

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

*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 Celebrates a Milestone - 10 Years

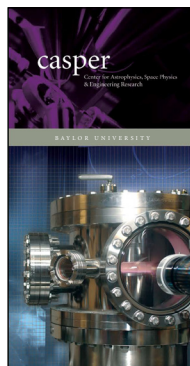


BAYLOR
UNIVERSITY

CENTER FOR ASTROPHYSICS,
SPACE PHYSICS & ENGINEERING RESEARCH



Texas State
Technical College
Waco



New CASPER brochures are available if you would like a copy. Please contact us at 254-710-3763 and we will send you one in the mail.

Hypervelocity Impacts, Dusty Plasmas Lab and Space Science Lab

3801 Campus Drive
Waco, TX 76705

www.baylor.edu/CASPER
(254) 867-3167 (voice)
(254) 710-3763 (voice)
(254) 867-DUST (fax)

Center for Astrophysics, Space Physics & Engineering Research

One Bear Place 97310
Baylor University
Waco, Texas 76798-7310

www.baylor.edu/CASPER
(254) 710-3763 (voice)
(254) 867-3167 (voice)
(254) 710-7309 (fax)

CHANGE SERVICE REQUESTED

In this issue

CASPER Celebrates a Milestone Stuttgart Agreement

Faster than the Speed of Light Group Updates

- EAG
- ASSTG
- GCAP
- EUCOS

Physics Circus

CASPER Summers

New Members / Award

Ten Years of Success

Selected Seminar Speakers

Research Updates

- Proposals and Awards
- Publications
- Presentations

CASPER notes

Personnel Updates

- Graduations
- Awards
- Babies

The Center for Astrophysics, Space Physics & Engineering Research (CASPER) was established in 1999 having but a single faculty member housed in the Marrs McLean Science Building. Ten years later, CASPER supports six different research groups and has over thirty faculty and staff located around the world.

CASPER is an interdisciplinary, flat-earth center in the truest sense of Friedman's definition: at Baylor its faculty hold appointments within the College of Arts and Sciences, the School of Business, the School of Education, the School of Engineering and CASPER. Through memorandums of understanding, CASPER faculty around the world hold appointments at the MCT Petropolis (Brazil), the Chinese Academy of Sciences (China), the Chongqing University of Posts and Telecommunications (China), the University of Stuttgart (Germany), NASA's Johnson Space Center (USA) and Texas State Technical College Waco (USA).

CASPER research is conducted within one of six groups. Theoretical research is conducted within the Astrophysics and Space Science Theory Group (ASSTG), the Early Universe Cosmology and Strings Group (EUCOS) and the Gravity, Cosmology and Astroparticle Physics Group (GCAP). Experimental research is carried out in one of CASPER's outstanding laboratory facilities including the Hypervelocity Impacts and Dusty Plasmas Lab (HIDPL) and the Space Science Lab (SSL). Through a Memorandum of Understanding between CASPER and the Central Texas Astronomical Society, CASPER faculty, staff and students also conduct research using the Paul and Jane Meyer Observatory, often in collaboration with University of Texas faculty and graduate students working at McDonald Observatory.

Baylor's admission in 2005 to the Universities Space Research Association (USRA), an elite, private, nonprofit consortium established by the National Academy of Sciences, speaks directly to the success of CASPER's first decade. Consisting of the top 104 research universities in the world offering graduate programs in the space sciences or aerospace engineering, the Universities Space Research Association has been a driving force behind cutting-edge space science research and education since 1969. Baylor's acceptance into this prestigious alliance, due specifically to ongoing research and education efforts within CASPER, places the Center squarely in the ranks of other USRA



members such as Caltech, Harvard, MIT and Yale.

Both undergraduate and graduate students remain an essential part of the equation at all levels. CASPER faculty include these students in cutting-edge research while CASPER seminars expose them to outstanding speakers across multiple fields. As a result, CASPER undergraduates are accepted for graduate study at schools such as MIT and the University of Cambridge, while the research of CASPER graduate students makes headlines around the world. Finally, CASPER's outreach efforts impact over 2000 K-12 students and teachers each year through programs like the Physics Circus (in both English and Spanish), and its National Science Foundation Research Experiences for Teachers (RET) and Research Experiences for Undergraduate (REU) initiatives.

I invite you to explore this issue of the *CASPER Newsletter* to learn more about a few of the wonderful things our faculty and students have been a part of over the past year. Finally, if you'd like to introduce your friends to CASPER, please feel free to request copies of our most recent brochure.

Best wishes to all for another outstanding decade!

Dr. Truell W. Hyde, Director, CASPER

For more information on the USRA and a complete list of members, see www.usra.edu

For a list of recent CASPER seminars see www.baylor.edu/CASPER/seminars

For a list of recent CASPER spotlights, see www.baylor.edu/CASPER/spotlight

Baylor Signs International Agreement with University of Stuttgart, Gains Bird's-Eye View

It is unusually large, flies by remote control and is intended to collect environmental data on pastures, bodies of water and forests. In March 2008, in a special christening ceremony at the IRS (the Institut für Raumfahrtssysteme or Institute for Space Systems in English), the latest University of Stuttgart unmanned aerial vehicle (UAV), the Adler, was debuted. The aircraft was constructed by students and professors in a collaborative effort between IRS and its sister institute, the Institute for Aerospace Engineering.

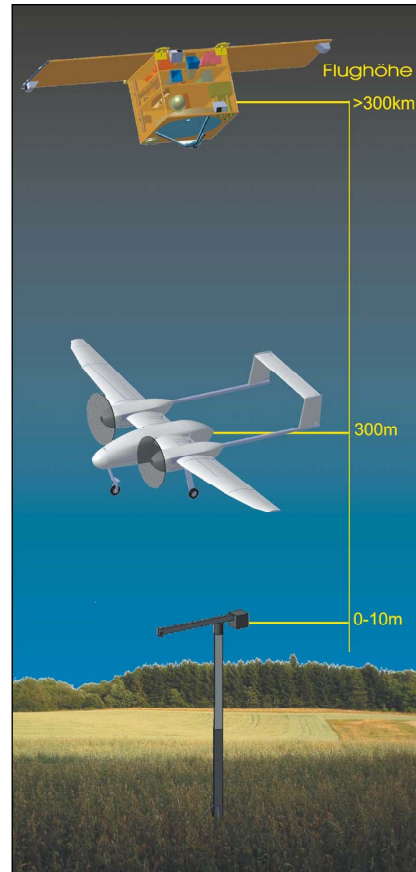
Dr. Hans-Peter Roeser, the Director of the IRS, stated that "Combined with other IRS platforms, such as student-built satellites, this unmanned aerial platform will collect and evaluate environmental data such as the Bi-directional Reflectance Distribution Function (BRDF) and the Temperature Directional Brightness Distribution (TDD). The reflectance of most surfaces shows anisotropic behavior, which means the reflectance varies with solar and viewing position."

The Adler is 2.6 m long with a wingspan of 4.3 m. It has a maximum operating weight of 25 kg and the capability to carry a seven kilogram payload to an altitude of 300 m for periods as long as 45 minutes. The UAV is powered by two electric motors and currently commanded through a remote control system, although eventually, an autopilot system will be installed. With pre- and post-flight preparation times of less than 30 minutes, the UAV platform is rapidly deployable to almost any location.

The data from the UAV can be combined with satellite and ground measurements as shown in the image to the right. (Image courtesy of Grafik:Institute.) The UAV carries three cameras, operating in the green, red and near-infrared spectrum. A spectrometer is also scheduled for installation in the near future. At a typical operating altitude of 300 m (~1000 ft), the resolution for each is ~10 cm (optical), 30 cm (thermal) and 50 cm (spectrometer). As such, the Adler as described has the potential to accomplish a diverse range of science missions; for example, it is able to recognize changes in vegetation patterns

and health, or document environmental changes in bodies of water. Other missions could include conducting animal population counts, collecting data on water dike structural conditions, determining fire damage and reconnaissance or aiding in the evaluation of landfills or environmental spill and clean-up effectiveness. The system could also be used for homeland defense or emergency response.

Over the summer, CASPER personnel erected a satellite downlink antenna and installed VHF and UHF satellite communications hardware and software within the HIDPL. Under the Memorandum of Understanding between Baylor and the University of Stuttgart, this capability now provides members of CASPER access to the instruments on board the German satellites currently on orbit. The next step in CASPER's long-term plan is the installation of a S-band antenna, which will provide additional throughput for both downlink and uplink communications and control capability.



