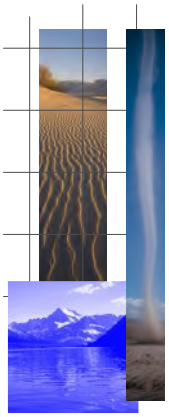


Schrödinger's Tiger

The Clemson University Physics and Astronomy Newsletter

Spring 2011 Volume 5, Issue 2

New Frontiers in Quantum Foundations Clemson University/Perimeter Institute 2011

Conference participants at the Madren Center discuss new frontiers in quantum physics

From March 9th to the 11th, a conference was held at Clemson's Madren Center on the shores of Lake Hartwell, to discuss new frontiers in quantum physics foundations. Led by **Drs. Murray Daw** and **Antony Valentini** of the Physics Department, the meeting was an assembly of all the latest thinkers on this exciting topic. The CUPI 2011 conference was part of the Clemson University/Perimeter Institute (CUPI) partnership that is being set up between Clemson and the Perimeter Institute for Theoretical Physics in Waterloo, Canada. The aim of the partnership is to promote high-quality research in the foundations of quantum mechanics.

In addition to a biannual and joint conference held at Clemson, the partnership allows up to five Clemson students and postdocs per year to visit Perimeter Institute for a month each. Perimeter Institute will provide accommodation and a per diem; Clemson will cover travel. The partnership also requires a shared postdoc position in quantum foundations, with the postdoc spending nine months per year at Clemson and three months per year at Perimeter Institute (with each institution paying the appropriate salary). The postdoc will be of the highest international standards and could teach a course at Clemson. Funding on Clemson's side to support the shared postdoc is under discussion.

The focus of the March conference was to explore the mystery surrounding quantum mechanics that has only increased over time. At stake is our understanding of the whole of fundamental physics, from elementary quantum phenomena, such as nonlocality and contextuality, to the creation of primordial fluctuations in the early universe, as well as information loss in evaporating black holes and the problem of time in quantum gravity. The subject is being attacked from a variety of perspectives. The many recent theoretical developments include: physical axioms for quantum theory, the application of collapse theories and of de Broglie-Bohm theory to cosmology, understanding probability and classicality in the many-worlds interpretation, understanding the structure of possible hidden-variables theories, making collapse theories Lorentz invariant, reconstructing quantum theory from general probabilistic and operational frameworks, new perspectives on black-hole information loss, *(See page 3)*

Dr. Peter Barnes, Chairman,
Physics & Astronomy

A Message from the Department Chair

The 2010-2011 academic year was another successful year for our undergraduates, some of whom will attend the best graduate schools in the country. An example is **Kemper Talley**, who graduates with four first-author refereed papers to his credit, as well as being a Goldwater Fellow and winning a prestigious NSF Fellowship to pursue his Ph.D. in a joint program with the University of Tennessee and Oak Ridge National Laboratory. Our number of graduating seniors averages between 15 and 20 per year, placing Clemson in the Top 50 programs in the country. We compete well with departments that are typically twice our size. Research funding continues to grow, along with the department's reputation, leading to ever improving graduate student credentials applying to our program.

Finally, this will be my last Chair's letter. I am resigning my position as Chair and will retire from Clemson at the end of August. **Dr. Mark D. Leising** is the new Interim Chair, and he will assume his duties in June. I have enjoyed my 10 years as the Physics and Astronomy Chair and am very proud of the accomplishments of the outstanding faculty I have been privileged to lead. I will continue as a Senior Dixon Fellow in the Calhoun Honors College after retirement, working with a group of outstanding young Honors College students.

Best wishes,

Peter A. Barnes, Professor and Chair
Department of Physics and Astronomy
Clemson University, Clemson SC 29654-0978
Voice: (864)656-3416/e-mail: peterb@clemson.edu

Creating a Legacy — Giving to Clemson Physics & Astronomy

You can create a lasting legacy through your donation to the Clemson University Physics and Astronomy Department Foundation. Endowments to Clemson assure the best faculty, the brightest students and the most creative research projects. A substantial endowment can transform a good university into a great one.

