The State of the Department
New faculty

Xu Du, condensed matter physics experiment. He arrived a few days ago. Xu is interested in graphene and other layered materials with possible technological applications. Ph.D. form U. Florida, postdoc at Rutgers U.

Approaching ballistic transport in suspended graphene
New faculty

Patrick Meade, C. N. Yang Institute for Theoretical Physics. Ph.D. Cornell University, postdoc at Harvard, the Institute for Advanced Study.

Interested in the physics of the TeV scale and the upcoming experiments at the Large Hadron Collider. The dynamics of strongly coupled gauge theories, dark matter and its connections to collider experiments.

New faculty

Dmitri Tsybytchev, high energy experiment. Started in January, 2009. He has a Ph.D. from the University of Florida, and he was postdoc working on D0 in Stony Brook.

Currently member of D0 and Atlas collaborations. “New Physics at the Energy Frontier” NSF grant.
Jin Koda, extragalactic astrophysics, joined us as Assistant Professor in Jan. 2009. He was a Senior Postdoc at Caltech.

Jin is an expert in millimeter-wavelength observations and often performs numerical simulations. He is leading the survey of molecular gas in nearby galaxies using the Combined Array for Research in Millimeter Astronomy (CARMA). He and co-workers have recently discovered new tidal debris stripped away from colliding galaxies.

New faculty

Michael Douglas, YITP, the first permanent member of the Simons Center for Geometry and Physics. He was the director of the New High Energy Theory Center (NHETC) at Rutgers University.

He is known for his research on nonperturbative formulations of string theory, for his work on Dirichlet branes and on noncommutative geometry in string theory, and for the development of the statistical approach to string phenomenology.
Barbara Jacak was elected the member of the National Academy of Sciences.

Welcome back to those on the faculty who were on leave last year:
Bob McCarthy, Tom Weinacht (fall), Deane Peterson (fall)

On leave this year:
Gene Sprouse, Editor in Chief, APS
Emilio Mendez, Director, Center for Functional Nanomaterials, BNL
Fred Walter, sabbatical leave
Phil Allen, sabbatical leave
Peter Koch, sabbatical and research leave
News of the faculty

A special welcome back to Jack Marburger, joining us again after being BNL director and Science Advisor to the President of the US.

Retired or left:

Gerry Brown, retired after 41 years of service. Gerry is recovering from complications arising of his hip surgery, and he and his wife Betty can be visited at the Long Island State Veterans Home, adjacent to Campus. Enrique Moreno-Mendez, Gerry’s 70th student, defended in May.

Adam Durst, took an applied physics position at Photon Research Associates, an aerospace company in Port Jefferson that does mathematical modeling, simulation, and analysis of optical sensor data for spacecraft and aircraft.

Gilad Perez, accepted a Senior Scientist position at the Weizmann Institute
News of the faculty

- John Hobbs was promoted to full professor.
- Abhay Deshpande and Leonardo Rastelli were promoted to associate professor.
- Paul Grannis received a Honorary Doctorate from Ohio University.
- Peter Paul won the highest civilian service award (Distinguished Service Cross First Class) bestowed by the German government.
- Kostya Likharev was elevated to IEEE fellow “for contributions to superconducting digital electronics and single-electron tunneling devices.”
- Vladimir Goldman became a member of the APS Publication Oversight Committee until 31 December 2012.

