2012 • Volume XIII

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

NASA rocket mission carries Baylor student experiment

Baylor joins Virginia Tech, University of Colorado and University of Puerto Rico in RockSat-X educational project

A group of CASPER students put their skills to the test when their atmospheric and technology experiments flew on a NASA suborbital sounding rocket this fall. Four experiments, including an interstellar dust detector built by Baylor engineering students in collaboration with CASPER faculty and staff, were launched on September 21, 2012. The launch was part of RockSat-X, an educational program designed to provide students hands-on experience in designing, fabricating, testing and conducting experiments for space flight.

The selected experiments for this year's RockSat launch were from Baylor, the University of Colorado at Boulder; the University of Puerto Rico; and Virginia Polytechnic Institute and State University (Virginia Tech) in Blacksburg, Va.

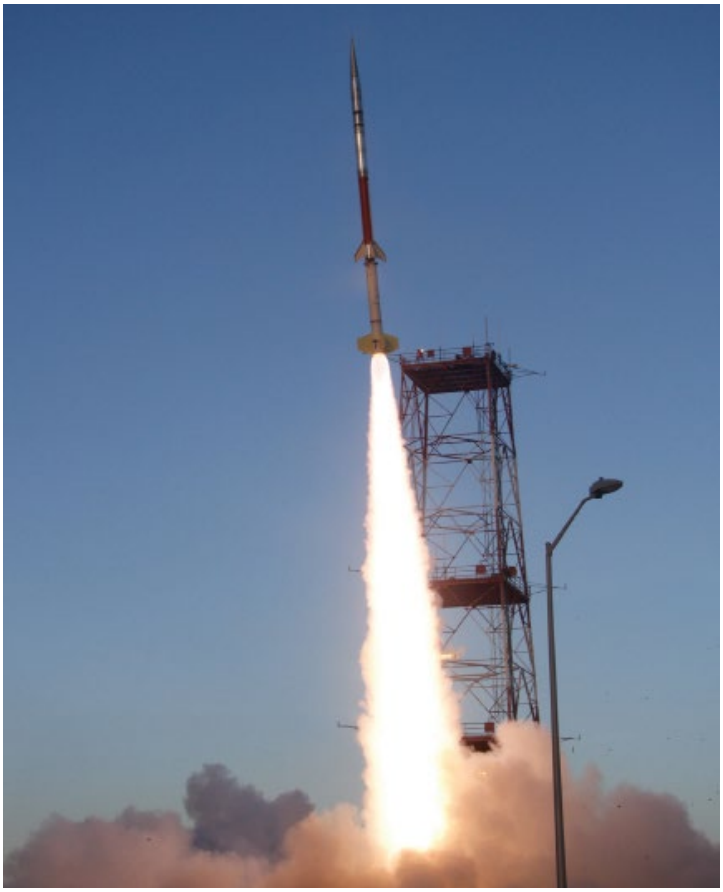
"Baylor was selected for this project because of an existing partnership we've had with Greg Earle, who was formerly with the University of Texas at Dallas and is now with Virginia Tech, and Troy Henderson, a CASPER physics graduate, also now at Virginia Tech," says Dr. Truell Hyde, vice provost for research at Baylor and CASPER director.

Interstellar dust detector

As the threat from orbital debris continues to increase, national and private space concerns require the data necessary to adequately answer questions impacting overall mission viability. In the sub-mm particle regime, the only avenue open at the current time to collect such data is through in-situ instrumentation placed in extended orbit.

Virginia Tech and Baylor have teamed up to measure nitric oxide and atmospheric dust and also provide flight experience to the two sensors designed by students. During the spring, Baylor senior engineering capstone students built and tested a Piezo Dust Detector (PDD), a miniaturized, in-situ instrument that collects data on small interstellar dust and orbiting debris particles.

The PDD's original design was produced by CASPER faculty Dr. René Laufer, Dr. Ralf Srama and their students within the Cosmic Dust Group located at the University of Stuttgart and Max Planck Institut für Kernphysik. This design was then implemented by senior design students at Baylor's School of Engineering and Computer Science as part of a senior design project overseen by engineering faculty members Dr. Brian Garner and Dr. Ian Gravagne.



The Terrier-Malmute sounding rocket lifts off from NASA's Wallops Flight Facility in Wallops Island, Va. The rocket carried experiments designed by Baylor students to an altitude of approximately 98 miles. Image credit: NASA

The sounding rocket flight will provide valuable data to improve the PDD design towards the flight model scheduled for flight as part of the the ARMADILLO mission, a nano-satellite currently under development by a student team of the University of Texas at Austin lead by Dr. Glenn Lightsey.

See NASA, page 2

NASA, continued from page 1

The spring student design group from Baylor's School of Engineering and Computer Science included Aimie Cox, team manager; Jason Curran, structural specialist, mechanical team; Jordan Wood, interfacing specialist, mechanical team; Lucas Devine, assembly specialist, mechanical team; Chris Faulkner, hardware specialist, electrical team; Matthew Fellows, digital specialist, electrical team; and Anthony Mendiola, interfacing specialist, electrical team.