As a non-profit organization, the Foundation is exempt from federal income tax under Section 501(c)(3) of the1986 Internal Revenue Code, as amended. The Foundation has been classified by the IRS as a public charity operated for the benefit of a state university as defined in the Internal Revenue Code of 1986 Section 170(b)(1)(A)(iv). Contributions to the University through the Foundation by individuals, corporations, organizations and other foundations qualify as tax deductions.

There are several ways to donate. You may use the enclosed envelope or you may send a check to the Clemson University Foundation, P.O. Box 1889, Clemson, SC 29633. Checks should be made payable to Clemson University Foundation with Physics and Astronomy specified on the memo line.

Alternately, you may visit the Clemson website **http://www.clemson.edu/alumni/giving/ways/index.html** and make a secure electronic donation. Again, please specify that the donation go the Physics & Astronomy Department and indicate to which project you would like to donate. Thank you, as always, for your continued support of the Department. You may contact the Annual Giving Office at (864) 656-5896, should you have any questions regarding your donations. If you have other questions you may contact the Department directly at (864) 656-3416.

Dr. Barnes takes conference participants for a ride in his boat on Lake Keowee.

and progress in solving the problem of time. On the experimental side, we have new fundamental tests, such as the three-slit experiment, tests of contextuality, and remarkable fluid-mechanical analogues of elementary quantum phenomena. Some workers in these sub-categories are not fully aware of the work being done elsewhere. The aim of the conference was to bring together representatives from this wide spectrum. For more information on the Perimeter Institute, please visit:

www.perimeterinstitute.ca

In addition to organizing the CUPI conference, Dr. Valentini was interviewed and filmed for a series for the *Science Channel*, called "Through the Wormhole with Morgan Freeman." The series, narrated by **Morgan Freeman,** asked detailed questions of and sought explanations from Dr. Valentini concerning his views about quantum physics, plus some shots of his driving a boat and throwing a bottle off his dock, to illustrate the physics of pilot-wave theory (the version of quantum theory on which he works). The show will air in August. For information on the series and show times, please visit: **http://science.discovery.com/tv/through-the-wormhole/.**

Antony is the latest addition to the Physics and Astronomy Faculty, and he hopes to develop a top-notch research program in quantum theory studies. He was born in 1965 in Greenwich, England, adjacent to London and home to the British Royal Observatory (which has played a major role in the history of astronomy and navigation) and the Greenwich Prime Meridian. As a boy, he attended school in London, and he later obtained his Bachelor of Arts in Mathematics and Physics from Trinity College at the University of Cambridge in 1986. His undergraduate research on the problem of classical radiation reaction earned him the Rouse Ball Mathematical Prize.

Following college, he did independent research in London, Paris, and Vienna on quantum field theory and the foundations of quantum theory, during which time he solved the long-standing Fermi problem regarding the causality of photon exchange. For his Ph.D., he attended the International School for Advanced Studies in Trieste, Italy, where he studied under the direction of **Dr. Dennis W. Sciama**, obtaining a doctorate in Astrophysics. His research focused on the foundations of quantum theory, with applications to quantum gravity and cosmology, and the re-interpretation and extension of the de Broglie-Bohm pilot-wave formulation of quantum theory.

He followed his doctoral studies with several positions, one of which as a Research Associate at Imperial College, London from 1999 to 2001, during which time he signed contracts with Cambridge University Press for two books, *Pilot-Wave Theory of Physics and Cosmology* and *Quantum Theory at the Crossroads*.

During the last decade he collaborated with Chalmers University in Sweden and visited the Perimeter Institute in Waterloo, Canada on many occasions, eventually holding a position there as a researcher from 2002 to 2006. He subsequently worked at the Centre de Physique Théorique, Luminy in Marseilles, France for a year and later ran the Theoretical Physics Group at Imperial College in London. In January of this year, he accepted a full professorship at Clemson University, South Carolina. We welcome him to the Department and wish him all the best, as he begins his career with Clemson.