International Workshop Coming to Baylor, Waco

Since 1986, the International Workshop on the Physics of Dusty Plasma has been held in the United States every two to three years. This workshop brings together the top dusty plasma physicists from around the world to discuss the latest developments in the field. Previous meetings have been held in Boulder, Colorado (sponsored by the University of Colorado, Boulder), Williamsburg, Virginia (sponsored by Virginia Tech and the Naval Research Lab), St. Thomas (sponsored by Auburn University), Iowa City (sponsored by the University of Iowa) and Santa Fe, New Mexico (sponsored by Los Alamos National Laboratory).

We are pleased to announce that the next workshop in this series will be held May of 2012 in Waco, Texas with CASPER / Baylor University as the host organization. Stay tuned for more details!

Personnel Updates

Former RET Inducted into Hall of Fame



Dr. Steve Rapp, 2008 and 2009 RET fellow was recently inducted into the National Teachers Hall of Fame. Only five teachers from across the nation were given this award in 2009. Rapp teaches astronomy, physics, engineering, and robotics to 10-12 graders at A. Linwood Holton Governor's School in Abingdon, Va. He has been teaching for 39 years. Congratulations Steve on your accomplishments!

Former REU Receives Space Internship



Aaron Cabe, 2008 REU fellow from Southern Nazarene University, was selected to study this past spring at the Johnson Space Center in Houston, Texas. Cabe's internship project was titled, "Standardizing Process Implementation Flow Diagrams for the Constellation Mission Operations Project Baseline Operations Plan." His internship was funded through the Oklahoma Space Grant Consortium which paid for all his expenses. Congratulations!

CASPER Student Receives Space Scholarship



CASPER student Cameron Buescher was selected as a 2009-2010 NASA Texas Space Grant Columbia Crew Memorial Scholar. The NASA Texas Space Grant Columbia Crew Memorial Scholarship, valued at \$1000, honors outstanding students who have demonstrated skill and excellence in undergraduate academics, and are meant to encourage graduate study in a space-related area. Congratulations Cameron!

Babies



Lachlan Swint Matthews was born December 29, 2008 to Lorin and Chris Matthews, 6 lbs 13 oz, 20.5 inches long.



Paul Ward Barge was born to Bill and Laura Barge April 14, 2009, 8 lbs 3 oz, 20 inches long.



Elva G. Qiao was born May 7, 2009 to Ke (Mike) and Snow Qiao, 7 lbs 12 oz, 19.5 inches long.



Randall Roberto Cruz Dunkin was born November 5, 2008 to Randall and Olga Dunkin, 7 lbs 4 oz, 21 inches long.



Jorge Adbiel Carmona was born June 2, 2008 to Jorge and Amparo Carmona, 7 lbs 8 oz, 20 inches long.



Asher Elliott Swint was born August 28, 2008 to Reuel and Amy Swint, 8 lbs 10 oz, 19.5 inches long.

Personnel Updates Graduations



Eileen Fernandez graduated with a bachelor of science in physics in May 2009 and completed her honors thesis, "Circumplanetary Dust: The Martian System and Saturn's F ring." Congratulations!



Andreas Tziolas successfully defended his doctoral dissertation, "Colliding Branes and Formation of Spacetime Singularities in Superstring Theory" in March 2009 and graduated from Baylor with a Ph.D. in theoretical physics in May 2009. In addition, his dissertation has received widespread interest and has now been published as a monograph by Verlag Publishing House. Congratulations!



Matt Robinson successfully defended his doctoral dissertation, "Towards A Systematic Investigation of Weakly Coupled Free Fermionic Heterotic String Gauge Group Statistics" in March 2009 and graduated from Baylor with a Ph.D. in mathematical physics and string theory in May 2009. Congratulations!



Richard Obousy successfully defended his doctoral dissertation "Investigations into Compactified Dimensions: Casimir Energies and Phenomenological Aspects" and graduated from Baylor with a Ph.D. in String Theory and Cosmology in December 2008.



Qiang "Bob" Wu successfully defended his doctoral dissertation, "Brane Cosmology in String/M-Theory and Cosmological Parameters Estimation" in May 2009 and graduated from Baylor with a Ph.D. in physics in August 2009. Congratulations!

Ta (Hart) He successfully defended his master's thesis, "Classification of Cosmological Models in Einstein's General Theory of Gravity" in May 2009 and graduated with a MS in physics in August 2009.

Jonathan Perry graduated with a bachelor of science in physics in May 2009. Congratulations!

Outstanding Doctoral Graduate Student Award

The Graduate Student Association awarded CASPER graduate student, Qiang "Bob" Wu, the 2008-2009 Outstanding Doctoral Graduate Student Award. He was nominated for this award by Dr. Anzhong Wang. Bob Wu's commitment to academic and scholarly work has been exemplified in numerous forms, including his record of publications and conference presentations. He received the highest praise from Dr. Wang, saying in part, "[Bob Wu is] outstanding not only because of his high scores over all the courses that he took in the past five years at Baylor, but also because of his excellent performance in his research, leadership, and interpersonal relationships with his classmates...". Congratulations, Bob!

TSTC Graduates

Sharon Bozeman	Christina Gustafson
Jeremy Gonzales	Benjamin Carey
Michael Lambden	Michael Perkins
Chase Pearson	Benjamin Carey
Arron Westbrook	Christina Gustafson
David Hollingsworth	Michael Perkins
Morgan Gilmer	Michael Pope
Chris Gonzales	Robert Santiago
Jeremy Gonzales	

Traveling Faster Than the Speed of Light: Two CASPER Physicists Have a New Idea That Could Make it Happen

Two CASPER scientists have come up with a new method to cause a spaceship to effectively travel faster than the speed of light, without breaking the laws of physics.

Dr. Gerald Cleaver, associate professor of physics and head of CASPER's EUCOS group, and Dr. Richard Obousy, a recent CASPER graduate who came to Baylor through the CASPER REU program several years ago, theorize that by manipulating the extra spatial dimensions of string theory around a spaceship with an extremely large amount of energy, it would create a "bubble" that could cause the ship to travel faster than the speed of light. To create this bubble, the physicists believe manipulating the 10th spatial dimension would alter the dark energy in three large spatial dimensions: height, width and length. Cleaver said positive dark energy is currently responsible for speeding up the expansion rate of our universe as time moves on, just like it did after the Big Bang, when the universe expanded much faster than the speed of light for a very brief time.

"Think of it like a surfer riding a wave," said Cleaver, who co-authored the paper with Obousy about the new method. "The ship would be pushed by the spatial bubble and the bubble would be traveling faster than the speed of light."

The method is based on the Alcubierre drive, which proposes expanding the fabric of space behind a ship and shrinking space-time in front of the ship. The ship would not actually move, rather the ship would sit in a bubble between the expanding and shrinking

space-time dimensions. Since space would move around the ship, the theory does not violate Einstein's Theory of Relativity, which states that it would take an infinite amount of energy to accelerate a massive object to the speed of light.

String theory suggests the universe is made up of multiple dimensions. Height, width and length are three dimensions, and time is the fourth dimension. String theorists used to believe there were a total of 10 dimensions, with six other dimensions that we can not yet identify because of their incredibly small size. A new theory, called M-theory, takes string theory one step farther and states that the "strings" all things are made of actually vibrate in an additional spatial dimension, which is called the 10th dimension. It is by changing the size of this 10th spatial dimension that Baylor researchers believe could alter the strength of the dark energy in such a manner to propel a ship faster than the speed of light.

The CASPER physicists estimate that the amount of energy needed to influence the extra dimension is equivalent to the entire mass of Jupiter being converted into pure energy for a ship measuring roughly 10 meters by 10 meters by 10 meters.

"That is an enormous amount of energy," Cleaver said. "We are still a very long ways off before we could create something to harness that type of energy."

The paper appears in the *Journal of the British Interplanetary Society*.

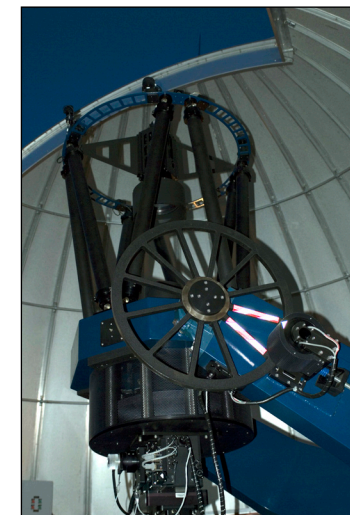
Experimental Astronomy Group Research Updates

The Experimental Astronomy Group had a good year conducting observational research utilizing the Paul and Jane Meyer Observatory near Clifton, Texas. CASPER graduate and undergraduate students gain hands-on access to conduct real-time research with undergraduate students also having the opportunity to pursue projects applying classroom theory.

The Group also sponsors summer REU and RET students from various universities to conduct stellar research. Under the mentorship of Dr. Dwight Russell and Dick Campbell, the students experience the life of an observational astronomer working under the dome all night, and learning the science of accurate data collection and analysis.