Curran and Fellows also worked on the project during the summer as part of Baylor's Research Experiences for Undergraduates (REU) program, funded by the National Science Foundation, Waco Aviation Alliance and CASPER.

Baylor research experiences

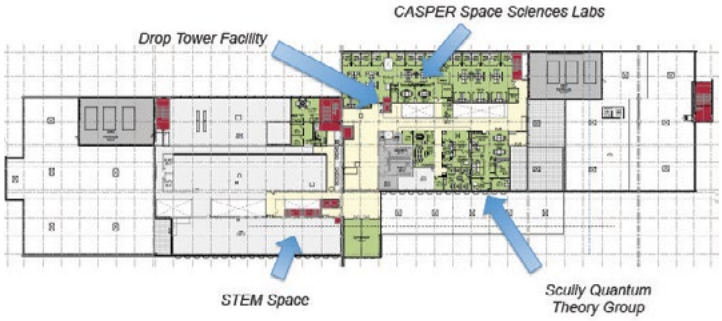
Baylor's participation in programs like RockSat-X reinforces the university's emphasis on increasing opportunities for students – both undergraduate and graduate – to engage in research with faculty at all phases of the discovery process, enhancing connections between teaching and scholarship.

"Experiences such as this allow Baylor students at all levels to develop a way of life that integrates the work they do in the classroom with the larger opportunities available in their future," says Hyde.

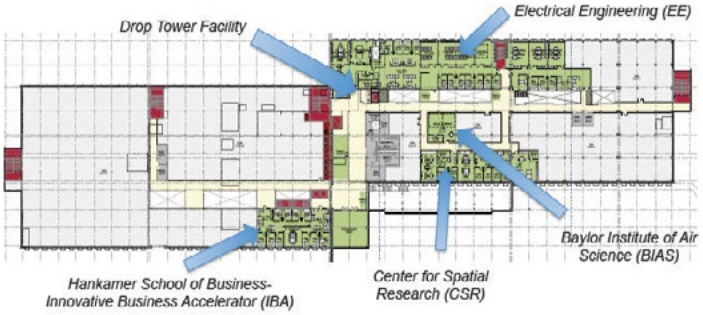
BRIC UPDATES

CASPER laboratory and office space build-out nearing completion

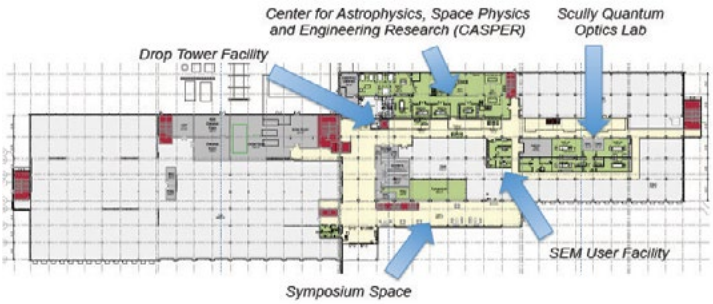
The BRIC facility after completion of Phase 1 construction. Diagrams at right show floor plans for various groups which will occupy the facility beginning in early 2013.



Phase 2a Floor Plan Level 3



Phase 2a Floor Plan Level 2



Phase 2a Floor Plan Level 1

Following the 2012 completion of Phase 1 — the building's exterior construction and landscaping — the focus has now turned to interior spaces and communications infrastructure at the Baylor Research and Innovation Collaborative (BRIC), the discovery park that forms the centerpiece of the planned Central Texas Technology and Research Park.

Phase 2a build-out of approximately 45,000 square feet of university research labs and offices began in the first week of August 2012. The new space will bring CASPER facilities under one roof for the first time.

Throughout the last six months, multiple meetings were held between faculty and the BRIC architects (Perkins + Will) to ensure each Baylor researcher moving into the BRIC participated in the design of the laboratories and offices.

The current build-out includes space for:

- Dr. Marlan Scully, Optics and Quantum Physics Lab
- Dr. Lea Steele, Veterans Research Lab
- Dr. Dennis O'Neal, Dean, School of Engineering and Computer Sciences
- Department of Electrical Engineering Research Labs
- Baylor Institute for Air Science
- Center for Astrophysics, Space Physics and Engineering Research
- Center for Spatial Research
- Innovative Business Accelerator

EDA-funded work begins on optical fiber connectivity to the BRIC

A drill stem surfaces near the Baylor Law School after boring under the Brazos River. The drilling will provide a path for installation of optical fiber connectivity between the main Baylor campus and the BRIC.

Construction under an Economic Development Agency (EDA) grant to provide optical fiber communications capability between the main Baylor campus and the BRIC began in the second week of August. The project includes boring under the Brazos river, laying over 9,000 feet of cable to the BRIC, construction of BRIC interior IT rooms including approximately 750 cable drops, and installation of electronics upgrades at both the Waco and Dallas Internet2 junctions. These junction upgrades will provide expanded bandwidth to better serve the BRIC and Baylor in the future.

