December 2004
Volume 3, No. 1

American Physical Society New York State Section

Physics Newsletter

Zohreh Parsa, Editor-in-Chief

Editor's Foreword

Greetings from the editor: Our December 2004 Newsletter is now available. We hope you enjoy this issue, and look forward to your comments and contributions to the future issues. Our purpose is to provide information and communicate physics related events and current New York State (NYS) affairs that would be particularly interesting to local (regional) members.

This issue contains: several letters (Council, and from the Chair); the section 'For Students and Teacher' contains: outreach program, 2004 outreach awards and Poster awards. Followed by the sections on Physics Nobel Prize Winners and NYS Prize Winners.

The section on "Physics Highlights and News in NYS" includes: Neutrinos Deep Underground; Dark Energy and Cosmic Expansion; Nano Technology section contains: Self Assembly at IBM, and QCD on a Chip; and The Physics of Hot Air Ballooning. APS New York State Section Future (2005) and Recent (2004) Symposia information and photos from 2004 symposia, and the Executive Committee membership listing, are also provided.

The photo on this page (right column, front row), shows some of the Executive Committee members at the Fall 2004 meeting: first from left is James (Jim) Owens the new Chair (2005), 2nd from left, the outgoing Chair E. Galvez, 3rd from the left, Zohreh Parsa, etc. We congratulate the committee members for completing their term (2001-2005) and for their contributions.

In the "NYS Prize Winners" section, we list some information regarding the physics prize winners. Our congratulations to: David J. Gross, H. David Politzer, and Frank Wilczek, on winning the 2004 Nobel Prize.

Physics Topics and News included here illustrate the types of information you can send to us to be included in the upcoming issues of the APSNYSS newsletter.

Please send any comments, suggestions, physics highlights, news, and information you consider important and newsworthy. [Newsletter is also available at www.nysaps.bnl.gov]

Dr. Zohreh Parsa
Physics Department, 510A
Brookhaven National Laboratory
P. O. Box 5000, Upton, NY 11973-5000

Council?

If you ever wondered what the American Physical Society does for you, read on. Perhaps you already know that APS has a Council where the business of the Society is conducted. There are seven officers and 32 councillors, of which eight are also members of the Executive Board; continued, on page 6

From the Chair

Dear NYSS-APS Members,

Welcome to our 2004 Newsletter. Since our last newsletter we have had two meetings. Our Spring meeting was at Buffalo State College. The topic of the meeting was Physics Education. It was a healthy change in our symposia topics, which are normally about physical phenomena, to one about how to teach physics. We are all physics teachers in one capacity or another. For the fall meeting we went to the other end of the state to Brooklyn. At New York City College of Technology we had a symposium on the Physics of the Microworld. We have been trying to host a meeting in the New York City area for a long time, so we were very pleased to finally go there. I would like to thank the local organizing committees of both institutions, and in particular, to the people that "pulled it continued, on page 6

In this issue:

For Students and Teachers

Outreach Program

In the 2004-2005 academic year the NYSSAPS and the NYSSAAPT will join together to offer an expanded outreach grants program. The purpose of this program is to support projects that increase public understanding and appreciation of physics particularly for K-12 students. There will be two award cycles, one in the fall of 2004 and one in the spring of 2005. The outreach committee will support projects up to a maximum of $2,000, with some additional funds available for personal expenses. The application and the guidelines are available on the NYSSAPS website http://www.aps.org/units/nyss/.

Outreach Grants
2004 – Fall Awards

- Janie Schwab, Dudley Observatory, New Paltz, Educational materials needed to expand the Rising Star Internship program, $2,000.
- Lesia Thaisz, Gloversville High School, Teaching materials to introduce students to physics concepts and the applications of these concepts in their daily lives, $800.
- Deborah F. Lynn, Ithaca High School, Ithaca Student Projects for AP Physics program, $840.

