

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*

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CASPER, University of Stuttgart extend agreement

In 2007, CASPER and the Institut für Raumfahrtssysteme (IRS), University of Stuttgart, Germany signed a memorandum of understanding (MOU) to begin collaborations in the field of space science - especially related to the Stuttgart small satellite activities. The University of Stuttgart, founded in 1829, is situated in the middle of a highly dynamic economic region and has a worldwide reputation for excellence in science and technology. The university is noted for fostering cooperation between technical, physical and human sciences over a comprehensive range of subjects with a focus on technical and physical disciplines. Within the University of Stuttgart, the IRS is the largest space science program in Europe with over 150 faculty and staff.

Initial discussions between CASPER and IRS personnel ranged from setting up a CASPER ground station at Baylor University to provide Baylor faculty and students access to IRS satellites already on orbit, to the exchange of personnel and students. As part of this agreement, Dr. Rene Laufer from the Stuttgart Institute was appointed as a CASPER associate research professor during the summer of 2009. Since Laufer's arrival, additional areas of interest have been identified, all connected to overlapping research interests between CASPER and its new University of Stuttgart colleagues.

Currently, collaborations between the two include research into small satellites, plasma technology, remote sensing, airborne platforms and in-situ instrumentation development. These research areas will be driven by personnel exchange in both directions in the near future, as provided by the current MOU.

Additionally, both institutions are currently in building campaigns with new lab and office space coming on-line in the near future in the Space Center Baden-Wuerttemberg in Stuttgart and the Baylor Research and Innovation Collaborative (BRIC) in Waco. Given the early success of the partnership and planned increases in joint activities in the near future, the MOU between CASPER and the Institute of Space Systems at the University of Stuttgart was extended recently through 2014.

Finally, with CASPER's new regional partners at the University of Texas at Dallas and Austin (see full story in the next CASPER News), the design and development of a pico satellite orbital mission is currently under consideration. To qualify and validate such instruments, airborne platforms and high-altitude balloons are valuable test vehicles - therefore initial steps have been taken



Ground facilities for the Stuttgart Small Satellite Program - much of this will hopefully be twinned within CASPER in the near future (photography courtesy of the University of Stuttgart).

to fly and operate Stuttgart's unmanned aerial vehicle (UAV) "Eagle" at Baylor during campaigns of a few months length. During its time at Baylor, the UAV will also be available for remote sensing research and sensor technology development. To develop and test in-situ space instrumentation, CASPER is also setting up a space plasma simulation facility using a plasma source based on a proprietary design developed at the IRS in Stuttgart. The so called IPG (inductively-heated plasma generator) is able to provide a wide range of plasma states to simulate conditions on the moon, comets, asteroids or in deep space. Spacecraft components and instruments encounter a wide range of conditions when in space and CASPER plans to set up other facilities to test and qualify flight hardware, such as a drop tower for microgravity experiments and a thermal-vacuum chamber. Additional projects are under consideration as part of the planning for CASPER's new location at the BRIC, which will provide space for a small satellite ground station and control center, mission design and instrument integration facilities, a plasma generator laboratory and a drop tower for microgravity research.

CASPER Space Science Lab expands activities

CASPER's roots began within the Space Science Lab (SSL) more than four decades ago. The SSL has a proud heritage in space science research including flight projects from Explorer I forward. With the recent extension of the memorandum of understanding (MOU) between CASPER and the Institute of Space Systems at the University of Stuttgart, the SSL is returning in many ways to its roots and expanding its current scope of work. Upon arrival in

Waco, Dr. Rene Laufer was appointed as the Head of the SSL and will lead the effort to establish new facilities signifying a return to space science research. One of the early areas scheduled for activity will include collaboration on existing small satellite missions with the IRS at the University of Stuttgart. As part of the original MOU, CASPER has already put in place a ground station equipped with amateur radio

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BAYLOR
UNIVERSITY

CENTER FOR ASTROPHYSICS,
SPACE PHYSICS & ENGINEERING RESEARCH



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Space Science Lab expands activities

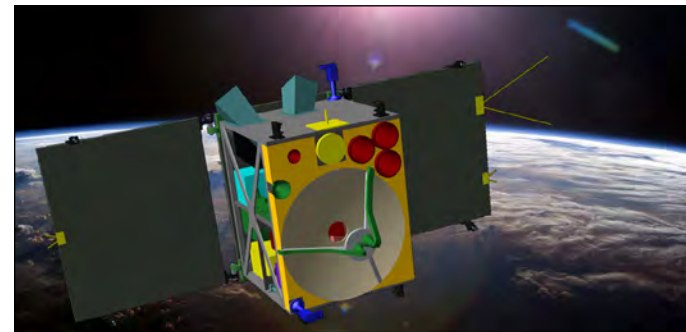
Continued from page 1

frequency bands in both UHF/VHF and has current plans to extend this capability to include both S band, X band and finally Ku and Ka bands in the future. Once operational, this will position CASPER as one of the primary partners in the Stuttgart ground station network, providing CASPER personnel access to IRS satellites and remote sensing data.

CASPER is also on track to act as one of the primary ground station nodes for the Stuttgart lunar orbiter mission. This project will open several new research areas for students and faculty within CASPER, including earth observation, disaster management, and radio frequency research for telecommunication and navigation. The development and testing of in-situ instrumentation is also directly related to such small satellite space missions. CASPER's expertise in both complex dusty plasmas and in-situ dust particle detection recently resulted in the opportunity to propose an instrument for an upcoming Stuttgart small satellite mission. Under Dr. Laufer's directions, the SSL continues to expand its opportunities for participation in other flight missions, particularly in the areas of in-situ measurement and remote sensing instrumentation

for lunar and planetary missions and near-earth orbital satellites.

CASPER is actively seeking both regional and national partners for involvement in these projects with discussions for further collaborations underway. The overall goal of the SSL is to establish capability for CASPER faculty and students to participate in space flight missions ranging from near earth to lunar orbit!



Schematic view of the "Flying Laptop" remote sensing satellite in Earth orbit (photography courtesy of the University of Stuttgart).

CASPER member spends summer at the International Space University's Space Studies Program



During the summer of 2010, CASPER Associate Research Scientist Dr. Rene Laufer, spent much of his time in Strasbourg, France as a faculty member within the International Space University's (ISU) Space Studies Program 2010 (SSP10). The SSP is an intensive nine-week program for post-graduate students and young professionals in all disciplines related to the space sector. Over the course of the program, students are exposed to both academic and research courses including space business and management, space engineering, space life sciences, space policy and law, satellite applications, space physical sciences, and space and society. Dr. Laufer, who was the acting chair of the ISU physics department, ran lectures and workshops with a dozen colleagues

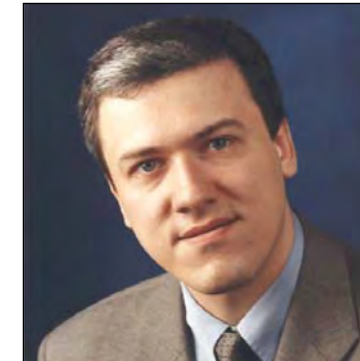
from Austria, Canada, France, Germany, Ireland, Norway, South Africa, the United Kingdom and the United States. Presentations and hands-on seminars covered such diverse topics as aerogel production, drop tower experiments, radio astronomy observations, asteroid detection, small satellite design, solar system exploration, and cosmology.