Last summer, CASPER REU Fellows Bridget Onan and Maria Tiongco conducted research on pulsating white dwarf (WD) stars. This research required them to learn telescope operations, instrumentation techniques, and develop data analysis methods. CASPER RET Fellow Shelly Hynes also worked at the observatory while also developing new curricular material for her astronomy students by learning to operate the observatory and program mathematical analyses for the collected data.

This year's work has already made several discoveries that have added to the body of knowledge of WD stars, including refining the boundary of the instability strip. Research on this subject is ongoing with a collaboration with the McDonald Observatory. Other research opportunities include participation in the Whole Earth Telescope operations, and the Near Earth Asteroid crossing program.



EAG Members

Faculty and Staff
Dick Campbell
Dwight Russell
RET Fellow
Shelly Hynes
REU Fellows
Bridget Onan
Maria Tiongco

Left: Because of the CTAS relationship, CASPER students have access to the Paul and Jane Meyer Observatory. CASPER's Experimental Astronomy Group works in conjunction with the UT astronomy department to measure luminosity curves for white dwarf stars.

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

CASPER members within the ASSTG/HIDPL had a very busy year!

The year began with Truell Hyde, Lorin Matthews, Victor Land, Bernard Smith, Jay Kong, Ke Qiao, Cyndi Hernandez, Jorge Carmona Reyes, James Creel, Victor Zhang, Theresa Ma, Jonathan Perry and Erick Remkus attending the 50th Annual Meeting of the Division of Plasma Physics of the American Physical Society (APS) in Dallas, Texas. A total of eight presentations representing research undertaken by faculty, staff, graduate, undergraduate and high school students were presented during multiple sessions. CASPER also accepted an invitation to host a booth at the APS Plasma Expo, an event for local middle and high school students and teachers highlighting CASPER's Education / Outreach activities through the Physics Circus. As part of this invitation, Dr. Truell Hyde gave an invited talk on "Complex Plasma Physics and Rising Above the Gathering Storm" in the APS Education and Outreach session.

Next, Truell Hyde, Lorin Matthews, Victor Land, Bernard Smith, Jay Kong and Ke Qiao traveled to the 61st Annual Gaseous Electronics Conference in Dallas, Texas where the latest research results from the HIDPL were presented as three presentations and one poster presentation.

Earlier in the year, Truell Hyde and Lorin Matthews attended the 37th Committee on Space Research (COSPAR) Scientific Assembly in Montreal, Canada where they presented a total of three talks and one poster presentation.

Truell Hyde and Cyndi Hernandez co-presented an invited talk at the NCEP/GEAR UP Annual Conference, San Francisco, CA.

Truell Hyde, Lorin Matthews, Victor Land, Bernard Smith, Jay Kong, Ke Qiao, Jorge Carmona Reyes, James Creel, Victor Zhang, Theresa Ma and Jonathan Perry attended the 12th Workshop on the Physics of Dusty Plasmas, Denver, Colorado where they presented five presentations on recent research.

During the same time period, Truell Hyde presented invited colloquiums on Dusty Physics, at the Department of Physics, University of Texas, Austin, TX and the Department of Physics, University of Texas, Dallas, TX.

Truell Hyde also presented an invited colloquium, "Self-Assembling Nanosystems in Complex Plasmas" and served as an invited panelist on Accelerating Nanotechnology Commercialization for the Nobel Laureates Legends Program held at NanotxUSA'08, Dallas, TX.

The above led to seven publication in peer-reviewed journals. All in all, quite a year!

ASSTG / HIDPL Members

Faculty/Staff

Dr. Truell Hyde
Dr. Lorin Matthews
Dr. Jie Kong
Dr. Ray Nazzario
Dr. Ke Qiao
Dr. Bernard Smith
Dr. Victor Land
Rene Laufer
Jorge Carmona-Reyes
Michael Cook
Jimmy Schmoke
Dr. Phillip Anz-Meador

Graduate Students

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

REU Fellows

Megan Johnson
Michael Pope
Diana Bolser
Cheridan Harris
Aaron Cabe
Allison Youngblood
Chase Pearson
Adam Goler
Korey Haynes
Brian Morris
Robert Enzweiler
Jennifer Tuggle

Interns

Jason Brown
Tony Burns
Jeff Mullen
Robert Tibbs
Jonathan Whiteley
Sharon Bozeman
Benjamin Carey
Morgan Gilmer
Chris Gonzales
Jeremy Gonzales
Christina Gustafson
David Hollingsworth
Michael Lambdon
Chase Pearson
Michael Perkins
Robert Santiago
Aaron Westbrook

Undergraduate Students

Eileen Fernandez
Kristen Deline
Erik Remkus
Stephen Pickett
David George
Foster Lerner

High School Scholars

Brooks McMaster
Divyaprakash Singh

RET Fellows

Randy Hall
Gary Shetler
Steve Rapp

Research Updates Recent Presentations

On highly effective interface finite difference schemes for light wave propagation simulations, Q. Sheng, Invited Speaker at the First AMS Joint International Meeting with the Shanghai Mathematical Society, Shanghai, China, December 17-21, 2008.

On the stability of semi-adaptive iterative splitting for solving two-dimensional reaction-diffusion equations, Q. Sheng, American Mathematical Society Meeting #1036, Courant Institute of Mathematical Sciences, New York University, New York, NY, March 2008.

On theory of dynamic equations on time scales and its applications in hybrid numerical solutions of partial differential equations, Q. Sheng, Invited Speaker at the Third International Conference on Scientific Computing and Partial Differential Equations, Hong Kong Baptist University, Hong Kong, December 8-12, 2008.

Pair Interactions in a Complex Plasma Between Dust Particles with Dipole Moments, K. Qiao, L. Matthews and T. Hyde, presented at the 12th Workshop on the Physics of Dusty Plasmas, Denver, Colorado, 2009.

Probing the Sheath Electric Field in Dusty Plasma Using Thermophoresis, V. Land, L. Matthews, M. Benesh and T. Hyde, presented at the 12th Workshop on the Physics of Dusty Plasmas, Denver, Colorado, 2009.

Providing a Seamless Science Education Program (K-Graduate School), T. Hyde, L. Matthews, B. Smith, G. Shetler, S. Rapp and J. Carmona-Reyes, Presented at COSPAR, Montreal, Canada, 2008.

Self consistent modeling of dusty plasma experiments within a GEC reference cell, V. Land, E. Shen, L. Matthews, T. Hyde, paper presented at the 61st Annual Gaseous Electronics Conference in Dallas, Texas, October 13-17, 2008.

Self-Assembling Nanosystems in Complex Plasmas, Truell Hyde, Invited Lecture, NanotxUSA'08, Dallas, TX, 2008.

Splitting and interface methods, Q. Sheng, Invited Speaker at the Applied Mathematics Colloquium, University of Texas at Arlington, Arlington, TX, April 18, 2008.

STEM Education in Light of a Flat Earth, Truell W. Hyde, Invited Lecture at the Texas-Ohio STEM Education Mini-Conference, University of Texas at Dallas, May, 2008.

The 4th State of Matter and the TEKS, B. Smith, J. Carmona-Reyes, C. Hernandez and T. Hyde, Presented at CAST, Dallas, TX, 2008.

The CASPER REU Program, T.W. Hyde, Invited Presentation at the NSF-REU Physics Site Directors Workshop, American Center for Physics, College Park, Maryland, 2008.

Three Major Challenges in Cosmology, Particle Physics, and Their Possible Solutions in String/M Theory, A. Wang, LeTourneau University, Longview, Texas, October 2, 2008.

The Beauty, Order, and Complexity of Creation Revealed through the New Cosmology, G. Cleaver, Wheaton College, March 26, 2008.

The Beauty, Order, and Complexity of Creation Revealed through the New Cosmology, G. Cleaver, Valparaiso University, March 28, 2008.

The String Landscape & Multiverse, the Anthropic Principle, and Anselm's Ontological Argument, G. Cleaver, Baylor University, February 13, 2008.

The String Landscape & Multiverse, the Anthropic Principle, and Anselm's Ontological Argument, G. Cleaver, Wheaton College, March 26, 2008.

The God of the Stringy Multiverse, G. Cleaver, Wheaton College, August 11-15, 2008.

CASPER Notes

Dr. Lorin Matthews was recently awarded a National Science Foundation CAREER award. The title of her proposal was "Charging and Coagulation of Dust Grains in Astrophysical and Laboratory Environments." The funding began June 1 and runs for five years. The Faculty Early Career Development (CAREER) Program is a National Science Foundation-wide activity that offers the Foundation's most prestigious award in support of early career-development activities of those teacher-scholars who most effectively integrate research and education within the context of the mission of their organization. Congrats!