Grant Williams Appointed New Director of MMT Observatory

Grant Williams, with the 21-foot diameter MMT Observatory on Mount Hopkins, Arizona in the background. (Photo: Howard Lester, MMTO)

As of January 1, 2011, the MMT Observatory, a joint venture of the University of Arizona and the Harvard-Smithsonian Center for Astrophysics, is under new leadership. **Grant Williams**, who has served as the observatory's associate director since 2007, has been appointed the new director of the MMT. Williams follows **Faith Vilas**, an astronomer at the UA's Steward Observatory, who headed the MMTO for five years.

The MMTO operates a 6.5-meter (21-foot) telescope, the MMT, on the summit of Mt. Hopkins approximately 60 kilometers (37 miles) south of Tucson, Arizona, on the grounds of the Smithsonian's Fred Lawrence Whipple Observatory. "I'm very honored to be given the opportunity to lead such a premier astronomical observatory," Williams said. "As an astronomy student, I was awe-struck by telescopes such as the MMT. Even now, as the incoming director, I get goose bumps whenever I see that enormous primary mirror." Said **Charles Alcock**, director of the Harvard-Smithsonian Center for Astrophysics, "The MMT remains a major instrument in unraveling the mysteries of the universe. I'm confident that Dr. Williams' leadership will ensure the MMT's continued scientific productivity." Williams received a bachelor's degree in physics from the University at Buffalo in 1994 and a doctorate from Clemson University in 2000. He first joined the MMTO in September 2002 when he was awarded the Firestone Postdoctoral Fellowship.

He was hired as an MMT staff scientist in March 2004 and worked as a technical coordinator from 2005 until 2007, when he was appointed associate director. His research focuses on the study of very evolved high-mass stars called Wolf-Rayet stars and the stellar explosions (supernovae and gamma-ray bursts) they produce. "Over the past eight years, I've gained an intimate knowledge of the MMT and have become passionate about its capabilities and scientific potential. I've established an excellent working relationship with the MMT staff, and I plan to use this knowledge and passion to motivate everybody to work toward a common goal of maximizing the efficiency and performance of our observatory," Williams said.

During the past few years, the MMT has been used to study objects in our solar system (asteroids, comets, moons and trans-Neptunian objects), stars and star clusters in our Milky Way galaxy and in nearby galaxies, distant galaxies, galaxy clusters, quasars and exploding stars, such as supernovae and gamma ray bursts. Some of MMT's most recent exciting discoveries include dwarf galaxies lingering in the outskirts of our Milky Way and hypervelocity stars racing out of our galaxy at speeds of more than 1 million miles per hour – so fast that they will never return. Using a new device to quench excessive star light, astronomers at MMTO obtained images of a planet on a much closer orbit around its parent star than any other previously photographed extrasolar planet.

The original Multiple Mirror Telescope combined the light from six 1.8-meter mirrors on a common mount to provide the effective collecting area of a 4.5-m telescope. At the time of its dedication in 1979, the MMT was the third largest optical telescope in the world. In 1998, the observatory began a two-year conversion project during which the 4.5-m telescope was replaced with a new telescope that utilized a single 6.5-meter mirror produced in the Steward Observatory Mirror Lab. The new telescope, dedicated on May 13, 2000, more than doubled the light-gathering power of the original MMT.

(See next page)

The 6.5-meter MMT is currently the third largest in the continental U.S. Until recently, the MMT operated the world's only adaptive secondary mirror. The MMT Adaptive Optics system uses both natural and laser guide stars to correct image distortions caused by the Earth's atmosphere at a rate of 500 times each second.

On any given night, the MMT can be configured to use one of three different secondary mirrors. Its broad set of capabilities allows the telescope to be used to study a variety of astronomical sources. Its proximity to a large metropolitan center such as Tucson makes the MMT an extremely accessible and convenient telescope for both observers and the operations support staff.

"As director, I plan to ensure that the MMT remains a highly competitive scientific research instrument serving the interests of both parent institutions," Williams said. "Although the MMT is already a very reliable highly productive telescope, there is always room for improvement."

