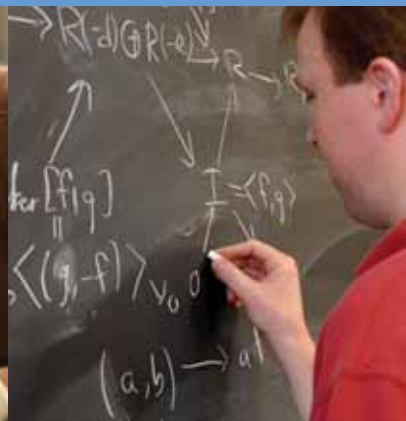


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Renaissance

JORDAN HALL OF SCIENCE • THE GLOBAL HEALTH CRISIS



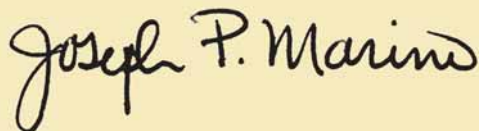
LETTER FROM THE DEAN

September 14, 2006, was a day of memorable events, beginning with the second annual Notre Dame Forum, The Global Health Crisis: Forging Solutions, Effecting Change, and ending with the activities and ceremonies surrounding the dedication of our new Jordan Hall of Science. Many of us who attended both events were keenly aware of the connection between addressing the most pressing needs of mankind—that of easing hunger, poverty, and disease worldwide—and providing undergraduates with the finest science learning environment in the country in the hope that they will one day be part of the solutions to global health problems.

I want to take this opportunity to thank all those who gave so much to make this day a reality. Planning for Jordan Hall was an immense undertaking that had its roots as far back as the late 1980s when it became clear that a new science learning center was an absolute requirement if Notre Dame were to become one of the nation's premier universities of the 21st century. The task of designing Jordan Hall fell on relatively few people. The time and effort they gave in the years leading up to the dedication were truly noteworthy.

This issue of *Renaissance* is a tribute to those who gave so much. Notre Dame has been making steady progress toward becoming one of the premier universities in the nation. On September 14, 2006, we made a tremendous leap forward. The Jordan Hall of Science will allow us to be a leader in undergraduate science education. And like all physical resources, the building is not the most important thing. Rather, it is what goes on inside.

Best regards,



Joseph P. Marino
William K. Warren Foundation Dean
College of Science



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Jordan Hall of Science Benefactors



“Although at times the tasks ahead may seem daunting, the potential for scientific breakthroughs has never been better or the opportunities greater. We are at a turning point of tremendous potential both in science education and scientific research. The young scientists we educate today are the ones who will take that turn, and we are optimistic our students at Notre Dame will be well-equipped to make their mark on the greatest scientific discoveries of the 21st century.”

CRISLYN D’SOUZA-SHOREY, in her remarks at the concluding dinner following the September 14 dedication of the Jordan Hall of Science.

Tony Bendinelli was certain of one thing on coming to Notre Dame from Columbus, Ohio: His heart had told him to major in science. But his heart was silent on the all-important particulars.

“When I started out here as a freshman three years ago, I honestly had no idea what I would become, or what I would choose for a major,” he announced to the gathering of dignitaries attending a dinner following the dedication of the Jordan Hall of Science.

Eventually, he settled on math and physics.



JORDAN HALL:

This summer, Bendinelli had the opportunity to help Prof. Dinshaw Balsara on an astronomy research project in the field of computational astrophysics. Bendinelli was inspired. “However, the thing that perhaps cemented my interest in the subject was when I saw the power and potential of the Digital Visualization Theater for the first time,” he recalled. The magnificent images cast on the domed screen of the most modern theater in the world convinced him that “any decisions I make from now on will almost certainly be weighted toward astronomy.”

The opening of this stunning structure for students like Bendinelli means that Notre Dame has positioned itself to take its science curriculum to the highest level. Coupled with the University’s reputation for service to humanity, Notre Dame has taken another step “to be a great force for good in this world,” said Notre Dame President John I. Jenkins, C.S.C.

Such is what Tristan VanVoorhis had in mind when it came to choosing a college. Long before he came to Notre Dame, VanVoorhis knew he wanted to pursue a career in medicine.



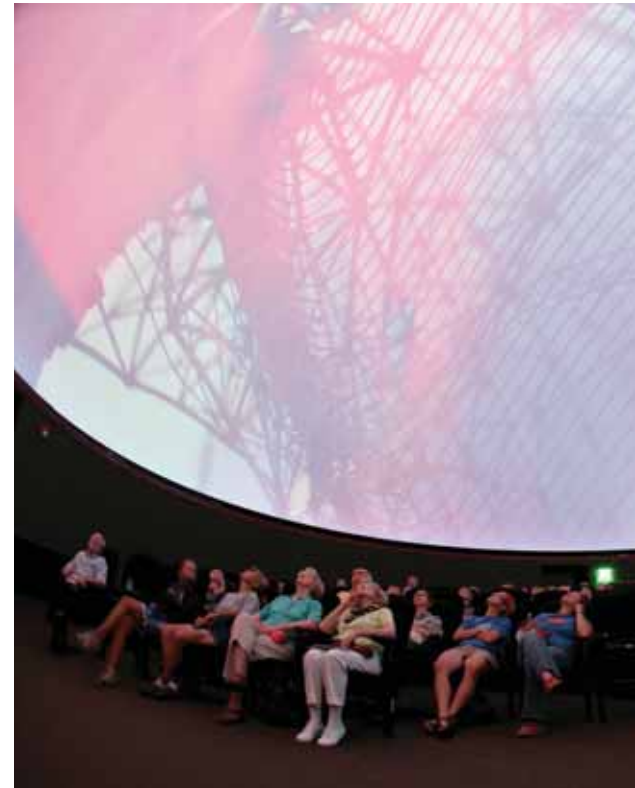
Shaping 21st-Century Leaders

Having grown up in Georgetown, N.Y., the second oldest of eight adopted children—all in medical need—Tristan was motivated at an early age to provide the same care “that was extended to my siblings.”

Notre Dame’s emphasis on ethics and values and its strong Preprofessional Studies Program made his choice of college easy. And, there, rising on the eastern edge of campus, was the new Jordan Hall of Science. VanVoorhis’ timing was perfect. This fall semester he walked into Jordan Hall for the first time on a trek that will take him to medical school.

“Jordan Hall will have a profound impact at Notre Dame,” said Fr. Jenkins at the ceremonies dedicating the most advanced building in the nation for the teaching of science to undergraduates.

Science is taught at Notre Dame within the University’s mission to instill within its students the importance of love, compassion for others, altruism, and a deep sense of responsibility. Scientific research devoid of moral and spiritual values is a recipe for disaster. As Albert Einstein said, “Concern for man himself must always constitute the chief objective



of all technological effort.”

Frank Collins, director of the Center for Global Health and Infectious Diseases, observed: “If you are somebody who is impacted by the needs of sick people, then something sinks in that then makes your career in medicine all the more meaningful.”

The center’s researchers have made substantial progress to understand and treat scourges like malaria, toxoplasmosis, tuberculosis, lymphatic filariasis, leishmaniasis, dengue, and West Nile encephalitis. Collins and his wife, Nora Besansky, have traveled to

the equatorial regions of the globe in safari-like trips to understand the mysteries of *Anopheles gambiae*, the primary mosquito that transmits the malaria parasite, *Plasmodium falciparum*.

Another husband-and-wife team with the center, Michael Ferdig and Mary Ann McDowell, went to Rwanda and Uganda last summer, not for research, but as a family vacation. Their son, Sam, 13, and daughter, Georgia, 10, were just as captivated by elephants and lions in the wild as the sight of long queues of people streaming from the market at all



hours of the day. Georgia was the focus of attention of other children at the market. Her older brother learned an important lesson from Rwandan children who remain haunted from losing family members and friends in the civil war.

“Sam learned that people are people everywhere,” McDowell said. “Even if they are dirt poor they will still invite you into their homes.”

The hospitality was no different “than going to see Grandpa and Grandma at the farm,” Ferdig added.

McDowell’s research, devoted to understanding an illness called leishmaniasis, and Ferdig’s research into the genomic underpinnings of malaria have created another extended family—one that comprises all of the graduate students in their respective laboratories. All are dedicated to understanding the biological basis of mankind’s most dangerous diseases.

It is through the efforts of Rev. Thomas Streit, C.S.C., a Holy Cross priest and professor of biology, that Notre Dame has created a strong presence in Haiti. Fr. Streit

One of the most advanced scientific instruments in Jordan Hall is the **Bruker Nuclear Magnetic Resonance spectrometer**, the 400 MHz NMR.



The arrival of the spectrometer in October means that Notre Dame leads the way in undergraduate research in organic and synthetic chemistry. Spectroscopy is the preeminent technique for determining the structure of chemical compounds.

Here, Dominic Vernon prepares a sample for analysis. “I have wanted to go to Notre

Dame since I was 12 years old,” Vernon said. “But when I saw the plans for Jordan Hall, I knew this was the place for me! The new labs have been incredible. Everyone has an individual lab space with brand new equipment. It is a great opportunity to be able to work in such a facility.”

Adam
Gadzinski '08

PHYSICS-IN-MEDICINE

The Jordan Hall of Science is an amazing building. The laboratories are very spacious, and are equipped with some of the best technology. Having such a laboratory



environment shows that the University is dedicated to providing its students with experiences that will help them decide whether they desire to pursue a career in research.

Though I am a junior and will only have a few lab courses in Jordan, I know that the building will aid in preparing Notre Dame students for successful careers in scientific research, or for those pursuing other careers, a

solid foundation in scientific problem solving.

All these amazing things, occurring under the watchful eyes of Galileo, Pasteur, Curie, Saint Albert the Great, Fr. Nieuwland, and Fr. Zahm, whose statues adorn the three entrances to Jordan, will certainly lead to Domers who will become leaders in the scientific community.

has devoted his career to eliminating lymphatic filariasis from Haiti and reducing the incidence of dengue fever and malaria there.

Not everybody who passes through the Jordan Hall of Science is destined to work in a Third World country as the next Mother Teresa in order to make a difference. Matthew Hubbard, a 2002 Notre Dame graduate, founded the Dr. Tom Dooley Society in 2005 to organize Notre Dame alumni in the health professions to support the University and its commitment to Catholic values.

The society was an immediate success. With membership numbers over 700, it offers stipends to students who go abroad for the summer in service to the poor and afflicted.

Now a first-year resident in general surgery at Case Western University Hospitals in Cleveland, Hubbard has made it his life's work to honor Dooley, who was educated at Notre Dame in the 1950s and went on to achieve recognition for a distinguished career in medicine and service to humanity. ●

Tara Johnson '07

SCIENCE PREPROFESSIONAL MAJOR AND INTERNATIONAL PEACE STUDIES MINOR



I'm really excited about the new Jordan Hall of Science. The labs are well-equipped and state-of-the-art; the lecture halls are beautiful and technologically advanced; and the study areas are

inviting and relaxing. The resources that the building provides will help students experiment, explore, and find their niches in science. From my science education and experiences at Notre Dame, I've decided that I want to enter the field of international medicine and dedicate my life to serving the underserved as a physician.