The Universities Space Research Association (USRA) recently elected **Dr. Truell Hyde** to serve as a member of the Issues and Programs Committee. Dr. Hyde already serves as Baylor's USRA Institutional Representative. USRA's Council of Institutions

Issues and Programs Committee was specifically formed to develop national and international policies and strategically address issues surrounding current scientific policies with Congressional representatives and the National Academy.

Dr. Truell Hyde was recently selected as one of 35 individuals chosen to serve on the National Science Foundation's Committee of Visitors (COV), conducting the triennial MSP review. By NSF policy, each program that awards grants and cooperative agreements must be reviewed at three-year intervals by a COV comprised of qualified external experts who are funded in a MSP field. NSF relies on the judgment of the COV to maintain high standards of program management, provide advice for continuous improvement of NSF performance, and insure openness to the research and education community served by the Foundation. The COV is also tasked with monitoring the integrity and efficacy of NSF processes, the quality and significance of the Division's pro-

grammatic investments and the relationship between award decisions, program goals and the Foundation's strategic plan. Reports generated by COVs are used in assessing agency progress in meeting government-wide performance reporting requirements.

Dr. Truell Hyde is currently serving a three-year term on the Southeastern Universities Research (SURA) Association's Jefferson Lab Program Committee. He is one of 36 members on the extended committee with responsibilities including administering internal funding, fostering communications with users and community stakeholders and monitoring the Lab's use of non-DOE support. The Committee is also tasked with monitoring reviews of the Lab's scientific programs as well as aiding in the transfer and commercialization of Lab discoveries.

Research Updates Recent Presentations

Complex Plasmas with Two Distinct Particle Sizes: Comparing Systems with Large Differences in Particle Size to Systems with Small Differences in Particle Size, B. Smith, L. Matthews and T. Hyde, presented at the 12th Workshop on the Physics of Dusty Plasmas, Denver, Colorado, 2009.

Conducting Grains in Dusty Plasmas, J. Carmona-Reyes, L. Matthews, T. Hyde, paper presented at the 37th COSPAR (Committee on Space Research) Scientific Assembly in Montreal, Canada, July 13-18, 2008.

Conducting particles in a Complex Plasma, J. Carmona, Ke Qiao, V. Zhang, J. Murphree, L. Matthews, and T. Hyde, poster presented at the 50th Annual Meeting of the Division of Plasma Physics, Dallas, Texas, November 19, 2008.

Cosmological Constant and Current Acceleration of the Universe in string/M-Theory, A. Wang, Brazilian National Observatory, Rio de Janeiro, Brazil, May 23, 2008.

Cosmological Constant and Current Acceleration of the Universe in string/M-Theory, A. Wang, Physics Institute, the State University of Rio de Janeiro, Brazil, March 19, 2008.

Current status of the late cosmic acceleration of the universe, A. Wang, Zhejiang University of Technology, July 27, 2008.

Decomposed z-stretching interface adaptive methods for light beam propagation computations, Q. Sheng, Fifth European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008), Venice, Italy, June 30-July 5, 2008.

Decomposition and adaptation in numerical PDEs, Q. Sheng, Invited Speaker at the Mathematics Colloquium, Department of Mathematics, Fu Dan University, Shanghai, China, December 17, 2008.

Developing a Seamless Science Education Program (K-Graduate School), B. Smith, J. Carmona-Reyes, T. Hyde, L. Matthews, paper presented at the 37th COSPAR Scientific Assembly in Montreal, Canada, July 13-18, 2008.

Dipole-dipole interactions of Charged Magnetic Grains, J. Perry, E. Remkus, L. Matthews, and T. Hyde, poster presented at the 50th Annual Meeting of the Division of Plasma Physics, Dallas, Texas, November 19, 2008.

Dipole-Dipole Interactions of Charged-Magnetic Grains, J. Perry, L. Matthews and T. Hyde, presented at the 12th Workshop on the Physics of Dusty Plasmas, Denver, Colorado, 2009.

Dust Particle Contamination Detection Mechanisms, J. Creel, J. Carmona, L. Matthews, and T. Hyde, poster presented at the 50th Annual Meeting of the Division of Plasma Physics, Dallas, Texas, November 19, 2008.

Dusty Physics, T. Hyde, Invited Colloquium, Department of Physics, University of Texas, Austin, TX, 2009.

Dusty Physics, T. Hyde, Invited Physics Colloquium at the University of Texas at Dallas, 2008.

Effect of Plasma Distribution Function on the Growth of Fractal Aggregates, L. Matthews, V. Land and T. Hyde, paper presented at the 37th COSPAR Scientific Assembly in Montreal, Canada, July 13-18, 2008.

Effective mesh stretching strategies for paraxial lightwave propagation simulations, Q. Sheng, Invited Speaker at the International Workshop on Beam Propagation Methods for Nonlinear Refractive and Absorptive Media, Dayton, Ohio, June 1-3, 2009.

Effects of Particle Dipole Moments in a Coulomb Crystal, K. Qiao, L. Matthews and T. Hyde, paper presented at the 50th Annual Meeting of the Division of Plasma Physics, Dallas, Texas, November 19, 2008.

Electric dipole moments in conducting particle Coulomb crystals, K. Qiao, L. Matthews and T. Hyde, poster presented at the 61st annual Gaseous Electronics Conference in Dallas, Texas, October 13-17, 2008.

From matrix exponential computations to parallel computations, Q. Sheng, Department of Mathematics, Shanghai Normal University, December 18, 2008.

From matrix exponential computations to parallel-split algorithms for partial differential equations, Q. Sheng, Invited Speaker at the Seminar on Scientific Computation, Department of Mathematics, Hong Kong University of Science and Technology, Hong Kong, December 12, 2008.

From matrix exponential function approximations to parallel/split computations, Q. Sheng, Invited Speaker at the Lectures on Pure and Applied Mathematics, University of Southern Mississippi, October 23, 2008.

Further Systematic Investigations of the Heterotic String Landscape, G. Cleaver, Baylor University, April 23, 2009.

Further Systematic Investigations of the Heterotic String Landscape, G. Cleaver, String Vacuum Project Workshop, April 15, 2008.

Gear Up Waco, CASPER and STEM Education, T. Hyde, Invited Colloquium, NCCEP / GEAR UP Annual Conference, San Francisco, CA, 2009.

Interaction Forces Between Particles in a Vertical Dust Chain, J. Kong, T. W. Hyde, B. Harris, K. Qiao, L. Matthews, B. Smith, and J. Carmona-Reyes, paper presented at the 50th Annual Meeting of the Division of Plasma Physics, Dallas, Texas, November 19, 2008.

Interparticle Forces Between Dust Particles Confined within a Glass Box in a GEC Chamber, Jie Kong, Truell, Hyde Lorin Matthews, Ke Qiao, Zhuanhao Zhang, Jimmy Schmoke and Mike Cook, presented at the 12th Workshop on the Physics of Dusty Plasmas, Denver, Colorado, 2009.

Interaction Forces Between Particles in a Vertical Dust Chain, J. Kong, L. Matthews and T. Hyde, Presented at the Gaseous Electronics Conference, Dallas, Texas, 2008.

Light Gas Gun Testing of PVDF by Undergraduates, T. Hyde, J. Carmona-Reyes, L. Matthews, poster presented at the 37th COSPAR Scientific Assembly in Montreal, Canada, July 13-18, 2008.

Manipulating particle traps in a GEC Reference Cell through Thermophoresis, V. Land, E. Shen, L. Matthews, and T. Hyde, paper presented at the 50th Annual Meeting of the Division of Plasma Physics, Dallas, Texas, November 19, 2008.

Modified iterative shooting procedures for solving optical wave quenching-collapsing problems, Q. Sheng, 7th AIMS International Conference on Dynamical Systems and Differential Equations, Arlington, TX, May 18-21, 2008.

Numerical Simulation of Particle Alignment in Complex Plasmas, K. Qiao, L. Matthews, and T. Hyde, paper presented at the 50th Annual Meeting of the Division of Plasma Physics, Dallas, Texas, November 19, 2008.

Gravity, Cosmology & Astroparticle Physics Group Updates

The Gravity, Cosmology, and Astroparticle Physics Group (GCAP), founded in 2006, is one of three theoretical research groups in CASPER. Recent research topics include late cosmic acceleration of the universe, cosmology in string/M theory, the hierarchy and cosmological constant problems, the Horava-Lifshitz theory of gravity and its applications to cosmology and astrophysics, higher dimensional black holes, and their thermodynamics and formation.

