2015 • Volume XV

CASPER

Astrophysics & Space Science Theory Group • Early Universe Cosmology & Strings Group
Gravity, Cosmology & Astroparticle Physics Group • Hypervelocity Impacts & Dusty Plasmas Lab
Space Science Lab • Meyer Observatory

CASPER researchers benefit from highly productive international collaborations

New and continuing CASPER research partnerships span multiple continents.

International collaboration is a core CASPER principal that first became cemented in the Center's operations in 2007 when CASPER director Dr. Truell Hyde was introduced to Dr. Hans-Peter Roeser of the University of Stuttgart's Institute for Space Systems (IRS). Only a year later Roeser accepted an invitation to Baylor to conduct a colloquium and the groundwork was laid for an international research and educational relationship that blossomed from the very start.

Roeser soon dispatched Rene Laufer, one of his top young engineering students, to CASPER to share in research. Laufer earned his Ph.D. from the IRS (with Hyde sitting as an outside reader) and now serves as an assistant research professor at Baylor. In addition to administering CASPER's continuing collaboration with Stuttgart/IRS and heading up CASPER's Space Science Laboratory, Laufer mentors a dozen or more German graduate exchange students each year.

Additional relationships with other University of Stuttgart/IRS researchers followed, including thermodynamicist Dr. Georg Herdrich, who developed technologies key to CASPER's inductively-driven plasma generator (see page 2), and Dr. Ralf Srama who heads the Cosmic Dust Group at IRS. Both scientists are now adjunct CASPER faculty researchers.

CASPER faculty Dr. Truell Hyde, Dr. Lorin Matthews and Dr. Anzhong Wang also collaborate on a regular basis with other international colleagues from around the world. Drs. Hyde and Matthews are currently working with Dr. Gerhard Wurm and his students at the University of Duisberg-Essen on the impact of photophoresis on basalt microparticles under microgravity and with Dr. Nilakshi Das of Tezpur University in India on the formation of extended particle chains in complex plasmas.

Dr. Anzhong Wang has brought a number of eminent Chinese researchers to Baylor for closer collaboration on several key projects.

Dr. Anzhong Wang

Most recently, in August, adjunct CASPER researcher Professor Jianxin Lu traveled to Waco from his appointment at the University of Science and Technology of China to continue their joint work on black hole physics.

This October, Professor Xun Xue, a researcher at Southwest Normal University, visited CASPER to work with Dr. Wang on anti-de Sitter spacetime/conformal field theory (AdS/CFT) correspondence.

Planned for the near future, Professors Hongwei Yu of Ningbao University and Zohgheng Zhu of Beijing Normal University will come to CASPER to collaborate on research into cold atoms and quantum effects in the very early universe.

The Center's international collaborations today encompass an array of disciplines and institutions in China, Russia, India, Canada, Brazil, Germany, Greece and Hungary, and boast an extensive roster of internationally esteemed investigators that includes CASPER's trio of distinguished new assistant directors of research, Drs. Peter Hartmann, Oleg Petrov and Vladimir Nosenko (see story on page 9). Credit that early Stuttgart partnership for sparking a spirit of collaboration that has quickly grown to permeate CASPER's very culture.

In This Issue

CASPER inductively-driven plasma generator (IPG) expands capabilities.

For more than four years, CASPER researchers have worked to reveal the inner workings of nature's fourth state of matter using the Center's induction-driven plasma generator (IPG).

IPGs are used to create plasmas from a variety of gases, which are selected specifically for the type of research being done. Researchers studying plasmas that form around a spacecraft as it reenters the Earth's atmosphere would inject air into the IPG, for example. A similar study for Mars-bound spacecraft would use a gas mixture approximating the Martian atmosphere, which is 96 percent carbon dioxide. Scientists most often use the inert gas argon to produce plasmas that won't readily react to form chemical compounds that could compromise their data.

The original configuration of CASPER's IPG – technically an "IPG6-B" (the "B" is for Baylor) – was modeled after a scaled-back version of a more powerful IPG3 operating at the University of Stuttgart's Institut für Raumfahrtsysteme (Institute for Space Systems). That first IPG6-S (for Stuttgart) was adapted by a team of German researchers that included aerospace engineer Dr. Georg Herdrich, space sciences engineer Dr. Rene Laufer, and graduate student Michael Dropmann.