Brad Tucker '07

PHYSICS AND PHILOSOPHY DOUBLE MAJOR SCIENCE, TECHNOLOGY, AND VALUES MINOR

When you walk into Jordan for the first time, you take a step back in awe. The new equipment in the observatory is incredible. Jordan Hall gives science majors a Coleman-Morse, a place to study and call home. Not only is it of great scientific use, but it feels like a home. Instead of being cramped into small spaces in the old buildings, undergraduate science majors now have their own building with the best equipment.



Ted Brown '07

ANTHROPOLOGY AND BIOLOGY DOUBLE MAJOR

I believe Jordan Hall will further allow undergraduates at Notre Dame to realize the importance of scientific inquiry through benchtop



research. With the improved facilities at Jordan, I hope more students will be excited about taking advantage of the opportunities to get involved in research. The experience I have gained working with

Prof. Tenniswood and graduate student Sarah Mordan-McCombs, has been invaluable in my science education that I hope to carry with me to medical school.

A Student's Perspective

by Wade Iams '08



recall the moment I walked into the Jordan Hall of Science and the feelings of pride and admiration that overwhelmed me as I entered this magnificent building.

As a biology major, I was proud that my University has made such a tremendous investment in undergraduate science by devoting an entire building to teaching. In utilizing the most recent technology available, the College of Science improves every student's ability to learn and develop both theoretical and practical skills to be applied in future careers and graduate school.

At the same time, I was filled both with awe and a sense of my own responsibility. I realized then that Jordan Hall is meant for every individual student who walks down the breathtaking galleria and goes into a classroom, lecture hall, or laboratory.

Such investment from the University is not one-sided, and after dwelling for a bit on the reciprocity of Jordan Hall, I see that premium facilities will demand premium effort from students. The first day in the building I stepped into one of the main lecture halls of Jordan and was told that each student would have his or her own Internet connection! I observed the increased area for note-taking as well, and together this promises to be a much more learning-conducive environment. Moving to the individual laboratories did not change my conclusions. My first lab class in Galvin Life Science Center was so crowded and cluttered that the students had to gather in the center for a pre-lab lecture. In contrast, the spacious laboratories in

Jordan Hall were designed for excellent acoustics. A student at the back of the room can hear the professor clearly, even without a microphone. Such improvements in the learning experience make Jordan an exciting and challenging place for students.

I came to Notre Dame for its wonderful educational opportunities. Notre Dame is part of my family. My grandmother worked here. My father, who graduated from Notre Dame in 1981, studied mechanical engineering and played baseball. I am a third-year biology major and a walk-on on the football team and play defensive back. Blue and gold is in our blood. Now we have even more reason to be proud of Notre Dame.

Notre Dame is truly a special place and has made a bold statement to the world. Everything from technology-filled lecture halls, spacious and picturesque corridors, and individual labs stocked with equipment that spares no expense, shows that the University has declared that it is committed to providing the best possible education for undergraduate science students.

Now we as students have to live up to what is expected of us. My thoughts are reflected well in the proverb that with greater stakes come greater rewards.

Global Health Forum

Solutions for Global Poverty and Disease “Within Reach”

Physician and anthropologist Dr. Paul E. Farmer has a gift for painting a scene with words. But his landscape is Haiti and the colors on Dr. Farmer’s palette are predominantly dark and grim. The lauded humanitarian described Haiti as home to the world’s most beleaguered poor.

At the second annual Notre Dame Forum, a panel composed of three noted guest speakers, Paul E. Farmer, Jeffrey Sachs, and Miriam Lake Opwonya, was joined by two alumni, Keri Oxley '04, member of the Notre Dame Board of Trustees, and David Gaus '84. The panel also included two seniors: Michael Dewan, a preprofessional studies major who worked in Uganda, and Ailis Tweed-Kent, who worked with children in AIDS-stricken Lesotho, Africa. Gwen Ifill, managing editor of PBS' *Washington Week* and *The NewsHour with Jim Lehrer*, served as moderator for the discussion.





Dr. David Gaus and Fr. Jenkins

His comment to his audience at the Joyce Athletic and Convocation Center “that we ought to think about treating hunger with food” sent a wave of uneasy laughter rippling through the multitude of thousands. This “radical notion,” as Dr. Farmer so ruefully put it, drove home the point that even the simplest solution to a never-ending

tragedy has been largely beyond the grasp of the most intelligent species on Earth.

Some heads dropped perceptibly, in a way acknowledging the irony. Others weighed the indefensible with a sardonic expression.

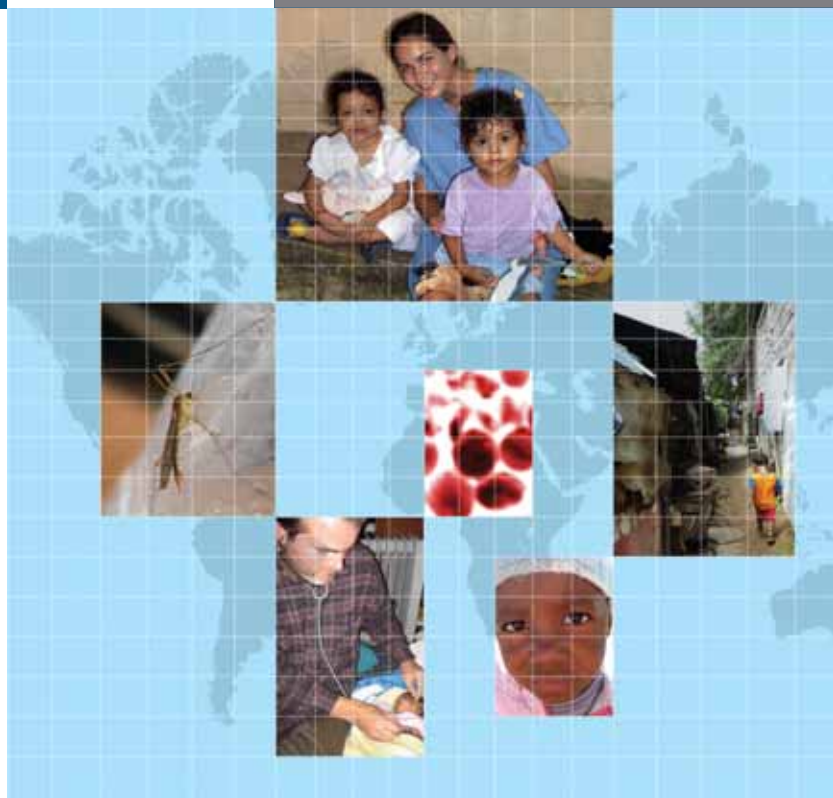
Some students at the forum winced as if Dr. Farmer’s comment produced a sharp pain. In a way, it did. These students had just returned to campus after spending a large part of their summer working in Third World countries. Still fresh in their minds were their recent experiences dealing with extreme poverty, ceaseless hunger, disease, and despair.

It was an especially difficult moment for Tara Johnson and Nathan Serazin. Their thoughts drifted back to the town of Pedro Vicente Maldonado in the Andes Mountains in Ecuador where the two had spent their summer working with Andean Health and Development, Inc. and its cofounder, Dr. David Gaus.



PHOTO PROVIDED

Nathan Serazin



Johnson and Serazin had heard much about Dr. Farmer, the founder of the humanitarian agency Partners in Health, regarded as “America’s most celebrated doctor for the poor.” Now they shared the experience of having seen with their eyes, heard with their ears, and touched with their hands. They were in awe of him.

Many at the Joyce that day were also energized by the words of economist Jeffrey Sachs, director of the U.N. Millennium Project and author of *The End of Poverty*, who asserted that mankind has the ability to end extreme poverty by 2025. “We have tools that are incredibly powerful. We just don’t use them,” Sachs said. “We need to understand why that is. We need to figure out how we can use them.”

Serazin, a junior biochemistry major from Elyria, Ohio, spent half of his time in Ecuador working in a local hospital and then serving as a coach for a youth baseball team. He was moved by Farmer’s and Sachs’ remarks. “It was as if I were transported back to Pedro Vicente Maldonado,” he said. “When they spoke of their grim experiences with health care in developing countries, it struck a chord deep within my soul because I could not separate their experiences from what I saw this summer.

right: panelists
Farmer, Sachs, and Opwonya

The people they described were not the anonymous statistics that are commonly thrown out to shock people, but rather, they were the people that I met this summer. They were Aladino, Fernando, and Olberman,” he said “...and this is something that can be hard to cope with.”



PHOTOS PROVIDED

Sarah Wheaton (above) and friends
Bryan Hambly (left) and friend



His return to Notre Dame in August was not with the usual rah-rah enthusiasm of most of his classmates. But having returned to campus from his summer experience in Ecuador, Serazin arrived at this conclusion: “I thought about it and realized that I was not going to change the world this

summer, but that it was going to change me. And that’s what happened.”

Johnson, too, had that lump-in-the-throat reaction to Dr. Farmer’s words. “In Ecuador, I had a neighbor get dengue fever because the water accumulating in his apartment had become a breeding ground for mosquitoes. I saw numerous pregnant teenage girls, and I saw some of my own students struggling with alcohol dependencies,” she recalled.

People can escape debilitating poverty if the structure is in place to help them. Johnson, a senior in pre-professional studies, has decided that after graduation in May, she will work “to improve their lives and [help



them] escape the cycle of poverty and halt the proliferation of the global health crisis.”

Half a world away from where Serazin and Johnson were working in Ecuador, Sarah Wheaton and Bryan Hambly had joined the Maryknoll priests in Cambodia. They, too, were placed in this foreign country by Notre Dame’s Center for Social Concerns’ International Summer Service Learning Program, whose mission is to give students a broader global view about the causes of poverty.

Hambly described the conditions in a Cambodian settlement camp where people had no chance for escape: “There are no jobs. The government has marginalized these people. There is no structure and no opportunity for advancement, either in education or in employment, or socially even,” said Hambly, a junior. “Just by reading books, I had no idea what it was like.” The camp “was the worst place to get AIDS or tuberculosis because almost no one there is able to get health care.”

Those who were not ill were the fortunate few. If their luck held, they could earn 50 cents a day selling baked rice, or 25 cents sewing pants or shirts. But more often than not there was no work. Every day was part of a repetitive cycle of hopelessness.

Hambly and Wheaton worked for Maryknoll, the Catholic mission society. He taught English. She conducted classes in human rights. They mingled with the poor, offering hope and encouragement.