News of the faculty

- Ilan Ben-Zvi has been recognized as an IEEE Fellow for “leadership in superconducting accelerators, high brightness electron sources and free electron lasers.”
- Madappa Prakash was awarded the “Distinguished Mentor of the Honors Tutorial College” prize at Ohio University.
Adjunct and Affiliated Faculty

The department made 2 new adjunct faculty appointments to:

Ben Ocko - BNL, soft condensed matter group
Frithjof Karsch - BNL, theoretical high energy physics

Artem Oganov (Geosciences) was appointed affiliated Associate Professor in Spring 2009

BNL Research opportunities

Current and recent research:
Highe energy theory (Dawson, Karsch)
Accelerator physics (Satogata, Litvinenko, Ben-Zvi, Peggs)
Condensed matter theory (Wei Ku, Maslov)
Electron microscopy (Yimei Zhu)
Energy conversion (Ocko)
Condensed matter exp. (Johnson)

Mendez, Stephens, Jacak, Deshpande, Hemmick, Drees
BNL Research opportunities

**Future opportunities:**

Interdisciplinary Science Bldg., planned

Joint Photon Science Institute (JPSI)

Center for Accelerator Science and Education (CASE)
Director: Tom Hemmick

NSLS II, under construction, will appoint 60 beamline scientists

---

Building and other infrastructure

**Expected:**

The five portable water chillers and plumbing will be removed from the Physics lawn sometime in early October 2009.

The Physics/Math Parking Lot will be repaired sometime in early Spring of 2010. New chilled water supply and return lines will be installed.

Renovation of the "Concrete deck", the area around the building, will start in early Spring 2011.
Simons Center

Simons Center for Geometry and Physics

As seen from room B-145, approx 1 photo each day, starting in May, last photo in September
Graduate student PhDs awarded

December, 2008 Ph.D.s

- Shivani Ahuja (Steven O. Smith) Molecular Mechanism of Light Activation of Rhodopsin
- Torsten Dahms (Axel Drees) Dilepton spectra in p p and Au Au collisions at RHIC
- Gang Wang (Ilan Ben-Zvi, BNL) Coherent Electron Cooling and Two Steam Instabilities Due to Electron Cooling
- Kenneth Herner (John Hobbs) Search for Neutral Higgs Bosons Decaying to Tau Pairs Produced in Association with b quarks
- Sarah Nichols (Tom Weinacht) Strong Field Dynamics and Control of Molecular Dissociation
- Dylan Walker (Sergei Maslov, BNL) The Physics of Complex Systems in Information and Biology
Graduate student Ph.D.s awarded

May, 2009 Ph.D.s

• Claire Allred (Hal Metcalf) Neutral Atom Lithography with Metastable Helium
• Robert Bennett (Abhay Deshpande) Measurements of the Direct Photon Cross Section and Double Longitudinal Spin Asymmetry in 200 GeV p p Collisions at PHENIX
• Yu-tin Huang (Warren Siegel) Off-shell N=4 super Yang-Mills
• Keun young Kim (Ismail Zahed) Holographic QCD
• Dan Li (Wei Zhao) SAPHIRE (Scintillator Avalanche Photoconductor with High Resolution Emitter Readout) for low dose x-ray imaging
• Anne March (Louis DiMauro) Strong Field Studies of Cesium Using Intense Mid-Infrared Light

May 2009 Ph.D.s (cont.)

• James Nesteroff (Dmitri Averin) Coherent Quasiparticle Transport in Multi-Antidot Structures with Potential Applications to Quantum Information
• Matthew Nguyen (Barbara Jacak) Two Particle Correlations with Direct Photon and m0 Triggers in 200 GeV p p and Au Au Collisions
• Ionel Patu (Barry McCoy) Correlation Functions of One-Dimensional Impenetrable Anyons
• Jonathan Rameau (Peter Johnson, BNL) High Resolution Photoemission Experiments on Copper Oxide Superconductors
• Ying Xu (Vladimir Korepin) Entanglement in Valence-Bond-Solid States and Quantum Search
**Graduate student PhDs awarded**

**August 2009 Ph.D.s**

- **Enrique Moreno-Mendez** *(Gerry Brown)* Black-Hole Binaries As Relics Of Gamma-Ray Burst / Hypernova Explosions
- **Xiao Shen** *(Phil Allen)*: Theory of ZnO and GaN: Nanostructures, Surfaces and Heterogeneous Photo-catalysis
- **Philip Schiff** *(Adam Durst)* Low temperature thermal conductivity in a d-wave superconductor with coexisting order parameters
- **Jun Guo** *(Robert L. McCarthy)* A Precision Measurement of the W Boson Mass
- **Luigi Longobardi** *(Jim Lukens)* Studies of Quantum Transitions of Magnetic Flux in a rf SQUID Qubit
- **Emanuel Strauss** *(John Hobbs)*: From ZZ to ZH : How Low Can These Cross Sections Go or Everybody, Let’s Cross Section Limbo!