One remarkable discovery over the past decade in astronomy is that currently our universe is undergoing accelerating expansion. In Einstein's theory, a new component to the matter fields of the universe with a large negative pressure, or dark energy, is needed to account for such acceleration. The fundamental question now is the nature and origin of dark energy. The hierarchy and cosmological constant problems are also outstanding problems in particle physics and cosmology. To solve these problems brane-world scenarios are proposed, in which our four-dimensional universe is considered as a brane embedded in a higher dimensional bulk. One important result of such investigations is that higher dimensional black holes are predicted to be produced in the TeV energy scale, which can be explored directly by colliders in laboratories, such as the LHC. Very recently, Horava proposed a new quantum gravity theory motivated by the Lifshitz theory in solid state physics. The Horava-Lifshitz theory is non-relativistic and power-counting ultraviolet-renormalizable, and should recover general relativity in the infrared limit. The effective speed of light diverges in the UV regime, 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. In the theory's infancy, a more complete understanding of it is highly demanded. In addition, theories of gravity, including general relativity, predict the existence of black holes and gravitational waves. Black holes and their thermodynamics and formation from gravitational collapse have been one of the main focuses of GCAP in the last couple of decades. These studies have further been promoted by several gravitational wave detectors, built a couple of years ago, such as LIGO (USA), GE600 (Germany & England), Virgo (Italy & France), and TAM300 (Japan).

EUCOS Updates

Dr. Jerry Cleaver conducts research in early universe cosmology and string phenomenology. Cleaver and Dr. Tibra Ali have been investigating half-flat manifolds for heterotic strings. Cleaver and his students are conducting a long-term systematic study of the generic physical properties of the string landscape in the free-fermionic heterotic region. Richard Obousy, Matt Robinson and Cleaver's *A Non-Standard String Embedding of E8* and Obousy and Cleaver's *Radius Destabilization in Five Dimensional Orbifolds Due to an Enhanced Casimir Effect* both appeared in *Mod. Phys. Let.* in 2009. Obousy and Cleaver's article, *Warp Drive: A New Approach*, published in the *Journal of the British Interplanetary Soc.* in 2008, was reviewed in the recently published, *Frontiers in Propulsion Science*, a collection of technical and scientific papers edited by the former director of NASA's Breakthrough Propulsion Physics program Marc Miller. The book is intended as a document that researchers can use as a reliable starting point for productive research, chipping away at the issues and unknowns that might one day enable practical interstellar flight.

Cleaver serves as the associate editor of the *Journal of Physics, Astrophysics and Physical Cosmology*. In May, Cleaver presented a plenary talk, *Towards a Systematic Investigation of the Free Fermion Heterotic String Landscape and Dark Matter*, at the 3rd International Workshop on the Interconnection Between Particle Physics and Cosmology, at the Univ. of Oklahoma. In August Cleaver was elected as a Fellow of the American Scientific Affiliation.

GCAP Members

Faculty/Adjunct Faculty

Dr. Anzhong Wang
Dr. Qin (Tim) Sheng
Dr. Rong-Gen Gai
Dr. N.O. Santos
Dr. Yumei Gong

Graduate Students

Michael Devin
Te Ha
Yongqing Huang
Preet Sharma
Andreas Tziolas
Qiang Wu

Undergraduate Student:

Janie Hoormann

REU Fellow

Erik Lentz

EUCOS Members

Faculty and Staff

Dr. Gerald Cleaver
Dr. Tibra Ali

Graduate Students

Matt Robinson
Richard Obousy
Tim Renner
Jared Greenwald
Kristen Pechen

Undergraduate

Cameron Buescher

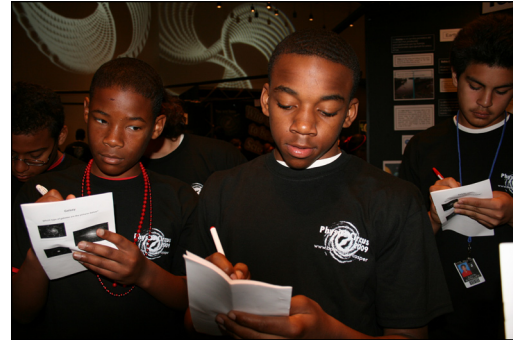
REU

Michael Janas
Gunner Miller

Continued on next page

CASPER Physics Circus

Since the first Physics Circus in 2000, the event has focused on encouraging students to major in a STEM (Science, Technology, Engineering & Mathematics) discipline by creating a seamless pathway from the earliest stages of the educational process through post-graduate work. Throughout this period, the Physics Circus has continued to evolve each year in order to better accomplish this goal. The most recent changes have taken place under the direction of Dr. Cyndi Hernandez, CASPER's new Assistant Director for Educational Research and Outreach.



Numerous studies over the past decade have shown that for the United States to remain competitive in an ever flattening global economy, its citizens must possess the scientific competency and



technological superiority that virtually every job will require in the future. Unfortunately, the number of students concentrating on a STEM education has continued to decline over the past several decades. The National Clearing House for Educational Statistics (NCES) recently released a study showing that the number of students from the United States majoring in a STEM field has continued to decline rapidly during a time when universities in Europe and the Far East, particularly China, are producing record numbers of STEM degrees.

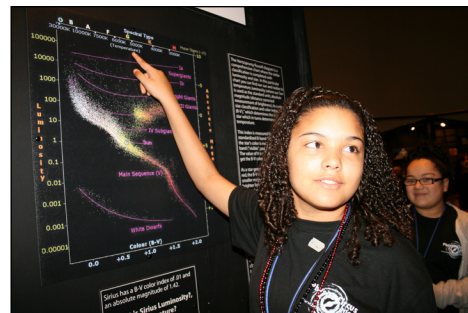
Providing true access involves much more than simply giving teachers written curriculum and presenting the Physics Circus performance. Innovative teacher training has been (and must be) an integral component of any initiative. This becomes an even greater priority in light of the fact that many thousands of public school teachers across the nation are assigned to subject areas in which they are neither trained nor certified.

CASPER is responding to these challenges, forging new collaborative partnerships with regional school districts and teach-

ers in order to provide a pathway for the delivery of quality professional development employing curriculum specifically designed around the Physics Circus.

This curriculum, developed and written by CASPER research scientists and educational experts, strictly aligns to both state and national standards and is correlated with CASPER 'Curriculum Tubs' containing the equipment, manipulatives and instructional materials necessary for implementation. Using current research on brain development, the Physics Circus curriculum is also designed to provide students the essential background knowledge necessary for the enhancement of neural connection development. This in turn enables the students to better retain the in-depth science concepts presented in the Physics Circus performance, Fun House and Game Show.

Understanding that knowledgeable teachers will always deliver the best instruction, another priority of CASPER is to become a premier clearinghouse for STEM resources. This is accomplished through the CASPER equipment loan program that affords students and teachers the ability to borrow some of the highly technical equipment they need but that is not available at most public schools. A science teacher list serve is also designed to give them information regarding grant and scholarship opportunities, educational resources, web-based training and a vehicle for asking questions of a real scientist.



Research Updates Recent Publications

Shearing Expansion-free Spherical Anisotropic Fluid Evolution, L. Herrera, N.O. Santos, and A. Wang, *Phys. Rev.* Vol. D78, No. 084026, 2008.

Simulation of dust voids in complex plasmas, W. J. Goedheer and V. Land, *Plasma Phys. Control. Fusion*, Vol. 50, 2008.

Stable and "bounded excursion" gravastars, and black holes in Einstein's theory of gravity, P. Rocha, R. Chan, M.F.A. da Silva, and A. Wang, *Journal of Cosmology and Astroparticle Physics*, Vol. 11, No. 010, 2008.

Stable Gravastars of Anisotropic Dark Energy Fluid, R. Chan, M.F.A. da Silva, P. Rocha, and A. Wang, *Journal of Cosmology and Astroparticle Physics*, Vol. 03, No. 010, 2009.

Structural Phase Transitions and Vertical Mode Spectra in 2D Finite Plasma Crystals, K. Qiao and Truell W. Hyde, *IEEE Transactions on Plasma Science*, Vol. 36, No. 5, pp. 2752-2758, 2008.

The cosmological constant in the brane world of string theory on S^1/Z_2 , A. Wang and N.O. Santos, *Phys. Lett.* Vol. B669, pp. 127-132, 2008.

Thermodynamics and classification of cosmological models in the Horava-Lifshitz theory of gravity, A. Wang and Y. Wu, *Journal of Cosmology and Astroparticle Physics*, Vol. 07, 2009.

Warp Drive: A New Approach, G. Cleaver, R. Obousy, *Journal of the British Interplanetary Society*, 2008.

Submitted for Publication as of July 2009

A Non-Standard String Embedding of E8, G. Cleaver, R. Obousy and M. Robinson, Submitted to *Mod. Phys. Lett A.*, 2009.