*right: Student and alumni participants
Tweed-Kent, Dewan, Oxley, and Gaus*



For Wheaton, the academic forum solidified her resolve to make an impact in the world after graduation. I really liked it when Paul Farmer emphasized working with the people and not for the people...” Sara said, “...because from what I saw in Cambodia the most effective programs were the ones that worked with the Cambodian people using their own ideas and letting them take the initiative.”

Miriam Lake Opwonya



“I think for a lot of Notre Dame students the forum was

Jeffrey Sachs



great because they were not able to have the experience that we were lucky enough to have,” Hambly said.

Doctors Farmer, Sachs,

and Miriam Lake Opwonya, a Ugandan doctor who coordinates clinical trials on HIV/AIDS therapy, were invited to the second campus-wide forum by a committee that included Frank Collins, the director of the Center for Global Health and Infectious Diseases. Collins said the forum connects perfectly with the Center for Social Concerns’ International Summer Service Learning Program. “I can’t overstate the importance of actually having students confront the consequences of global health and having them see people who are affected by poverty and disease.”

Not everyone can do this. But about 300 students were able to experience the next best thing. After the conclusion of the academic forum, they gathered in the Monogram Room of the Joyce Center to meet with Farmer in a session arranged by the Center for Social Concerns.

Patrick Brown was among those who attended. “Perhaps the most memorable part of the question-and-answer session with Dr. Farmer was the very first

Gwen Ifill



question,” Brown said. It was a question posed by a student from Haiti. The two spoke in Haitian Creole. Dr. Farmer interpreted the Haitian student’s angry complaint that while all of Haiti is obviously very poor, the women are often much worse off than the men. Dr. Farmer agreed, talk-

ing about the extremely high maternal mortality rate and showed deep concern for the student’s individual story and his pain.

“Throughout the rest of the questions, Dr. Farmer displayed this same intensely interested attitude toward every student,” Brown recalled. “He learned every student’s name, giving honest and sometimes humorous answers to their questions. It amazed me how Dr. Farmer connected with every student who asked a question.”

“He expressed his delight at being able to talk about Catholic social teachings like the corporal works of mercy at a prestigious university like Notre Dame, which was something he couldn’t do at other schools. Yet, despite his embrace of Catholic teachings, Dr. Farmer wasn’t afraid to address some of the issues

on which his opinions differ from Catholic doctrine, such as the necessity for free contraception to slow the spread of AIDS in impoverished nations. Dr. Farmer also spoke a good deal about the feminization of poverty in countries such as Haiti and the necessity of addressing issues such as these along with the more readily apparent problems of disease control," Brown said.

The students, many in the College of Science Preprofessional Studies Program, streamed to the microphone wanting to learn more. One student described Dr. Farmer as having "rock star status," in clear reference to Bono, humanitarian and the lead singer of the Irish rock band, U2.

Paul E. Farmer

"The entire Q&A was scheduled to last 60 minutes but we went 20 minutes over the scheduled time. We could have gone on longer, but we had to cut it off," said Rachel Tomas Morgan, director of International Service Learning and Justice Education.

The lively session bumped into an event held at the Center for Social Concerns where Dr. Farmer had dinner with 40 students, many of whom had spent their summer working abroad in the International Summer Service Learning Program.

What struck Tomas Morgan was the sense that the day had deeply affected many of the students, especially those who had spent time with Dr. Farmer. "I received many e-mails from students who had met with Farmer. This solidified their commitment to the health-related field and service to the poor," said Tomas Morgan.



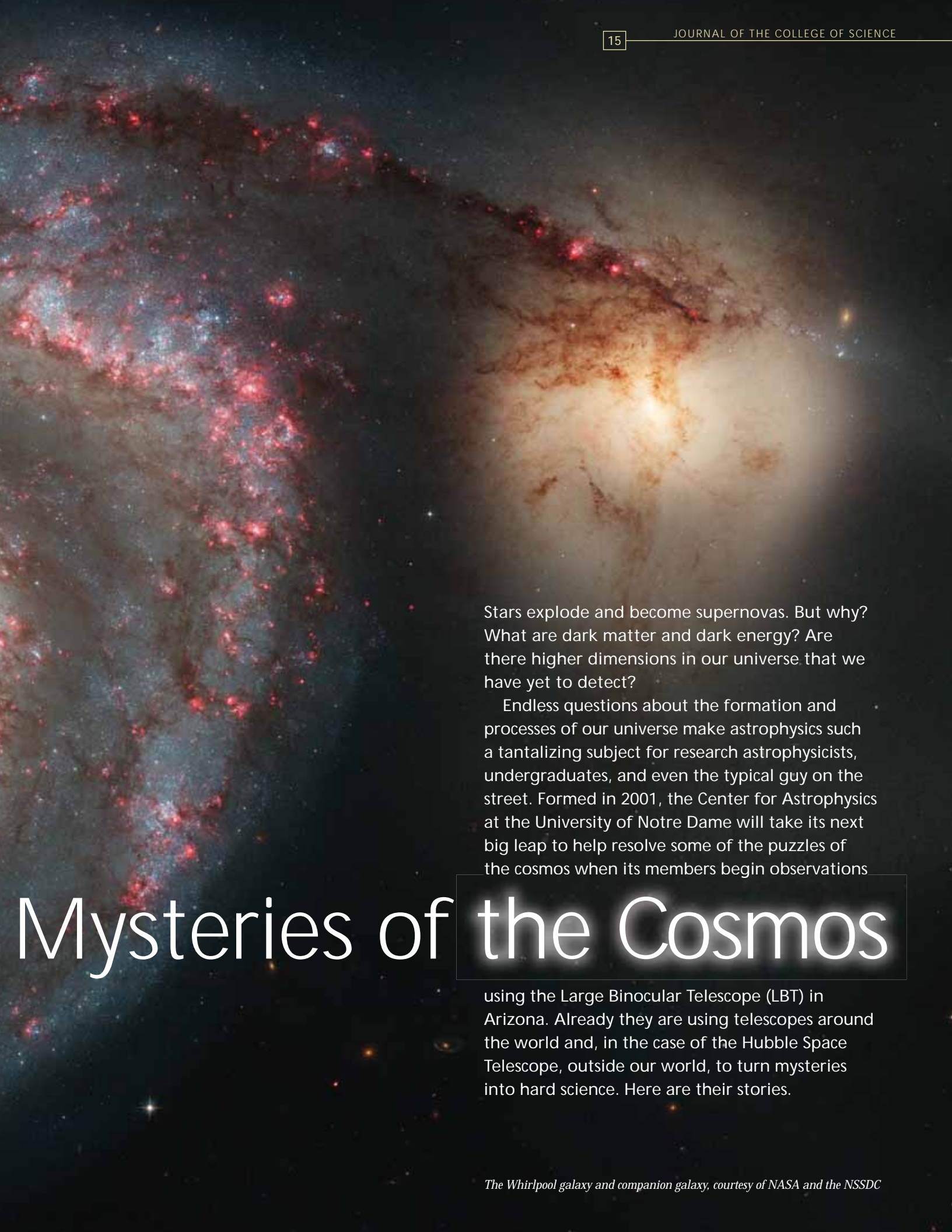
This awakening among students took another turn following the forum with a series of informal meetings held in the dorms. The sessions revealed continued interest among students to develop a framework for them to get involved in humanitarian programs, said Ann Firth, associate vice president for Student Affairs. The lively discussions provoked students into joining Jeffrey Sachs' Millennium Village Project and several student organizations are discussing fundraisers related to global health issues.

"There was a lot of energy at the meetings and right now we want to keep it going. We certainly don't want to lose momentum," Firth said. 🌍





Resolving the

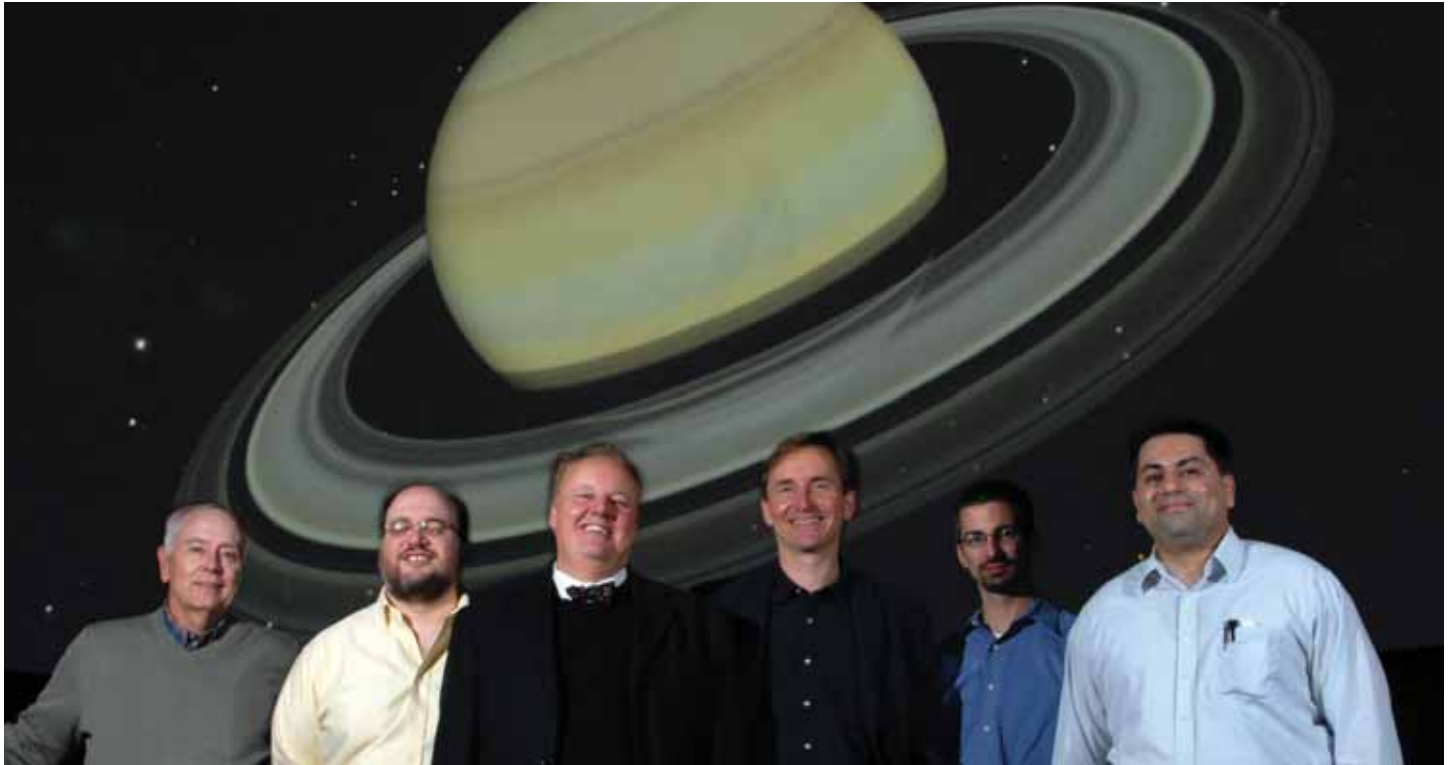


Stars explode and become supernovas. But why? What are dark matter and dark energy? Are there higher dimensions in our universe that we have yet to detect?