**President’s Award**

2009 Distinguished Doctoral Student:
Shivani Ahuja *(advisor: Steven O. Smith)*
Incoming graduate students

<table>
<thead>
<tr>
<th>Name</th>
<th>Country</th>
<th>University</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sjan Dabholkar</td>
<td>India</td>
<td>ITT Madras</td>
</tr>
<tr>
<td>Andrey Elizarov</td>
<td>Russian Federation</td>
<td>Saint-Petersburg State University</td>
</tr>
<tr>
<td>Loshaj Frasher</td>
<td>Yugoslavia</td>
<td>University of Prishtina</td>
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<td>Huijun Ge</td>
<td>China</td>
<td>Shanghai University</td>
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<tr>
<td>Andrey Gromov</td>
<td>Russian Federation</td>
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<td>Joshua Iany</td>
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<td>Carnegie Mellon University</td>
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<td>Adam Jacobs</td>
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<td>Hendrix College</td>
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<tr>
<td>Joy Hyun Jo</td>
<td>Korea</td>
<td>Seoul National University</td>
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<tr>
<td>Jan C. Kaiser</td>
<td>Germany</td>
<td>Julius-Maximilians-Universitaet</td>
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<tr>
<td>Vladimir Khachatrian</td>
<td>Armenia</td>
<td>Yerevan State University</td>
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<td>You Jin Kim</td>
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<td>Kyungpook National University</td>
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<td>Morgan Lynch</td>
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<td>Rahul Patel</td>
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<td>Florida International Univ</td>
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<td>Wolfger Peelaers</td>
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<td>Yachao Qian</td>
<td>China</td>
<td>Fudan University Shanghai</td>
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<td>Sooraj Krishnan</td>
<td>Radhakrishnan India</td>
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<tr>
<td>Omer Rahman</td>
<td>Bangladesh</td>
<td>University of Dhaka</td>
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<tr>
<td>Eric Rarnyake</td>
<td>Sri Lanka</td>
<td>University of Peradeniya</td>
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<tr>
<td>Jeremy Reeves</td>
<td>United States</td>
<td>SUNY Coll Geneseo</td>
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<tr>
<td>Raul Santos Sanhueza</td>
<td>Chile</td>
<td>Pontificia U. Catolica de Chile</td>
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</table>

Incoming graduate students (cont.)

<table>
<thead>
<tr>
<th>Name</th>
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<tr>
<td>John Schneeloch</td>
<td>United States</td>
<td>Worcester Poly Institute</td>
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<td>Rashad Simon</td>
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<td>National Tsinghua University</td>
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<tr>
<td>Marina von Steinkirch</td>
<td>Brazil</td>
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<td>Joern Wilhelm</td>
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<td>Greg Wille</td>
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</tr>
<tr>
<td>Tianmu Xin China</td>
<td>Peking</td>
<td>University</td>
</tr>
</tbody>
</table>

MAT Program:
- Toposhi Biswas
- Pawel Kurzyna
- John Mallorca
- Daniel Vaeth

25 PhD
1 MSI
2 Exchange MA
4 MAT

Where do new students come from?
- United States
- Asia
- Europe
- South America
Tiffany Kataria, Raema Obbie, Christopher Presuto, and Jude Safo received Undergraduate Recognition Awards.