Poster Awards
2004 – Fall Awards

1st Place Graduate Award:

- Mayumi Noto, Polytech University, Optical Micro Cavity as a Protein Molecular weight Sensor
- Madgalena Djordjevic, Columbia University, Heavy QUARKS at RHIC and LHC

1st Place Undergraduate Award:

- Fatima Mahmood, Union College, Neutral Meson Analysis of Photo Production from the Proton

2nd Place Undergraduate Award:

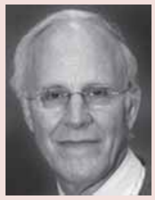
- Alex Zaharakis, Hofstra University, Temporal Pattern of Ectopic Activity in a Simple Cardiac Cell Model of the Heart
- S. Luo, Sarah Lawrence College, Comparison of Mean Nan Particle Size Determination Methods

3rd Place Undergraduate Award:

- Kevin Faehndrich, Ithaca College, Cesium Magnetometer Surveys at a 1000-Year-Old Pithouse Village in Southwest New Mexico
- Greg Shear, Ithaca College, Reduction of Parallax Error in Cesium Magnetometer Surveys Using Laser Alignment
- Andrew Benedict, Rowan University, Computer Controlled Timing for Ultra cold Plasma Experiments

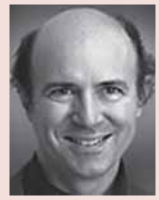
Editors Note: Information for the Above Outreach and Award and Poster Winners were provided by S. Nunes, J. Owens, E. Galvez, Larry Josbino.

2004 Nobel Prize Winners



David J. Gross
Kavli Institute for Theoretical Physics, University of California, Santa Barbara, USA

H. David Politzer
California Institute of Technology (Caltech), Pasadena, USA



Frank Wilczek
Massachusetts Institute of Technology (MIT), Cambridge, USA

The 2004 Nobel Prize "… for the understanding of how the theory of one of Nature's fundamental forces works, the force that ties together the smallest pieces of matter–the quarks" the winners are David Gross, David Politzer and Frank Wilczek.

NYS Prize Winners

2004 W.K.H. Panofsky Prize

Arie Bodek, University of Rochester

"For his broad, sustained, and insightful contributions to elucidating the structure of the nucleon, using a wide variety of probes, tools and methods at many laboratories."

2005 Oliver E. Buckley Prize

Myriam Sarachik, City College of New York

"For fundamental contributions to experimental studies of quantum spin dynamics and spin coherence in condensed matter systems."

2005 J. J. Sakurai Prize

Susumu Okubo, University of Rochester

"For groundbreaking investigations into the pattern of hadronic masses and decay rates, which provided essential clues into the development of the quark model, and for demonstrating that CP violation permits partial decay rate asymmetries."

2004 Dissertation in Nuclear Physics Award

Andrew W. Steiner

"For his in-depth studies of the phase structure of dense matter containing quarks, neutrino-quark interactions, superconductivity in quark matter, and in particular for the delineation of the neutrino signals which are likely to reveal the structural components of dense matter."

Announcement:

Graduate Teaching Assistantships for the spring semester available at SUNY Albany, NY 12222. Those interested contact Carolyn McDonald, (send e-mail to): c.macdonald@albany.edu.

Neutrinos Deep Underground

The discovery of neutrino mass, mixing and oscillations has stimulated new ideas for studying those properties. One idea envisions sending a very intense neutrino beam (Superbeam) from Brookhaven National Laboratory on Long Island, New York through the earth to a very large underground detector located far away. That detector would be the centerpiece of a multipurpose Deep Underground National Laboratory with capabilities to search for proton decay, supernova neutrinos, etc. By measuring muon neutrino disappearance as well as electron neutrino appearance, such a project would be capable of determining all 3 generation mixing angles along with the magnitude of CP violation, providing a major advance in neutrino science.

Some possible sites where the Deep Underground lab might be located are illustrated in Fig. 1, along with the corresponding neutrino beam trajectory. Either Brookhaven or Fermilab (or both) could provide the neutrino source. The key to this approach is a very long distance for the oscillations to develop and interfere.