Today Herdrich is a CASPER adjunct researcher and Laufer heads CASPER's Space Sciences Laboratory. Dropmann is now a resident researcher and doctoral candidate at CASPER who organizes and conducts experiments with the IPG.

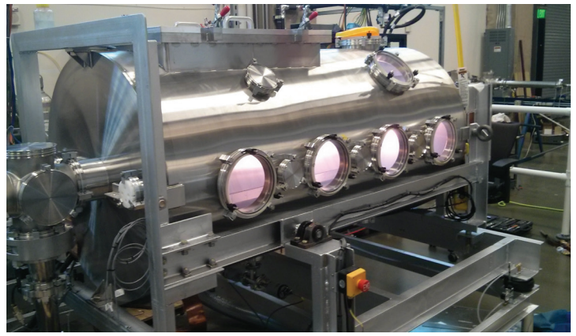
In 2011, Dropmann carried design drawings for the IP6 to Baylor and worked more than a year with CASPER technicians Jimmy Schmoke and Mike Cook on the initial version of CASPER's IPG only to have his student visa expire before he got to see it operate.

"I was working to optimize the (plasma generator) design but had to leave and go back to Germany before it was finished. So I missed 'first light,'" he said, using a term researchers use to describe the first time a scientific instrument is powered up. "That happened a few weeks after I left."

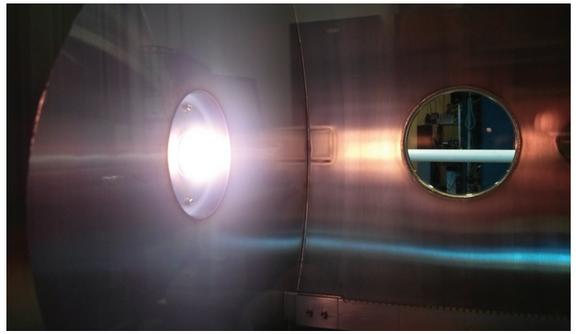
Though less powerful than its IPG3 predecessor, CASPER's IPG6-B bears some notable features of its own, including an operating frequency that is three times higher and an improved plasma injector.

The IPG generates plasma by using radio frequency energy to excite a stream of gas atoms or molecules that has been injected into the device. The atoms and molecules become so energetic that electrons tear away from their bound orbits. An intense magnetic field accelerates the resulting charged particles into a torrent that ultimately surges into a large, cylindrical vacuum chamber where the plasma can be observed and measured. The first version of CASPER's IPG utilized a carbon steel vacuum chamber repurposed from a Van de Graf generator used in the lab.

At that time, CASPER's experimental groups were based in facilities at Texas State Technical College Waco, a few miles up I-35. The TSTC lab was shuttered in the fall of 2012 in preparation for



CASPER IPG 6-B



IPG 6-B in operation

relocation to the Baylor Research and Innovation Collaborative (BRIC) in January of 2013. That move brought all the CASPER groups under one roof for the first time.

Even as the CASPER lab was being readied for the move to the BRIC, work was underway on the current version of the IPG 6-B, which would be a much more versatile scientific instrument. Most notably, a new vacuum chamber was being designed by CASPER director Truell Hyde and research technicians Jimmy Schmoke and Mike Cook. It would be larger, more symmetrical, have an in-line vacuum pump and include up to a dozen instrumentation access ports and eleven optical viewing ports to allow researchers to observe the plasma jet during experiments — a vast improvement over the original chamber's single viewing port.

When the gleaming new stainless steel chamber arrived from the California manufacturer, however, it was just a shell. It was up to Schmoke and Cook to install all the electrical and communications cabling, mounting flanges, gas and water lines and other equipment before the new and improved IPG could be used. It was an intensive process that took the two technicians ten months to accomplish.

[continued on next page]

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"It was a major challenge to get it all done," said Schmoke. "People don't realize how difficult the simplest jobs can be on a piece of scientific equipment. Even running diagnostics cables has to be done exactly right to make sure interference from other systems won't affect the data the cables are carrying. It can take days or weeks to do the simplest jobs." Technician Mike Cook pointed out another innovative feature of the new chamber.