Bachelor degrees, December 2008 (4)

Thomas Fitzpatrick
Christopher Galloway seeking employment, may apply to graduate schools in the future
Sang Won Lee
Christopher Presuto employed at Photonics Industries, Hauppauge

May 2009 (14)

Tomasz Bakowski graduate school, SBU, Engineering
Andrew Broussard graduate school, Univ. of Louisiana, Math & Physics teaching program
Cory Clifton

Undergraduate Degrees

May 2009 (cont.)

Glenna Dunn
Imran Istihar
Tiffany Kataria graduate school, University of AZ, Planetary Sciences
Devora Klein Advisor, SBU, Engineering
John Logan will apply to graduate school, Ph.D. program in physics
Carlos Marques
Sergiy Nazarenko seeking research job
Raema Obbie
Simone Park
William Raphaely seeking teaching position, grades 7-12
Michael Saganic NYU, Master’s program in telecommunications

August 2009 (1)

Eric Jones will apply to graduate school
<table>
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<td>1626</td>
<td>1810</td>
<td>1912</td>
<td>1918</td>
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Research Experience for Undergraduates (REU)

**SUMMER 2009**

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<thead>
<tr>
<th>Name</th>
<th>Institution</th>
<th>Advisor</th>
</tr>
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<tr>
<td>Mara Anderson</td>
<td>Dickinson College</td>
<td>John Noé</td>
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<tr>
<td>Maxwell Grady</td>
<td>Loyola University Chicago</td>
<td>Monica Bugallo</td>
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<tr>
<td>Ryan Maunu</td>
<td>U. of Minnesota - Twin Cities</td>
<td>Robert McCarthy</td>
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<tr>
<td>Matthew Onstott</td>
<td>Wichita State University</td>
<td>Thomas Hemmick</td>
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<td>Thomas Rao</td>
<td>Stony Brook University</td>
<td>Richard Lefferts</td>
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<td>Max Tolkoff</td>
<td>Tufts University</td>
<td>John Noé</td>
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<td>Rachael Tomasin</td>
<td>Central Michigan University</td>
<td>Michal Simon</td>
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<td>Thomas Vidabæk</td>
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<td>John Noé</td>
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<td>Andrea Welsh</td>
<td>Boston University</td>
<td>Michael Rijssenbeek</td>
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<tr>
<td>Amanda White</td>
<td>Drexel University</td>
<td>Stanimir Metchev</td>
</tr>
</tbody>
</table>
Research Experience for Undergraduates

Outstanding Teaching Award

John Hobbs, PHY 335: Electronics and Instrumentation Lab
Thanks to Chang Kee Jung and the WEB Committee, especially Chi Ming Hung for the new WEB page. Also thanks to Pam Burris and Dean Schamberger for creating a new “About” page.

New WEB page

Colloquium

Sept. 1: Karin Rabe (Rutgers University) Designer oxides that work

Sept. 15: Jerry Bernholc (NCSU) Computational Nano and Bio Physics: The Era of Applied Quantum Mechanics

Sept. 22: Steve Smith (Stony Brook University) The Photophysics of Vision

Attending colloquium – Physics and Astronomy is a collection of special research areas that are all connected in deep and interesting ways. The weekly colloquium is our opportunity to learn about the richness of physics and expand our horizons. It is our responsibility to join in this central activity of the Department.
‘Pulse Shape Spectroscopy’:
2D UV Fourier Transform Spectroscopy

From Pulse Shaper

Detection

Pump

Pump

Probe

Fourier transform of
Pump-Pump delay (THz)

Probe frequency (THz)

T=50 fs

Timing stability of better than 2 attoseconds!
Working to understand Photostability of DNA
Faculty: Tom Weinacht

Ultracold many-body quantum systems

Atoms (BEC) in state-dependent optical lattice

State-selective quantum phase transition (superfluid/Mott ins.)

Goal: simulate “old” and build “new” condensed-matter systems using AMO methods.

Faculty: Dominik Schneble

PhD position available!
**Molecular structure calculations**

Fitted and observed energies, reduced by an average rotational energy, to show the large perturbation effects.