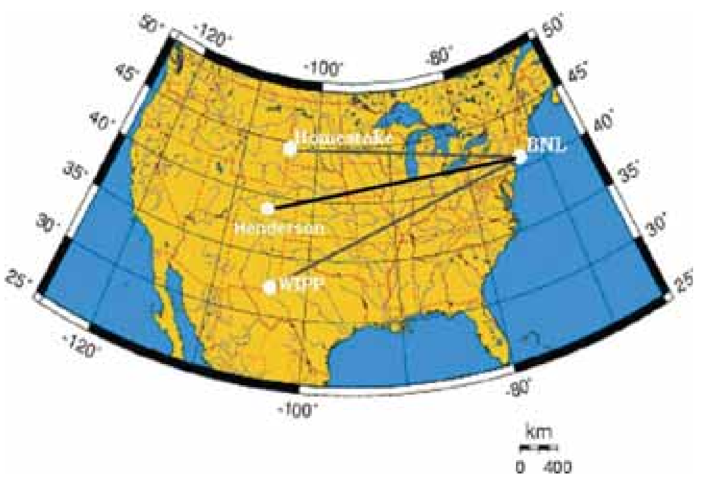


Fig. 1: *Possible extra long neutrino baselines from BNL to Lead (Homestake) SD (❑ 2540 Km), to Carlsbad (WIPP) NM (❑ 2900 km), and to the Henderson Mine in Colorado (❑ 2700 km).*

The super-beam and very large detector approach to neutrino oscillations was endorsed last year by Ray Orbach of the DOE as part of its 20-year research plan. More recently, the APS Neutrino Study Report ranked such an effort as one of its highest priorities and called for a rapid decision to begin this program.

A preliminary report (The Neutrino Matrix) of the APS multidivisional "Neutrino Study" included as high priority recommendations: "**a phased program of sensitive searches for neutrinoless nuclear double beta decay.**"; and "**a comprehensive U.S. Program to complete our understanding of neutrino mixing, to determine the–character of the neutrino mass spectrum and to search for CP violation among neutrinos.** *This comprehensive program would have several components: an experiment built a few kilometers from a nuclear reactor, a beam of accelerator-generated neutrinos aimed towards a detector hundreds of kilometers away, and, in the future a neutrino 'superbeam' program utilizing a megawatt-class proton accelerator. The interplay of the components makes possible a decisive separation of neutrino physics features that would otherwise be commingled and ambiguous. This program is also valuable for the tools it will provide to the larger community. For example, the proton accelerator makes possible a wide range of research beyond neutrino physics… ."* (The final report is now posted on the APS website.)

Fig. 2: *Pictured in their official underground attire during a recent visit to the Henderson Mine are from left to right: Chang Kee Jung (UNO detector Spokesman), Bill Marciano, Bob Palmer, Bob Wilson, Zohreh Parsa, Stan Wojicki, Brett and Yoko Viren.*

Detectors for the very long baseline experiment: Several candidate sites for a deep underground national laboratory are being considered by the National Science Foundation. Among those are the Homestake Gold Mine in Lead, South Dakota, known to physicists for the Ray Davis Nobel Prize winning

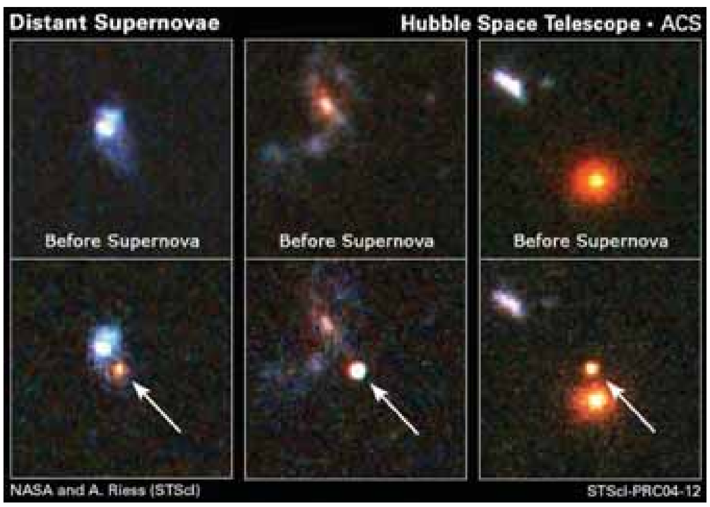
Fig. 3: *Pictured in the mine, clockwise from left to right: Zohreh Parsa, Bob Wilson and William Marciano (a mine staff also shown in the background).*

Solar neutrino experiment. The distance from Brookhaven National Lab to the Homestake mine is 2540 kilometers, that long distance would provide an opportunity for a long-baseline neutrino oscillation experiments from BNL. Another interesting site is the Henderson Mine in Colorado, etc. (*see Figs. 1-3*).