The concluding phase of the SSP requires the completion of a team project with students working together to produce a complete conceptual design for an international space project and/or program covering all technical, financial, organizational and policy aspects. Dr. Laufer also chaired one of four team projects entitled RE-FOCUS (Respect Earth: Future Opportunities for Carbon Understanding and Sustainability) while supervising colleagues from Australia, Spain and the United States. The project team, comprised of 39 participants representing 17 countries, was tasked with investigating and analyzing the gaps in the carbon cycle data and addressing how the situation might be improved through space-based assets. The team's final report provided recommendations regarding scientific observations, technical systems, policy and international cooperation as well as outreach to increase the awareness of the carbon cycle and its importance on climate change.

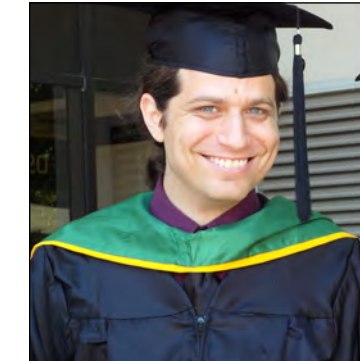
Personnel Updates Graduations



James Creel successfully defended his master's thesis, "Characteristic Measurements within a GEC rf Reference Cell," in July 2010 and graduated from Baylor with a M.S. in physics in August 2010. Congratulations!



Rene Laufer successfully defended his doctorate dissertation "Lunar Mission BW1: Scientific Objectives and Small Satellite Concept" in December 2009 and graduated summa cum laude from the University of Stuttgart with a Ph.D. in Aerospace Engineering. Congratulations!



Jay Murphree successfully defended his master's thesis, "Nanomanipulator Perturbation of Dust Crystals in a GEC rf Plasma Cell," in June 2010 and graduated with a M.S. in physics in August 2010. Congratulations!

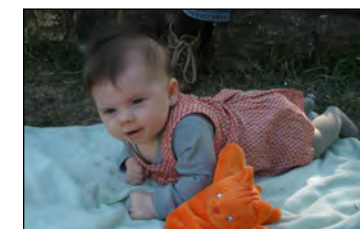


Kristen Pechan successfully defended her master's thesis, "Investigation of Low Higgs String Models," in June 2010 and graduated from Baylor with a M.S. in Physics in August 2010. Congratulations!

Babies



Dara Carmona was born February 4, 2010 to Jorge and Amparo Carmona, 6 lbs 12 oz, 20.5 inches long.



Elizabeth Carmona was born January 6 to Victor Land and Anne Land Zandstra, 8 lbs 9 oz, 20.5 inches long.



Jasmijn Sofie Land was born August 3, 2009 to Ethan and Pamela Swint, 7 lbs, 21 inches long.



Lillian Brooke Swint was born August 3, 2009 to John and Maggie Vasut January 20, 2010, 7 lbs, 7 oz, 20 3/4 inches long.

CASPER (through the Baylor Department of Physics) now offers both the B.A. and B.S. in Astronomy and Astrophysics!

Research Updates Recent Presentations

Orbifold Branes String/M Theory and Their Applications to Cosmology, A. Wang, Department of Astronomy, Beijing Normal University, June 18, 2010.

Orbifold Branes in String/M Theory and Their Applications to Cosmology and Astrophysics, A. Wang, Physics Department, Baylor University, April 16, 2010.

Phase transition studies for conducting dust, Jorge Carmona Reyes, Truell Hyde, Lorin Matthews, David George, Mike Cook, Jimmy Schmoke, poster presented at the 51st Annual Meeting of the Division of Plasma Physics, Atlanta, Georgia, November 2-5, 2009.

Philosophical Implications of the Multiverse, Gerald Cleaver, Baylor Philosophy Club, April 8, 2009.

Physics Circus – A Successful Model for Making Science Concepts Accessible, Cyndi Hernandez & Truell Hyde, Invited Colloquium, NCCEP/GEAR UP Annual Conference, San Francisco, CA (2009).

Science at the Cutting Edge: Implications of a Multiverse, Gerald Cleaver, Secularization and Revival: The Fate of Religion in Modern Intellectual History, Baylor, Oct 8-10, 2009.

String/M Theory 101, Gerald Cleaver, University of Texas at Dallas, April 7, 2009.

The Development Of A Probabilistic Model For Tholin Aggregation In Titan's Atmosphere, C. C. Harris, L. S. Matthews, T. W. Hyde, poster presented at the 41st Annual Lunar and Planetary Science Conference, The Woodlands, Texas, March 1-5, 2010.

Thermophoresis experiments in complex plasma containing multiple dust crystals, Stephen Pickett, Victor Land, Divyaprakash Singh, Diana Bolser, Lorin Matthews, Truell Hyde, poster presented at the 51st Annual Meeting of the Division of Plasma Physics, Atlanta, Georgia, November 2-5, 2009.

Trends on the splitting methods for singular differential equations, Q. Sheng, Taiwan-Japan Annual Workshop in Numerical Analysis, Taipei, Taiwan, November 7-8, 2009 (invited speaker).

Using Dust and Thermophoresis to Probe a Plasma Sheath, Lorin Matthews, seminar presented to the Physics Department at Baylor University, October 14, 2009.

Void formation and closure in different complex noble-gas plasmas under microgravity, Victor Land, Diana Bolser, Lorin Matthews, Truell Hyde, paper presented at the 51st Annual Meeting of the Division of Plasma Physics, Atlanta, Georgia, November 2-5, 2009.

Zeta functions of quantum graphs and cosmological pistons, Klaus Kirsten, Workshop on Cosmology, the Quantum Vacuum, and Zeta Functions, Universitat Autònoma de Barcelona, Barcelona, Spain, March 8 – 10, 2010.

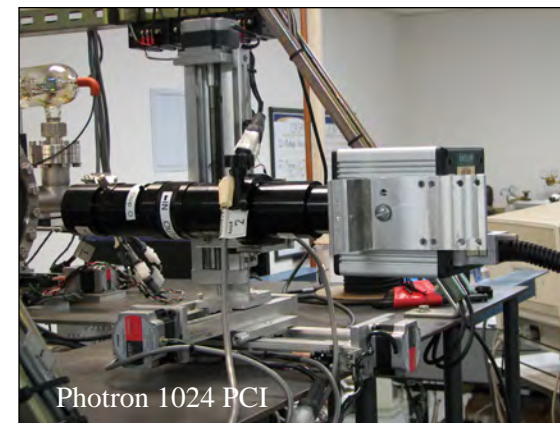
Zeta functions on surfaces of revolution, Klaus Kirsten 8th International Conference on Dynamical Systems, Differential Equations and Applications, Dresden University of Technology, Dresden, Germany, May 25 – 28, 2010.

CASPER's new equipment



Haas lathe (TL-2)

Through an award from the SBA, CASPER is now the proud owner of a suite of outstanding advanced manufacturing equipment! As part of the \$196,000 award, the HIDPL/SSL now has two Summit mills equipped with auto feeds, digital response and immediate (zero to full in four seconds) response, a Haas lathe (TL-2) equipped with the Haas advanced programming system (intuitive programming) that allows jobs without the need for G-Code, a Haas trainer which has the ability to both write, test and transfer programs to the lathe and a Fryer 5-Axis CNC Machining Center which allows the production of highly complex parts, molds and electrical pieces. Finally, through a combination of grant funding (including Dr. Matthew's NSF Career Award) the HIDPL also recently took ownership of two Photron 1024 PCI ultra high speed and high resolution cameras. The Photron can provide speeds in excess of 100,000 fps and offers unparalleled capability for researchers within the lab. All in all, a very good summer!