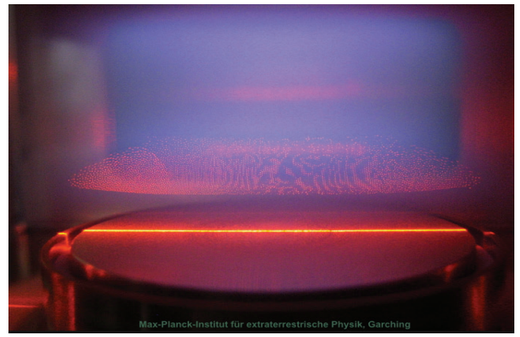
"The set-up on the old machine had the generator mounted on the top shooting vertically down. On the new machine the generator is horizontal because we set it up that way. But eventually we'll be able to raise it completely vertical or hold it at any angle in between vertical and horizontal."

Future improvements will give the IPG even greater ability to determine the electrical profiles of plasmas in detail, as well as their electron and ion densities. The first of these is a more advanced probe currently under design that will allow researchers to move instruments around within the vacuum chamber in three dimensions.

International Space Station laboratory completes probe of plasma crystals

Adapted with permission from an item by Rebecca Boyle, International Space Station Program Science Office.

One of the most frequently used physics laboratories on the International Space Station recently completed its final set of experiments. The Plasma Kristall Experiment (PK-3 Plus) lab, a Russian-German cooperation in operation since January 2006, has provided new insight into an unusual type of matter called plasma crystals. Recently appointed CASPER assistant directors of research, Dr. Oleg Petrov and Dr. Vladimir Nosenko have been central members of the PK-3 Plus team since its inception.



PK-3 Plus Plasma Kristall

Though the experiments came to a close on June 14, 2014, the research continues to open an exciting world of potential technological spin-offs. The unique environment of microgravity allows physicists to study how these crystals form inside dusty plasmas — a unique form of matter found throughout the cosmos — in ways not possible on Earth.

The PK-3 Plus investigation was designed to create dusty plasmas containing argon or neon gas as well as small, micron-size particles. A radio-frequency discharge device ionizes the gas molecules so they form a plasma; particles are then injected into it. A laser lights them up and a camera records what happens as the particles move through the plasma and organize into crystalline structures. Basic experiments were designed to test a wide range of particle sizes and different gas types, giving researchers a plethora of interesting new phenomena.

Results from PK-3 Plus eventually could be used in agriculture, medicine and hygiene. Indeed, plasma has already shown itself to have unique and highly useful properties.

Because it is a gaseous state, plasma can disinfect surfaces quickly and efficiently, even neutralizing drug-resistant bacteria like MRSA in a few seconds.

Other studies have shown that in concert with chemotherapy, plasma efficiently fights cancer, boosting cancer cell inactivation by up to 500 percent compared to chemotherapy alone. Plasma can even jump-start plant growth.

But as with many areas of scientific investigation, the exact transfer from basic research in dusty plasma physics to applications on Earth is difficult to predict and often occurs in unexpected ways, which points up the importance of funding basic research without imposing application-oriented restrictions.

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Astrophysics & Space Science Theory Group (ASSTG)
Space Science Lab (SSL)
Hypervelocity Impacts & Dusty Plasma Lab (HIDPL)

46th Lunar and Planetary Science Conference

Members of the ASSTG/SSL/HIDPL team attended the 45th Lunar and Planetary Science Conference, March 17–21, 2014, in the Woodlands, Texas. Attending from Baylor were Truell Hyde, Lorin Matthews, Michael Dropmann, Rene Laufer and former REU student Jesse Kimery. The group presented the following posters:

Lunar Swirls and Plasma Magnetic Field Interaction in the Laboratory, authors: M. Dropmann, R. Laufer, R. Herdrich, L.S. Matthews and T.W. Hyde.

Photophoretic Force on Fractal Aggregates in a Protoplanetary Disk, authors: J.B. Kimery, L.S. Matthews and T.W. Hyde.

Lunar Swirls and Plasma Magnetic Field Interaction in the Laboratory, authors: M. Dropmann, R. Laufer, G. Herdrich, L.S. Matthews and T.W. Hyde.

56th annual meeting of the American Physical Society's Division of Plasma Physics

October 27-30, 2014, Dr. Truell Hyde led a delegation of Baylor researchers and graduate students to the 56th annual meeting of the American Physical Society's Division of Plasma Physics in New Orleans, Louisiana. Attendees included Truell Hyde, Lorin Matthews, Jorge Carmona-Reyes, Jie Kong, Ke Qiao, Michael Dropmann, Razieh Yousefi, Bo Zhang and Mudi Chen. The group displayed three posters and conducted eight presentations:

Measurement of Interbundle/Interstring Forces in Vertically Aligned Dust Particle Systems, authors: T. W. Hyde, J. Kong, O. Petrov, B. Zhang, and L. S. Matthews.