---

**Claire Allred’s Nano-fabrication and Thesis Defense**

Faculty: Hal Metcalf
**X-ray optics & microscopy**

Fluorescence tomography of cyclotella (marine protist):

- **Phosphorous, Sulfur, Silicon**

Phase contrast needed to align low-statistics fluorescence tilt series. de Jonge et al., APS; Holzner et al., Stony Brook

Through-focus lensless x-ray image of yeast at 13 nm resolution (J. Nelson et al.)

**Faculty:** Chris Jacobsen  
**Students:** Jan Steinbrener, Lisseth Gavilan, Xiaojing Huang, Christian Holzner, Rachel Mak, Josh Turner, Johanna Nelson, Robert Towers.

---

**Nuclear and Computational Astrophysics**

Convection in a White Dwarf Preceding a Type Ia Supernovae Explosion  
Convective field shown just 1 second before the ignition of a Type Ia supernovae. Radial velocity surfaces (red: outflowing; blue: inflowing) and nuclear energy generation rate (yellow to green) close to the point of ignition. Only the inner (1000 km) are shown. (Zingale)

Neutron Star Mass-Radius Relation Using Finite-Range Thomas-Fermi Model  
Studies of the nuclear equation of state can be used to predict the relationship between a neutron star’s mass and radius. (Lim, Lattimer)

**Faculty:** Alan Calder, Jim Lattimer, Doug Swesty, Mike Zingale  
**Grad students:** Constantinos Constantinou, Aaron Jackson, Bryan Kim, Brendan Krueger, Yeunhwan Lim, Chris Malone  
**Undergraduate students:** Adam Siegel  
1 high school student

Deflagration to Detonation Transition in Type Ia Supernovae  
A model of Type Ia supernovae explosion, following the propagation of a flame front through the star, and forcing the transition to a detonation. Reaction progress variable (color map), deflagration-detonation transition density (green contour), and convective boundary (blue contour) (Jackson, Calder)
High-contrast imaging group

Faculty: Metchev, Koda, Simon, Sivaramakrishnan, 2 postdocs (starting Fall 2009) Seeking graduate students ~$1M in NASA + NSF grants

Imaging Extrasolar Planets

HR8799 b,c,d: the only imaged multi-planet system high-contrast imaging over 2007–2009
Stan Metchev et al. (2009), Marois et al. (2008)
newest data (<2 weeks old) show:
- 3-year orbital motion
- nearly face-on orbits
- periods of 100–470 years

Galactic collisions: Jin Koda

Orbital Motion of the 3 planets HR8799 b,c,d

Deep optical image of Arp 220. New tidal debris is seen as the southern extension—doubling the size of the object from previously-known.

Condensed matter theory

Using quantum mechanics to study the physical chemistry of water/solid interfaces. A main aim is to understand how to use sun light to split water into H₂ and O₂.

Faculty: Phil Allen and Marivi Fernandez-Serra

Water between metallic surfaces: spontaneous polarization!
Faculty: Marivi Fernandez-Serra
Student: Adrien Poissier

II. Oxidation Reaction Pathway

Key Oxidation Steps:
1. CH₃ + H₂ → CH₄ + H₂O
2. CH₃ + OH → CH₂ + H₂O
3. HO₂ + HO₂ → O₃ + H₂O
4. CH₃ + H₂ → CH₄ + H₂

BNL & Stony Brook
Condensed matter theory

Spin-charge dynamics in 1 dimension

**Spin-Calogero model** – 1d particles with charge and spin interacting via $1/r^2$ potential.

Phase space of spin-Calogero


**Faculty:** Sasha Abanov  
**Student:** Manas Kulkarni

---

Superconducting qubits

Studies of mesoscopic qubits and quantum information remain one of the most active areas of condensed-matter physics.