–Dr. Zohreh Parsa, Brookhaven National Lab
http://www.neutrino.bnl.gov

Dark Energy and Cosmic Energy Expansion

For 300 years the defining feature of gravity has been its attractive nature, epitomized by the apple falling on Isaac Newton's head. Cosmologists expected it to be retarding the expansion of the Universe, until observations of distant supernovae proved otherwise. In 1998 the repulsive side of gravity was revealed with the unexpected discovery that the expansion of the Universe is actually speeding up, not slowing down as one would expect due to the attractive force of gravity. The root cause is not well understand but is most commonly attributed to a non-trivial cosmological constant (or more generally a diffuse dark energy with negative pressure) which dominates the present mass-energy budget of the Universe.



Hubble Spots Distant Supernovae in Search of Properties of Dark Energy

The question then arises: Has the Universe always been speeding up, or this a recent phenomenon? The answer has profound implications: without an earlier epoch of matter-dominated, decelerating expansion, we would be at a loss to explain the existence of our galaxy, other galaxies and all the structure observed in the Universe today. The formation of these cosmic structures involves the attractive action of gravity overcoming the expansion of the Universe which is moving matter apart. Evidence for the expected early slowing phase would help confirm the new cosmological paradigm and would be an important first step in understanding the underlying cause of the present period of cosmic acceleration.

To search for earlier cosmic deceleration we employed the same technique used in 1998 to detect the acceleration: sample past epochs of the past expansion using supernovae (exploding stars) as tracer particles. The challenge was to find even more distant supernovae than ever before to probe further in the past. This became possible in 2002 when the Hubble Space Telescope (HST) was outfitted with the Advanced Camera for Surveys, converting HST into a supernova hunting machine. In the first year of this project we found six of the seven most distant supernovae, well beyond the anticipated "coasting" point. These supernovae confirm past cosmic deceleration and the reality of recent cosmic acceleration by disfavoring alternative explanations. According to the data it appears that the mathematical transition or "coasting point" occurred approximately five billion years ago.

Now that this experiment and other independent cosmological tests have confirmed the reality of dark energy, the bigger question looms. What is it? Nothing short of understanding our cosmic destiny is at stake as the ultimate fate of the Universe will be dictated by the nature of the dark energy. More observations of distant supernovae and great ideas will be required to find the answers.

–Dr. Adam Riess, STScI

Nano Technology

Self-assembly Work at IBM Research

In the world of semiconductors, it's all about making smaller, faster, and less expensive chips. The industry is quickly reaching limitations to how much we can shrink devices using conventional methods. The wavelength of light is one of those physical limitations that could one day stop the march of Moore's Law. In addition, the rising costs of lithography–especially for photomasks–is making it increasingly expensive to create circuit patterns. For example, a set of masks for a complex chip design is approaching $100 million. These issues are forcing the industry to consider new ways for manufacturing smaller and more powerful devices. Self assembly offers an exciting prospect using nanotechnology for achieving such continued performance improvements.

Last year IBM researchers demonstrated the use of a molecular self-assembly technique in fabricating microelectronic devices. The self-assembly technique relies on the tendency of certain types of molecules to organize themselves into regular nanometer-scale patterns. The breakthrough at IBM was to utilize these patterns in combination with state-of-the-art semiconductor processing techniques to fabricate electronic devices. The molecular patterns were used to form critical device features that are smaller, denser, more precise, and more uniform than can be achieved using conventional patterning methods. In particular, IBM researchers demonstrated the use of self-assembly to create a nonvolatile FLASH memory device. The demonstration was enabled by the integration of self-assembling materials with the standard tool set used in semiconductor manufacturing. IBM has shown that the polymer material can be used as a template for building critical device structures that would be exceedingly difficult to create with today's lithography equipment. The fundamentals of the molecular self-assembly techniques were first studied in a collaboration between researchers at IBM and the University of Massachusetts -Amherst. The technique involves polymer materials that self organize into honeycomb patterns with evenly spaced regions, with typical dimensions of 20 nanometers.