Dust as In-Situ Probes for Plasma Magnetic Field Interactions in a Dusty Plasma, authors: M. Dropmann, R. Laufer, G. Herdrich, L. S. Matthews, and T. W. Hyde.

Dust particles as probe in a complex plasma, authors: R. Yousefi, A. Davis, J. Carmona-Reyes, L. S. Matthews, and T. W. Hyde.

The Potential Field within a Biased Indium Tin Oxide Glass Box Located in a Dusty Plasma Environment, authors: J. Carmona-Reyes, L. S. Matthews, and T. W. Hyde.

Small Dust Cluster Probes within a Dusty Plasma, authors: J. Kong, K. Qiao, L. S. Matthews, and T. W. Hyde.

Mode Coupling and Resonance Instabilities in a Dust Chain, authors: K. Qiao, J. Kong, L. Matthews, and T. W. Hyde.

Discrete Stochastic Charging of Dust Aggregates Immersed in Plasma, A. Haines, L. S. Matthews, B. Shotorban, and T. W. Hyde.

Measurement of the Charge Reduction and Asymmetrical Interaction Force Created by the Ion Wakefield in a Dusty Plasma, author: M. Chen, R. Yousefi, J. Kong, K. Qiao, J. Carmona-Reyes, L. S. Matthews, and T. W. Hyde.

Using Dust Particle Clusters as Probes for Mapping Trapping Potentials in Complex Plasmas, authors: B. Zhang, J. Kong, L. S. Matthews, T. W. Hyde.

A Seven-Year Longitudinal Study of the Research Outcomes for the CASPER Physics Circus, authors: J. Carmona-Reyes, A. Land-Zandstra, G. Stark, L. Tarman, M. Menefee, L. Wang, M. Cook, J. Schmoke, L. S. Matthews, and T. W. Hyde.

Characterization of the Inductively Heated Plasma Source IPG6-B, authors: M. Dropmann, R. Laufer, G. Herdrich, L. S. Matthews, and T. W. Hyde.

Astrophysics & Space Science Theory Group
Space Science Lab
Hypervelocity Impacts & Dusty Plasma Lab

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Faculty and Staff

Truell W. Hyde
Lorin S. Matthews
Jie Kong
Ke Qiao
Rene Laufer
Michael Dropmann
Oleg Petrov
Peter Hartmann
Vladimir Nosenko
Ray Nazzario
Jorge Carmona-Reyes
Michael Cook
Jimmy Schmoke

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John Fitch
Georg Herdrich
Rainer Sandau
Ralf Srama
Marlene Rosenberg
Sean Casey
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Christoph Montag
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Jesse Cadenhead
Kyle Carter
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Wendy George
Jeff Lam
Tyrell McSpadden
Nicole Sohns

Experimental Astronomy

Group Members

Faculty

Dwight Russell
Dick Campbell

Gravity, Cosmology & Astroparticle Physics Group

GCAP director Dr. Anzhong Wang served as co-chair of the local organizing committee for the Hangzhou International Workshop in Gravitation and Cosmology, September 3-7, 2014, in Hangzhou, China.

In addition, he took part in the Summer School of Gravity, String and Cosmology, at Lanzhou University, in Lanzhou, China, July 12 - 20, 2014, giving a series of four talks on the theme Quantum Gravity at Lifshitz Fixed Points: An Overview.

Dr. Wang also delivered a plenary talk on precision cosmology and quantum effects in the very early universe at the annual meeting of the Chinese Gravitational Physics and Astrophysics held July 7-12, 2014, in Zhangzhou, China, and attended the Cross Strait Workshop in Particle Physics and Cosmology in Hefei, China, May 4 - 10, 2014, at which he gave a plenary talk on gravitational quantum effects in the very early universe.

The Early Universe Cosmology and Strings Group

EUCOS welcomed three new members this year, Adjunct Research Professor Jeff Lee, graduate student Andy Lawler, and undergraduate student Robert Gil.