Endless questions about the formation and processes of our universe make astrophysics such a tantalizing subject for research astrophysicists, undergraduates, and even the typical guy on the street. Formed in 2001, the Center for Astrophysics at the University of Notre Dame will take its next big leap to help resolve some of the puzzles of the cosmos when its members begin observations

Mysteries of the Cosmos

using the Large Binocular Telescope (LBT) in Arizona. Already they are using telescopes around the world and, in the case of the Hubble Space Telescope, outside our world, to turn mysteries into hard science. Here are their stories.



Members of Notre Dame's Center for Astrophysics, from left to right: Terrence Rettig, David Bennett, Grant Mathews, Peter Garnavich, Chris Howk, and Dinshaw Balsara

Terrence Rettig Keying on Planet Formation

It was just 11 years ago when astronomers conclusively answered positively the age-old question, "Are there other planets whirling around other stars?" That discovery has brought an avalanche of more planet discoveries, now up to 210 and counting. Most are large, hot, gaseous planets of various sizes. But their discovery begs a central question: "What is the process by which planets form?"

There is little doubt that stars form when dense cold clouds of hydrogen and helium contract into a giant ball that suddenly erupts

with a fusion chain reaction and in astronomer parlance "goes thermonuclear." What is important to a group of Notre Dame astronomers is the material left behind from the star formation process that encircles the young star as a flattened circumstellar disk. In general terms, that disk of dust and gas is then thought to somehow coagulate to larger and larger particles from which planets are eventually formed. The formation process of planets from small particles of dust is one of the least understood processes in astronomy.

A team of Notre Dame astronomers led by physicist Terrence Rettig has provided a key piece of evidence to help understand the planet-forming process. Results of the team's work were published in the July 2006 issue of *The Astrophysical Journal*. Their paper describes high-resolution spectral observations from the 10-meter telescope on Mauna

Kea in Hawaii, which provided the first observational data showing how gas and dust settle to the midplane of the protoplanetary disk.

"Astronomers have only been guessing over the years as to how quickly dust settles to the midplane relative to the gas," Rettig said. The reason that rate is important is that dust settling must occur rather quickly, so that the coagulation of smaller particles to larger particles (to eventually form planetesimals, the precursors to planets) can occur before dissipative processes related to the young star begins. An important criteria for this settling process is the amount of turbulence in the disk midplane where planet formation occurs. "Turbulence is the regulating process that determines how fast the dust can settle to the planet-forming region. Essentially, planetesimals and planets can't form if the dust is too stirred up," Rettig explained. "If it is very turbulent, then it

is unlikely that sufficient numbers of particles can settle and stick together to form planetesimals,” Rettig said. A simple analogy is that on a quiet, humid night you can expect frost to form on your car windows, but on a windy night, too much turbulence prevents that process from occurring.

By looking along the line of sight to disks surrounding the targeted stars, the team was able to measure the gas-to-dust ratios to provide an essential measure of the settling rate. The level of turbulence in the planet-forming region cannot be measured directly, but the observed settling rate provides important clues as to how much turbulence is occurring in that region. These clues can then be used to infer the rate of dust coagulation and the potential for formation of an inchoate planet in the disk’s midplane.

“The observations and analysis for this project were difficult, and that is why no one had attempted it previously,” Rettig said, adding that the paper was the result of four years of planning, obtaining the observations, and developing a numerical model to explain the results. The authors expect the results to be used by many theorists in ongoing efforts to understand the process of grain growth to eventual planet formation. The long-term goal of this research is to better understand how planets form from the debris left over during star formation.

Joining in this effort were associate professor Dinshaw Balsara and research associate David Tilley from Notre Dame, as well as colleagues Sean Brittain, a former doctoral student at Notre Dame now at Clemson University; Erika Gibb, formerly a postdoc at Notre Dame and now at the University of Missouri, St. Louis; Ted Simon from the University of Hawaii; and Craig Kulesa from the University of Arizona. 🌌

Chris Howk Of Big Bangs and Stellar Evolution

A spiral galaxy much like our Milky Way has lately drawn the interest of Chris Howk, Notre Dame’s newest astrophysicist. Howk shows a Hubble Space Telescope image of an edge-on galaxy 55 million light-years from Earth. He points to the wispy image of clouds of dusty gas spewing from the edges of a spiral galaxy. The clouds billow from violent supernovae explosions that kick up enormous eruptions of material—in much the same way massive volcanoes like Mount Pinatubo ejected material high into our atmosphere. But in the case of these eruptions, some of this material is ejected completely out of the NGC 4013 galaxy itself.

Howk is interested in understanding how these plumes, or filaments, of superheated gas, borne of some of the most violent explosions in the universe, go on to form the next generation of galaxies and stars. “These massive stars are born in groups, or families. So they all age and die about

the same time,” Howk explained. The shock waves of these multiple explosions forge metals and heavy elements. Those elements will travel out into the cosmos, eventually being incorporated into other stars and galaxies.

An edge-on photo of NGC 4013 reveals that the pancake-like pinwheel galaxy sprouts hair-like jets of superheated gas. Howk has enlisted the help of undergraduates Marissa Pitterle and Alec Hirshauer to view images of NGC 4013 taken by the Hubble Space Telescope and take measurements of the gases being blown out of the plane of the galaxy. “These filaments of gas are 400 parsecs long, and a parsec is over three light years. So these are just enormous distances,” said Pitterle, a sophomore from Milwaukee.

Our view of galaxy evolution was enhanced with the launching of an orbiting space telescope, the Galaxy Evolution Explorer, which was sent into space in 2003 on a mission to map the history and evolution of the universe by taking pictures of early galaxies in the ultraviolet spectrum. Howk and collaborators will use this instrument to further study the outflows of gas from galaxies.

Howk came to Notre Dame knowing that soon he would have a chance to observe this process using the Large Binocular Telescope on Mt. Graham in Arizona. “The LBT will have an exquisite set of instruments, one of which



The Hubble Space Telescope captured this image of superheated gas being ejected by violent supernova explosions in the NGC 4013 galaxy

will allow us to find and measure the properties of hundreds of galaxies at once,” he said. One instrument in particular, the Multi-Object Dual Spectrograph (MODS) will allow Howk to study the galaxies from which metals are blown out into the intergalactic medium. A large telescope like the LBT is required to study these galaxies, given their huge distances from our own Milky Way Galaxy.

“The data from the LBT will fit directly into the types of questions that people have been asking about how galaxies are first born and how they evolved. The answers to these questions are still unknown,” he said. 🌌

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David Bennett Detecting Planets Just Like Ours

Four planets located between our sun and distant stars near the center of the Milky Way Galaxy have so far been detected by a technique known as gravitational microlensing. Many more such discoveries lie ahead because gravitational microlensing is a much more precise way to detect distant planets around ordinary main-sequence stars like the sun, according to Notre Dame astrophysicist David Bennett, a lead scientist in the most recent planetary “find.”

Recent improvements in gravitational microlensing science means that detection of rocky planets that could conceivably harbor life is more likely than ever, said Bennett, who was among the first to prove the feasibility of using this technique to detect low-

mass planets comparable to our Earth.

Bennett was part of a team of astrophysicists who first employed gravitational microlensing in a 1993 search for dark matter, the mysterious substance that emits no light and yet dominates every corner of the universe. The scientists searched for MACHOS, Massive Compact Halo Objects, or normal matter like brown dwarfs or other faint objects—even free-floating planets ejected by their



With gravitational microlensing, light emitted from a distant source is bent by the gravity of a massive object, like a star, which acts like a lens. If the source, massive object, and the observer lie on a straight line, the source will appear as a ring behind the massive object.

host stars—that might offer a plausible explanation for dark matter, something that continues to baffle scientists to this day.

Seven years earlier, Princeton University’s Bohdan Paczynski made a novel and startling proposal: Why not use gravitational microlensing, predicted by Albert Einstein as a consequence of his general theory of relativity, to detect MACHOS? Gravitational microlensing is predicated on Einstein’s insight that space-time is warped by massive objects. Thus light from a distant object is bent along the contours of warped space-time in the vicinity of huge objects like stars. If the star in the foreground is aligned with a distant star and Earth just right, the light will be not only bent, but also magnified. Planet hunters then reasoned that if another object, a planet, is revolving around the nearest star, then the telescope will record extra spikes in brightness, indicating an orbiting planet. Scientists could then proceed to calculate the mass of the smaller object with great precision. Bennett was part of a NASA Hubble Space Telescope research team that, for the first time, managed to characterize the host star of a planet discovered by the microlensing technique.

Bennett and his colleagues want to take this phenomenon to the next logical step—to space—with their proposed Microlensing Planet Finder. They argue that the search for terrestrial planets would make a giant leap if NASA funded the Microlensing Planet Finder, which would greatly increase the odds of locating habitable planets—especially those far out near the galactic bulge.

“The identification of the host star is crucial for a complete understanding of the planets discovered by microlensing,” Bennett said. 🌌

Grant Mathews Big Surprises from Little 'Bumps' in the Data

Theoretical astrophysicists are the deep thinkers of science who ruminate about tiny deviations in piles of data in hopes that a small anomaly may lead to bigger discoveries.

For Notre Dame professor of astrophysics Grant J. Mathews, investigating little quirks in data is a never-ending pursuit to find the elusive “new physics” that lies just beyond the grasp of science. This quest causes him to ponder the interior of a new class of stars whose cores may be composed of strange quarks. In particular, he has scanned the available astronomical data concerning white dwarfs. Such stars are the remnants of aged sun-like stars that have long burned out. Some of them, however, exhibit a peculiar trait of being too compact. Such stars could be among a small population of white dwarfs that have strange-matter cores. If they exist, they could provide evidence for the formation of strange matter either in the early universe or in violent neutron star collisions. Moreover, it would be evidence of a new form of matter at high density.

“There are 20 or 30 white dwarfs whose radius can be directly measured and as many as eight of them are possible candidates for having

strange-quark cores,” Mathews said. “From the standpoint of a theorist we must ask ‘Is this an observation that can lead to the next breakthrough?’ If we could discover strange-quark matter somewhere, this would be really important.”

Such little discrepancies in the data may lead to new physics.