Photron 1024 PCI



Summit mills



Haas trainer

Experimental Astronomy Group Research Updates

Through CASPER's signed agreement with the Central Texas Astronomical Society, both graduate and undergraduate students continue to gain hands-on access to real-time research within the Experimental Astronomy Group (EAG). In addition to working with Baylor students, the EAG also sponsors summer REU and RET students from universities around the world, conducting research in stellar physics. Under the mentorship of Dr. Dwight Russell and Dick Campbell, these students experience the life of an observational astronomer working under the dome throughout the night learning the science of accurate data collection and analysis.

During the summer of 2010, CASPER REU fellow Amanda Towry developed an experimental procedure to detect Kordylewski dust clouds theorized to exist at the L4 and L5 Lagrangian points of the Earth-Moon system. This research required her to learn advanced telescope operations, instrumentation techniques, and develop data analysis methods. Baylor physics major Kimberly Orr also worked at the observatory, collecting data on Kuiper Belt Objects to apply to detection software developed in related CASPER research. Recent CASPER students have also been exposed to other research opportunities including

participation in the Whole Earth Telescope operation and the Near Earth Asteroid crossing program. Finally, the EAG continues its relationship with McDonald Observatory, collaborating in ongoing Pulsating White Dwarf research. Here's hoping for dark skies!

Student Spotlight

Former CASPER REU Jared Greenwald chose Baylor to pursue his master's degree due in large part to his REU experience as an undergraduate. As an REU, he worked with Dr. Gerald Cleaver studying string phenomenology and string model building. Jared is still working with Dr. Cleaver on string phenomenology and model building, but is also working with Dr. Anzhong Wang on alternative gravity theories as well. Jared says he chose Baylor because he knew what he would be working on and with whom, and because he could get started working on his research earlier than he could with other schools. Jared, we're glad you're here!



EAG Members

Faculty and Staff
Dwight Russell
Dick Campbell

Undergraduate Student
Kimberly Orr

REU
Amanda Towry

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

The Astrophysics & Space Science Theory Group (ASSTG) and the Hypervelocity Impacts Dusty Plasma Lab (HIDPL) had another very good year publishing thirteen papers and presenting at five international conferences. In November of 2009, Lorin Matthews, Truell Hyde, Angela Douglass, Stephen Pickett, Zhuanhao Zhang, Jie Kong, Victor Land, Ke Qiao, Jorge Carmona, and James Creel attended the 51st Annual Meeting of the Division of Plasma Physics held in Atlanta, Georgia. The group presented nine papers and posters in theoretical and experimental plasma physics. In March of 2010, Drs. Rene Laufer, Lorin Matthews, Truell Hyde, and students Jonathan Perry and Cheridan Harris (CASPER REU) attended the 41st Annual Lunar and Planetary Science Conference in the Woodlands, Texas presenting five posters. In July of 2010, Truell Hyde, Lorin Matthews and Jonathan Perry attended COSPAR 2010 in Bremen, Germany, where they presented three papers in space science. In addition to the group's conference activity, Lorin Matthews presented an invited seminar to the Physics Department at Texas Christian University in February 2010, Peter Hartmann presented a paper at the annual meeting of the Hungary Physical Society and Truell Hyde and Rene Laufer participated in the Lunar Dust, Plasma & Atmospheres: The Next Steps workshop held at LASP at the University of Colorado, Boulder.

The ASSTG/HIDPL/SSL also sponsored several CASPER adjunct or visiting faculty members over the year. CASPER Adjunct faculty Georg Herdrich, Hans-Peter Roeser and Ph.D. student Sebastian Leim visited the group to discuss development of the next generation Inductive Plasma Generator scheduled to be built at Waco. Peter Hartmann, Research Fellow with the Research Institute for Solid State Physics and Optics of the Hungarian Academy of Sciences and CASPER Adjunct Faculty member, visited Waco for two weeks, working in the HIDPL studying freezing of dust crystals. Dr. Marlene Rosenberg, University of California, San Diego, also visited CASPER as a visiting scholar. All in all, a very good year!



(top right) Truell Hyde, Lorin Matthews and graduate student Jonathan Perry stand near the Musicians of Bremen statue in Bremen, Germany. The three attended the COSPAR conference in July. (above) Rene Laufer, Lorin Matthews, Cheridan Harris, Truell Hyde, Jonathan Perry, and Jorge Carmona attended the 41st Annual Lunar and Planetary Science Conference, The Woodlands, Texas, March 1-5, 2010.



ASSTG / HIDPL Members

Faculty/Staff

Truell Hyde
Lorin Matthews
Jie Kong
Ray Nazzario
Ke Qiao
Victor Land
Rene Laufer
Jorge Carmona-Reyes
Michael Cook
Jimmy Schmoke

Interns

Jason Brown
Anthony Burns
Deanna Craig
Michael Daughtry
Alan Kilgore
Salvador Lopez
Jeffrey Mullen
Robert Tibbs
Jonathan Whitely
Aaron Westbrook

Undergraduate Students

Kristen Deline
Stephen Pickett

High School Scholars

Christine Chien
Jonathan Dallas
Patrick Facheris

Adjunct Faculty

Phillip Anz-Meador
John Fitch
Peter Hartmann
Georg Herdrich
Ralf Srama

Graduate Students

Angela Douglass
James Creel
Jay Murphree
Alex Price
Victor Zhang
Brandon Harris
Theresa Ma
Jonathan Perry

REU Fellows

Lindsay Buckingham
Doug Coleman
Erwin Gostomski
Megan Marshall
Suzannah Wood
Natalie Walker
Lauren Bain
Brandon Doyle
Jonathan Whitely
Ben Ball
Amanda Towry

RET Fellows

Steve Rapp
Gary Shetler
Randall Dunkin

Research Updates Recent Presentations

Does the Casimir effect rule out large extra dimensions?, Klaus Kirsten Jena University, Jena, Germany, 06/24/2010.

Dust particle probes in a complex plasma, Angela Douglass, Truell Hyde, Lorin Matthews, Michael Pope, Bernard Smith, poster presented at the 51st Annual Meeting of the division of Plasma Physics, Atlanta, Georgia, November 2-5, 2009.

Effect of Charged-Magnetic Grains in Protoplanetary Disks, J. Perry, L. Matthews, T.W. Hyde, Presented at COSPAR, Bremen, Germany (2010).

Establishing an Environmental Simulation Facility for Lunar Dust Research, R. Laufer, T. W. Hyde, L. Matthews, G. Herdrich, R. Srama, H.-P. Roeser, poster presented at the 41st Annual Lunar and Planetary Science Conference, The Woodlands, Texas, March 1-5, 2010.

Establishing an Environmental Simulation Facility for Complex (Dusty) Space Plasma Research, R. Laufer, T.W. Hyde, L. Matthews, G. Herdrich, R. Srama, H.-P. Roeser, Presented at COSPAR, Bremen, Germany (2010).

From exponential functions to exponential splitting computations, Q. Sheng, Mathematical Colloquium, National Center for Theoretical Sciences, National Tsing Hua University, Taiwan, November 20, 2009 (invited speaker).