The Phase 2a interior build-out and the EDA-funded communications efforts are scheduled for completion in January 2013.

Micro-gravity and vacuum environment drop tower construction set to begin

The design phase of the micro-gravity drop tower within the BRIC began in July, with construction set to begin soon. Construction of the near-zero gravity drop tower will provide researchers the ability to conduct a variety of tests across a multi-disciplinary science and technology spectrum. The 78-foot vertical tower will provide approximately 2.2 seconds of freefall, useful for research in physics, engineering and other research areas. The drop tower facility will also include a 70-foot vertical vacuum tube which will enable CASPER researchers to conduct additional complex plasma and space-related physics experiments in a vacuum environment.

The placement of the drop tower control room within a roof-top mechanical penthouse will also create a signature architectural element at the BRIC facility.

In addition to Baylor research projects, the drop tower will also give CASPER scientists the ability to schedule research operations with their national and international research partners.

Researchers interested in using either the micro-gravity drop shaft or the vacuum environment vertical pipe system should contact the Office of the Vice Provost for Research at Baylor.

The drop tower facility is funded in large part by a generous grant from Waco's Cooper Foundation.

BRIC receives additional NASA shuttle artifact awards

Since 2009, Baylor has participated in a NASA program that awards unique components of the space shuttle program to universities and museums across the United States. To date, Baylor has been awarded over 70 artifacts valued by NASA at $5.4 million.

The program has provided Baylor with a variety of artifacts ranging from the Tethered Satellite System — so large it had to be stored in an aircraft hangar in preparation for its display at the BRIC — to smaller items such as vacuum-sealed food packets and uniform components worn by shuttle astronauts. During the most recent award period alone, Baylor received thirty additional items from Johnson Space Center, Kennedy Space Center and Goddard Space Flight Center. The newest of these include an astronaut space suit test station (pictured below), a shuttle leading-edge wing section and nose wheel, and a mission control launch console.

While many of the items awarded are for display purposes only, some of the electronics instrumentation is in good working order and will be used for training and education in CASPER laboratories.

A NASA space suit fit / check console was among the artifacts recently received by Baylor. The console will join other items on display at the BRIC.

CASPER/IRS research exchange brings Stuttgart students to Waco

Continuing the successful exchange of graduate students from CASPER's German partner, the Institute of Space Systems (IRS) at the University of Stuttgart, a second and third group of graduate students recently performed collaborative thesis research at the Space Science Lab.

Previous students complete graduate theses

Christoph Gomringer, Helmut Koch and Alexander Wolf, aerospace engineering graduate students at the University of Stuttgart, worked at CASPER during the 2011-2012 academic year on research projects co-supervised by Dr. René Laufer, head of CASPER's Space Science Lab.

Gomringer designed and set up a gas sensor diagnostics system and performed initial tests to allow side-arm development for the Stuttgart-Baylor IPG6 (inductively-heated plasma generator model 6) facility. Implementation of the IPG6 will allow investigations of the effects created by plasma on materials and components. Gomringer's thesis was co-supervised by Dr. Frank Hammer and CASPER adjunct faculty Dr. Georg Herdrich (both faculty at the Univ. Stuttgart) and successfully defended in June 2012.

Pressure measurements within plasma jets

The design, development and initial operations of a Pitot probe for pressure measurements within the plasma jet of the IPG6 facility was the topic of Koch's research thesis. The Pitot probe is an essential diagnostics tool used to characterize plasma. Dr. Herdrich again acted as the co-supervisor and scientific and technical advisor for Koch's thesis which was successfully defended in Stuttgart in October 2012.

Space dust and debris detector

Wolf's thesis was part of the development of a miniaturized space dust and debris detector, a collaborative instrument developed between CASPER's Space Science Lab and Univ. Stuttgart's Cosmic Dust Group lead by CASPER adjunct faculty Dr. Ralf Srama. Dr. Srama also co-supervised the thesis. Wolf acted as project engineer for design, development, assembly and initial testing of the Piezo Dust Detector (PDD) prototype. The PDD was selected to fly on top of a sounding rocket launched from NASA Wallops Flight Facility in September. Wolf defended his thesis successfully in June 2012 and recently accepted a position in industry. Two papers on his results were presented at Germany's national space conference in Berlin and at the International Astronautical Congress in Naples, Italy.

All three students also presented posters on their research projects at the Lunar and Planetary Science Conference in Houston and the Workshop on the Physics of Dusty Plasma at Baylor before they returned to Germany.

During the summer of 2012, three new aerospace engineering graduate students from Germany arrived at CASPER to work within the Space Science Lab: Andreas Jochum from Univ. Stuttgart and Kirk Boehm and Christoph Montag from Technical University of Dresden, Germany.

Satellite ground station

Jochum is acting as the project engineer on the design of a satellite ground station facility as part of his research thesis. Development of such a station would allow CASPER to participate in Stuttgart's small satellite activities and to collaborate with other international partners (e.g. Tohoku University, Japan). Jochum's project is co-supervised by Stuttgart ground station engineer Ulrich Beyermann and Prof. Dr. Hans-Peter Roeser, director of the Institute of Space Systems.

