn is developing computational schemes for solving highly coupled non-linear systems.
Chirality in triaxial nuclei

\[ R \] – rotational vector-intermediate axis
\[ j_\pi \] – proton orbital
\[ j_V \] – neutron orbital

Orthogonal angular momenta: left- & right- handed geometries.

The Axion is the Goldstone boson that corrects the Strong CP Problem in the Standard Model.

The search for axions is continuing for 20 years.

If axion exists it can be produced in nuclear transitions of magnetic dipole character from excited states to the ground state of the \(^{12}\text{C}\) and \(^{8}\text{Be}\) nuclei.

The Giant Dipole Resonance group is searching for the axions through their decay into electron-positron pairs.

A semispherical array of 65 scintillator detectors in coincidence with 4 neutron detectors can resolve pairs.
Trapping polarized Francium atoms for measuring their Nuclear Magnetic Moments-A test of the Atomic Theory of Fr

David Cardoza, Kerim Gulyuz, Jerry Sell and Gene Sprouse
Heavy ion physics
The Stony Brook group of Barbara Jacak, Axel Drees, Tom Hemmick, Michael Marx were leaders in building the PHENIX experiment at the BNL Relativistic Heavy Ion Collider. With first data in 2000, new results indicating the existence of a quark gluon plasma are emerging.

USB uses PHENIX at RHIC to study the QCD Phase Transition

Phenix drift chamber
Suppression of energetic particles: the dense matter at RHIC induces huge energy loss of quarks & gluons passing through it...

charged particles per NN collision

Suppression sets in gradually as the centrality increases. J. Jia/USB
PHENIX looks for $J/\Psi \rightarrow e^+e^-$ QGP should melt $c\bar{c}$ bound state

Finding an electron is like looking for a needle in a haystack: must find electron without mistaking a pion for an electron at the level of one in 10,000

We do find the electrons: Analysis underway: QGP or effect of surrounding nucleons?
Nucleon Decay and Neutrino Group

Super-Kamiokande

UNO

40m

JHFnu

K2K

C K Jung, C McGrew, C Yanagisawa
Postdocs: A Sarrat, K Kobayashi
Senior Grads: T Kato, D Kerr, M Malek, C Mauger
Summer Grads: A Dion, D DePietro, S Gromoll
M Kinoshita, L Whitehead
SuperTankers of Physics -- Ring Imaging Water Cherenkov Detectors

Massive Active Volume for
Atmospheric $\nu$ Interactions
Solar $\nu$ Interactions
Relic SuperNova $\nu$
Nucleon Decay Signals

50 kton Tank of Water (all Active)
One Detector/Two Experiments

Neutrino Experiment

- Neutrino Masses & Mixing
  - Lepton Mixing Matrix
  - Bi-Maximal Mixing?
  - vs. Small Mixing w/ Quarks
- Lepto-Genesis
  - Matter vs. Anti-Matter

Cosmic Neutrino Sources

- Super-Nova Neutrinos
- Relic Super-Novae

Proton Decay Search

- Signature of Unification
  - Test of GUTs
  - Test of String Theory
- Related to Neutrino Mass?
  - Seesaw Mechanism
- Baryon Conservation: Why?
HEP Experiments at Accelerators:

**DØ at Fermilab p¯p collider**: back in routine operation after 5 year upgrade. Tuning & first physics now appearing (Paul Grannis, John Hobbs, Bob McCarthy, Michael Rijssenbeek, Dean Schamberger)

Proper B decay length \( (B \rightarrow J/\psi + X) \)

B lifetime consistent with world avg.

1\text{st} measurement of W and Z production in Run 2 at \( E_{CM} = 1.96 \text{ TeV} \)

\[ \sigma B(p\bar{p} \rightarrow W \rightarrow ee), \]
\[ \sigma B(p\bar{p} ightarrow Z \rightarrow ee) \]

Now on to search for the Higgs boson and supersymmetry!
KØPIØ — CP in the SM, $K_L \rightarrow \pi^0 \nu \nu$, $3 \times 10^{-11}$ branching ratio (Mike Marx, Dean Schamberger et. al. at BNL):
Collaboration & conceptual design ready; R&D money to SB.

Atlas — at CERN LHC (Rod Engelmann, Bob McCarthy, Michael Rijssenbeek); Installing calorimeter HV feedthroughs

pp2pp — elastic pp scattering at BNL RHIC (Michael Rijssenbeek) 1st data taking in past year
SUSY, STRING THEORY

- SUSY: Strings, Waves & Solitons
- BRANES: Our world as a boundary; compactification
- M-THEORY: What the really big picture could be like
- TACHYONS: Their interpretation in string theory
- NONCOMUTATIVE FIELD THEORY: $xy \neq yx$

Superwaves, W. Siegel
Covariant Quantization of Superstrings
P.A.Grassi, P.van Nieuwenhuizen et al.
Local Casimir Energy for Solitons, A.Goldhaber
A.Litvinsev, P.van Nieuwenhuizen

Higher Codimension Branes, O.Corradini, A.Iglesias, Z.Kakushadze

M-Theory Compactifications,
L.Anguelova, C.Lazaroiu

Does the Tachyon Matter? P.Langfelder* et al.

Noncommutative solitons, M.Rocek et al.
Breaking CPT by Mixed Noncommutativity,
I.Mocioiu, R.Roiban, M.Pospelov

*ITP-Santa Barbara Predoctoral Fellow
Some of what they’re up to . . . .

New Developments in the 8-Vertex Model,
B.McCoy & K.Fradianus
Dimers & the Critical Ising Model, Genus > 1,
R.Gotts-Santos & B.McCoy**
Quantum Correlations and Number Theory,
H.Boos & V.Korepin

Quantum Error Correcting Criterion,
V.Korepin & J.Terilla

Exact Potts Model Partition Functions,
S.C.Chang** & R.Shrock

*Dean’s thesis award

**Miller visiting prof., UC Berkeley.

• EXACTLY SOLVABLE MODELS: New symmetries
• QUANTUM COMPUTING: Coherence criteria
• GRAPH THEORY & PHYS: Colorings to calculations
**H.E. FIELD THEORY PHENOMENOLOGY**

- **NEUTRINOS**: first physics beyond the Standard Model

  * Neutrino Masses & Dynamical Symmetry Breaking, **R.Shrock** & **T.Appelquist**
  * Before & After the SNO Neutral Current Measurement, **J.Bahcall & M.C.Gonzalez-Garcia**
  * Oscillations with two scales, **I.Mosciou & R.Shrock**

**QCD**: From quarks to hadrons in field theory & new physics searches

  * Polarized NLO Distributions, **J.Smith** et al.
  * Joint Resummation, **G.Sterman**
  * Energy Flow in Interjet Radiation, **C.F.Berger, T.Kucs, G.Sterman**
  * Hadron Dynamics & Proton Lifetime, **A.Goldhaber et al.**

*Oscillations at BNL Proposal*  
^Particle Data Group

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**YITP -- 3**

**9th CTEQ School on QCD Phenomenology**
Conclusion

We see an impressive (but bewildering) array of activity in the Physics and Astronomy Department - and this is as it should be. Physics/Astronomy is highly inter-connected, and our students and staff are exploring new combinations and directions.

We salute the aspirations and accomplishments of the 200 faculty, research staff who make the Department, and wish all well for the coming year. In particular, welcome to the new grad students - we hope you thrive and teach us all new secrets of Nature.