**Faculty:** Dima Averin and Sergey Tolpygo

Pioneering work on the most advanced superconducting qubits was done in this department, in particular in the group of Jim Lukens, who first observed quantum coherence of macroscopically distinct states.

This year, Sergey Tolpygo and Dima Averin received a large grant from IARPA ($7,000,000 / 5 years) for the development of advanced fabrication technology for superconducting qubits with long coherence times.
Hybrid CMOS / Nanoelectronic Circuits

Faculty: K. Likharev, J. Lukens, V. Patel
Students: N. Simonian, Z. Tan
Collaboration: Prof. A. Mayr (Chemistry)

Basic idea: complement a usual silicon (“CMOS”) circuit with nanowire crossbar:

CMOL features:
- CMOS can address each nanodevice
- enables high circuit performance
  (about 10 to 15 year of the Moore's Law extension)

Main challenge: reproducible crosspoint devices with
- high field endurance
- long retention time
- high ON/OFF ratio

Current research:
(i) metal oxide devices (E):
(ii) integration (E):
(iii) molecular devices (T):

Thin film deposition

Real-time x-ray diffraction and growth experiments at NSLS

If you liked last week's colloquium...this is the experimental side of that field...we make designer oxides that work!
Our lab is now fully operational and we have lots of experiments to do...Grad students: Come and join us!

http://mini.physics.sunysb.edu/~mdawber/
**X-ray diffraction**

NSLS beamline X16C  
**Faculty:** Peter Stephens  
**Students:** Saul Lapidus, Kevin Stone

- $\text{Ag(pyz)}_2(\text{S}_2\text{O}_8)$ (pyz = Pyrazine)  

- $\text{HxK}_{1-x}\text{M}^\text{II}[\text{Ru}_2(\text{CO}_3)_4](\text{H}_2\text{O})_y(\text{MeOH})_z$  
  (M = Mn, Fe, Co, Ni, Mg)  

**Fe}_{1.01}\text{Si}, 8.5K superconductor**  

---

**Condensed matter experiment**

**Faculty:** Xu Du

setting up lab will need students! Dirac fermions in graphene, ballistic graphene devices with suspended layers

**Faculty:** Michael Gurvitch  
(in collaboration with Serge Luryi and Sensors CAT): Investigation of $\text{VO}_2$ films for sensor applications
First observation of spin waves in Co/CoO and CoO nanoparticles

**Faculty:** Meigan Aronson

Co/CoO nanoparticles

D ~ 11nm

CoO nanoparticles

D ~ 50nm

---

**C.N. Yang Institute for Theoretical Physics**

YITP

Currently 12 faculty (2008: Michael Douglas; 2009: Patrick Meade) with research covering a wide range in theoretical physics -- about 15 students working in all areas, arranged as with other faculty and research groups.

-- playing a key role in establishing the new Simons Center for Geometry and Physics, and developing ties to Brookhaven theory groups, including opportunities for student research.

-- bringing visitors and workshops, including annual math/physics summer Simons Workshop and, in 06/10, "Loops and legs" on high order Feynman diagrams (with BNL).
YITP (cont.)

Some recent topics & titles of pubs featuring students
(Almeida, Huang, Pomoni, Sung, Xu . . .):

Collider Physics: "Probing Gauge Content of Heavy Resonances",
"Threshold Resummation for Dihadron Production".
Beyond the Standard Model: "Gaugino Contributions to Soft Leptogenesis".
Fields & Strings: "First Quantized N=4 Yang Mills",
"Large N Field Theory and AdS Tachyons".
Solvable Models & Quantum Information: "Entanglement in Valence-Bond-States".

+ many ongoing projects in "beyond standard model": dark matter & astroparticles; neutrino and QCD phenomenology; field & string theory, solvable models, quantum solitons, quantum information . . .

---

Magnetic Component of Quark-Gluon Plasma is also a Liquid!