Vacuum drop tower

Boehm is working on the design and development of the BRIC vacuum drop tower. The drop tower will allow for high-quality microgravity experiments to enable research, technology development and testing under these conditions. The Cooper Foundation is partially funding construction of the drop tower through a $250,000 award to Baylor. Dr. Olaf Przybilski (Techn. Univ. Dresden) and CASPER adjunct faculty Dr. Herdrich (Univ. Stuttgart) are co-supervising this project.

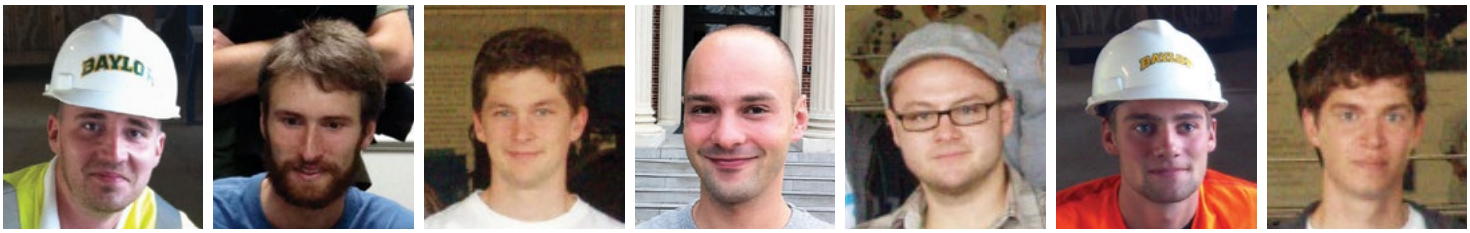
Volcanic ash detector

Montag is working on a volcanic ash detector system. The system will provide a diagnostic tool for fundamental ground-based research in the field of volcanic ash detection experiments. In addition to CASPER adjunct faculty Dr. Srama, the project is also co-supervised by Dr. Przybilski.

First Stuttgart Ph.D. student at CASPER

Michael Dropmann returned to Baylor University in May 2012 to begin work as a research assistant within the Space Science Lab while conducting research as a Ph.D. candidate at Univ. Stuttgart. Dropmann was previously at CASPER in 2011 for his diploma thesis research (master's thesis), which involved setting up the IPG6, a hybrid plasma facility for fundamental research built in collaboration with the Institute of Space Systems, Univ. Stuttgart.

As part of his Ph.D. work, Dropmann will utilize the IPG6 for experiments to investigate wall materials in nuclear fusion reactors exposed to the harsh dust and plasma environment.



From left to right: Kirk Boehm, Michael Dropmann, Christoph Gomringer, Andreas Jochum, Helmut Koch, Christoph Montag, Alexander Wolf

CASPER faculty contributes to ground-breaking re-entry demonstration

Above, the SHEFEX II spacecraft undergoes preparations before its flight. Right, the sounding rocket launch from the Andoya Rocket Range in Norway. Image credits: DLR

On June 22, the German Aerospace Center (DLR), Germany's national space agency and research center for aeronautics and space, successfully launched the SHEFEX II spacecraft on top of a sounding rocket. The spacecraft reached an altitude of 110 miles and accelerated to a speed of roughly 11 times the speed of sound.

SHEFEX II (SHarp Edge Flight EXperiment) is the second in a series of three spacecraft designed to investigate new thermal protection systems for reentry vehicles. The new system is meant to reduce the cost and complexity of the vehicles by replacing traditional curved contours with sharp-edged plane panels.

Within this collaboration of multiple DLR institutes, a team lead by CASPER Adjunct Faculty Dr. Georg Herdrich from the Institute of Space Systems at the University of Stuttgart contributed to an aerothermodynamics instrument called COMPARE (COMbined Pyrometric And Radiometric trajectory rebuilding Experiment).

COMPARE was developed to assess heat fluxes, pressure and enthalpy during the atmospheric entry of a spacecraft with the goal of providing reference data for future new ablative heat shields for use in Earth reentry, and on Mars and other planets and moons.

Numerical simulations and experimental investigations of atmospheric entry (using large plasma wind tunnels) as well as design and development of flight hardware for re-entry missions are several of the main topics considered by Dr. Herdrich's group with experience and expertise in missions like MIRKA, X-38, EXPERT, Stardust and more.

HONORS AND AWARDS

Baylor/CASPER graduate students earn prestigious Texas Space Grant fellowships

Two Baylor graduate students recently earned fellowships in support of their doctoral study. Jared Greenwald and Brandon Harris, both doctoral candidates in Baylor's Department of Physics and members of CASPER, were awarded Texas Space Grant Consortium Graduate Fellowships for the 2012-2013 academic year.

TSGC Fellowships are awarded annually to encourage graduate study in science and engineering. Funded by a training grant from NASA, the fellowships provide financial support to students pursuing master's or doctoral degrees in a space science related field at consortium member institutions.

A total of 21 students from 16 Texas universities were awarded fellowships in this year's round of funding.