Jeff Lee joined EUCOS in March, 2014. During a summer visit to Baylor he became an Adjunct Assistant Professor of CASPER. Lee received his Bachelor of Science in Physics from York University in Toronto, Ontario, where he was awarded the Denise Hobbins Prize for Physics. His Master of Science in Physics is from the University of Windsor in Windsor, Ontario, where he investigated laser-induced fluorescence spectroscopy.

Concurrently, Lee did graduate work in Applied Human Biomechanics. He is a tenured faculty member of Crescent School in Toronto, Ontario, where he lectures on physics and earth and space sciences. His areas of research are quantum black holes and relativistic radiation and thermodynamics. Additionally, Lee retains research interests in the field of Instructional Strategies for Students with High Functioning Autism.

During his four-week visit to Baylor this summer, Lee and Dr. Cleaver collaborated on three papers: *The Inability of the White-Juday Warp Field Interferometer to Spectrally Resolve Spacetime Distortions, Effects of External Radiation on an Alcubierre Warp Bubble, and Ultra-relativistic Thermodynamics and Aberrations of the Cosmic Microwave Background Radiation.* All were submitted to appropriate journals and are under review.

Andy Lawler, a Ph.D. candidate in statistics at Baylor University, is pursuing astrostatistics research using time-series analysis. Lawler has always maintained a keen interest in astronomy and mathematics. As a high school student in rural Ohio, he bought his first Newtonian telescope, participated in dark sky events and attended lecture series hosted by the Miami Valley Astronomical Society in Dayton, Ohio. Lawler then moved to New York City and attended CUNY Baruch College as a Macaulay Honors College student, where he graduated magna cum laude with degrees in English literature and mathematics.

In the spring of 2014 Lawler participated in a series of astrostatistics workshops lead by astronomer David Hogg of New York University. He then attended the week-long La Serena School of Data Science: Applied Tools for Astronomy in Chile and gained exposure to techniques in time-series analysis, machine learning and astronomical image processing.

Robert Gil became interested in physics his junior year of high school during his first physics class. Gil has always been interested in how and why things work the way they do. From an early age he would often take apart his parents' old appliances. He chose physics as a major out of a desire to learn how the universe works. Gil grew up in a military family and so has traveled quite a bit internationally, including living in Korea for two years.

During his 2014 sabbatical Dr. Jerry Cleaver, head of EUCOS, spent two months at NASA-Johnson Space Center in Houston examining the breakthrough propulsion projects of the Engineering and Propulsion (EP) division's Eagleworks Lab. He was a member of a Blue Ribbon Panel assigned to evaluate both the validity of the hypothesized physical basis behind NASA-JSC's "Quantum Thruster" program and its experimental viability. Cleaver was invited to be a member of the Blue Ribbon Panel because of his past theoretical study with now graduated Ph.D. student, Richard Obousy, and current phenomenological examinations of the proposed Alcubierre warp drive (AWD), another focus of NASA's breakthrough propulsion research.

Gravity, Cosmology & Astroparticle Physics (GCAP)

Group Members

Faculty and Adjunct Faculty

Anzhong Wang
Qin (Tim) Sheng
Rong-Gen Gai
Yumei Wu
Yungui Gong
Klaus Kirsten
Nilton Oscar Santos

Graduate Students

Bao-Fei Li
Xinwen Wang
S.V. Honnappa

Early Universe Cosmology and Strings

Group Members

Faculty and Adjunct Faculty

Gerald Cleaver
Jeff Lee

Graduate Students

Andrew Lawler
Yanbin Deng
Brandon Mattingly

Undergraduate Students

Drake Gates
Robert Gil

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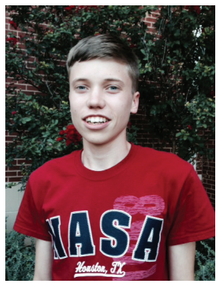
Graduate students attend prestigious conference

Two Baylor graduate students, Yanbin Deng and V. H. Satheeshkumar, attended the Prospects in Theoretical Physics summer school June 16-20 at the Institute for Advanced Study in Princeton, New Jersey.

The two heard lectures from a who's who of string theorists, including Nima Arkani-Hamed, Juan Maldacena, Alexander Polyakov, Nathan Seiberg and Edward Witten. The two also attended the Strings 2014 conference at Princeton held June 23-27. Satheeshkumar was awarded a housing grant by the organizers of the conference.