Gear Up Waco, CASPER and STEM Education, Truell Hyde, Cyndi Hernandez, Jorge Carmona-Reyes, NCCEP/GEAR UP Annual Conference, Washington, DC (2010).

Growth of Fractal Aggregates Within a Protoplanetary Disk, L. Matthews, Victor Land and T.W. Hyde, Presented at COSPAR, Bremen, Germany (2010).

Horava Theory of Quantum Gravity, A. Wang, School of Physics, Beijing University, Beijing, China, June 18, 2010.

Horava Theory of Quantum Gravity and Its Applications to Cosmology and Astrophysics, A. Wang, Department of Physics, Beijing Normal University, Beijing, China, June 28, 2010.

Horava-Lifshitz Theory of Quantum Gravity, A. Wang, Physics Department, University of Texas at Dallas, October 9, 2009.

Horava-Lifshits theory of quantum gravity and its applications to cosmology and astrophysics, A. Wang, Texas Cosmology Network Meeting 2009, Austin, Texas, October 29-30, 2009.

Interparticle forces between dust particles confined within a glass box in a GEC chamber, Jie Kong, Truell Hyde, Lorin Matthews, Ke Qiao, Zhuanhao Zhang, Brandon Harris, Gary Shetler, Steve Rapp, Jimmy Schmoke, Mike Cook, paper presented at the 51st Annual Meeting of the Division of Plasma Physics, Atlanta, Georgia, November 2-5, 2009.

Investigations of the String Landscape, Gerald Cleaver, Baylor Physics Dept. Colloquium, Dec 2, 2009

Investigations of the String Landscape, Gerald Cleaver, Second Texas Cosmology Network Meeting, U. of Texas at Austin, Oct. 30, 2009.

Investigation of the Wakefield Interaction within 3D Dust Particle Clusters in a Complex Plasma, K. Qiao, T. W. Hyde, L. S. Matthews, J. Kong, J. C. Reyes, Z. Zhang, J. Schmoke, and M. Cook, Presented at the 51st Annual Meeting of the Division of Plasma Physics (American Physical Society), Atlanta, GA (2009).

Kristályosodás 2D komplex plazmában, Peter Hartmann, Kovács Anikó, Donkó Zoltán, Angela Douglass, Jorge C. Reyes and Truell W. Hyde, Hungary Physical Society, 2010.

Late Cosmic Acceleration of the Universe in String/M Theory on S1/Z2, A. Wang, Institute of Cosmology and Gravitation, Portsmouth University, England, June 3, 2009.

Low-Velocity Impacts on PVDF Targets Using a Light Gas Gun., J. A. Carmona, M. Cook, J. Schmoke, R. Laufer, L. S. Matthews and T. W. Hyde, poster presented at the 41st Annual Lunar and Planetary Science Conference, The Woodlands, Texas, March 1-5, 2010.

M Theory and the Multiverse 101, Gerald Cleaver, LeTourneau University Physics Colloquium, Oct. 15, 2009.

Measurements within a GEC rf Reference Cell, James Creel, Truell Hyde, Lorin Matthews, David George, Jorge Carmona Reyes, Brooks McMaster, Ke Qiao, Mike Cook, Jimmy Schmoke, Presented at the 51st Annual Meeting of the Division of Plasma Physics (American Physical Society), Atlanta, GA (2009).

Mr. Einstein is on Fire Again: Horava-Lifshitz Theory of Quantum Gravity, A. Wang, Physics Department, Baylor University, February 17, 2010.

On decomposition methods for solving singular and nonlinear partial differential equations, Q. Sheng, Mathematics Colloquium, National Chung-Hsing University, Taiwan, December 3, 2009 (invited speaker).

On full adaptation and split schemes for singular heat equations--an exploration, Q. Sheng, Computational Seminar, Center of Mathematical Modeling and Scientific Computing, National Chiao Tung University, Taiwan, December 1, 2009 (invited speaker).

One stone two birds--adaptive decompositions for solving singular partial differential equations, J. Q. Sheng, joint NCTS and CMMSC Research Lecture, National Center for Theoretical Sciences, National Tsing Hua University, Taiwan, November 13, 2009 (invited speaker).

Research Updates Recent Presentations

A Baylor University Payload Contribution to the Universities Stuttgart Moon Orbiter, R. Laufer, T. W. Hyde, L. Matthews M. Lachenmann, G. Herdrich, R. Srama, H.-P. Roeser, poster presented at the 41st Annual Lunar and Planetary Science Conference, The Woodlands, Texas, March 1-5, 2010.

A highly effective finite difference approach for oscillatory optical beam equations, Q. Sheng, SIAM Annual Meeting, Pittsburgh, July 12-16, 2010.

A new approach in moving mesh finite difference methods for multidimensional singular reaction-diffusion equations, Q. Sheng, Mathematics Colloquium, Hong Kong Baptist University, Hong Kong, December 8, 2009 (invited speaker).

A survey of new concepts in adaptive and decomposed computations and beyond, Q. Sheng, Mathematical Colloquium, University of Macau, Macau, December 14, 2009 (invited speaker).

A Study of the Resonance Frequency of Conductive Grains in a Dusty Plasma, Zhuanhao Zhang, Truell Hyde, Lorin Matthews, Jie Kong, Jorge Carmona Reyes, Ke Qiao, Jimmy Schmoke, Mike Cook, Presented at the 51st Annual Meeting of the Division of Plasma Physics (American Physical Society), Atlanta, GA (2009)

Adaptive splitting finite difference methods for solving singular equations, Q. Sheng, AMS Fall Central Section Meeting #1051, Waco, TX, October 16-18, 2009 (invited speaker).

Adaptive and adaptive decomposition methods for quenching-combustion equations and beyond, Q. Sheng, Mathematical Colloquium, Tatung University, Taiwan, November 26, 2009 (invited speaker).

An exploration of decomposed finite difference methods for solving singular partial differential equation problems, Q. Sheng, Applied Math Colloquium, Applied Math Department, Hong Kong Polytechnic University, Hong Kong, December 16, 2009 (invited speaker).

An Exploration of the Numerical Approximations of Dynamic Derivatives for Adaptive Computations, Joint Mathematics Meetings in San Francisco, Jan. 13-16, 2010. Anzhong Wang, Q. Sheng.

An exploration of the numerical approximations of dynamic derivatives for adaptive computations, Q. Sheng, Joint AMS-MAA Annual Meetings, San Francisco, Jan. 13-18, 2010 (invited speaker).

Branes in the $MD \times Md+ \times Md$ - Compactification of type II string on $S1/Z2$ and their cosmological applications, A. Wang, T. Ali, G. Cleaver, M. Devin, and Q. Wu., in Texas

Cosmology Network Meeting 2009, Austin, Texas, October 29-30, 2009.

Brane Cosmology in String/M Theory, A. Wang, Advanced Theoretical Physics Conference on the origin and nature of Dark Energy, May 27 -June 6, 2010, Tunxin, Anhui, China.

Brane Cosmology in String/M Theory, A. Wang, College of Mathematics and Physics, Chongqing University of Post and telecommunication, Chongqing, China, May 25, 2010.

Brane Cosmology in String/M Theory on $S1/Z2$, Anzhong Wang, The 12th Marcel Grossman Meeting, Paris, France, July 12 -18, 2009.