Jinfeng Liu and Edward Shuryak
Department of Physics and Astronomy, State University of New York, Stony Brook, NY 11794
(April 1, 2008)

The so-called magnetic scenario recently suggested in [1] emphasizes the role of monopoles in strongly coupled quark-gluon plasma (QGP) near/above the deconfinement temperature, and specifically predicts that they help reduce its viscosity by the so-called "magnetic bottle" effect. Here we present results for monopole-(anti)monopole correlation functions from the same classical molecular dynamics simulations, which are found to be in very good agreement with recent lattice results [2].

We show that the magnetic Coulomb coupling does run in the direction opposite to the electric one, as expected, and it is roughly inverse of the asymptotic freedom formula for the electric one. However, as T decreases to Tc, the magnetic coupling never gets weak, with the plasma parameter always large enough (\* > 1). This nicely agrees with empirical evidence from RHIC experiments, implying that magnetic objects cannot have large mean free path and should also form a good liquid.

Note that at higher T correlation is stronger
⇒ Magnetic coupling runs opposite to asymptotic freedom <= Dirac 1931:
eg = const

---

FIG. 2: (color online) Monopole-antimonopole correlators versus distance: points are lattice data [2], the dashed lines are our fits.
**RHIC and Gauge/Gravity Duality**

**Brownian Quark**

\[ M \frac{dx}{dt} = -\eta x - \xi(t) \]

**Stochastic String Pulling on Quark**

- Our world
- Quark
- Hawking Radiation
- Black Hole

**Faculty:** Derek Teaney, collaborating with Dam Son,
**Students:** Keun Young Kim (PhD 09), Jorge Casalderrey Solana (PhD 06)

**Phases, Billiards and Geometry**

**Phase of the Dirac Operator and Geometry of the Dirac Spectrum**

\[ e^{2i\theta} = \frac{\det(D + \mu U(\phi))}{\det(D^\dagger + \mu U^\dagger(\phi))} \]

\[ = \prod_k \Lambda_k \Lambda_k^* \]

**Physics of QCD at finite baryon density is determined by the properties of this phase.**

**Faculty:** Jac Verbaarschot, collaboration with M.P. Lombarda, K. Splittorff

**Transport properties of chaotic quantum billiards**


Induced Violation of Time-Reversal Invariance in the Regime of Weakly Overlapping Resonances

High Energy Collider Group - DØ Experiment at Fermilab Tevatron

Faculty: Grannis, Hobbs, McCarthy, Rijssenbeek, Schamberger, Tsybychev

**What the world needs is a Higgs boson** - to break the EW force into separate Weak and EM interactions and give masses to all the quarks, leptons and gauge bosons, as in these diagrams.

The unknown Higgs boson mass influences masses of top quark and W boson. Plot shows $M_W$ vs $M_t$. Diagonal lines are constraints for different Higgs boson masses from 114 to 1000 GeV. The biggest uncertainty now comes from the W boson mass. Infer Standard Model Higgs boson $< ~160$ GeV.

Stony Brook played a lead role in measuring $M_W$ by comparing (transverse) mass distribution in **DATA** to **Simulation**. World's best (0.05%) measurement, with 1 fb$^{-1}$.

Next act: looking for grad students to halve uncertainty with 5 fb$^{-1}$.

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**It's fine to constrain the Higgs, but lets go find it!**

Higgs production cross section is small, so need to use every possible decay mode. Stony Brook has added two new channels: $Z(\mu^+\mu^-) H(b\bar{b})$ and $W/Z (q\bar{q}) H(\tau^+\tau^-)$.

Multivariate analysis (boosted decision trees) to give good separation of Higgs signals and backgrounds. Set limit on ratio of signal cross section to that expected in SM. Combine our results with all other channels to get Tevatron exclusion.