(Adapted from Daniel Stolte's January 4, 2011 article for the University of Arizona, found at: http://uanews.org/node/36473)

Grant Williams with Clemson mentor, Dr. Dieter H. Hartmann

Special Section of Physics to be Offered for Majors

Clemson's Department of Physics & Astronomy has launched an innovative approach to introductory physics, based on a landmark textbook. The new textbook is currently being used in a section reserved for physics majors --- also something new for Clemson.

Physics for Realists, by Dr. Anthony Rizzi of the Institute for Advanced Physics, is a radically different textbook that uses the students' common sense to discover and clarify modern physics. The text establishes the foundation of physics, incorporating the most basic, generic principles of nature. The resulting pedagogical approach makes physics more accessible and its beauty more evident. The textbook is being introduced at Clemson by **Dr. Murray Daw**, the R. A. Bowen Professor of Physics.

To explain the approach and to attract physics majors to the section, Dr. Daw asks the students a simple question: *What is momentum?* "Most students --- based on their high school physics course --- will want to say that momentum is mass times velocity," Daw observes. "However, that equation is a relation between measurables, it is NOT what momentum IS." The fact is that everyone --- by virtue of our experiences in the world --- has a common-sense, intuitive understanding of momentum. By making explicit and using the basic principles of nature, *Physics for Realists* shows that, logically, one understands momentum as the cause of locomotion. Other basics such as mass, force, kinetic energy, even special relativity (in the last chapter) are all based on the fundamental principles.

In addition, Clemson has begun the practice of reserving a special section of introductory physics just for its physics majors. "Our freshman class numbers 15 to 25 students every year," **Department Chair Peter Barnes** notes. "We have found that giving the physics majors their own section of introductory physics is a more effective way to prepare them for their advanced physics courses. We have also found that it attracts physics students to Clemson --- they're much happier to be in a smaller class with their physics peers that is focused on preparing them as physicists."

"The approach in *Physics for Realists* would work well for any section, not just one for physics majors," Daw says, "because the emphasis is on understanding --- on digesting the material in terms of basic principles. The textbook is mathematically rigorous, the difference being that the students come to a deeper appreciation of how mathematics arises from our physical experience of the world."

Kemper Talley Receives Prestigious NSF Graduate Research Fellowship

Kemper Talley

Kemper Talley, student of **Dr. Emil Alexov**, has received several awards on the departmental, college, and university level over the past few years, including the Goldwater Fellowship. None of these, however, can be compared with the prestigious fellowship through The National Science Foundation's Graduate Research Fellowship Program (GRFP) that he was recently awarded. The program recognizes and supports outstanding graduate students in NSF-supported science, technology, engineering, and mathematics disciplines, who are pursuing research-based Master's and doctoral degrees at accredited U.S. institutions. The fellowship provides three years of support, with a $30,000 annual stipend, and a $10,500 cost-of-education allowance. It also offers international research and professional development opportunities and access to the TeraGrid Supercomputer.

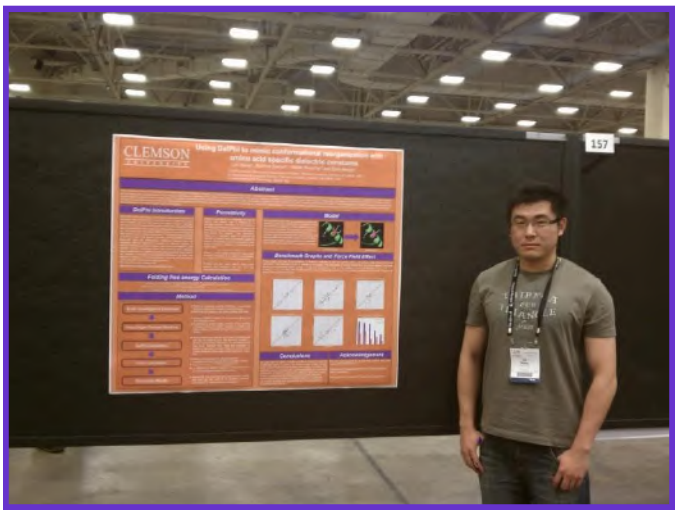
These benefits provide students excellent opportunities to further their career research goals. Kemper joined the Department of Physics and Astronomy in 2007 as an undergraduate and as a researcher at the Computational Biophysics and Bioinformatics Lab. Since then, he has collaborated on five peer-reviewed papers, being the first author on four of them. At the same time, he has managed to keep his GPA at 4.0 and to be involved in many student activities. This combination of hard work and being in the right environment, coupled with his passion for computational biophysics research, has resulted in his tremendous scientific productivity. We all wish Kemper the best, as he builds a very successful scientific career.