Brane cosmology in the Horava-Witten heterotic M-Theory on $S1/Z2$, A. Wang, in Texas Cosmology Network Meeting 2009, Austin, Texas, October 29-30, 2009. Together with Y.-G. Gong and Q. Wu.

Characteristic measurements within a GEC rf reference cell, James Creel, Victor Land, Truell Hyde, Lorin Matthews, David George, Jorge Carmona Reyes, Brooks McMaster, Ke Qiao, Mike Cook, Jimmy Schmoke, poster presented at the 51st Annual Meeting of the Division of Plasma Physics, Atlanta, Georgia, November 2-5, 2009.

Complex Plasmas in Space and Laboratory Experiments, L. Matthews, presented to physics and chemistry classes at North Lamar High School, Paris, Texas, March 10, 2009.

Cosmological pistons and zeta functions of graphs, Klaus Kirsten Conference on Non-perturbative Quantum Field Theory, Oklahoma University, Norman, OK, April 9 – 10, 2010.

Cosmic Dust Bunnies and Laboratory Dust Crystals: An introduction to complex plasma research, Lorin Matthews, seminar presented to the Physics Department at Texas Christian University, Fort Worth, Texas, February 19, 2010.

Current Acceleration of the Universe in Brane Cosmology of String/M Theory, A. Wang, Chinese National Observatories, Beijing, June 30, 2010.

Dances with lights--the endeavor of an adaptive finite difference method on interfaces, Q. Sheng, Joint NCTS and CMMSC Research Lecture, National Center for Theoretical Sciences, National Tsing Hua University, Taiwan, November 19, 2009 (invited speaker).

Decompositions-a journey of the exponential splitting methods for solving singular PDEs, Q. Sheng, Mathematical Colloquium, National Taiwan University, November 20, 2009 (invited speaker).

Dipole-Dipole Interactions of Charged-Magnetic Grains, Jonathan Perry, Lorin S. Matthews and Truell W. Hyde, poster presented at the 41st Annual Lunar and Planetary Science Conference, The Woodlands, Texas, March 1-5, 2010.

Gravity, Cosmology & Astroparticle Physics Group Updates

The Gravity, Cosmology and Astroparticle Physics Group (GCAP) led by Dr. Anzhong Wang has had a banner year adding yet another new faculty member, Dr. Klaus Kirsten, to the group. Recent research topics include the nature and origin of the late cosmic acceleration, inflationary universe, large-scale structure formation, brane worlds in string/M theory, Horava-Lifshitz theory of quantum gravity, black holes, their thermodynamics and formation, highly efficient and effective computer simulations, Casimir efforts, and their applications to astrophysics and cosmology.

Horava proposed a new theory of quantum gravity motivated by the Lifshitz theory in solid state physics. The Horava-Lifshitz theory is non-relativistic, power-counting, ultraviolet renormalizable. The effective speed of light diverges in the UV, and this potentially resolves the horizon problem without invoking the inflationary scenario. In addition, almost scale-invariant super-horizon curvature perturbations can be produced without inflation. As the theory was still in its infant time, a more complete understanding of it is highly demanded.

One of the remarkable discoveries over the past decade in astronomy is that currently our universe is at its accelerating expansion. In Einstein's theory, to account for such an acceleration, a new component to the matter fields of the universe with a large negative pressure is needed, the so-called dark energy. A fundamental question now is the nature and origin of dark energy. The hierarchy and cosmological constant problems are other outstanding problems in particle physics and cosmology. To solve these problems, brane-world scenarios were proposed, in which our four-dimensional universe is considered as a brane embedded in a high dimensional bulk. An important result of such investigations is that high dimensional black holes are predicted to be produced in the TeV energy scale, which shall be explored directly by colliders in laboratories, such as LHC.

In addition, theories of gravity, including general relativity, predict the existence of black holes and gravitational waves. Forthcoming CMB polarization experiments, pulsar timing arrays, and terrestrial/space-based interferometers will probe a wide range of frequencies of the gravitational waves. On the other hand, black holes, their thermodynamics and formation from gravitational collapse have been one of the main focuses in gravitational physics in the last couple of decades. Our studies on these subjects are both analytical and numerical.

Casimir efforts are physical forces arising from a quantized field. A typical example is of two uncharged metallic plates in a vacuum, placed a few micrometers apart, without any external electromagnetic field. GCAP is investigating these efforts among branes in string/M theory.

EUCOS Updates

The Early Universe Cosmology and Strings Research Group (EUCOS) is led by Dr. Gerald Cleaver. Current research topics within EUCOS in string theory include the construction of phenomenologically realistic superstring models, string/M-theory cosmology, and the string landscape. Cleaver and Dr. Tibra Ali continue to investigate half-flat manifolds for heterotic strings while Cleaver and his graduate students are conducting a long-term systematic study of the generic physical properties of the string landscape in the free-fermionic heterotic region.

In December 2009, two books were accepted by Springer for publication. The first, *A Simple Introduction to Particle Physics: Part I. Foundations and the Standard Model* was written by Matthew Robinson, Karen Bland, Gerald Cleaver and Jay Dittmann; the second, *A Simple Introduction to Particle Physics Part II: Geometric Foundations and Relativity*, was written by Matthew Robinson, Tibra Ali and Gerald Cleaver.

In October 2009, Cleaver was also interviewed by a film crew for the Discovery Channel relating to his work on theoretical string/M theory realization of the Alcubierre effect. The related television show aired on the Discovery Channel in March 2010.

This past fall, Cleaver and his graduate students traveled to the Second Texas Cosmology Network Meeting and in the spring, they traveled to the spring 2010 meeting at Texas A&M University.

Cleaver and his former Ph.D. student Richard Obousy, continues to receive national and international attention for their recent article, *Warp Drive: A New Approach*, including a listing of their research in the "What's Cool" category of the October 2009 issue of *Astronomy Magazine*.

GCAP Members

Faculty/Adjunct Faculty

Anzhong Wang
Qin (Tim) Sheng
Rong-Gen Gai
N.O. Santos
Yumei Wu
Yungui Gong
Klaus Kirsten

Graduate Students

Michael Devin
Yongqing Huang
V H Satheeshkumar
Preet Sharma

Raziyeh Yousefi

Undergraduate Student:

Janie Hoormann

EUCOS Members

Faculty and Staff

Gerald Cleaver
Tibra Ali

Graduate Students

Tim Renner
Jared Greenwald
Kristen Pechen
Douglas Moore
Yanbin Deng

Undergraduates

Scott Ruhnau
Cameron Buescher

New CASPER Members



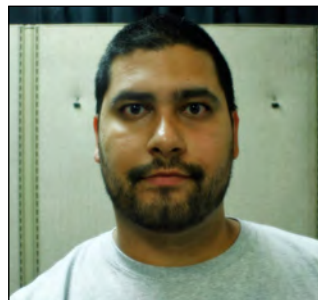
Dr. Klaus Kirsten is a professor of mathematics at Baylor University. He received a master's and Ph.D. in Theoretical Physics in 1992 from the University of Kaiserslautern, Germany. His research focus centers on the application of spectral analysis to different areas of physics. As such, it lies at the interface of differential geometry, partial differential equations and complex analysis yielding an interaction between the different fields that makes it a very interesting area. Dr. Kirsten's most recent research is focused on the pure quantum effects that exist as a result of the extremely small size of systems.