Casimir Energy and Brane Stability, G. Cleaver, R. Obousy. Submitted to *Int. J. Mod. Phys. A*, 2009.

Coagulation of Fractal Aggregates with Dipole-Dipole Charge Interactions, L. Matthews and T. Hyde, submitted to *Astrophysical Journal*, 2008.

Dipole-Dipole Interactions of Charged-Magnetic Grains, Jonathan Perry, Lorin S. Matthews, and Truell W. Hyde, Submitted to *IEEE Transactions on Plasma Science*, 2009.

Free Fermionic Heterotic Model Building and Root Systems, G. Cleaver, M. Robinson and M. Hunziker. Submitted to *Mod. Phys. Lett A.*, 2009.

Grover's Quantum Search Algorithm and Free Fermionic Heterotic Models, G. Cleaver, M. Robinson. Submitted to *Computational Science and Discovery*, 2009.

Hydrodynamic and kinetic modeling of complex radio frequency plasmas, W. J. Goedheer, J. Venema, and V. Land. Submitted to *J. Phys. D: Appl. Phys.*, 2009.

On the consistency and accuracy of finite difference approximations of the Black-Schole's equation on nonuniform grids, Myles D. Baker and Daniel D. Sheng, submitted to *Involve*, 2009.

Pair Interaction of Dust Particles with Image Particles in a Complex Plasma, Ke Qiao, Lorin Matthews and Truell W. Hyde, Submitted to the *Physical Review E*, 2009.

Probing the Sheath Electric Field Using Thermophoresis in Dusty Plasma Part Two: Experimental Measurements, Victor Land, Erica Shen, Matthew Benesh, Lorin Matthews and Truell W. Hyde, Submitted to *IEEE Transactions on Plasma Science*, 2009.

Probing the Sheath Electric Field Using Thermophoresis in Dusty Plasma Part One: Numerical Analysis, Victor Land, Erica Shen, Matthew Benesh, Lorin Matthews and Truell W. Hyde, Submitted to *IEEE Transactions on Plasma Science*, 2009.

Vibrational Modes and Instabilities of a Dust Particle Pair in a Complex Plasma, Ke Qiao, Lorin Matthews and Truell W. Hyde, Submitted to *IEEE Transactions on Plasma Science*, 2009.

Radius Destabilization in Five Dimensional Orbifolds from Lorentz Violating Fields, G. Cleaver, R. Obousy, Submitted to *Mod. Phys. Lett A.*, 2009.

Book Submitted for Publication

A Simple Introduction to Particle Physics: Part I. Foundations and the Standard Model, G. Cleaver, M. Robinson, K. Bland, and J. Dittmann, 2009.

Recent Presentations

Accelerating Nanotechnology Commercialization, T. Hyde, Invited Panelist, Nobel Laureates Legends Program, NanotxUSA'08, Dallas, TX, 2008.

Adaptive decomposition computations for optical systems, Q. Sheng, Fifth M.I.T. Conference on Computational Fluid and Solid Mechanics-Focus: Advances in CFD, Cambridge, MA, June 17-19, 2009.

Anisotropic interaction forces between two vertical particles in the plasma sheath, J. Kong, L. Matthews and T. Hyde, paper presented at the 61st annual Gaseous Electronics Conference in Dallas, Texas, October 13-17, 2008.

Before the Big Bang: String Theory, God, & the Origin of the Universe, G. Cleaver, Baylor University, Feb 5, 2009.

Coagulation of Fractal Aggregates in Lorentzian Space Plasma with Ultraviolet Radiation, L. Matthews, V. Land and T. Hyde, paper presented at the 50th Annual Meeting of the Division of Plasma Physics, Dallas, Texas, November 19, 2008.

Complex Plasma Physics and Rising Above the Gathering Storm (Invited Talk), T. Hyde, Invited presentation at the 50th Annual Meeting of the Division of Plasma Physics, Dallas, TX, 2008.

Complex Plasma Studies with Conductive Dust, J. Carmona Reyes, L. Matthews and T. Hyde, presented at the 12th Workshop on the Physics of Dusty Plasmas, Denver, Colorado, 2009.

Complex Plasmas with Two Distinct Particle Sizes, B. Smith, L. Matthews, T. Hyde, paper presented at the 50th Annual Meeting of the Division of Plasma Physics, Dallas, Texas, November 19, 2008.

Complex plasma with two distinct particle sizes, B. Smith, L. Matthews, T. Hyde, paper presented at the 61st Annual Gaseous Electronics Conference in Dallas, Texas, October 13-17, 2008.

Continued on next page

Research Updates Recent Publications

A moving-mesh splitting scheme for 2-dimensional quenching problems, Q. Sheng, *Proc. Appl. Math. Mech.*, Vol. 7, 2008.

A Note on the standard embedding on half-flat manifolds, G. Cleaver, Tibra Ali, *Journal of High Energy Physics*, Vol. 0807, 2008.

A paradoxical consistency between dynamic and conventional derivatives on hybrid grids, Q. Sheng, *Comm. Numer. Math.*, Vol. 1, pp. 198-213, 2008.

A semi-adaptive split-cosine scheme for the sine-Gordon equation, Q. Sheng, *Proc. Appl. Math. Mech.*, Vol. 7, 2008.

An accurate semi-implicit method for circularly symmetric quenching optical waves, Q. Sheng, *Dynamic Systems and Applications*, Vol. 18, 2009.

An effective z-stretching method for paraxial light beam propagation simulations, L. Gonzalez, S. Guha, J. W. Rogers and Q. Sheng, *J. Comp. Phys.*, Vol. 227, pp. 7264-7278, 2008.

An effective semi-implicit method for circularly symmetric quenching optical waves, Q. Sheng, *Dynamic Systems and Applications*, Vol. 18, No. 1, 2009.

Bounded excursion stable gravastars and black holes, P. Rocha, A.Y. Miguelote, R. Chan, M.F. da Silva, N.O. Santos, and A. Wang, *Journal of Cosmology and Astroparticle Physics*, Vol. 06, No. 025, 2008.

Brane cosmology in the Horava-Witten heterotic M-Theory on S^1/Z_2 , Q. Wu, Y. Gong, and A. Wang, *Journal of Cosmology and Astroparticle Physics*, Vol. 06, No. 015, 2009.

Colliding Branes and Formation of Spacetime Singularities, A. Tziolas and A. Wang, *Phys. Lett.* Vol. B661, No. 5-10, 2008.

Colliding branes and formation of spacetime singularities in string theory, A. Tziolas, A. Wang, and Z.C. Wu, *Journal of High Energy Physics*, Vol. 04, No. 038, 2009.

Complex Plasma Studies with Conductive Dust, Jorge Carmona Reyes, Lorin Matthews and Truell Hyde, *Proceedings of the Twelfth Workshop on the Physics of Dusty Plasmas*, Denver, Colorado, 2009.

Complex Plasmas with Two Distinct Particle Sizes: Comparing Systems with Large Differences in Particle Size to Systems with Small Differences in Particle Size, Bernard Smith, Lorin Matthews and Truell Hyde, *Proceedings of the Twelfth Workshop on the Physics of Dusty Plasmas*, Denver, Colorado, 2009.

Cosmological constant and late transient acceleration of the universe in the Horava-Witten Heterotic M-Theory on S^1/Z_2 , Y.-G. Gong, A. Wang, and Q. Wu, *Phys. Lett.* Vol. B663, No. 1, pp. 47-151, 2008.

Dark energy and cosmic curvature: Monte-Carlo Markov Chain approach, Y.-G. Gong, Q. Wu, and A. Wang, *Astrophys. J.* Vol. 681, No. 27-39, 2008.

Description of light focusing by a spherical lens using diffraction integral method, S. Guha, L.P. Gonzalez and Q. Sheng, *Proc. Appl. Math. Mech.*, Vol. 7, 2008.

Dipole-Dipole Interactions of Charged-Magnetic Grains, Jonathan Perry, Lorin Matthews and Truell Hyde, *Proceedings of the Twelfth Workshop on the Physics of Dusty Plasmas*, Denver, Colorado, 2009.

Effect of Dipole-Dipole Charge Interactions on Dust Coagulation, Lorin Matthews and Truell W. Hyde, *New Journal of Physics*

11, 063030, 2009.

Effective stretching strategies for paraxial lightwave propagation simulations, Q. Sheng, J. W. Rogers, Jr. and S. Guha, *Computers & Structures*, Vol. 87, No., 11-12, pp.784-792, 2009.

Experimental and Computational Characterization of a Modified GEC Cell for Dusty Plasma Experiments, Victor Land, Erica Shen, Bernard Smith, Lorin Matthews and Truell W. Hyde, *New Journal of Physics*, Vol. 11, No. 063024, 2009.