“Almost everything I do involves looking at little bumps in the data,” he said. For example there are little bumps in the size distribution of fluctuations in both the cosmic microwave background and clusters of galaxies. What you see is a little bump on a small scale that could be evidence of a very heavy (Planck-mass) particle formed at the very instant of creation and at the end of the cosmic inflation that produced our universe. It turns out that this fits our theory pretty well.”

Another matter of intrigue is that observational astrophysicists recently discovered that there might be a preferred axis in the universe, a strange line in the depths of space that scientists whimsically call “the axis of evil.” If the data turns out to be true, why is there a distinct orientation in the universe?

“One interpretation is that the universe is wrapped up on itself on that scale,” Mathews said. “I had a student who just finished his Ph.D. looking at all possible observational evidence in that direction and every other direction in the sky. If right, you should be able to look down

that axis and see the back of your head. Actually, you would be looking back in time, so what you would see is the Milky Way Galaxy as it was forming billions of years ago.”

“If we could find our own galaxy, it would be like looking into a time machine. That would be a huge breakthrough,” he said, adding the proviso that this mystery may simply be nothing more than an aberration in the data caused by a more mundane physical effect such as photons scattering from hot electrons in a nearby galaxy cluster.

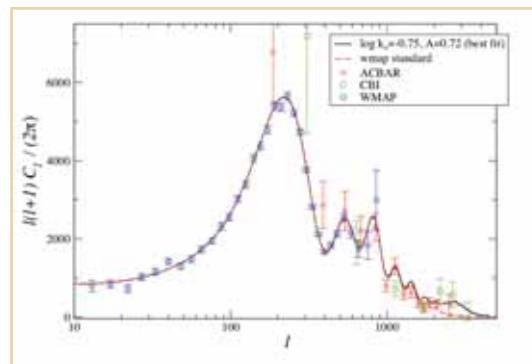
The search for new physics recently led Mathews to consider

the taunting evidence that the helium abundance in the universe “consistently appears too small” and contradicts what scientists understand of the nuclear physics of

the early universe. Could this be explained by the existence of higher dimensions in the universe? “We wrote a paper on that,” he said.

And, of course, the big buzz among cosmologists these days is the discovery of dark matter and dark energy. “Are they the same thing? They have about the same energy density,” he offered. Could it be that dark energy is just dark matter flowing from some unseen higher dimension into this dimension? Again, this was the gist of a paper he submitted just two months ago.

“These are complicated things. I think the next breakthroughs in theory will probably be the discovery



This graph shows a “bump” in the cosmic microwave background as a black line above the dotted line on the lower right.

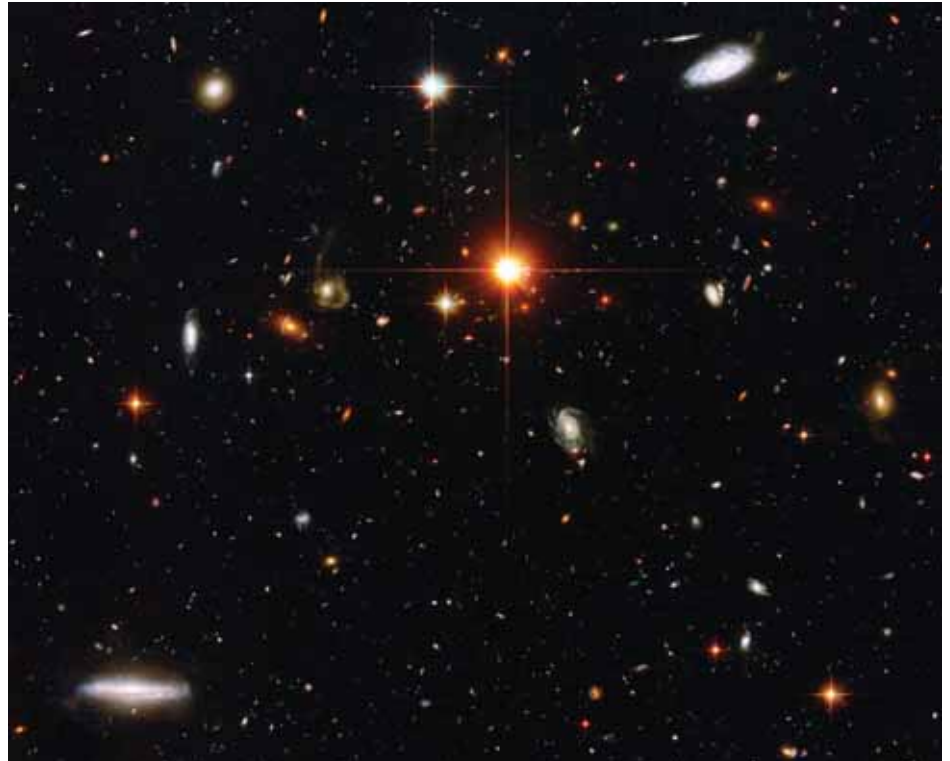
of the existence of higher dimensional physics and supersymmetry in the universe. Supersymmetry, in particular, is such an elegant theory that most theorists believe it's got to be correct. Every time such an elegant mathematical symmetry has been noted, it has been discovered in nature. For example, at one time anti-matter seemed like a bizarre concept. Its existence was postulated based upon mathematical symmetry. Now we know that anti-matter is common. It is being produced in this room due to natural processes as we speak."

There is always rejoicing when theorists like Mathews catch their quarry and are proved right. In time, however, the excitement will die down. And there will be another quest just beyond their reach, other conundrums in the data taunting theorists to seek an explanation. 🌌

Peter Garnavich Dark Energy a Dark Secret

Until 1998 it was a common belief among cosmologists everywhere that the expansion rate of the universe was slowing down ever so slightly.

But that year, scientists who were routinely examining distant supernovas—or gigantic explosions of dying stars—were puzzled by data that suggested that the opposite was true. Researchers checked and rechecked their calculations and were astonished to find that the rate of expansion was actually increasing. Their



A zoo of galaxies, courtesy of NASA and the NSSDC

announcement of their discovery was just another stunning example that we have a lot to learn about the universe.

The first step to understanding this conundrum, said Notre Dame astrophysicist Peter Garnavich, is to locate a large number of supernovas and precisely measure their distances and, hence, characterize their pace of expansion. This will narrow the parameters that will help define what mysterious, pervasive repulsive force is constantly pushing outward on the fabric of space and time.

Is it some kind of constant vacuum energy, or an exotic, dynamic new kind of energy?

"It turns out to be extremely difficult to map out the expansion history of the universe at an accuracy we need to describe what dark energy is," Garnavich said. He has two supernova searches going on simultaneously.

The first is called the ESSENCE program, involving over two dozen

leading scientists in the field, including Garnavich, who are using the 4-meter Victor Blanco telescope in Chile to catalogue about 200 distant supernovas and study them in an attempt to put constraints on the dark energy data. These supernovas are located in distant galaxies 5 billion light years away. They were formed 9 billion years after the Big Bang. At that distance, they are out far enough to give astrophysicists a good way to calibrate the accelerating universe and thus narrow down the list of plausible theories that could account for this puzzle.

However, clouds of dust and gases, hot and cold, are obscuring their observations just as a whirling dust storm in a desert renders a set of binoculars useless. "So we have to cut through this dust because we want to give the theorists some direction because right now they are wandering around over this mystery," he said.

Intergalactic dust is good. We are

made of this hodge-podge of elements, light and heavy. But dust has a dark side if we are to understand dark energy. It's as if the atoms and molecules, grains and granules, of future worlds and future people are getting in the way.

The scientists connected with the ESSENCE project will one day supply the Hubble Space Telescope with a few supernovas of which to make infrared images. "By looking in the infrared we can cut through the dust and by comparing the optical observation from ground and infrared images from the Hubble, scientists can tell whether the dust is dimming the supernovas slightly and throwing off our observations.

"Eventually, we will require some space-based mission dedicated to making the measurements of supernovas to use them as distance indicators. But using our method we can narrow down the data and eliminate some possible theories regarding what dark energy is all about," he said.

"But it's really crazy when you think about it. We're trying to measure the derivative of the derivative of the expansion rate, and we need to accomplish this at an accuracy rate of under 1 percent," he said.

The second survey is the Sloan Digital Sky Survey II using the 2.5 meter telescope at Apache Point Observatory near Sunspot, New Mexico. This survey follows on the heels of the hugely successful first sky survey that mapped 200 million objects in deep space and transformed our knowledge of the universe.

This second survey has three objectives, one of which is to sweep the heavens for supernovas that will help map the rate of this mysterious acceleration. 🌌

Dinshaw Balsara When Turbulence is a Good Thing

Scientists are providing clearer answers to those fundamental questions that humans have long been asking about the nature of our universe and our place in it. These new understandings of the origins and evolution of astrophysical systems in our universe are re-

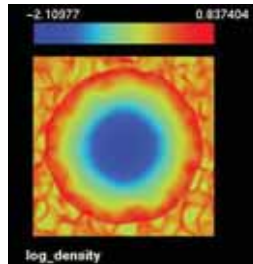


Figure 1

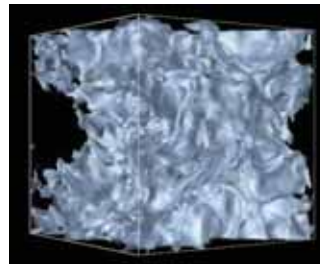


Figure 2

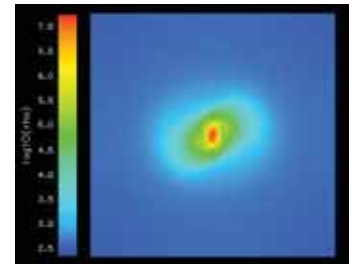


Figure 3

vealing a universe that is even more wondrous than we ever imagined.

It is this sense of excitement that Dinshaw Balsara puts into his research and conveys to his students at Notre Dame. Balsara is able to use the University's supercomputers to simulate the formation of stars and planets from giant clouds of gas and dust in our galaxy with the objective of comparing simulations to real data.

Increasingly, the result of his computer models are matching observations from space-based observatories, such as the Hubble Space Telescope and the Chandra X-ray Observatory.

Among the many key questions Balsara is addressing are those

involving galaxy evolution, the role that turbulence plays in forming the molecular clouds that become nurseries for star formation, how stars are born within these molecular clouds, and finally, how the leftover material from these young stars goes on to form planets. "These are some of the most important questions dealing with our cosmic origins," Balsara said.

Many of these research themes have attracted National Science Foundation and NASA funding. This funding has enabled him to bring students and postdoctoral researchers into these areas of study. Since coming to Notre Dame in 2001 Balsara's group has published a number

of frequently-cited papers. One of his papers shows the density distribution from a simulated supernova remnant that is expanding into the interstellar medium, heating it and creating turbulence. (Figure 1)

"We have been able to take such detailed simulations and compare them with actual x-ray images of supernova remnants that are available from NASA's Chandra satellite. The results enable us to analyze the accuracy of models for supernova remnants and also gain insights into the state of the interstellar medium," he said.