Clemson Students Recognized by the Council on Undergraduate Research

From left to right: Matthew Stone, Mercy Lard, and James Turner

The research achievements of three former Clemson physics majors, **Matthew Stone**, **Mercy Lard**, and **James Turner**, were highlighted by the Council on Undergraduate Research (CUR) in January 2011 (http://www.cur.org/highlights/phy.asp). Their recognized achievements account for three of the 128 entries within the discipline of Physics and Astronomy selected by the CUR since 2002. The cited research was conducted in the Ke lab and published in 2010 in the premier journals of *Small Physical Chemistry* (**Stone, Lard**), *Chemical Physics* (**Lard**), and *The Journal of Physical Chemistry C* (**Turner**). CUR is a national organization whose mission is to support and promote high-quality undergraduate scholarship at its affiliated colleges and universities. Matthew is currently pursuing a Ph.D. in Biophysics at the University of Michigan; Mercy is a Ph.D. student in Biophysics and Nanoscience at Lund University in Sweden, and James is conducting his Ph.D. research in Bioengineering at Clemson University.

Strong Presence of Clemson Biophysics Students at 2011 American Physical Society Meeting in Dallas



Lin Wang with his poster at this year's APS meeting in Dallas

The Annual March meeting of the American Physical Society is the largest event for all physicists around the world. This year it was held in the Dallas Convention Center. The Clemson Computational Biophysics and Bioinformatics Laboratory was prepared for the event. Four graduate students, **Zhe Zhang**, **Shawn Witham**, **Lin Wang,** and **Subhra Sarhar** came to the meeting to present their research. These students all work with **Dr. Emil Alexov** at Clemson. Zhe Zhang gave a contributed talk at Session T39 "Computational Molecular Biophysics", and the title of his talk was "In Silico Investigation of Molecular Effects Caused by Missense Mutations in Creatine Transporter Protein." This work was done in collaboration with **Dr. Charles Schwartz** of the Greenwood Genetic Center, located in Greenwood, South Carolina. It was supported by grants from the National Library of Medicine at the National Institutes of Health. The Greenwood Genetic Center is a non-profit institute, organized to provide clinical genetic services and laboratory testing, to develop educational programs and materials, and to conduct research in the field of medical genetics. Serine synthase (SMS) is a key enzyme controlling the concentration of spermidine and spermine in the cell. The importance of SMS is manifested by the fact that single missense mutations were found to cause Snyder-Robinson Syndrome (SRS). At the same time, currently there are no single nucleoside polymorphisms (nsSNPs, harmless mutations) found in SMS, which may imply that the SMS does not tolerate amino acid substitutions, i.e. it is not mutable. To investigate the mutability of the SMS, Mr. Zhang carried out *in silico* analyses of the effects of amino acid substitutions at the missense mutation sites that have been shown to cause SRS. The study revealed that mutability depends on the detail of the structural and functional factors and cannot be predicted based on conservation of wild-type properties alone. Also, nsSNPs can be expected to occur even at sites at which missense mutations were found to cause diseases. His talk was very successful and was well received.