The industry is starting to recognize self assembly as a viable contender for overcoming many roadblocks associated with chip miniaturization. In fact, IBM researchers Chuck Black and Kathryn Guarini recently received the 2004 World Technology Award for their work on applications of self assembly to microelectronics. These awards are presented each year to the outstanding innovators in the IT industry. Previous winners of this award include Linus Torvalds, Gordon Moore and Tim Berners-Lee.

Further evidence that self-assembly is a viable solution:

Since last year's announcement, IBM researchers have continued to demonstrate the utility of self assembly in improving microelectronic devices, identifying other key implementations of the technique in integrated circuit (IC) fabrication. One such device is called an onchip decoupling capacitor, or decap, which helps stabilize the chip power supply and is thus ubiquitous in all high-performance ICs. By incorporating the self assembly process into an otherwise conventional device fabrication, researchers has created decaps with a novel structure that gives a much higher capacitance and therefore saves valuable chip real estate.

Going one step further, IBM researchers have recently made improvements to the molecular self assembly process which allows them to control and align the position of structures only 20 nanometers in dimension. Pattern alignment is a critical aspect of IC fabrication, and so this development represents a major enabler for self assembly to assume an even broader role in microchip fabrication.

–Dr. James B Hannon, by Matt Berry Watson/IBM

Editor's Note: The above article was edited for this newsletter.

QCD on a Chip

QCDOC (QCD On a Chip) is a highly parallel super computer developed specifically for the first principles numerical calculations in lattice QCD. It is based on state-of-the-art "system on a chip" technology and can provide computing performance in the range of tens of TFlops (10^{12} floating point operations per second) at a construction cost of about \$1 per MFlops (10^5 floating point operations per second) and power consumption of about 5 milli watts MFlops.

QCD, the Quantum Chromodynamics, is the fundamental theory of strong interaction. It describes this complicated interaction in terms of quarks and gluons. As the forces among them grow with their relative distance, a non-perturbative method of calculation is required to disentangle it. Lattice QCD is the only known non-perturbative definition of the theory, and supercomputers have been used for first-principles calculations of it for the past 30 years.

A collaboration of RIKEN-BNL Research Center (RBRC) and Columbia University six years ago completed a supercomputer called QCDSP (QCD on DSP or Digital Signal Processors), and pioneered the use of five-dimensional lattice technology called domain wall fermions (DWF) method in the field. This method revolutionized the field by enabling reliable first principles calculations of hadron electroweak transition matrix elements for the first time ever.

Following this success, the development of the QCDOC computer started in the year 2000 as a collaboration of RBRC, Columbia and IBM Research. The most important task was the design of an ASCI (Application Specific Integrated Circuit). A QCDOC ASIC is a stand alone computer built on a single chip of 13mm x 13mm. Each is capable of 1GFlops calculation, and 6-dimensional nearest neighbor communication with its peers. IBM Research provided the system-on-achip technology, and theoretical physicists from RBRC and Columbia provided design of components vital for the 6D fast serial communication well in balance with the GFLops. Soon the British UKQCD collaboration joined the effort, and helped mainly software developments.

In the spring of 2003 the ASIC design was finalized, and IBM provided first prototype ASIC by that summer. They are successfully tested and verified. By early 2004 all the peripheral component designs were complete, and prototype configurations with 512 and 1024 ASICs have been successfully tested. Subsequently orders were made to build two 10-TFlops computers, one for RBRC and another for UKQCD. These are being assembled as of now, and are expected to be operational at BNL and in Edinburgh by the end of the year. In addition, there will be another 10-TFlops QCDOC computer supported by DOE at BNL by the spring of 2005.

–Dr. Shigemi Ohta, Riken-BNL Center
shigemi.ohta@kek.jp

The Physics of Hot Air Ballooning

The physics of hot-air ballooning seems to interest students of all ages. The history of ballooning may even be more fascinating. After all, man's first successful flight was made in a balloon about 200 years ago, and the assumptions about the process were not always based on sound physical principles! For interested readers I would recommend the Time-Life book *The Aeronauts*, D.D. Jackson, 1981.