Satheeshkumar also co-authored a paper on string theory over the summer with former classmate and now CASPER alumnus, D. G. Moore. The paper, *Spectral dimension of bosnonic string theory*, was published in Physics Review, D 90.

CASPER High school research assistant participates in NASA-sponsored Texas High School Aerospace Scholars program



Alexander Good-Suhm, now a senior at Waco's Rapoport Academy Meyer High School, participated in NASA's week-long Texas High School Aerospace Scholars (HAS) program this past summer. Nominated by Texas State Representative Doc Anderson, Good-Suhm was one of 260 high school juniors selected from across Texas to take part. He has worked as a research assistant at the BRIC for the past two summers under the mentorship of Dr. Lorin Matthews, a Baylor physics professor and CASPER associate director.

Good-Suhm and his fellow participants traveled to NASA's Johnson Space Center (JSC) in Houston where they toured facilities, heard briefings by NASA experts and presented their jointly developed proposal for a mission to Mars before a gathering that included their parents, members of the Texas Legislature, representatives of the Houston Livestock Show and Rodeo, Rotary Club and JSC senior management.

Established in 1999 as a partnership between the state of Texas, JSC and the Texas educational community, HAS encourages students to pursue studies and careers in science, technology, engineering and mathematics, known as the "STEM" disciplines. More than 7,700 Texas students have taken part in the program.

Good-Suhm garnered additional recognition in October when the National Merit Scholarship Program named him a "Commended Student" for 2015, placing him among the top 5 percent of the 1.5+ million students who competed in the program.

Good-Suhm plans to study physics upon graduation.

High-achieving local twins take part in High School Science Scholars Program at CASPER

photo credit Rod Aydelotte

Like all identical twins, Abbey and Caroline Haines share many traits, interests and goals. For these two, though, it is a passion for learning that unites them.

When they graduated salutatorian and valedictorian (respectively) of nearby China Spring High School's Class of 2014 last May, they applied for the Baylor University Summer Science Research Program sponsored by the College of Arts and Sciences. The program gives superior students hands-on research experience by working on genuine projects with Baylor science professors in many disciplines.

Abbey worked in the CASPER plasma lab with Dr. Truell Hyde, and in the CASPER theory group with Dr. Lorin Matthews using the GEC RF reference cell and CASPER numerical algorithms to study the effects of stochastic charging on cosmic dust aggregation.

Caroline teamed with Dr. Dwight Russell and Mr. Dick Campbell using the Paul and Jane Meyer Observatory's research-grade 24-inch Cassegrain telescope to record *exoplanets* — planets beyond our solar system — as they race across the faces of the immensely distant stars they orbit.

The two are now freshmen at Baylor laboring under the watchful eye of a certain Baylor faculty member they call "Dad," economics lecturer Thomas S. Haines, Jr.

Brett Biddington

Adjunct Professor at the Security Research Institute in the School of Computer and Security Science at Edith Cowan University in Perth, Western Australia

Space Activities in Australia: Challenges, Opportunities and Responsibilities.

Abstract: Dr. Biddington is a member of the Order of Australia and founder of a Canberra-based consulting company specializing in space and cyber security matters. Space systems lie at the heart of Australia's alliance relationship with the United States. They are pivotal to our national strategy yet rarely discussed in these terms. At the operational level, the workhorse applications of space - communications, Earth observation and position, navigation and timing (PNT) are increasingly understood as elements of virtual critical infrastructure on which the whole world depends. The nature and utility of these systems, is not well known or understood, nor are the associated vulnerabilities.

Biddington described Australia's space journey and explained how Australia's location and geography are opening new possibilities for space development, some of which may be vital to the security of the space environment into the future. He said national alliance and global security interests are converging in interesting and challenging ways.