Dr. Georg Herdrich is a research scientist at the Institute of Space Systems at the University of Stuttgart, Germany, and head of Plasma Wind Tunnels and Plasma Technology. He received both his master's degree and his Ph.D. in aerospace engineering from University of Stuttgart. Herdrich has been actively involved in plasma and atmospheric entry research with ESA, NASA and JAXA for more than 10 years. He is an active participant in flight instrument development as well as space missions including EXPERT, Stardust, Cassini/Huygens and X-38. Dr. Herdrich is a German delegate to the United Nations working group for nuclear power in space and author/co-author of more than 100 publications in journals, books and conference proceedings. Herdrich's current research areas include atmospheric entry simulation (experimental and numerical), electric propulsion systems, in-situ diagnostics and instrumentation and industrial plasma technology applications.



Dr. Ralf Srama holds a senior scientist position at the Max Planck Institute for Nuclear Physics in Heidelberg, Germany. Dr. Srama received his Ph.D. in aerospace engineering from the University of Munich and is also a guest researcher at the University of Stuttgart, Germany. Dr. Srama is actively involved in the multiple flight missions including the LADEE-Lunar Dust EXperiment instrument, the simulation of high-speed capture of interstellar grains, the advanced dust telescope (trajectory and large area mass analyser), the investigation of hypervelocity impacts of organic micrograins and the MMO dust instrument onboard Bepi Colombo. He was recently the activity coordinator for EuroPlaNet and the organizer of the European Planetary Science Congress. Dr. Srama has 75 refereed publications in international journals and over 200 total publications as listed by WOS.



Roberto Santiago is the Physics Circus technician for technology for GEAP UP. He attended Texas State Technical College Waco, graduating with an AAS in media communication and information in August 2009. Santiago started as a CASPER intern working on media for the Physics Circus and continues to create and oversee all media involved with the Physics Circus. He is certified by the Texas Film Commission as a production assistant and active in the video production industry as a cameraman and editor.

For a complete list of CASPER's faculty, adjunct faculty, research faculty, postdocs, staff and international university partners, visit www.baylor.edu/CASPER/personnel

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New CASPER Members

Randy Hall is a lecturer in the Baylor Physics department and works with software development for CASPER. He received his bachelor of science degree in physics and mathematics from Baylor in 1971 and a master of science degree in mathematics from Baylor in 1972. Hall did additional graduate work in mathematics and computer science at the University of Texas at Austin. Hall was president and CEO of DIGATEX, Inc., a developer and supplier of route accounting and management software for soft drink bottlers and other food and beverage distributors from 1978–2007. He also taught at the University of Texas at Austin and Austin Community College.



John Fitch is a CASPER adjunct associate professor and the founder of Birkeland Current LLC. Fitch has worked at the Space Telescope Science Institute, Chrysler Technologies Airborne Systems in Waco, on the NASA Stratospheric Observatory for Infrared Astronomy program, and at L-3 Advanced Concepts in Rockwall, Texas. In late 2009, L-3 Integrated Systems reorganized into smaller independent groups and moved away from a central R&D strategy. Based on the strategy and success of Advanced Concepts, Fitch started Birkeland Current LLC in January 2010 with a business plan intended to privately reconstitute the Advanced Concepts disruptive R&D model by 2012 as part of the Baylor BRIC.



Birkeland Current, formed in December 2009, is designed to work in the interfaces between science, engineering and business. The primary goal of Birkeland Current is to apply disparate technologies and concepts of operations to enduring problems in such a way as to provide disruptive market solutions.

Birkeland Current is not a production company, but a means to rapidly demonstrate proofs of concepts and de-risk a business model. Typically this means taking concepts to a TRL level 3 (Technology Readiness Level) in the first phase of a program and from TRL 3 to TRL 6 in the second phase of a program.

Birkeland Current also provides business case development, technology assessment, technology sweeps, competitive assessments, and program planning services in support of ideas.

Birkeland Current's staff has over 60 years of combined experience in engineering, science and design, with degrees and professional licenses in engineering, physics, space physics, astronomy and architecture. Program experience spans electrical, electro-mechanical and electro-optical systems, structures, design, development, production, operations and field support. In addition they have consulting or partnering relationships with a number of subject matter experts or institutions spanning virtually all technical disciplines.

Specific prior project experience covers commercial, DOD, and NASA development efforts. Birkeland Current is a registered government contractor with a significant portion of our business expected to be in support of U.S. Government S&T efforts.



13th Workshop on the Physics of Dusty Plasma is coming to Baylor, Waco

The International Workshop of the Physics of Dusty Plasma will be coming to Waco in May 2012.

CASPER and Baylor University are excited to be hosting this workshop!

Stay tuned for more details!

CASPER Summers

2010 Fellows

1. Suzannah Wood (REU)
2. Amanda Towry (REU)
3. Natalie Walker (REU)
4. Lauren Bain (REU)
5. Erwin Gostomski (REU)
6. Gary Shetler (RET)
7. Lindsay Buckingham (REU)
8. Jonathan Dallas (HSS)
9. Megan Marshall (REU)
10. Doug Coleman (REU)
11. Brandon Doyle (REU)
12. Steve Rapp (RET)
13. Ben Ball (REU)
14. Jonathan Whitely (REU)
15. Randall Dunkin (RET)

Not pictured

Kristen Deline (UR)
Christine Chien (HSS)
Patrick Facheris (HSS)



REU and RET Summer Program Sponsored by the National Science Foundation and CASPER

Since 1993, CASPER has hosted the National Science Foundation Research Experience for Undergraduates (REU) and Research Experience for Teachers (RET) programs as part of CASPER Summers. During the summer of 2010, eleven undergraduate students and three high school teachers participated in the program working with CASPER Faculty as well as faculty in the Department of Physics and the School of Engineering. Theoretical and experimental research projects were conducted under the direction of Mr. Dick Campbell, Mr. Jorge Carmona-Reyes, Dr. Truell Hyde, Dr. Jay Kong, Dr. Victor Land, Dr. Lorin Matthews, Dr. Jeff Olafsen, Dr. Linda Olafsen, Dr. Ke Qiao and Dr. Dwight Russell. Three high school students also participated in summer research through the High School Summer Science Research Program (HSSSRP) sponsored by the College of Arts and Sciences and the CASPER High School Scholars program. Students, teachers, faculty, and grad students participating in summer research attended weekly Wednesday Lunch Bunch Seminars and Friday Updates, enticed by the prospect of free food and interesting conversation. At the Wednesday seminars, faculty members presented short talks on various topics including fractals and chaos, the physics of golf, and the optimum consumption level of a can of Dr Pepper® in order that it remain stable on the dashboard of a car in motion. The students were also given tips on literature searches, writing papers, preparing posters and presentations, and applying to graduate school. On Fridays, the participants gave updates on their research experience and shared examples of their culinary capabilities. The CASPER team also traveled to UT Dallas to listen to Nobel Laureate Dr. Russell Hulse, tour the carbon nanotube labs in UT Dallas' Alan G. MacDiarmid NanoTech Institute, and learn about educational outreach activities at the Plano Public Libraries and as part of the Contact Science program at UT Dallas. At the end of the summer, each of the participants prepared a poster, gave a twelve-minute presentation, and wrote a paper detailing their research and results. The program culminated with a dinner and awards presentation at The Palladium.