Our Milky Way Galaxy has witnessed billions of these explosions over its lifetime. Many of the elements needed for producing life on

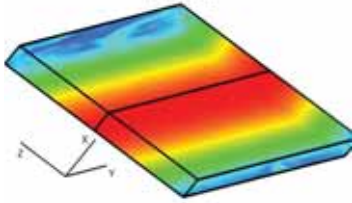


Figure 4a

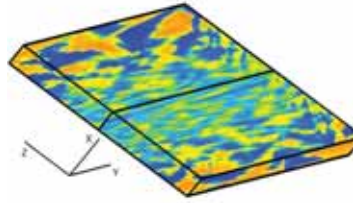


Figure 4b

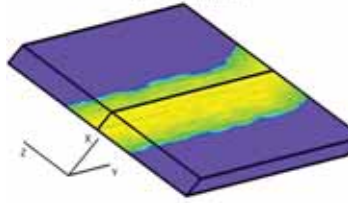


Figure 4c

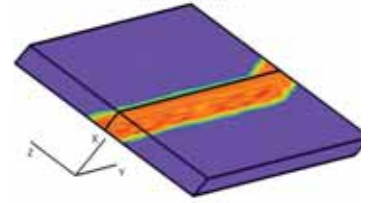


Figure 4d

Earth, such as carbon, nitrogen, and oxygen, are made in such explosions. As astronomer Carl Sagan famously said, “We are all made of star stuff.”

Balsara has simulated thousands of such explosions that have produced colliding streams of matter, which then go on to form giant molecular clouds (Figure 2). These are the stellar nurseries of our galaxy.

The gravitational collapse of gas that will form a new star will also be accompanied by the formation of a disc-like structure, known as an accretion disc, around this young star. “Eventually, the matter in the accretion disc comes crashing down on the surface of the protostar, thereby increasing its mass,” he said. Left behind in the disc are elements, called “dust,” needed for forming planets around young stars. “Dust particles, which have begun to condense out into the midplane of the accretion disc, begin the first steps toward the formation of planets,” Balsara noted.

One of the keys to this process is turbulence. Turbulence causes the motion of solid grains in this circumstellar disc and substantially enhances the efficiency of forming large lumps of material that eventually go on to form protoplanetary cores. The effect is similar to the turbulence air travelers experience

when their jet passes through rough air. Scientists describe turbulent motions as chaotic swirls of gas that permeate all the length scales of the problem and sometimes create eddies and whirlpools.

The largest lumps of matter get richer by drawing in more and more of the surrounding dust—a process that has recently come to be known as oligarchic growth.

Figure 3 shows the final state reached by a collapsing protostar. One clearly sees that a disc has formed around the star. Planet formation takes place in discs like these.

To explain this process in fine detail, Balsara and his postdoctoral researcher, David Tilley, use Notre Dame supercomputers to remove a very small section of that accretion disc and put this section under what might be called a cosmic microscope. If turbulence keeps the dust in the accretion disc swirling lightly, then conditions for planet formation will be just right. In his computer model, Balsara incorporates the effects of a magnetic field, because these fields and turbulence have a profound influence on how gas and dust coalesce to form planets.

Figure 4a shows the gas density in such a simulation with the z-axis indicating the direction in which the dust is stratified. We can see

that the gas is concentrated in the disk’s midplane. Figure 4b shows the turbulent velocity field that develops naturally in the disk. Figure 4c shows the smaller dust grains and we see that they remain buoyant in the turbulence that has developed. Figure 4d shows the larger dust grains that connect much less to the turbulence and, therefore, sink to the midplane of the accretion disc. “The effect is very similar to a small airplane being buffeted around much more than a larger one when both airplanes pass through turbulence,” explains Balsara.

The process that Balsara’s research has uncovered is a first step in forming planets. As dust coagulates, the smaller dust grains become larger and they, too, make their way into the midplane of the accretion disc. Eventually, the concentration of dust is strong enough to cause further gravitational contraction of the dust, growth of the fragments, and formation of a full planet. Rocky planets like our Earth are made up of the coalescence of such dust. Even gaseous planets like Jupiter and Saturn need the initial formation of a rocky core before they can pull in their remaining gaseous material. The process discovered by Balsara and his group seems so natural as to be an inevitable pathway to full planethood. 🌌

Jankó Team Investigates

BLINKING

Phenomenon



Boldizsár Jankó

James Johnson, a graduate student in Prof. Bradley Smith's biochemistry laboratory, is accustomed to observing semiconductor nanocrystals—or quantum dots—twinkle “like stars in the sky” under a fluorescent microscope.

Johnson recalls being surprised when he first encountered this odd behavior in Smith's lab in Stepan Chemistry Hall. It was as if these quantum dots had a mysterious “on” and “off” switch that would randomly flick back and forth. In the quantum world, that neatly sums it up. Johnson is not alone in being puzzled. Anyone who has ever used microscopy to peer deep into the heart of the strange nanoscale world has run into this phenomenon.

The actual cause of this blinking, or luminescence intermittency, has baffled physicists for most of the 20th century. Clearly the phenomenon has its roots in the *Alice in Wonderland* realm of quantum mechanics. It's a world where electrons can jump from one discrete energy level to another without making any transition in between, the basis of the expression “quantum leap.” Scientists have held to the conventional wisdom that the very act of shining a light on a quantum dot to observe it produces an electron “hole.” The theory is that the electron leaves the quantum dot and becomes ionized, and for a while the quantum dot no longer emits light, the idea went.

But that theory is wrong, says Masaru “Ken” Kuno, a Notre Dame assistant professor of chemistry and biochemistry. Kuno has already broken ground

as the discoverer of what is known as the “universal power-law” distribution that mathematically describes the intermittent intervals, or intensity fluctuations, in quantum dots. His early work made him a perfect fit to join a collaboration led by Notre Dame physicist Boldizsár Jankó, who has long dreamed of getting to the root of this blinking behavior.

Jankó’s proposal was accepted by the National Science Foundation’s Nanoscale Interdisciplinary Research Team (NIRT), which awarded the team \$1.2 million to study the phenomenon. The two are joined by James Merz, the Frank M. Freimann Professor of Electrical Engineering and interim dean of the College of Engineering, and Gregory Snider, professor of electrical engineering, who will play key roles in developing a more exacting theory.

Quantum dot blinking is not an obscure problem, but one that bedevils physicists, biologists, and biochemists alike. As Johnson described, “The blinking that is observed with quantum dots can be somewhat troublesome when we biochemists want to track the path of whatever the quantum dot is attached to. Many times there is an interest to see where certain things migrate within a cell.

“If you have a blinking reporter element—the quantum dot—on whatever you are wanting to track—possibly some protein—you cannot be as certain as to where it may be moving around. You may miss some detail about where it went, or what it may have interacted with while the dot was too dim to see,” he said. “Also, in fluorescent microscopy, you focus on a fairly thin plane of whatever you are looking at. Things that are above and below this plane are not readily visible, leaving you with the question of whether your quantum dot may have just simply moved above or below your focal plane, or did it blink.”

The “off” state can last as long as 10 seconds, “which, in the quantum mechanical world, is an eternity,” said Jankó, whose NIRT grant followed on the heels of a recent NIRT grant that focused on development of hybrid materials, such as the submicron-patterned superconductor-diluted magnetic semiconductor bilayers that would utilize the so-called spin of electrons to be used in advanced 21st-century electronics.

At first, one possible use of quantum dots was in the operation of a new breed of supercomputers. Lately these crystals have generated much interest as markers for several biological applications. Semiconductor

quantum dots have several key advantages over fluorescent organic dyes or stains that are commonly used today, thereby permitting biologists to more easily track proteins or viruses invading a cell.

“Fluorescent molecules lose fluorescence over time due to photobleaching,” explained Notre Dame molecular biologist Edward H. Hinchcliffe. Quantum dots are much more photostable. In addition, they can emit many different colors of light that offer researchers a broader range of options for marking cells, parts of cells, viruses, or even organs than red or green fluorescent dyes. These advantages open new opportunities for imaging living cells *in vivo*.

Jankó wants not just to develop quantum dots as a new generation of biological imaging markers, but also to explain the phenomenon. “It has to be something fundamental,” he said. It is a goal sought by many scientists because knowing the cause may one day offer them a way to prevent the brief blackout periods. One possible explanation is that the charge is being lost on the surface of the quantum dot such that it becomes polarized. “Then suddenly you have a very different optical behavior,” Jankó added. “Today, we don’t know how. But, if you know what the problem is, then you are more likely to solve it.”

In the Fitzpatrick Hall of Engineering, Prof. Gregory Snider will perform measurements using a lock-in amplifier, which he describes as “the most sensitive charge detector known.” Snider will look for telltale signals of charge changes in electrical current that may be affected by the presence of nearby blinking quantum dots. “What we hope to do in this project is to see if these electrons are hopping on the quantum dot molecule and if the light goes out,” he said. If that is the case, then researchers should see that charging phenomenon with the electrometer, or single electron transistor.

Prof. Merz will use a Near-Field Scanning Optical Microscope to examine the dot as Snider is using an electrometer. “We will look for a correlated electrometer signal that when the electron leaves, we will also see through the optical microscope and see if the events are correlated,” Snider said.

If the Notre Dame team of experts can overcome technical problems that have plagued other attempts to explain this mysterious blinking, the use of quantum dots to trace the route of a virus into a living cell will become as routine a procedure as the current use of dye markers. 🗨️



Logic Group faculty with current graduate students

Math's Logic Group Among the Nation's Top Ten

The University of Notre Dame has consistently been ranked by *U.S. News & World Report* as one of the top tier of universities, placing 20th in the nation in the magazine's *Best Colleges* edition last August.

Yet, if you look deeper under the magazine category "America's Best Graduate Schools 2007," you will find that the Logic Group within the Notre Dame Department of Mathematics is ranked seventh in the nation.

"They have had this reputation for a very long time," said William Dwyer, department chairman. "This group has had a long tradition of excellence going back certainly to the mid-1970s."

Four faculty members currently comprise this group: Julia Knight, Steven Buechler, Peter Cholak, and Sergei Starchenko.

The National Science Foundation recognized their status among the elite logicians in the country when in 2004 it awarded the group a \$150,000-per-year grant for graduate student stipends. Only five grants were awarded in the country throughout mathematics "so it's a very distinguished award," said Buechler. "The award is about mentoring graduate students. The way we do it is very well designed for

bringing students along and making them feel a part of the math community, even at a very early stage. They are not so much students, but junior members of our group." Because of the strength of this program, recent Ph.D. recipients have landed positions at distinguished universities.