Feasible approximations of hybrid dynamic derivatives on time scales, Q. Sheng and A. Wang, *International J. Difference Eqns*, 2009, in press.

Growth factor parametrization in curved space, Y. Gong, M. Ishak, and A. Wang, *Phys. Rev.* Vol. D80, No. 023002, 2009.

How to make large, void-free dust clusters in dusty plasma under micro-gravity, V. Land and W. J. Goedheer, *New J. Phys.* Vol. 10, 2008.

Hybrid approximations via second order crossed dynamic derivatives with the diamond-alpha derivative, Q. Sheng, *Nonlinear Anal.: Real World Appls.*, Vol. 9 pp. 628-640, 2008.

Interparticle Forces Between Dust Particles Confined within a Glass Box in a GEC Chamber, Jie Kong, Truell, Hyde Lorin Matthews, Ke Qiao, Zhuanhao Zhang, Jimmy Schmoke and Mike Cook, *Proceedings of the Twelfth Workshop on the Physics of Dusty Plasmas*, Denver, Colorado, 2009.

Late transient acceleration of the universe in string theory on S^1/Z_2 , Q. Wu, P. Vo, N.O. Santos, A. Wang, *Journal of Cosmology and Astroparticle Physics*, Vol. 09, No. 004, 2008.

Measurement of the Vertical Non-Uniformity of the Plasma Sheath in a Complex Plasma, Jie Kong, Truell W. Hyde, Brandon Harris, Ke Qiao and Jorge Carmona-Reyes, Accepted for publication in the *IEEE Transactions on Plasma Science*, in press, 2009.

Modeling of Voids in Complex Radio Frequency Plasmas, W.J. Goedheer, V. Land, J. Venema, *Contribution to Plasma Physics*, Vol. 49, No. 4-5, pp. 199-214, 2009.

On geometrical interpretation of non-Abelian flat direction constraint, G. Cleaver, D. Nanopoulos, J. Perkins, and J. Walker, *International Journal of Modern Physics*, Vol. A23, 2008.

Pair Interactions in a Complex Plasma Between Dust Particles with Dipole Moments, Ke Qiao, Lorin Matthews and Truell Hyde, *Proceedings of the Twelfth Workshop on the Physics of Dusty Plasmas*, Denver, Colorado, 2009.

Probing the Sheath Electric Field and Ion Drag with an Externally Controlled Thermophoretic Force, Victor Land, Lorin Matthews, Matthew Benesh and Truell Hyde, *Proceedings of the Twelfth Workshop on the Physics of Dusty Plasmas*, Denver, Colorado, 2009.

Propagation of high intensity light in semi-conductors, L.P. Gonzalez, S. Guha and Q. Sheng, *Proc. Appl. Math. Mech.*, Vol. 7, 2008

Putting the 'Warp' into Warp Drive, G. Cleaver, R. Obousy, *Space-flight*, Vol. 50, No. 4, 2008.

Quasi-realistic heterotic-string models with vanishing one-loop cosmological constant and perturbatively broken supersymmetry?, G. Cleaver, A.E. Faraggi, E. Manno, and C. Timirgaziu, *Phys. Rev. D*, Vol.78, 2008.

Recent trends in splitting, adaptive and hybrid numerical methods for differential equations, Q. Sheng, *Neural, Parallel & Sci. Comp.*, Vol.16, pp. 283-301, 2008.

How BIG is the Universe?

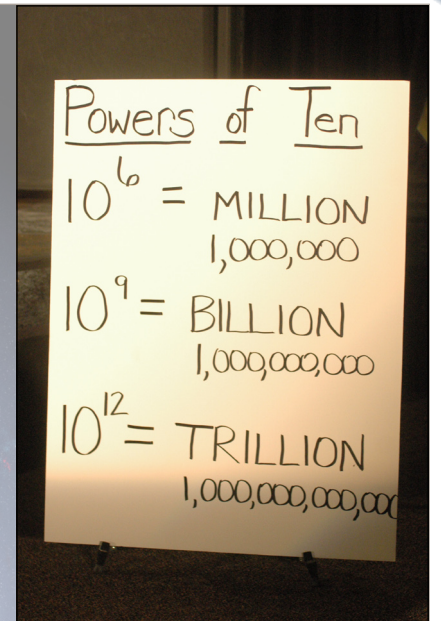
More than 2000 8th and 9th grade students from the Waco and LaVega Independent School Districts attended the 2009 Physics Circus covering the topic, "How Big is the Universe?" This concept will be built upon over the next two years as students explore the powers of ten, starting at the galactic scale, moving to the human scale and finishing with the nano scale. Concepts such as the distance between planets, the size of the solar system and the size of the galaxy were all discussed using astronomical units of measurement.

The 2009 Circus featured new demonstrations designed to both educate and entertain the students. For example, during the theater portion, a 'virtual' Clyde Tombaugh appeared on stage to explain to students why Pluto is now classified as part of the Kuiper belt. The criteria used to classify a planet were discussed, with students then invited on stage to illustrate the various planet sizes and distances using representative balls of varying sizes.

After the theater portion of the Circus, as with every Physics Circus, students were given time to explore physics behind the science within the Physics Fun House. CASPER faculty, staff and students helped the students learn more about individual concepts discussed during the show, with students encouraged to touch and feel the exhibits which were specifically designed to foster a better understanding of the physics concepts introduced during the show.

In all of the above, everything the students were exposed to was directly aligned with state and national standards and correlated to encourage interest in STEM careers in a fun, exciting and interactive manner.

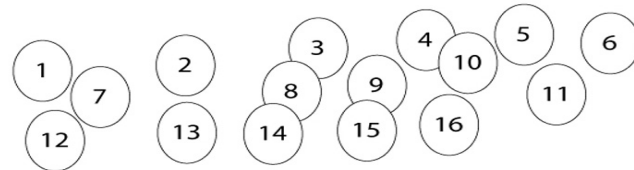
As always, a wonderful way to spend three hours!



CASPER Summers

2009 Fellows

1. Gary Shetler (RET)
2. Steve Rapp (RET)
3. Randy Hall (RET)
4. Gunnar Miller
5. Michael Janas
6. Pasha Tabatabai
7. Bruce Oliver
8. Diana Bolser
9. Cheridan Harris
10. Michael Pope
11. Megan Johnson
12. Kathryn Allshouse (RET)
13. Jessica Smith
14. Nethmi Ariyasinghe
15. Erica Shen
16. Lauren Ice



The past two summers CASPER, along with its partners in the Physics Department and the Schools of Education and Engineering and Computer Science, once again hosted the NSF REU/RET program under the direction of Dr. Truell Hyde. In 2009, twelve students participated in the REU (Research Experience for Undergraduates) program and four teachers took part in research activities under the RET (Research Experience for Teachers) program while in 2008, thirteen undergraduates and three high school teachers participated in the program.

One of the usual highlights of the program was the Wednesday Lunch Bunch seminars, where faculty members presented short talks on various topics; speakers in 2009 included Dick Campbell, Victor Land, Lorin Matthews, Tim Sheng and Gerald Cleaver from CASPER, Greg Benesh and Bennie Ward from Physics, and James Marcum from Philosophy.

At the end of the summer, the students presented their results in a conference setting and produced both a research poster and a journal article to take home. As always, thanks to everyone for all the hard work.



2008 Fellows

1. Steve Rapp (RET)
2. Gary Shetler (RET)
3. Allison Youngblood
4. Brian Morris
5. Maria Tiongco
6. Aaron Cabe
7. Nethmi Ariyasinghe
8. Chase Pearson
9. Korey Haynes
10. Kyle Taljan
11. Shelly Hynes (RET)
12. BJ Enzweiler
13. Jennifer Tuggle
14. Adam Goler
15. Bridget Onan
16. Erik Lentz

Research Updates Awards and Proposals

The Baylor society for conversations in religion, ethics and science
Templeton Foundation Local Societies Initiative
2008-2009 • \$5,000

GEAR UP Waco STEM Initiative
U.S. Department of Education
2006-2012 • \$11,360,124

Summer Undergraduate Research Experience
National Science Foundation
2006-2009 • \$429,628

Rapidly convergent quadrature-free methods for high oscillatory diffraction integrals in light beam propagations, stage III
Air Force Research Lab
2008-2009 • \$28,500

Charging and coagulation of fractal dust aggregates in plasma environments
National Science Foundation
2009-2014 • \$436,000

Rapidly convergent quadrature-free methods for high oscillatory diffraction integrals in light beam propagations, stage II
Air Force Research Lab
2009-2010 • 28,500

Meeting industries' critical workforce needs
U.S. Small Business Administration
2008-2010 • \$196,514

Laboratory enhancement at Baylor University
NASA
2006-2009 • \$658,000

Submitted Proposals

Real time emergency response satellite imagery and mapping system for the state of Texas to support emergency task force operations
State of Texas
2009 • Pending

Summer Undergraduate Research Experience
National Science Foundation
2009-2012 • Pending

Baylor alternative and renewable energy education and outreach
State Energy Conservation Office Preliminary
2009-2011 • Pending

Late cosmic acceleration of the universe in String/M-Theory
Department of Energy
2009-2012 • Pending

Former CASPER Member Works with NASA, Spacecraft for the International Space Station



Image courtesy of Chris Thompson/SpaceX: Dragon Capsule, Engineering Model.