The other two student presentations were on using and developing DelPhi, the very popular software for modeling electrostatic potential and energies in biological objects and nanosystems. They both were supported by a grant from National Institute of General Medical Sciences at National Institutes of Health, and the encouragement of **Dr. Barry Honig**. DelPhi is currently the only algorithm that can assign different dielectric constants to different regions in the modeling system. Biological systems undergo conformational changes, due to their function, interactions or mutations. These conformational changes result in local rearrangement of protein dipoles which can be treated through the local dielectric constant. Dielectric permittivity is a measure of how an electric field affects, and is affected by, a dielectric medium. Permittivity is determined by the ability of a material to polarize in response to the field, and thereby to reduce the total electric field inside the material. Thus, permittivity relates to a material's ability to transmit (or "permit") an electric field. It is directly related to electric susceptibility, which is a measure of how easily a dielectric polarizes, in response to an electric field. The title of Mr. Wang's poster was "Using DelPhi Capabilities to Mimic Conformational Reorganization with amino acid specific dielectric constants." He received many visitors interested in the topic and had a very busy day addressing their questions.

Awards Ceremony Recognizes Department's Super Students

Physics and Astronomy held its annual luncheon to recognize exceptional students within the Department on Saturday, April 2, 2011 in Kinard Hall. The event was attended by student winners, parents and other family members, their advising faculty member(s), as well as **Department Chair, Peter Barnes**. The following students received awards for their outstanding academic record:

L.D. Huff Junior Award
Kevin Cooke

SPS Sigma Pi Sigma Senior Award
Kemper Talley

College Level, Outstanding Senior Award
(to be presented at the College of Engineering and Science ceremony)
Kemper Talley

Graduate Teaching Assistant of the Year
Dhruva Kulkarni

Graduate Research Assistant of the Year
(College-level RA award)
Ramakrishna Podila

Congratulations to all these great students!

Dr. Peter Barnes presents award to Kemper Talley

Ramakrishna Podila and his wife, Pooja Puneet

A Clemson Distinction in Understanding Nanoparticles at Large

Dr. Pu-Chun Ke is the leading author of "A Biophysical Perspective of Understanding Nanoparticles at Large", a comprehensive field review, recently published in the journal of *Physical Chemistry Chemical Physics*. "This article attempts to provide a reflection on the biophysical inner workings that may impact and govern the behaviours of nanoparticles in aqueous phase and in living systems," Dr. Ke stated, dedicating this paper to his students. Established in 2003 at Clemson, the Ke lab is internationally known for its research prominence at the interface of biophysics and nanoscience, as examplified by its first demonstration of RNA delivery with a carbon nanotube transporter (*Nano Lett*, 2004), delineation of cylindrical nanostructure-amphiphile binding (*JACS*, 2006), the first study on the biophysical mechanism of nanotoxicity (*Nano Lett*, 2007), the discovery of carbon generational transfer in plants (*Small*, 2009), and the comparative study on plant and mammalian responses to nanoparticles (*Small*, 2010). In addition to this review, Dr. Ke has authored or coauthored three other review articles since 2007, including a Top Paper in the *Journal of Physics: Condensed Matter*.

Dixon Fellows Explore Science in the High Renaissance

Galileo Galilei

Beginning in the fall of last year, an extra-study, non-credit class was offered to eight Dixon Fellows from the Calhoun Honors College, to explore science in the Middle Ages and the Renaissance. Led by **Dr. Peter Barnes**, a Senior Dixon Fellow, the class focused on the renewal of scientific thought during the Renaissance. Beginning in the 14th century and ending in the 17th century, it was a period that saw the rebirth of art, science and education. Scientists during this time questioned the hegemony of the Catholic Church, which had been the dominant power and keeper of arts and sciences, from the third century on.

The Church's views were earth-centered, and when the "rebels" of the High Renaissance, **Leonardo da Vinci** (1452-1519), his rival **Michelangelo di Lodovico Buonarroti Simoni** (1475-1564), and later **Galileo Gallilei** (1564-1642), presented their opposing views, trouble quickly followed. This was the time of religious persecution called the Inquisition. This class explored this interesting period and these three key players, especially Galileo, who helped shape the future of science. It was offered both in the fall and spring semesters. Students had the opportunity to do stargazing, drifting on Lake Keowee in Professor Barnes's boat to observe meteor showers, and to share companionship and great Italian food.