Buechler and Starchenko specialize in model theory, or the study of structures that underlie mathematical systems. Buechler works on abstract geometries, while Starchenko studies foundational questions in the algebra and analysis of complex numbers.

Knight came to Notre Dame in

1977 as a model theorist. She moved into computability, and computable structure theory, in the 1980s. Knight and her students consider computability and complexity in familiar kinds of mathematical structures such as groups, fields, graphs, and linear orderings.

Cholak's specialty within the Logic Group is computability theory, which consistently considers the computational complexity of the solutions of mathematical problems. Its origins began in the 1930s with the work of Kurt Godel and Alan Turing.

The respected *Notre Dame Journal of Formal Logic* publishes papers in both philosophical and mathematical logic. Currently, the editors are Michael Detlefsen, a professor in the Notre Dame Philosophy Department, and Cholak. ±

LOGIC GROUP Ph.D. PLACEMENTS FOR THE PAST 10 YEARS

2006	... Jacob Heidenreich, Assistant Professor, Lorus College	..... Buechler
	... Wesley Calvert, Assistant Professor, Murray State University	..... Knight
2005	... Andrew Arana, Assistant Professor of Philosophy, Stanford University	..... Knight, Detlefsen
2004	... Rebecca Weber, Assistant Professor, Dartmouth College	..... Cholak
2002	... Alexander Berenstein, Doob Assistant Professor, University of Illinois, Urbana	..... Buechler
2001	... Evgueni Vassiliev, Doob Assistant Professor, University of Illinois, Urbana	..... Buechler
2000	... Charles McCoy, VIGRE/Van Vleck Assistant Professor, University of Wisconsin-Madison	..... Knight, Cholak
1999	... Colleen Hoover, Assistant Professor, Saint Mary's College	..... Buechler
	... Stephen Walk, Assistant Professor, St. Cloud State, University	..... Cholak
1997	... Alex McAllister, Young Instructor, Dartmouth College	..... Knight
1996	... Byunghan Kim, Moore Instructor, Massachusetts Institute of Technology	..... Pillay



Standing, left to right: Joanne Wang, Vivek Ratnam, Tan Zou, Yifan Feng, Ang Li, Lily Roberts, and Amardeep Crewal
Sitting, left to right: Dominic Ludovici, Dawn Zhao, Nimit Jain, Harini Srinivasan, Catherine McCarthy, Rochelle Rucker, and Xingping Shen

Notre Dame Hosts Siemens Competition

Some of the nation's brightest high school science students converged on the Notre Dame campus November 10–11 for the Midwest Regional Finals of the 2006–07 Siemens Competition in Math, Science & Technology.

Top honors in the Siemens Competition at Notre Dame went to one individual, Dominic Ludovici, and one team: Catherine McCarthy, Lily Roberts, and Rochelle Rucker.

Ludovici, a senior at University High School in Morgantown, West Virginia, won the individual category and a \$3,000 college scholarship for his project, in which he ran algorithms on data collected from scanning the plane of the galaxy and discovered three new pulsars. McCarthy, Rucker, and Roberts, from Hathaway Brown

School in Shaker Heights, Ohio, won the team category.

Using data collected from the Giant Meterwave Radio Telescope (GMRT) located in Pune, India, Ludovici used two different algorithms to analyze the data, discovering three new pulsars in the process. Pulsars are important because they can offer a testing ground for many physical theories, including Einstein's theory of relativity.

"This student's work is absolutely professional. The research reflects

hours of data analysis and data extraction using complex, numeric algorithms," said Notre Dame Prof. Grant J. Mathews, a judge and director of the Center for Astrophysics. "The discovery of pulsars is almost like finding a new planet, and for this young scientist to have found three is truly remarkable."

Catherine McCarthy, Rochelle Rucker, and Lily Roberts, two seniors and a junior at Hathaway Brown School in Shaker Heights, Ohio, will share a \$6,000 scholarship for their project, which won the team category, analyzing polymers taken from real NASA spacecrafts to determine which materials perform best in low Earth orbit. Their project in the field of materials science has the potential to maxi-

mize the lifespan of future spacecraft. By quantifying the extent of atomic oxygen erosion of a wide variety of polymers that occurred on a low Earth orbit spacecraft, their research results could be extremely valuable to spacecraft designers who decide which polymers to use in their designs.

“We were impressed by each team member’s breadth of knowledge in the field, the quality of their work, and their ability to interpret the results they extracted,” said Notre Dame Prof. Albert E. Miller of the Chemical and Biomolecular Engineering Department, who specializes in

materials science research.

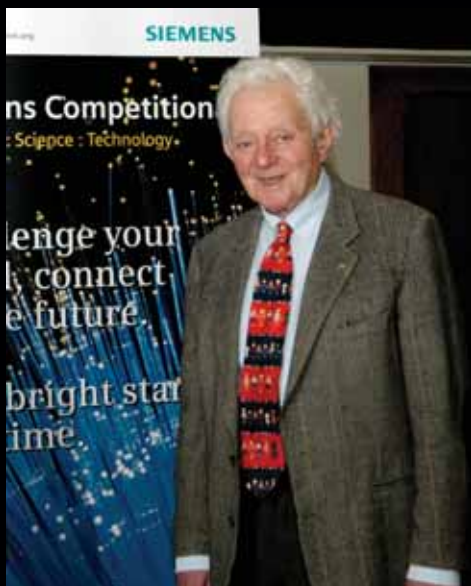
Begun in 1998, the Siemens Competition has become the nation’s premier high school science and math research competition. This year, 1,660 students entered the competition, including two Notre Dame QuarkNet Center students, Kristen Anderson of Bremen High School and Mengwen Zhang of Penn High School. Both seniors were chosen as semifinalists and traveled to the Massachusetts Institute of Technology (MIT) in Boston to present their research.

Their research, which involved the study of the characteristics

of optical fibers, was titled “Performance of Scintillating and Waveshifting Fibers for Particle Detectors.” They did their research during the summer of 2006 under the direction of Dan Karmgard and Mark Vigneault.

Other regional competitions were held at MIT (New England), Carnegie Mellon University (Middle States), Stanford University (West), Georgia Institute of Technology (South), and the University of Texas at Austin (Southwest).

The winners of the Siemens National Finals were announced at New York University on December 4.



Leon Lederman is not one to rest on his Nobel Laureate.

The 84-year-old Lederman has long been a strong advocate of greater public funding for improving science education in America’s schools. His keynote address at the Siemens Competition this year at Notre Dame was his second appearance at competitions held at Notre Dame. Lederman’s address, “Do We Need a New National Commission to Fix Pre-K Through 16 Science Education?” was delivered in the Sargento Family Auditorium of the Jordan Hall of Science.

While serving as the director of the Fermi National Accelerator Laboratory, Lederman was informed in 1988 that he had won the Nobel Prize in physics along with Melvin Schwartz and Jack Steinberger for their discovery in the early 1960s of a key subatomic particle, the muon neutrino.

After retiring from Fermilab the following year, Lederman devoted his energy to drawing attention to the chronic underfunding of science education in American schools. He is cofounder of the Illinois Mathematics and Science Academy (IMSA), a three-year residence public school for gifted children, in Aurora, Illinois, and remains on the academy’s board of trustees. The academy’s advanced residential college preparatory program enrolls 650 academically talented Illinois students in grades 10 through 12. Nearly 21,000 teachers and 52,500 students in Illinois and beyond have benefited from IMSA’s professional development programs and student aid programs.

STANDING OVATIONS

RECENT FACULTY APPOINTMENTS

Steven A. Buechler, professor of mathematics, was appointed to associate dean of Undergraduate Affairs for the College of Science. Since he joined the faculty in 1987, Buechler has held positions in the college as associate chair and associate dean for Research, and the chair of the Mathematics Department. Buechler's research interests are in model theory, a branch of mathematical logic, and bioinformatics.



Kathleen J.S. Kolberg, professional specialist in the Center for Advising in the Health Sciences, has been named assistant dean in the College of Science. She is a member of the National Association of Advisors for the Health Professions and specializes in advising students in the colleges of science and engineering on preparation and admission to health profession schools. Her research interests include newborn intensive



care unit (NICU) environment and care practices and their effect on infants, staff, and families.

Rev. James Foster, C.S.C., M.D., director of the Center for Health Sciences Advising, was appointed assistant dean in the College of Science. He is a member of the National Association of Advisors to the Health Professions and specializes in advising science preprofessional majors. After earning his medical degree from the University of Illinois Medical School and practicing medicine in the western suburbs of Chicago, Fr. Foster entered the Congregation of Holy Cross. After ordination, he completed a fellowship in clinical medical ethics at the MacLean Center for Clinical Medical Ethics at the University of Chicago. He has taught at Notre Dame since 1997.



Mitchell Wayne, professor of physics, has been named chair of the Physics Department. A member of the Notre Dame faculty since 1991, Wayne previously held the position of associate dean



for Undergraduate Affairs. He has received the Shilts-Leonard Teaching Award and the Kaneb Teaching Award. His current research includes the study of proton-proton collisions at Fermilab, proton collisions at 14 TeV, CMS collaboration at CERN, and a proposed international linear collider.

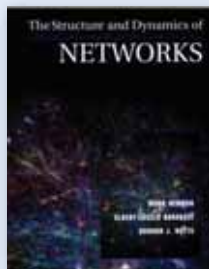
Michelle Whaley has been appointed as the Undergraduate Research Program coordinator for the College of Science. In her new role, Whaley will work through the Center for Health Sciences Advising to assist undergraduate students in finding research opportunities. A member of the biology faculty since 1993, Whaley has coordinated the NSF Research Experience for Undergraduates (REU) program for over 10 years. Additionally, she advises the Biology Club, which received the 2005–06 Academic Club of the Year for numerous improvements and community collaborations.



FACULTY ACCOLADES

Albert-Lászlo Barabási, the Hofman Professor of Physics, was named the recipient of the John von Neumann Medal. He is also the co-editor of a new book, *The Structure and Dynamics of Networks*.

The award is presented by the Hungarian-based John von Neumann Computer Society for outstanding achievements in computer-related science and technology. The award has been presented since 1976 to



a maximum of three individuals who have gained distinction in the dissemination of computer culture. Previous recipients of the award include Microsoft founder Bill Gates; former IBM chairman Louis Gerstner; and Intel Corporation board chair Andrew Grove.

The book brings together a series of articles from the fields of mathematics, physics, computer science, sociology, and biology that examine the new science of

networks. Topics covered in the papers range from the historical antecedents of network research to the robustness of networks and the spread of disease.

Harvey Bender, professor of biological sciences and director of the Human Genetics Program, has been named a "Distinguished Hoosier" by Indiana governor Mitch Daniels. The award, one of the highest honors given by the state to its citizens, was presented to Bender by Joseph C. Zakas, Indiana state senator, on

STANDING OVATIONS

July 18. Bender has been a member of the Notre Dame faculty since 1960. His present research involves human developmental genetics and the epidemiology of human genetic disease.