Selected Seminar Speakers



Dr. Trevor Garner, University of Texas, research associate at the Applied Research Laboratories: The Earth's ionosphere is the layer of plasma in the upper atmosphere, and it interacts with both ground and satellite-based radio signals. In particular, the ionosphere can be a major error source for the Global Positioning System (GPS), a satellite-based navigation system. Conversely, GPS error mitigation techniques can be inverted to make GPS the most abundant source of ionospheric measurements. The Applied Research Laboratories (ARL) at the University of Texas has been involved with GPS since the early 1980s, and is now involved with many aspects of GPS including constellation and signal monitoring and ionospheric determination. This talk will introduce the technique for measuring the ionosphere from the GPS signal, and some of the major research efforts using GPS signals at ARL.



Dr. Ralph Lorenz, Johns Hopkins University Applied Physics Lab: Saturn's giant moon Titan has been of considerable interest since the presence of an atmosphere was hinted at one century ago. The NASA-ESA-ASI Cassini-Huygens mission, at Saturn for the last 6 years, has transformed this curious dot in the sky into a remarkably diverse, complex and interesting world, which is in many ways more Earth-like than anywhere in the solar system. This talk will summarize some of Cassini's recent findings with emphasis on the interactions between Titan's surface and atmosphere. These include dune-covered sand seas, river channels that attest to violent but perhaps rare downpours and climate change, and unevenly-distributed lakes of liquid hydrocarbon that may attest to climate change on seasonal and astronomical timescales.



Brother Guy Consolmagno, Vatican Observatory, lectured on "Meteorites, Asteroids, and the Stratigraphy of the Early Solar System." Consolmagno's research explores the connections between meteorites, asteroids and the origin and evolution of small bodies in the solar system.

CASPER moving to the BRIC in 2012

In 2012/2013, all of CASPER will for the first time be under one roof! In October of 2009, Baylor announced the formation of the Central Texas Technology & Research Park and its cornerstone building, the Baylor Research and Innovation Collaborative (BRIC). The academic anchor for the BRIC will consist of the School of Engineering research labs, a Business School (the Innovative Business Accelerator) presence and several interdisciplinary centers and institutes including CASPER. The current proposal allocates approximately 25,000 square feet for lab and research areas within CASPER and includes exciting new possibilities such as an integrated drop tower/light gas accelerator facility. Phase one funding for the BRIC of \$32 million is in hand with completion of shell space on track for first quarter of 2012. Phase two funding will provide build-out of the necessary lab and meeting space as well as specialized user facilities.

Building on CASPER's research collaboration with the Institute for Space Systems (IRS) and the University of Stuttgart, Drs. Truell Hyde and Rene Laufer are currently working with the BRIC design team to provide the infrastructure necessary for the development of space hardware for the measurement of in-situ dust and plasma parameters, real time satellite imagery in either the visible or infrared and space instrumentation certification. The proposed space would also allow CASPER, in collaboration with ISR, to establish an entirely new, proprietary, flexible plasma source, based on the University of Stuttgart's existing design of an inductively-heated plasma generator (IPG). A plasma source of this sort would provide realistic



plasma conditions across a wide range of operating regimes and gasses while allowing for the introduction of multiple contaminants or plasma components. Possible research foci for the above efforts include (1) the simulation of space dusty plasma environments and associated complex dusty plasma effects in Earth orbit, on the surface of the Moon or on comets; (2) the development, validation, test and calibration of materials and sensors for terrestrial applications in high temperature environments; (3) dust simulants and their interaction in plasma environments for validation, calibration and improvement of basic dust simulants; and (4) the interaction between a complex dusty plasma and materials, components, and subsystems as development support for future hardware in high temperature environments on Earth or in spacecraft. Stay tuned!

Selected Seminar Speakers



Dr. Georg Herdrich, University of Stuttgart, Germany, Institut für Raumfahrtssysteme: Herdrich is a research scientist at the Institute of Space Systems at the University of Stuttgart, Germany, and head of Plasma Wind Tunnels and Plasma Technology. For more than 10 years, Herdrich has been actively involved in plasma and atmospheric entry research with ESA, NASA and JAXA. He participates in flight instrument development as well as space missions including EXPERT, Stardust, Cassini/Huygens and X-38. He is a delegate of Germany at the United Nations working group for nuclear power in space. Herdrich's current research areas are atmospheric entry simulation (experimental and numerical), electric propulsion systems, in-situ diagnostics and instrumentation and industrial plasma technology applications.



Dr. Hans Peter Roeser, University of Stuttgart: In many papers it has been shown experimental evidence that the critical transition temperature T_c of conventional (SC) as well as high temperature superconductors (HTSC) depends among other criteria on the crystal structure. For HTSCs there exist several families with transition temperatures between 20 K and 135 K at ambient pressure. For each element the maximum transition temperature requires an optimum doping by e.g. oxygen excess or deficiency. Assuming a homogeneous doping distribution we found a correlation between the doping distance x to the inverse of T_c in the form $(2x)^2 = m_1 \cdot 1/T_c$ with a slope of $m_1 = 2.771 \cdot 10^{-15} \text{ m}^2\text{K}$ and $M_{\text{eff}} = 2m_c$ which leads to $(2x)^2 \cdot 2M_{\text{eff}} \cdot \pi k T_c = h^2$ For conventional one component superconductors there exists also a correlation between the shortest distance x within the crystal structure and $1/T_c$ forming a straight line $(2x)^2 = m_2 \cdot 1/T_c$ with a slope of $m_2 = 3.06 \cdot 10^{-18} \text{ m}^2\text{K}$.



Dr. Eric Hirschmann, Brigham Young University, associate professor of physics: Among the strongest sources of possible gravitational wave signals are the mergers of binary systems containing compact objects such as neutron stars or black holes. Further, one of the likeliest candidates for the central engines of short, hard, gamma ray bursts is the merger of binary neutron star systems. Thus, understanding such mergers is possibly crucial for understanding some of the most energetic events in the universe. However, understanding such systems will require coming to grips with the intersection and interaction of a wide swath of physics including magnetohydrodynamics, radiative transfer, nuclear physics and general relativity. While such a comprehensive approach is still a considerable way off, we will attempt to describe some of our preliminary efforts in modeling binary systems of compact objects together with some of this crucial physics.



Dr. Peter Hartmann, Research Institute for Solid State Physics and Optics of the Hungarian Academy of Sciences, research fellow: A classical dusty plasma experiment was performed using two different dust grain sizes to form a strongly coupled asymmetric bilayer (two closely spaced interacting monolayers) of two species of charged dust particles. The observation and analysis of the thermally excited particle oscillations revealed the collective mode structure and dispersion (wave propagation) in this system; in particular, the existence of the theoretically predicted $k = 0$ energy (frequency) gap was verified. Equilibrium molecular-dynamics simulations were performed to emulate the experiment, assuming Yukawa-type interparticle interaction. The simulations and analytic calculations based both on lattice summation and on the quasilocalized charge approximation approach are in good agreement with the experimental findings and help in identifying and characterizing the observed phenomena.