Dr. Peter Hartmann

CASPER & MTA, Hungary

Using Dusty Plasmas to Study Deformations of Crystalline Solids

Abstract: Laboratory dusty plasmas are complex systems consisting of micrometer sized solid grains immersed in an electrical gas discharge. The dust grains charge up negatively and levitate between the electrodes due to the interaction with the background plasma and the electric field within. Often the strong electrostatic repulsion between the grains dominates the dynamics over the random thermal motion. Using mono-disperse powder and a plane-parallel electrode radio frequency discharge, one can easily form stable single layer (2D) crystalline structures (triangular lattices) that consist of thousands of grains and have characteristic distance and time scales easily observable by video microscopy or even by the unaided eye. These strongly coupled, many-particle systems are ideal experimental model systems to study collective processes (deformations, phase transitions, wave propagations, transport processes, etc.) *in situ* on the level of individual particles. Recently we have realized a slow shearing creep deformation experiment and have measured the exponents of the shear stress–shear rate and the shear stress–dislocation density relations, and have demonstrated that the creation of dislocation pairs, the rapid (partly supersonic) glide and annihilation of dislocations are the dominant microscopic processes, consistent with the Harper-Dorn creep model. As a long-term consequence, the shapes of the crystalline domains become elongated parallel with the shear. The main purpose of this talk was to convince the audience that dusty plasmas can be useful tools to uncover the microscopic details of macroscopic processes in condensed matter, and to build interdisciplinary bridges to the benefit of both the material science and the dusty plasma communities.

Dr. Gary Lum

Lockheed Martin Engineering Fellow, Lockheed Martin Space Systems Company

Survival of Electronics in a Space Environment

Abstract: Dr. Lum supports both satellite and missile programs in radiation testing and in risk assessment analyses of electronic components. This involves deriving the radiation environment for the system, transporting the environment into a package and assessing the radiation impact for the system and making recommendations for hardening solutions.

In his CASPER appearance, Dr. Lum lectured on the survival of electronics in a space environment, first describing the radiation environment of space, and then covering the interaction of radiation in materials and how radiation affects electronics. To conclude, he described hardening solutions.

CASPER hosts 20th annual REU/RET summer program

For the twentieth consecutive year, Baylor University's Center for Astrophysics, Space Physics and Engineering Research (CASPER) played host to high-achieving undergraduate science students as part of the National Science Foundation's Research Experiences for Undergraduates (REU) program. It was also the fifteenth year that CASPER hosted teachers in the REU's companion program, Research Experiences for Teachers (RET).

2014 CASPER REU/RET Fellows

This year, twelve students and three teachers traveled to Baylor from across the nation to participate in the REU and RET programs. Three high school students also participated in summer research through Baylor's High School Summer Science Research Program (HSSSRP) sponsored by the university's College of Arts and Sciences and the CASPER High School Scholars Program.

REU participants conducted research in astronomy, theoretical and experimental physics and engineering under the direction of Baylor and CASPER faculty within the center. RET participants developed the concept of an online science learning system, with students earning points to advance to the "BRIC Bowl", a multi-activity science competition directed by members of CASPER's Education Outreach Group.

Participants in both programs conducted research during the week, while joining faculty members and graduate students in weekly project status meetings. Participants also enjoyed pizza, barbecue, submarine sandwiches and other fare at Wednesday Lunch Bunch seminars. Each seminar began with a popular Physics Song Sing-Along segment in which participants sang a parody of well-known folk and other tunes with lyrics reflective of a scientific or technical topic.

The sing-along was followed by an informative and entertaining presentation by a faculty member. Topics ranged from The Physics of Star Trek and The History of Space Travel in the Movies, to Calculating the Effects of the Strong Nuclear Force on Supercomputers and Presenting Science with Sound. More practical talks instructed participants on how to conduct searches of scientific literature, write technical papers, prepare project posters and presentations, and apply to graduate school.

On Fridays, participants honed their presentation skills by updating faculty and fellow participants on the progress of their research. The REU fellows themselves prepared the refreshments served at these update sessions.

At the August 4 conclusion of the program, individual participants delivered twelve-minute PowerPoint summations of their research and took questions from faculty and other fellows. The presentations were videotaped for placement on the CASPER website. Each student also prepared a project poster and wrote a paper detailing the research and results. Papers also are posted online at the CASPER website.

The summer's program was capped by a catered Mexican buffet dinner and awards presentation at The Palladium, a popular downtown Waco events venue.

Faculty Mentors

Theoretical and Nuclear Physics
Daniel Bolton

Astronomy
Dick Campbell
Dwight Russell

Complex Plasma & Space Science
Truell Hyde
René Laufer
Lorin Matthews
Jorge Carmona-Reyes

Quantum Optics
Dmitri Voronine

Sponsored by the National Science Foundation, CASPER, the Greater Waco Aviation Alliance, the School of Engineering and Computer Science and the College of Arts and Sciences

CASPER acquires new research leadership

CASPER's affiliations with three European scientists have resulted in their coming aboard as assistant directors of research within the Center.