Mathematics professor Frank Connolly received a \$1.45 million grant from the National Science Foundation (NSF), which will be instrumental in guiding undergraduate students toward careers in math.



The grant, which supports sophomores, juniors, and seniors in the Honors Mathematics Program, has already enabled the expansion of the honors program from six to 13 students this fall semester. The grant will also pair undergraduates with graduate students in seminars that explore new topics in mathematics.

Crislyn D'Souza-Schorey, the Walther Associate Professor in Biological Sciences, received the \$30,000 Michael K. Guest Award for Innovative Research from the Walther Cancer Institute in November 2006. Schorey's research is devoted to both the understanding of the cellular processes that lead to the initiation and progression of cancer and the molecular basis of neurodegenerative disorders.

Michael Ferdig, assistant professor of biological sciences, received the Young Investigator Award at the 54th annual meeting of the American Society of Tropical Medicine and Hygiene. Ferdig's research focuses on genetics and genomics of drug resistance and virulence in the malaria parasite.

Malcolm Fraser Jr., professor of biological sciences, has been awarded the distinction of Fellow by the American Association for the Advancement of Science (AAAS) for distinguished contributions to genetics and transgenesis, specifically in the discovery, development, and dissemination of the *piggyBac* transposable element and derived transgenic vector system. The Fraser laboratory is developing a new approach to control dengue fever using genetically modified mosquitoes. Fraser is investigating novel strategies to modify *Aedes aegypti* in a manner that will insure propagation of

the engineered molecular mechanism for eliminating dengue in endemic areas. His work is being funded by a \$2.5 million grant from the Grand Challenges in Global Health initiative.

Matthew J. Gursky and Xiaobo Liu, professors of mathematics, were invited speakers at the International Congress of Mathematicians, held Aug. 22–30 in Madrid, Spain. The Congress is held once every four years and features the awarding of the Fields Medals, the highest honor in mathematics. Gursky presented "Conformal Invariants and Nonlinear Elliptic Equations" in a section on "Partial Differential Equations." Liu spoke on "Gromov-Witten Invariants and Moduli Spaces of Curves" in the geometry section.



Jessica Hellmann, assistant professor of biological sciences, was awarded the 2006 Career Enhancement Fellowship for Junior Faculty by the Woodrow Wilson National Fellowship Foundation. The foundation assists talented junior faculty pursue scholarly research and writing during the fellowship year. The award is granted to 20 individuals each year from applications across science, social science, and humanities. Hellmann is studying the diversity of ways in which local and regional climatic effects are altering population dynamics.



A. Alexandrou Himonas, professor of mathematics and assistant chair in Mathematics, received the Shilts/Leonard Teaching Award for the academic year 2005–06. Himonas joined the Notre Dame faculty in 1989 and specializes in the regularity of solutions to linear partial differential equations (PDE)

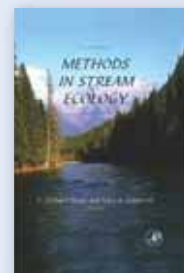


and in the Cauchy problem for nonlinear evolution equations.

Prashant Kamat, professor of chemistry and biochemistry, received the inaugural Lectureship Award from the Japanese Photochemistry Association (JPA) at the JPA annual meeting on September 9 in Sendai, Japan.

His research was highlighted in a September 16 article in *The Economist* on improved devices for converting sunlight into electricity. He and his team are developing a technique to make the most of the power generated by the sun. The technique involves using the carbon nanotube, a cylinder composed solely of carbon atoms.

Gary Lamberti, professor of biological sciences, has co-edited the second edition of the book *Methods in Stream Ecology*. The book presents the latest techniques for calculating various aspects of rivers and streams, including water flow, nutrients, water quality, geology, geomorphology, and living organisms such as crustaceans, common stream fishes, algae, and bryophytes. The detailed instructions, illustrations, formulae, and data sheets for conducting stream ecology were flexibly designed to be used not only in the classroom but also in field-based laboratories, community-based monitoring programs, and research studies.



Mijoon Lee, postdoctoral research associate in chemistry and biochemistry, received the Dr. Karl R. Ruddell Scholarship from the Walther Cancer Institute of Indianapolis. The late Dr. Ruddell was a skilled surgeon who stressed scholarship and training for medical researchers. Lee joined the Mobashery cancer metastasis project in 2003 and has focused on two enzymes, matrix metalloproteinase-2 and -9 (MMP-2 and -9), which have emerged as culprits in many cancer metastases.

David Lodge, professor of biological sciences, is part of a scientific team that recently received a \$1.1 million grant from the Great Lakes Protection Fund to

STANDING OVATIONS

STUDENT AWARDS AND RECOGNITION

improve ecosystem-wide management of invasive species in the Great Lakes and adjacent inland water bodies. He is also a part of a collaboration involving the Nature Conservancy's Great Lakes Program, University of Georgia researchers, and other private and public partners.

Associate Dean Joseph O'Tousa's general biology course (BIOS 20201) was identified as one of the top examples of best practices in a national study of biology courses conducted by the Center for Educational Policy Research (CEPR) on behalf of the College Board. A total of 149 courses from across the nation were reviewed. Kristin Lewis teaches the laboratory portion of the course. Lewis' laboratory plans and testing schemes were included in the materials that were provided to the CEPR. The goal of the study was to ensure that AP courses reflect the best of college teaching.

Philip Sakimoto, professional specialist in the Department of Physics, has been appointed by the National Research Council of the National Academies to serve on a 12-member study committee charged by Congress with evaluating the NASA precollege science, mathematics, and technology education program.

Rev. Thomas G. Streit, C.S.C., M.D., director of the Haiti Program, has been named to the inaugural class of ambassadors in the Paul G. Rogers Society for Global Health Research. Because of the measured success of the Haiti program, in 1999 the Gates Foundation awarded Notre Dame a five-year, \$5.2 million grant to research, treat, and eliminate lymphatic filariasis in Haiti. The Haiti program has already delivered more than 2.5 million treatments for filariasis and related conditions.

Rev. Joseph Walter, C.S.C., M.D., received the Central Association for Advisors to the Health Professions Award for outstanding advising at the National Association for Advisors to the Health Professions conference in June 2006 in Portland, Oregon.

Stephen Atwood '07 is the 2006–07 Robert P. Balles University of Notre Dame Mathematics Scholar. The award is presented to the senior honors math major with the highest cumulative grade point average in math courses completed at Notre Dame.



Julian Bigi '07 received the Norbert Wiech Chemistry Award last spring for excellence in research and academics. The award comes with a \$500 scholarship. Bigi also received a Wiech fellowship in 2005. Now a senior with a GPA of 3.98, Bigi is continuing his studies with Prof. Seth Brown on titanium complexes and intends to pursue graduate studies to conduct research on biofuel cells that use enzymes instead of expensive metal catalysts, like platinum, to drive chemical reactions.



Adam Booher '08, an honors mathematics major, received a Barry M. Goldwater Scholarship, which is awarded to highly qualified students who plan to pursue careers in math, science, and engineering. He is a participant of SUMR (Seminar for Undergraduate Mathematical Research), an enhancement of the honors mathematics track for undergraduates. He is already taking graduate courses in mathematics and was the only first-year student ever invited into the SUMR program at Notre Dame in 2005.



Amanda Cinalli '08 received the 2006 Mike Russo Character Award from the Alumni Association for her achievement, service to the Notre Dame community,

and strength of character. A preprofessional major from Ohio, Cinalli is a strong player on the Notre Dame soccer team and a dedicated volunteer at the Robinson Community Learning Center and at Memorial Hospital in the pediatrics unit.

Michelle Evans-White was selected as the 2006 recipient of the Eli J. and Helen Shaheen Graduate School Award in Science from the University of Notre Dame. This award is given annually to one graduate student in the College of Science who defended in the previous year and who demonstrated exemplary scholarship in both research and teaching as a Ph.D. student.

Graduate students Laura (Taylor) Johnson and Sally Entekin were awarded NABS Endowment President's Awards to support their research in aquatic ecology.

Outstanding Teaching Awards for 2005–06 were awarded by the Kaneb Center for Teaching and Learning to graduate teaching assistants James Whitcomb, Reuben Keller, Sarah Mordan-McCombs, Kelly Lane, Shane Fimbel, and David Choate.

ALUMNI NOTES

Christopher DeStephano '06, an outstanding pre-professional studies alumnus, received the Dean's Award and the Joseph L. Walter, C.S.C., Award at the College of Science awards ceremony in May 2006. He is currently attending the Mayo Clinic Medical School on a full scholarship.

Lauren Pallone '06, biological sciences major and science, technology, and values minor, received several medical school admissions offers and chose to attend Robert Wood Johnson Medical School on a full scholarship.



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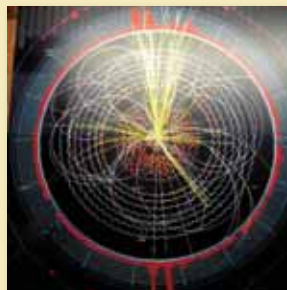
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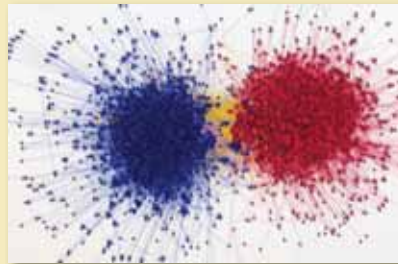
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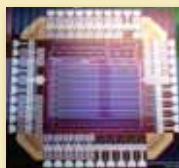
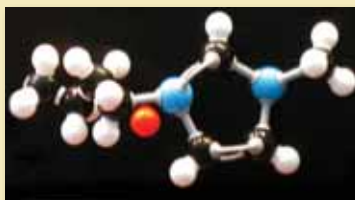
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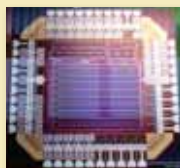
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Clockwise from upper left:

1. Notre Dame junior Nathan Serazin recently served the people of Ecuador through the International Summer Service Learning Program.

2, 4. University representatives visited children in a Millennium Village in Kenya.

3. Rev. Thomas Streit, C.S.C. director of the Notre Dame Haiti Program, speaks with local Haitians. The program seeks to eliminate lymphatic filariasis and other diseases of poverty.

5, 6. Tim Lyden, assistant director of the Notre Dame Millennium Development Initiative, visited local schoolchildren at a Millennium Village in Uganda, where Notre Dame will focus its resources.

7. The Notre Dame Haiti Program educates Haitians about available treatments. More than 2.5 million treatments for filariasis and related conditions have been delivered by the program so far.

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