The Texas Space Grant Consortium is a group of 47 government, industry, educational and non-profit institutions in Texas that work to bring the benefits of space research and technology to all Texans. Baylor and CASPER have been involved in TSGC since the organization's formation, with Baylor and CASPER faculty participating in the proposal for the initial NASA block grant which created the consortium.

Georg Herdrich awarded habilitation at University of Stuttgart

CASPER adjunct associate professor Dr. Georg Herdrich, head of plasma technology of the Institute of Space Systems and collaborator in several CASPER projects, successfully achieved the habilitation at the School of Aerospace Engineering and Geodesy at the University of Stuttgart in May 2012.

His habilitation thesis addresseed space-relevant plasmas and their applications-related classifications. He received the *venia legendi* of the university in the field of space plasma research.

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

ASSTG and HIDPL group members had a productive summer and fall in 2012. Drs. Truell Hyde, Lorin Matthews, Victor Land and René Laufer served as the local organizing committee for the 13th Workshop on the Physics of Dusty Plasma, hosted at Baylor May 20-23. Twelve CASPER members presented research at the workshop.

Matthews and Land were invited to speak at the Workshop on Dust and Grains in Low Gravity and Space Environment, held April 2-4 in Noordwijk, The Netherlands. The workshop was sponsored by the European Space Agency.

Dr. Hyde presented a paper entitled *Collective Phonemona in Extended Vertical Chains within Dusty Plasma* at the 39th European Physical Society Conference on Plasma Physics / 16th International Conference on Plasma Physics held in Stockholm, Sweeden. The conference was sponsored by the European Physical Society and held July 2-5.

Members of CASPER, along with Stuttgart graduate students Helmut Koch, Christoph Gomringer, and Alexander Wolf also attended the 43rd Lunar and Planetary Science Conference held in The Woodlands, Texas, March 19-23. The group presented a total of four posters including: *Setup of an Inductively–Heated Plasma Generator and Diagnostics to Build a Hybrid Plasma Simulation Facility for Complex Space Environment Investigations* (authors M. Dropmann, C. Gomringer, H. Koch, S. Peters, G. Herdrich, M. Cook, J. Schmoke, R. Laufer, L. S. Matthews, T. W. Hyde), *Effects of Monomer Shape on the Formation of Fractal Aggregates Under a Power Law Distribution* (authors J. D. Perry, J. Kimery., L. S. Matthews, and T. W. Hyde), *Piezo Dust Detector (PDD) — A Modular Miniaturized In-Situ Measurement Instrument for Dust Research* (authors A. Wolf, R. Laufer, G. Lightsey, G. Herdrich, R. Srama, H.-P. Röser, T. W. Hyde), and *Multi Wall Carbon Nano Tubes as Material for a Space Elevator on the Moon* (authors J. A. Carmona Reyes, S. Peters, G. Herdrich, R. Srama, J. Schmoke, M. Cook, L. Matthews, R. Laufer, T. W. Hyde)

Early Universe Cosmology and Strings Research Group (EUCOS)

At String Phenomenology 2012, held June 25-29 in Cambridge, England, Dr. Gerald Cleaver presented a summary of his group's work entitled *Systematic Investigations of the Heterotic String Landscape*. While at Cambridge, Cleaver also presented *Philosophical and Theological Implications of a String Multiverse* at the university's Faraday Center.

Cleaver's research in string phenomenology was recently discussed and cited by authors Luis Ibanez and Angel Uranga in their book, *String Phenomenology and Particle Physics* (Cambridge Press, Cambridge, 2012).

Dr. Klaus Kirsten presented a series of three lectures titled *The Casimir effect and its mathematical implications* at the Conference on Mathematical Structures in Quantum Systems and Applications held in Benasque, Spain, July 8-14, 2012.

EUCOS Ph.D. students also presented three papers at PASCOS 2012 in Marinda, Mexico: Jared Greenwald presented *Automated Systematic Generation of Flat Directions in Free Fermionic Heterotic Strings*; Douglas Moore presented *Systemtic Construction of Free Fermionic Heterotic String Models* and Yanbin Deng presented *Systematic Surveys of the NAHE (Variation) Landscape*.

ASSTG/SSL/HIDP Members

Faculty and Staff

Truell Hyde
Lorin Matthews
Trey Cade
Dick Campbell
Randy Hall
Jie Kong
Ray Nazzario
Ke Qiao
Victor Land
René Laufer
Jorge Carmona-Reyes
Michael Cook
Jimmy Schmoke

Adjunct Faculty

Phillip Anz-Meador
John Fitch
Peter Hartmann
Georg Herdrich
Rainer Sandau
Ralf Srama
Marlene Rosenberg

Graduate Students

Mudi Chen
Brandon Harris
Bo Zhang

Visiting Graduate Students

Aniko Kovacs
Andreas Jochum
Christoph Montag
Kirk Boehm
Michael Dropmann

Interns

Jason Blackwell
Robert Murphy
Abram Nelson
Nathaniel Sosa
Blake Winchester
Blake Woodliff