The Physics of Ballooning: The lift is based on the fact that warm air is lighter than cold air of the same volume. To calculate the lift involves a nice application of Archimedes' principle and the ideal gas law. Take as an example a typical balloon,

Pictures show after and about to lift hot air balloons with Prof. Josbeno, and his students.

classified as AA-6 by the Federation Aeronautique International, and use the following data: V = 1590 m3, volume, P_0 = 1.29 kg/m3, density of air at STP, g=9.81 N/kg, gravitational field strength, T_0 = 273K, standard temperature, T_a, ambient air temperature (Kelvin).

We recognize that with such a large volume (V = 1590 m3) of air, relatively small changes in temperature lead to large changes in lift (F). There exists a simple approximation called Langford's rule, which says: $\frac{dF}{dT_a} = -VgP_0T_0\frac{1}{T_a^2}$. Substituting actual numbers gives: $\frac{dF}{dT_a} = -70$ N/K (for T_a=280K)

This means that a fall in outside temperature of about 10°C makes it possible to take one more passenger. We see that as T_a becomes very large, F approaches a limit asymptotically. Students may wonder how this can be. A simple explanation could be to say that at very high temperatures the density is so low that the balloon essentially becomes "empty," and there is nothing more to gain.

An Aeronaut use charts based on these equations to determine the amount of lift necessary. After setting up the equations and determining the lift necessary to put four people into the air, my students set up and launch the balloon. In the early years we would draw three names from the class, and the students, (if willing), would get a ride. These days we tether the balloon (using my SUV as an anchor), and they all (if they choose to) get rides.

This is a fun exercise allowing the student to see the equations, graph of the equations (in chart form) and the physical representation of the equation and graphs at the same time.

–Lawrence Josbeno
Professor of Physics, Corning Community College

Acknowledgements

Thanks to authors, contributors of information, and photos for the newsletter. We appreciate the efforts of all the symposia organizers, participants, and members of our Executive Committee for their input, and colleagues for providing photos taken during our visit to the Henderson Mine. Thanks also to the APS staff for processing and distributing about 4,000 copies of the newsletter in New York State (and surrounding states). Articles in this issue are opinions of the authors and are not an endorsement of APSNYSS or the editor.

–Zohreh Parsa, Editor-in-Chief

Council? continued, from page 1

there are also non-voting members, including the representatives of the Canadian and of the Canadian and Mexican Physical Societies and staff members. Divisions, Forums, and Topical Groups have representatives. State Sections have two voting representatives serving for four years in a sequence staggered by two years. There are eight sections (from the oldest to the newest: New England, Southeast, New York, Ohio, Texas, Four Corners, Northwest, and California). New York has a voting representative for calendar years 2003-2006. The Council meets two times a year, while the Executive Board more often than that. What do we do in these Council meetings? As the voting representative of the New York Section, I have been to two of these meetings–the third is just coming up in late November, therefore I still have a partial view of what we do and how we do it. For example, to give a brief overview, besides presentations on the financial status of the Society or on other technical issues (publications, meetings, etc.), we also hear reports on issues that change from year to year. For example, next year is the World Year of Physics; it is not an APS program, but APS helps coordinating activities based in the US. The status and health of our profession (from federal support for research to attracting K-12 students to physics courses) is of course of particular interest to APS. Another item that has been high on the agenda lately is the problem that many foreign students and visitors are experiencing in obtaining visas to enter the country; APS is working with other scientific organizations to bring these issues to the attention of high level government officials. And finally, the Society is working on a long-range planning, with the goal of seeing what the opportunities and challenges are for a Society to be as effective as possible in a 5 to 10 year span.

There are so many other things that APS does that it will require too much space here (see the minutes of the Council meetings on the website, under "governance"); suffice to say that I have came away from attending these meetings with an appreciation of the extent of the work done by the Society in matters that relate to physics.

–Gianfranco Vidali

From the Chair continued, from page 1

off": Dan MacIsaac and Mike DeMarco from Buffalo State College, and Roman Kezerashvili from City Tech.