Dr. Story Musgrave was selected as a scientist-astronaut by NASA in August 1967. He completed astronaut academic training and then worked on the design and development of the Skylab Program. He was the backup science-pilot for the first Skylab mission, and was a CAPCOM for the second and third Skylab missions. Musgrave participated in the design and development of all Space Shuttle extravehicular activity equipment including spacesuits, life support systems, airlocks and manned maneuvering units. From 1979 to 1982, and 1983 to 1984, he was assigned as a test and verification pilot in the Shuttle Avionics Integration Laboratory at JSC. He served as a spacecraft communicator (CAPCOM) for STS-31, STS-35, STS-36, STS-38 and STS-41, and lead CAPCOM for a number of subsequent flights. He was a mission specialist on STS-6 in 1983, STS-51-F/Spacelab-2 in 1985, STS-33 in 1989 and STS-44 in 1991, was the payload commander on STS-61 in 1993, and a mission specialist on STS-80 in 1996. A veteran of six space flights, Musgrave has spent a total of 1281 hours 59 minutes, 22 seconds in space. Musgrave is the only astronaut to have flown missions on all five Space Shuttles. Prior to John Glenn's return to space in 1998, Musgrave held the record for the oldest person in orbit, at age 62. He retired from NASA in 1997.

For a complete list of CASPER's seminar speakers, visit www.baylor.edu/CASPER/seminars

Research Updates Active Awards and Proposals

GEAR UP Waco STEM Initiative

U.S. Department of Education
\$11,360,124 • 2006-2012

Summer Undergraduate Research Experience

NSF
\$394,967 • 2010-2013

NASA Space Shuttle Program Historic Artifacts (first round)

NASA
\$17,686,870 • 2011-2013

NASA Space Shuttle Program Historic Artifacts (second round)

NASA
\$3,725,000 • 2011-2013

Celebrating the Laser in Waco, a cooperative venture involving Texas State Technical College, Baylor University, OP-TEC and School Science Teachers in the Waco Community

APS
\$10,000

Laboratory Enhancement to Baylor

NASA
\$658,000 • 2008-2010

Collaborative Research: The Casimir effect: Geometry and boundary condition dependence

NSF
\$150,000 • 2008-2011

NSF REU Supplement to CAREER Award

NSF
\$5,675 • 2010-2011

Charging and coagulation of fractal dust aggregates in plasma environments

NSF CAREER
\$436,658 • 2009-2014

Rapidly convergent quadrature-free methods for high oscillatory diffraction integrals in light beam propagations, stage II

Air Force Research Lab
\$28,500 • 2009-2010

Horava-Lifshitz Theory and Applications to Cosmology and Astrophysics

DOE
\$120,000 • 2010-2013

Meeting Industries' Critical Workforce Needs

U.S. Small Business Administration
\$196,514 • 2009-2010

Submitted Proposals

Aerospace Composites

NASA
\$400,000 • Pending

NIST Construction Grant

NIST
\$15,000,000 • Pending

Lunar Plasma Environment Simulation - Education Activity

NASA
\$67,673 • Pending

Lunar Plasma Environment Simulation

NASA
\$310,673 • Pending

Real time emergency response satellite imagery and mapping system for the state of Texas to support emergency task force operations

State of Texas
Pending • 2009

Late Cosmic Acceleration of the Universe in String/M-Theory on S1/Z2

DOE
\$189,000 • Pending • 2010-2013

Modified Gravity and Applications to Cosmology and Astrophysics

NSF
\$229,000 • Pending • 2010-2013

Space Satellite and Lunar Science Research Initiative

NASA
\$1,323,764 • Pending • 2010-2011

Congratulations!

Dr. Anzhong Wang recently received a \$120,000 U.S. Department of Energy grant to study the Horava-Lifshitz theory of quantum gravity and its applications to cosmology and astrophysics. Research began in August 2010 and will continue for three years. Congratulations!

physics THE GREATEST ON EARTH CIRCUIS



The Physics Circus marked its eleventh year with a 'CSI' theme - the CASPER Science Investigators. Over 2,000 9th and 10th grade students from the Waco and LaVega Independent School Districts acted as junior CASPER science investigators to help solve the case and find their missing principal.

As always, students were both entertained and educated through the comical theatrical performance that set the stage for solving the mystery in the Science Lab (Fun House). Dr. Cyndi Hernandez, assistant director for educational research and outreach for CASPER said, "It's always important to make the Physics Circus relevant for the GEAR UP Waco cohort, so we integrated popular music, science and math content aligned with grade equivalent national and state standards, and then created videos of each of the four school's principals to enhance the experience."

Students used clues embedded in the script and verified in the Fun House to create a timeline of events, determine an unknown element, understand the electrical wiring of their high school, calculate each suspect's kinetic energy, and compare different properties based on their atomic composition, all in an effort to rule out suspects and locate their missing principal. The positive educational outcome of the 2010 Physics Circus was validated as shown by a 91% increase in the students' biology, chemistry, and physics content knowledge based on pre- and post-assessment. Two of the primary goals of the Physics Circus are to improve the students' attitudes toward pursuing a STEM (science, technology, engineering and math) career while also preparing them academically for college. The 2011 Physics Circus will maintain the CASPER Science Investigator theme as the students use various aspects of nanotechnology to solve yet another mystery. Additionally, the 2011 Physics Circus will be the first to stream live video over the web in order to reach a wider audience. High definition videos of the performance as well as instructional displays will also be available for check out. If your school is interested in acting as a beta test site for either of these, please contact Dr. Cyndi Hernandez.



CASPER OUTREACH



CASPER Space Place is yet another outreach project offered by the Center designed to encourage students to pursue and excel in advanced mathematics and science. Students in the 5th and 6th grades are invited to participate in this after school activity, led by Dr. Cyndi Hernandez, CASPER assistant director for educational research and outreach, where they engage in weekly activities designed to stimulate critical thinking, develop problem solving skills, and discover exciting science careers for the 21st Century. Students meet for an hour after school each week and there is no cost to participate. More than 60 students attended the

2010 CASPER Space Place each week where several Waco Independent School District teachers assisted in implementing the initiative. One of the primary goals of the CASPER Space Place initiative is to increase the quality of after school programs throughout Waco by creating a proven research based method of delivering content specific instruction. Each after school lesson is packaged with supplies and materials that can be loaned to after school program coordinators. Additionally, each teacher is provided prepared presentations to use in their classrooms after the conclusion of CASPER Space Place.



CASPER's Lunar Research Experience for High School Students is a partnership between the Lunar and Planetary Institute (LPI), CASPER, and the Waco Independent School District (WISD). The program, which in 2010 included student teams from high schools across the country, was developed to provide research experiences that inspire students to consider lunar and planetary career paths. It additionally offers the unique opportunity for participating students to interact directly with active lunar scientists. This year's student-led CASPER proposal was one of five nationwide selected to participate by the Lunar and Planetary Institute and the National Science Foundation. The WISD high school students met once a week to research the formation and ages of lunar mare basalts. The research project

consisted of gathering published research literature to identify specific sites on the Moon's surface that could provide a better understanding into the distribution of ages seen between the oldest and youngest mare basalts, which cover about 17 percent of the lunar surface and are visible from Earth as dark areas on the moon. The project culminated with the presentation by the students of their research to a NASA review panel. "One of CASPER's primary goals is to encourage students to consider science, technology, engineering or mathematics careers, and this is a wonderful, fun way of doing that," said Dr. Truell Hyde, vice provost for research at Baylor, professor of physics and CASPER director. "These students benefited greatly from conducting research with CASPER scientists."

The Physics Circus website has an exciting new look and CASPER K-12 educational resources are now available for after school clubs, home schools, teachers and students. The website also includes information about the 2011 Physics Circus, how to join the CASPER Space Place Facebook group, and even an opportunity to "Ask a Physicist" questions. Check us out at

www.baylor.edu/physicscircus