Undergraduate Student

Will Barnes

EUCOS Members

Faculty and Staff

Gerald Cleaver
Klaus Kirsten
Qin (Tim) Sheng

Graduate Students

Yanbin Deng
Jared Greenwald
Douglas Moore

Undergraduate Students

Brandon Mattingly
Erik Remkus

Gravity, Cosmology & Astroparticle Physics Group (GCAP)

Dr. Anzhong Wang traveled to Kashiwa, Japan for the Testing Gravity with Astrophysical and Cosmological Observations conference, held Jan. 23-Feb. 3, 2012. He gave two presentations: *Overview of quantum gravity at Lifshitz point* and *Elimination of Spin-0 Gravitons in Horava's Gravity without Projectability Condition.*

GCAP members also gave invited talks at Texas A&M University, UT Austin, UT Dallas, UT Arlington, The State University of Sao Palo, Brazil, The State University of Rio de Janeiro, Brazil, the University of Tokyo in Kashiwa, Japan, and the Zhejiang University of Technology in Hangzhou, China.

GCAP Members

Faculty and Adjunct Faculty

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

Graduate Students

Yongqing Huang
Pedro Morales
V.H. Satheeshkumar
Raziyeh Yousefi

Undergraduate Student

Janie Hoormann

Experimental Astronomy Group (EAG)

The study of exoplanets is a new and active field in astrophysics that involves observations of planets orbiting stars other than our sun. This statistical study of planetary systems is important because it provides us with information on how planets form and evolve, and can confirm or deny the uniqueness of our own solar system. If an exoplanet passes in front of its host star while in the plane of view of our solar system, it creates a transit that is viewable from Earth.

During the summer of 2012, CASPER/REU research fellow Lydia Shannon and CASPER Experimental Astronomy Group faculty Dick Campbell of the Mechanical Engineering Department and Dwight Russell of the Department of Physics successfully observed exoplanet transits at the Paul and Jane Meyer Observatory (PJMO) with the aid of Central Texas Astronomical Society member Willie Strickland.

In addition to successfully observing the exoplanet transits at PJMO, the data collected was used to test the image-processing program Astro-ImageJ and its ability to analyze observations of objects with varying light curves.

During the summer, an algorithm was created for processing of the more than three hundred images taken over several hours and creating the corresponding light curves. From these curves, data about the ingress, egress, and magnitude drop of each transit were obtained, and the radius, semi-major axis, and velocity of each planet were calculated.

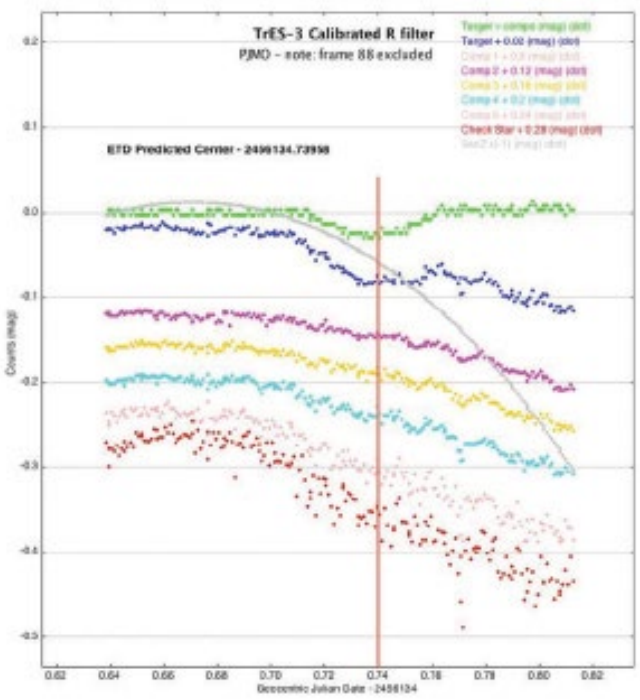
The graph, at right, shows the light curves for the TrES-3b transit. The blue curve is the raw transit data. The green curve shows the transit light curve corrected for instrumental and atmospheric effects. The gray line shows variation due to atmospheric thickness along the line of sight. The other curves are for nearby comparator stars used for calibration. The vertical red line marks the center of the transit. The ratio of the radius of the planet to the host star can be determined directly from the drop in light intensity at the center of the transit.

The results shown place TrES-3b in a class of exoplanets known as 'Hot Jupiters' with a radius roughly 1.3 times the radius of Jupiter. This demonstrates that the method applied at PJMO for observing and analyzing exoplanet transits is reliable.

EAG Members

Faculty

Dwight Russell
Dick Campbell



NEW CASPER MEMBER

Dr. Will Anderson

Dr. Anderson is an assistant professor in the Department of Mechanical Engineering in the School of Engineering and Computer Science at Baylor University. His current research is focused on numerical simulation of turbulent flows over surfaces with roughness that is multiscale and fractal-like. This effort has relevance to problems in engineering and geophysics. Common geophysical examples of multiscale roughness include geomorphological evolved fluvial landscapes, the wind-drive ocean surface, and vegetation.