Tevatron now excludes $160 < M_H < 170$ GeV. Indirect constraints favor $M_H$ just above LEP exclusion region $M_H<114$ GeV. Tevatron is now within factor 2 at low mass and should exclude any Higgs $M_H<200$ GeV (if not there!). Low mass Higgs will be tough for LHC. **Great thesis opportunities!**
HEP, Atlas at CERN

Exploring unseen territory
find the Higgs, SUSY?,
or best of all, maybe something
truly novel...

LHC, pp collider, \( E_{CM} = 7 \text{ TeV} - 14 \text{ TeV} \)
the largest fractional increase over
previous machine since early 70’s

First collisions and physics
running scheduled for Dec/Jan

But we’re already analyzing real
data (Atlas is ready…)

Work done by our graduate student
Regina Caputo & collaborators

HEP, Atlas at CERN

Also working on many other aspects:
calorimeter calibration, pixel detector commissioning,
underground tracker design, construction,
new particle searches, standard model bkgs.

Not shown: Carolina de Luca,
John Stupak, David Puldon, Burton deWild
Nucleon decay and Neutrino (NN) Group
(Super-Kamiokande, and T2K)

Faculty: C.K. Jung, C. McGrew, P. Paul, (W. Toki), C. Yanagisawa
Postdocs: I. Taylor, J. Imber
Grads: D. Beznosko, P.-T. Le, G. Lopez, K. Gilje, J. Hignight

T2K Long Baseline Neutrino Oscillation Experiment
• First long baseline neutrino oscillation experiment approved to measure $\theta_{13}$
• Stony Brook led US proposal to DOE fully approved for $4.7M$ in May 2007.
• Major construction work (POD detector) at Stony Brook in 2008 - 2009.
• 1st proton beam delivered on target (4/23/09); Data taking to start in Dec. 2009.

Stony Brook Leadership Roles in T2K (~400 collaborators)
• Jung: Elected Member, T2K Executive Committee; U.S. Spokesperson
• McGrew: Convener, ND280 POD detector group

On budget, on schedule completion of POD (pi-zero) detector construction at SBU, shipment to Japan and cosmic data run (~20 member crew including 5 graduates & 5 undergrads (traveled to Japan))
Quark gluon plasma is liquid!  How does it work?

Plasma opaque to light and heavy charm quarks
Strongly coupled: neighbors "talk" to each other
To learn: Do $b$ quarks stop too? How does it radiate?

Heavy quarks & light quarks

Upgrade:
Si strip/pixel vertex detector to tag $e^\pm$ from $B$ decays (2011)

What's this?
Next run (2010): Novel HBD (hadron blind Cerenkov detector) to reject $e^\pm$ background
Stony Brook group

- Discovered the low mass dilepton “bump”
- Big role in design & construction of hadron blind detector
  Reconditioning the HBD in the basement
  Even as we speak...

- Led discovery of jet suppression
  Collaborating on construction and data analysis
  preparations for silicon VTX detector

- We are anxious to find out the answers!
  Excellent thesis topics to be had...

The RHIC Spin Group

How do quarks, anti-quarks and the glue contribute to form a spin-1/2 proton?

Faculty: Abhay Deshpande

\[ \frac{1}{2} = \frac{1}{2} \Delta \Sigma + \Delta G + L_{Q,G} \]

Present Focus: Gluon’s Contribution

Future Physics Program: Opportunities for Graduate students
- Precision & Shape of DG(x) beyond 0.2 +/- 0.2
- Si VTX tracker upgrade being constructed now
- Investigation of anti-quark polarization via W^+/−
Electron Ion Collider
Role of glue in nucleons & nuclei and the study of orbital angular momenta of quarks & gluons (only BNL's proposal shown, other at Jefferson Lab)

Faculty: Abhay Deshpande
Detector & Physics simulations with Stony Brook's Undergraduate Students & BNL-EIC Task Force
  – Anders Kirleis, William Foreman, Michael Savastio (Summer 09)

Solenoid (4T)
Dipole ~3Tm

– New Students: Peter Schnatz, Huazhang Guo

Exciting opportunities in the group for UG research!

THE END