Astronomers May Have Witnessed a Star Torn Apart by a Black Hole

Artist's Illustration of star and black hole: NASA/CXC/M. Weiss

On March 28, 2011, NASA's Swift satellite caught a flash of high-energy X-rays pouring in from deep space. Swift is designed to do this, and since its launch in 2004 has seen hundreds of such things, usually caused by stars exploding at the ends of their lives.

But this time was hardly "usual". It didn't see a star exploding as a supernova, **it saw a star literally getting torn apart as it fell too close to a black hole!** The event was labeled GRB 110328A –a gamma-ray burst seen in 2011, third month (March) on the 28th day.

Normal gamma-ray bursts are when supermassive stars collapse (or ultra-dense neutron stars merge) to form a black hole. This releases a titanic amount of energy, which can be seen clear across the Universe. And those last two characteristics are certainly true of GRB 110328A; it's nearly *four billion light years away*[*], and the ferocity of its final moments is not to be underestimated: it peaked at a solid **one trillion times the Sun's brightness**!

Although initially cataloged as a GRB, follow-up observations indicated this was no usual event. The way the light grew and faded seemed to fit better with a star getting torn apart. And what can do that to an entire star? A black hole. Instead of the star in question *forming* a black hole, it apparently literally fell victim to one! The observations indicate the black hole in question may have as much as half a million times the mass of the Sun, meaning it's very probably a supermassive black hole in the very center of a distant galaxy. Hubble Space Telescope observations (not yet released to the public) also place the event very near the center of a galaxy, which is consistent with this scenario.

So what happened?

We think that at the center of every large galaxy (including our own Milky Way) lies a supermassive black hole, some with millions or even billions of times the Sun's mass. Some of these, like our own, are sitting there quietly. Without matter falling into them, black holes are pretty calm. But if a gas cloud, say, wanders too close, it forms a disk around the hole called an accretion disk. This disk heats up and can emit tremendous amounts of light (as in this illustration here). Some galaxies are continuously feeding of material like this, and we call them active galaxies. In the case of GRB 110328A, something else happened. The galaxy is known to be quiet; NASA's Fermi satellite can see gamma rays over much of the sky, and has reported no emission from this galaxy for the past couple of years. So whatever happened here was a singular event. What fits all the data is that of a star orbiting the center of the black hole. Perhaps it was on a safe orbit but got flung closer to the black hole after a close encounter with another star or gas cloud, or perhaps it started out close and over millions of years its orbit has brought it closer and closer to that monster at the galaxy's heart. Whatever happened, the star's life ended suddenly and catastrophically. Black holes have incredibly strong gravity, of course,

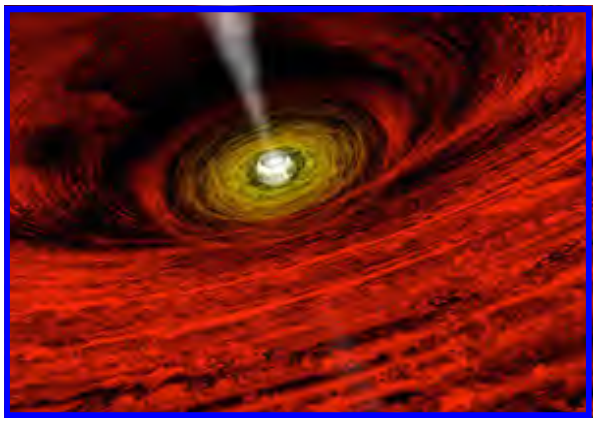


Illustration of accretion disk: A. Hobart, CXC (www.discovermagazine.com)