SELECTED CASPER SEMINARS

Dr. Frank Hammer – University of Stuttgart, Germany

From Space to Earth – Solid Electrolyte Gas Sensors for in-situ Process Monitoring in Harsh Environments

Dr. Hammer discussed the motivation for using gas sensors in space and presented some first results from the space experiment FIPEX on ISS. He also highlighted two specific applications of sensor elements for in-situ process monitoring applications in harsh environments, both of which will be mounted and tested in the plasma wind tunnel facilities of Baylor University.

Dr. Allen C. Newell – University of Arizona

Pattern Quarks and Leptons

Patterns with almost periodic structures turn up in animal coats, fingerprints, and more. They are macroscopic objects in the sense that patterns arising in very different contexts exhibit very similar features both in planform (stripes, hexagons) and defect structures (disclinations). Dr. Newell discussed the way various phase transitions give rise to objects which have many features in common with (heavy) quarks and (light) leptons such as invariants with fractional spins and charges.

Dr. Robert W. Schunk – Utah State University

Escape of Neutral Gas and Plasma From the Earth's Upper Atmosphere

As plasma drifts horizontally through the different high-latitude regions in response to electric fields, the ionosphere-atmosphere system and particle outflows become spatially structured and highly time-dependent. The ion outflows interact in a complex way with acceleration mechanisms that operate at high altitudes over the polar region. Dr. Schunk discussed the way these acceleration mechanisms can result in non-Maxwellian velocity distributions, including ion beams, conics, doublehumped, bi-Maxwellian, toroidal and others.

Dr. Babak Shotorban – University of Alabama in Huntsville

Stochastic Modeling in Dusty Plasmas and Dusty Turbulent Flows

Dr. Shotorban's talk focused on the stochastic modeling of the charge fluctuations of a dust particle within a plasma, and the stochastic modeling of the dynamics of a dust particle influenced by the turbulent fluctuations of its carrying flow. A dust particle within a plasma collects plasma particles, i.e., ions and electrons, at random times so its charge randomly fluctuates over time. He discussed recent developments concerning cases in which the dust particle charging process is nonstationary.

2012 NSF REU/RET Fellows

Top Row:

Gary Shetler
Raymond Fowler
Steve Rapp

Middle Row:

Lisa Tarman
Martin Iwanicki
Robert Fisher
Danielle Moore
Patrick Murray
Robert Moore

Bottom Row:

Lydia Shannon
Will Barnes
Rachel Elliott
Sarah Frazier
Chris Grigas
Jason Curran
Allen Davis

Matthew Fellows (not pictured)

REU and RET Summer Program

Sponsored by the National Science Foundation, CASPER, the Waco Aviation Alliance, the School of Engineering and Computer Science and the Department of Physics

For the eighteenth year, CASPER, along with Baylor's Department of Physics and the School of Engineering and Computer Science and the Waco Aviation Alliance, hosted the NSF Research Experience for Undergraduates (REU) and Research Experience for Teachers (RET) programs.

This year, thirteen undergraduate students and four high school teachers participated in the program. Theoretical and experimental research projects were conducted under the direction of Mr. Dick Campbell and Dr. Dwight Russell (astronomy), Dr. Gerald Cleaver (string theory), Dr. Truell Hyde, Dr. Jie Kong, Dr. Lorin Matthews, Dr. René Laufer, and Dr. Ke Qiao (complex plasmas and space science), and Dr. Ken Park and Dr. Zhenrong Zhang (surface physics).

Two high school students also participated in summer research in string theory and early planet formation through the High School Summer Science Research Program (HSSSRP) sponsored by the College of Arts and Sciences.

Students, teachers, faculty, and graduate students participating in summer research attended weekly Wednesday Lunch Bunch Seminars and Friday Updates, enticed by the prospect of (almost) free food – everyone was made to sing physics songs for their supper. At the Wednesday seminars, faculty members presented short talks on various topics of interest, including an update on the latest results on the search for the Higgs boson (a week before its discovery was announced), aural representation of physics data, numerical calculations of the strong force, and using a physics degree in software development.

The students were also given tips on literature searches, writing papers, preparing posters and power points, and applying to graduate school. On Fridays, the participants gave updates on their research experience, and shared their favorite physics-related (and non-physics related!) YouTube videos.

At the end of the summer, each of the participants gave a twelve-minute presentation on their research. The students also prepared a poster and wrote a paper detailing their research and results. Papers are available at the CASPER website on the REU page. The program culminated with a dinner and awards presentation at The Palladium.

REUs present research at astronomy conference

REU fellows Will Barnes and Sarah Frazier presented their work at the Texas Astronomy Undergraduate Research Symposium hosted by the Texas A&M University Department of Physics and Astronomy on September 14.

Barnes' talk was titled *Dust Grain Growth in a Protoplanetary Disk: Effects of Location on Charge and Size*, while Frazier presented a paper titled *Charging Behavior of Dust Aggregates in a Cosmic Plasma Environment.*

CASPER OUTREACH

Physics Circus 2012: "Energy Quest"

All-new presentation mixes fun with learning as students confront the challenges of sustainable energy production.