Lauren Dreyer, Baylor '05 electrical engineering, also attendee of one of CASPER's Summer High School Scholars Program, is SpaceX's Business Development Manager. SpaceX is revolutionizing access to space by developing a family of launch vehicles and spacecraft intended to increase the reliability and reduce the cost of both manned and unmanned space transportation, ultimately by a factor of ten. With its Falcon line of launch vehicles, powered by internally-developed Merlin engines, SpaceX offers light, medium and heavy lift capabilities to deliver spacecraft into any altitude and inclination, from low-Earth orbit to geosynchronous to planetary missions.

In 2006, SpaceX was named a winner under NASA's Commercial Orbital Transportation Services (COTS) competition. Under the existing COTS agreement, SpaceX will conduct the first flight of its Falcon 9 launch vehicle and Dragon spacecraft in 2009. The final flight, currently scheduled for 2010, will demonstrate Dragon's ability to berth with the ISS.



Image courtesy of SpaceX: Dragon Spacecraft with Solar Panels Deployed

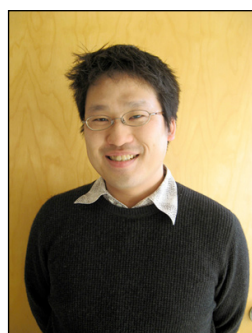
Selected Seminar Speakers



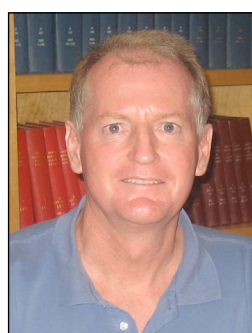
Dr. David Hough, Trinity University: "Parsec-scale Radio Jets in Lobe-dominated Quasars." **Abstract:** Relativistic outflows in the form of "jets" are often observed in active galaxies and quasars. These are thought to originate near supermassive black holes in the centers of these objects, and can transport energy out to the megaparsec scale. A review of some basic physics of jet models was given, and their role in "unified models" of active galaxies was discussed. The radio astronomy group at Trinity University is engaged in a long-term observational study of a sample of objects classified as "lobe-dominated" quasars. The statistics of jet properties in this sample to test jet models are being used. One particularly intriguing result suggestive of acceleration on scales of tens of parsecs was emphasized in this talk.



Dr. Roger Bengtson, UT Austin: "Fun Physics We Encountered on the VASIMR Project." **Abstract:** For more than 10 years UT Austin has been involved in a collaboration with NASA and Ad Astra Rocket company to develop a plasma thruster (VASIMR) for space applications such as station keeping on the International Space Station or manned trips to Mars. This seminar presented several of the interesting physics questions studied in this collaboration which resulted in six Ph.D. degrees, three MS degrees in physics in an engineering project. The helicon plasma studies, mostly done at The University of Texas at Austin and an experiment at Marshall Space Flight Center, Huntsville AL to demonstrate the detachment of a plasma plume from a magnetic nozzle, were discussed.



Dr. Eiichiro Komatsu, UT Austin: "The 5-Year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Cosmological Interpretation." **Abstract:** This talk reviewed the main ideas of goal-oriented error estimation and adaptation for the control of modeling errors. Goal-oriented error estimation is an approach in which errors in numerical approximations are estimated in terms of specific quantities of interest rather than with respect to usual global norms. Modeling error is to be understood here as the difference between the solution of fine-scale models and that of given surrogate models obtained for example through model reduction methods or homogenization techniques. These ideas toward the development of a coupling method for multi-scale modeling of nano-devices made of polymeric materials were also illustrated. Methods in which a molecular model is coupled to a continuum model via an overlapping region were also presented. This coupling approach provides for a surrogate model that is actually an approximation of the true molecular model. The process of how to extend the goal-oriented adaptive modeling technique so as to identify the regions in which the continuum and atomistic models should be used and thus to automatically predict the position of the overlapping region so as to deliver predictions of quantities of interest within preset tolerance at a reduced cost was explained. Two-dimensional and three-dimensional examples with application to nano-manufacturing were presented.



David Brower, UCLA, Research Fellow, Fusion Research Center, UT Austin: "Stochastic Magnetic Field Driven Particle and Momentum Transport in Collisionless Plasmas" **Abstract:** How are plasma particles and momentum transported along magnetic field lines that wander chaotically, as occurs for cosmic rays in the heliosphere and galaxy, thermally inhomogeneous interstellar and intergalactic plasmas, and laboratory plasmas? Transport resulting from stochastic magnetic fields has long been an important and unresolved issue in astrophysics and magnetic fusion research. For magnetic fusion plasmas, stochastic magnetic fields can arise from intrinsic global tearing instabilities that often underlie magnetic reconnection and lead to density relaxation. Understanding to date is largely limited by the lack of measurements of the magnetic fluctuation-induced particle flux in collisionless plasmas. In this talk, measurements were described for the high-temperature core of the MST reversed field pinch; particularly during magnetic reconnection when the stochastic field resulting from tearing instabilities was strongest. Direct determination of the flux and its divergence is accomplished by combining laser-based, differential interferometry with fast Faraday rotation diagnostic systems.

New CASPER Members

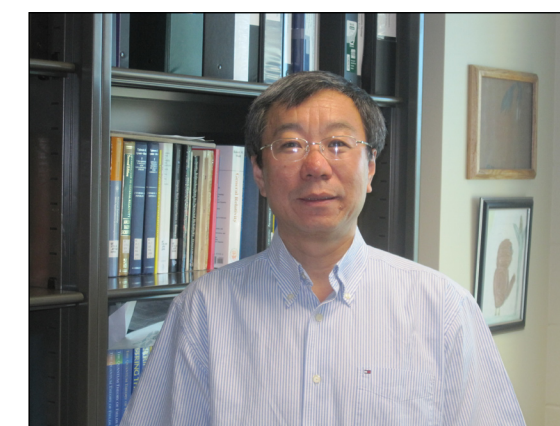


Rene Laufer comes to CASPER from Institute of Space Systems where he is finishing the Ph.D. in Aerospace Engineering at the University of Stuttgart in Germany. He is currently a CASPER associate research scientist where he works as the head of the small satellite group within the Space Science Lab. Laufer spent the summer teaching at the International Space University held at NASA.



Dr. Victor Land comes to CASPER from the FOM-Institute for Plasma Physics 'Rijnhuizen', where he completed his Ph.D. in 2007. He received his MSc in general astrophysics at Utrecht University in the Netherlands in 2003. He is currently a CASPER postdoctoral research associate where he works on particle transport, charging, and coagulation in dusty plasma.

Award for Outstanding Research by a Tenured Faculty Member



The head of CASPER's GCAP group, Dr. Anzhong Wang, recently received the award for outstanding research by a tenured faculty. Wang received his award May 15 at the commencement ceremony. Wang has formed an extremely active research group in gravitational cosmology within CASPER since coming to Baylor in 2003, working with six visiting professors and post-docs, twelve graduate students and five undergraduate students to produce 46 peer-reviewed journal articles (with five more in progress), two funded grant proposals, and multiple research awards in the last five years. His colleagues speak very highly of him, noting that his more than 100 total publications have been cited over 1100 times, with three of his papers listed as top cited articles in the field. Students who have had Wang as an instructor in a course also speak highly of him with his teaching reviews ranking him higher than the comparison group in each category. Congratulations!

CASPER would like to thank the following for their participation in the 2008-2009 NSF Research Experience for Undergraduates and Research Experience for Teachers.

Truell Hyde
 Greg Benesh
 Dick Campbell
 Jorge Carmona-Reyes
 Mike Cook
 Gerald Cleaver
 Jay Dittmann
 Cyndi Hernandez
 Sherri Honza
 Jie Kong
 Victor Land
 Rene Laufer
 Lorin Matthews
 Ray Nazzario
 Jeff Olafsen
 Linda Olafsen
 Ken Park
 Ke Qiao
 Dwight Russell
 Jimmy Schmoke
 Bernard Smith
 Anzhong Wang

Ten Years of Success

CASPER is created with one member, one 300 square foot office and a single theory group in space science.