but that gravity gets weaker with distance. Stars are big, a million or more kilometers across, and that means one side of the star was substantially closer to the black hole than the other, so the near side felt a stronger pull of gravity than the far side of the star. This has the effect of stretching the star in a process called tides. A star is held together by its own gravity. As the star in question here inched closer to the black hole, the force stretching the star got stronger, and at some point overcame its internal gravity. *The star got literally torn apart by the black hole!* The material swirled around the black hole, forming a small and temporary accretion disk. Observations indicate that for a short time, two beams of matter and energy called jets erupted from the black hole, and it was the flash of tremendous energy from this that triggered Swift, and a flurry of observations from other telescopes cascaded from that. It's not certain that this is actually what happened so far away in the core of that far-flung galaxy, but it does fit what's seen so far (and at least one other star has been seen to have been eaten by a black hole before). It also predicts that radio emission from the event will be highly variable, and that the visible brightness should brighten again over the spring. Astronomers are eagerly observing this distant event to see if their ideas will still hold true as time goes on, or if more surprises are in store.

Astronomer **Bill Keel** used a SARA 1-m telescope at Kitt Peak, Arizona to capture an image of the burst on April 1 and April 4. **Adria Updike**, a former graduate student of **Dr. Dieter H. Hartmann** and who currently works at Goddard Space Flight Center in Greenbelt, Maryland, helped to calibrate the data. SARA is the Southeastern Association for Research in Astronomy and represents a collaboration of Clemson University, the Florida Institute of Technology, East Tennessee State University, Florida International University, Valdosta State University, Ball State University, Agnes Scott College, The University of Alabama, Valparaiso State University, and Butler University. This consortium operates two telescopes: the 0.9-m SARA-North at Kitt Peak in Arizona, and the 0.6-m SARA-South at Cerro Tololo in Chile, allowing students of astronomy and consortium members remote viewing opportunities. Dr. Hartmann, while not a member of the Swift group, is funded through the Guest Investigator Program, and he serves as the Principal Investigator on the presentation of the telescope mission to the Senior NASA Review Panel. He will be hosting a Swift conference in Clemson in October of this year.

(Adapted from http://blogs.discovermagazine.com/badastronomy/2011/04/05/astronomers-may-have-itnessed-a-star-torn-apart-by-a-black-hole/)

Spring International Party

On Friday April 29th, the office staff threw a party to recognize and celebrate the diversity in the department, and to enjoy good food and drink. Students and faculty were encouraged to come in their native dress and to bring a dish of their country of origin. There was a great turnout, and everyone had a good time on the quad in front of Kinard. We hope to have more such fun events in the future.

Top: Several Indian students donned saris at the party. Bottom: Office staffers, Risé Sheriff (left) and Amanda Crumpton (in her native costume)

Share Your Story with Us

Gotten married? Added a new member to the family? Landed your dream job? If so, we'd love to share your good news in future issues. Visit **physics.clemson.edu** for contact information, or use the form below. Mail your completed form to: **Department of Physics & Astronomy, Clemson University, 118 Kinard Laboratory, P.O. Box 340978, Clemson, South Carolina 29634-0978.**

NAME: _____

CLASS: _____

E-MAIL ADDRESS OR PHONE NUMBER: _____

YOUR GOOD NEWS:

_____

The Clemson University Physics and Astronomy Newsletter

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Department News

*The Department wishes good health and a speedy recovery to **Dr. Dick Manson**.*

*We are currently seeking the donation of a used van, not older than three years of age, to replace our existing vehicle. The van will be used to transport students to events and to provide a means of travel to nearby conferences. If you are interested, please contact **Risé Sheriff** at 656-3419. Your donation will be tax deductible.*

*Congratulations to **Ramakrishna Podila** and **Pooja Puneet** on their recent marriage! Both are physics graduate students. Ramakrishna is the graduate student of **Dr. Aparao Rao**, and Pooja is the graduate student of **Dr. Terry Tritt**. The Department wishes them all the best.*

If you have any suggestions for the newsletter, or any other constructive input on its format, please email your thoughts to: rvogt@clemson.edu. To subscribe or unsubscribe to *Schrödinger's Tiger*, please go to our mail list at: **http://www.ces.clemson.edu/mailman/listinfo/panda-newsletter.**