I am happy to announce our upcoming events: elections of officers taking place in early Spring 2005, our Spring 2005 symposium at Rochester Institute of Technology on "Soft-Matter Physics," and our Fall 2005 symposium at Colgate University on "Albert Einstein." Since this is my last newsletter as Chair, I would like to take the opportunity to thank the members of the Executive Committee who are departing next Spring: Steve Duclos, from General Electric, Jim Hannon, from IBM, and Bill Kilgore and Zohreh Parsa from Brookhaven National Laboratory. I want to thank Zohreh for her hard work in making this newsletter possible.

Finally, I would like to give a special thanks to our past Chair, Rich Galik, for his many contributions to the section. Get well Rich! Hope to see you at Rochester.

–Kiko Galvez

Meetings Information

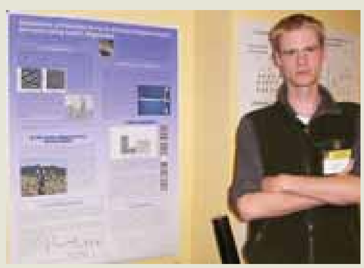
Recent Symposia

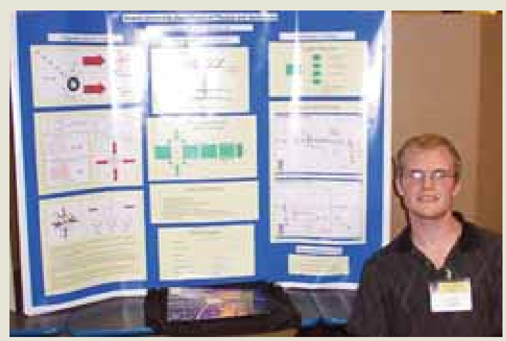
Spring 2004 Symposium:

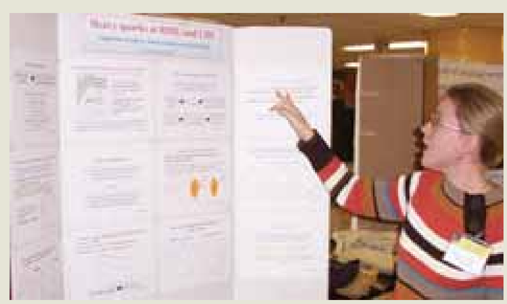
On 16-17 April, 2004, SUNY—Buffalo State College hosted the jointly convened Spring 2003 symposia of the NYSS-APS and NYSS-AAPT in Buffalo, New York. The co-convened symposium was on "What Physics Education Research says to Physicists and Physics Educators." Organizers were Dan MacIsaac, Mike Demarco, David Henry and Dewayne Beery of the SUNY-BSC. One hundred and 30 registrants attended. For list of speakers and further details see http://physicsed.buffalostate.edu/pubs/AAPTmtgs/NYSS/Apr2004NYSSPERconf/. From Mike DeMarko

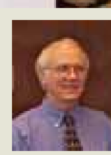
Fall 2004 Symposium:

On October 15-16, the New York State Section of the American Physical Society held a conference on "Physics of the Microworld: From Quarks to Nanostructures." The conference was hosted by the New York City College of Technology of the City University of New York in downtown Brooklyn. The organizers were: Steve Arnold, Saria Bouadana, Roman Kezerashvili, Lufeng Leng, Allan Wolfe. 193 registrants attended. For list of speakers and additional informations see http://www.nysaps2004.citytech.cuny.edu/. From Daria Bouadana









Dr. Parsa and participants of the Fall 04 APS/NYSS Symposium.

Dr. Rich Galik, (first from the left): we wish him well.

Upcoming Symposia 05

Spring 2005 Symposium:
FRONTIERS IN SQUISHY PHYSICS
Rochester Institute of Technology • April 15-16, 2005
G. Thurston, Co-Chair • gmtsps@rit.edu • (585) 475-4549

World Year of PHYSICS 2005

Fall 05 Symposium:
ALBERT EINSTEIN AND HIS LEGACY
Colgate University • E. Galvez, Chair
egalvez@mail.colgate.edu • (315) 228-7205

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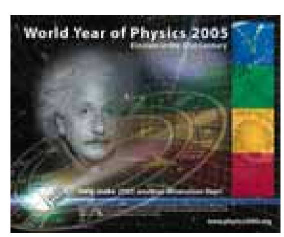

American Physical Society
New York State Section
One Physics Ellipse, College Park, MD 20740-3844
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