Dr. Peter Hartmann

Veteran CASPER adjunct researcher Dr. Peter Hartmann joined the CASPER research leadership this fall as assistant director of research. A graduate of Roland Eötvös University in Budapest, Hungary, Hartmann has been a CASPER adjunct faculty researcher since 2010 and a researcher at the Institute for Solid State Physics and Optics at the Wigner Research Centre for Physics of the Hungarian Academy of Sciences in Budapest since 2000. He also has had a visiting scholar appointment to Boston College since 2007, and has served on the International Scientific Committee, European Conference on the Atomic and Molecular Physics of Ionized Gases.

Hartmann has collaborated on experiments with CASPER researchers since 2009 and will continue that work. But in accepting the assistant director appointment he assumes an additional role, working between the graduate students in the lab and the upper tier of more senior professors, researchers and lab administrators.

"There is a layer between these two levels that the assistant director of research fills," he said. "That is the person who helps the students get the most benefit out of their work and guides them in getting their papers published. This is the part I try to help with."

Hartmann finds American researchers' openness and willingness to collaborate on equal footing to be especially conducive to good science. That's even more the case at CASPER; he attributes that environment to the lab's leadership.

"Dr. Hyde works with as many people as he can. He is open and he presents what he has to everyone," said Hartmann of CASPER director Dr. Truell Hyde.

"In some countries when I walk into an office everybody stops talking. Here if I enter an office everybody starts talking! I really believe that cooperation helps more than competition, and that fits with Dr. Hyde's philosophy. If we can benefit all, it's better for everyone. It's very enjoyable."

He also finds Texas a good fit on a more personal level. A self-described "gear-head," Hartmann loves working on his 1996 Audi when at home in Budapest and enjoys going to NASCAR races and demolition derbies when in Texas. He keeps the rental car radio tuned to a country station and proudly sports a big western belt buckle.

"I mesh well here," he says with a smile.

Also joining CASPER this past fall as assistant directors of research were Russian physicist Dr. Oleg Petrov and Ukranian physicist Dr. Vladimir Nosenko. Dr. Petrov is a plasma physicist, long-time associate of CASPER director, Dr. Truell Hyde, and serves as Deputy Director for Science at the Joint Institute for High Temperatures at the Russian Academy of Sciences, in Moscow. Dr. Nosenko currently is a research scientist at the German Aerospace Center DLR Research Group on Complex Plasmas in Weßling, Germany. He headed the GEC Plasma Laboratory at the Max Planck Institute for Extraterrestrial Physics in Garching, Germany from 2008 to 2013. Both researchers will be profiled in an upcoming issue of CASPER News.

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Recent CASPER Publications

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Babies

Ophelia Wanru Qiao
Born May 27, 2014
to Mike Qiao and Snow Gu

7 lbs 13 oz., 19 inches

Eva
Much-belated congratulations are due to longtime CASPER adjunct researcher Hans-Peter Röser, shown here with granddaughter Eva soon after her birth. Eva is now over a year-old and very much the apple of her "Opa's" eye.

Graduations

Dr. Brandon Harris

Congratulations to Brandon Harris who successfully defended his dissertation in June and received his PhD in physics from Baylor in August, 2014. Dr. Harris is a former CASPER researcher and the first BRIC-based student to earn a PhD.

Titled *Experimental Probe-induced Complex RF Plasma Phenomena*, Harris' dissertation explored how the presence of an instrument probe can itself affect the behavior of the plasma cloud it is measuring. Since graduation, Harris has taught physics at a local college preparatory school.

In October Harris accepted an appointment to the University of Liverpool. There he will conduct research on dusty plasmas that is aimed at verifying transport models for nuclear fusion reactors. Harris was one of only three candidates who were interviewed out of the 19 who applied for the appointment. He also will travel occasionally to the Netherlands for experiments at the Dutch Institute for Fundamental Energy Research.

CASPER STATS

Faculty publications (fiscal year 2014)

- 102 Papers
- 66 Presentations
- 4 Book Chapters
- 6 Proceedings

Current grant funding (fiscal year 2014)

- 31 Active Grants
- $16 million - Total Funding

Astrophysics & Space Science Theory Group • Early Universe Cosmology & Strings Group
Gravity, Cosmology & Astroparticle Physics Group • Hypervelocity Impacts & Dusty Plasmas Lab
Space Science Lab • Meyer Observatory

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