The Physics Circus marked its 13th year with another round of performances where professional actors presented serious science concepts along with a side of fun and games.

In all, over 800 students from the Waco and La Vega Independent School Districts attended this year's Physics Circus. As always, the students were entertained by a comical theatrical performance based on physics concepts and presented at grade-equivalent national and state curriculum standards. They also participated in a hands-on learning experience in the Physics Circus Funhouse.

Jorge Carmona-Reyes, CASPER research scientist, says this year's presentation was one of the most ambitious yet, with a historical theme that showed students the past, present and future of energy production.

"The main character was Albert Einstein, and we had him travel through time to explain energy concepts from different stages in history," he says.

The presentation opened with a dream sequence where Einstein traveled back in time and met with Nicola Tesla, one of the pioneers of the alternating current electrical system still in use today.

"We don't believe these two scientists ever met in real life, but we imagined a conversation they might have had and then used it to present issues surrounding alternating current versus direct current," says Carmona-Reyes. "Tesla illustrated the differences between the two systems and explained why we use alternating current today."

Next, students followed Einstein from the past to the present, landing in 2012 Spain, a location Carmona-Reyes says was chosen because of the country's leadership in the use of solar energy.

"Spain is one of the most advanced countries in terms of their use of solar panels and heliostats. We wanted to take the Einstein character to Spain to talk about solar power because the technology depends so heavily on Einstein's work. He won a Nobel Prize for explaining the photoelectric effect, but he never knew it would be used to produce energy."

After a discussion of modern solar power, the program moved into the future, where

students learned about nuclear fusion and fission; they also learned about ITER (International Thermonuclear Experimental Reactor) and considered the advantages and disadvantages of nuclear power.

Hands-on fun and learning

At the conclusion of the stage performance, students moved into the Physics Circus Funhouse, where they dug deeper into the concepts presented in the theatrical show. CASPER faculty and graduate students were on hand at each booth to help students learn about concepts including nuclear chain reactions, solar power, AC/DC distribution, fission and fusion.

After spending time in the Funhouse, students put their knowledge to the test in a game of "Ener-Jeopardy," where they answered questions based on the concepts presented in the show for the chance to win prizes.

What's next for the Physics Circus?

While the Physics Circus is fun for students and adults alike, the program has serious goals, including preparing students academically for college and improving their attitudes toward pursuing careers in science, technology, engineering and mathematics (STEM) fields.

Carmona-Reyes says future plans for the Physics Circus include taking the learning experience outside the live performance to what he calls a "Virtual Physics Circus."

"Instead of having the students come to a specific venue, we want to reach them using the most current technology available: the Web. We will produce a Physics Circus where students will get to learn physics concepts through a video game format," he says.

The planned game will have several levels of complexity to challenge students at every level, from basic physics all the way through

more advanced concepts. Teachers will be able to receive reports on their students' scores that will help them assess the students' understanding of physics concepts.

"The ultimate goal is to produce this virtual Physics Circus game as an app that can be played on any of the major smartphone platforms," says Carmona-Reyes. "We want it to not only be a teaching tool, but also a tool to measure and monitor the progress of the student."

Physics Circus website

The Physics Circus website picks up where the performance leaves off, with materials and resources for teachers, students, after-school clubs and home-schools.

Check out the website at **http://www.baylor.edu/physicscircus**.

Hungarian graduate student studys at CASPER through collaborative exchange program

Aniko Kovacs performed research at CASPER for three months as part of her PhD program.

Aniko Kovacs is a graduate student at the University of Pécs, Faculty of Sciences, Doctoral School of Physics in Hungary.

She earned her MSc degree in computational physics in 2010 at Babes-Bolyai University, Cluj-Napoca, Romania, and is currently working toward the PhD, supervised by CASPER adjunct faculty Dr. Peter Hartmann.

Dr. Hartmann is a member of the faculty at Wigner Research Centre for Physics of the Hungarian Academy of Sciences, Budapest, Hungary.

During her time at CASPER, Aniko worked on a Particle-In-Cell (PIC) code to model the plasma conditions inside the GEC rf reference cell with an open glass box sitting on the electrode.

This allowed her to determine the electrostatic potential in and around the box and how it influences the motion of dust. The glass box is used to study phenomena such as vertical dust strings, helical dust structures, and dust agglomeration.

Recent Publications

Peer-reviewed publications: (alphabetized by title; CASPER faculty and collaborators in bold)

A 2 MV Van de Graaff accelerator as a tool for planetary and impact physics research, A. Mocker, S. Bugiel, S. Auer, G. Baust, A. Colette, K. Drake, K. Fiege, E. Gruen, F. Heckmann, S. Helfert, J. Hillier, S. Kempf, G. Matt, T. Mellert, K. Otto, F. Postberg, **H.-P. Roeser**, A. Shu, Z. Sternovsky, **R. Srama**, Review of Scientific Instruments **82** 095111 (2011).

A future observational plan of dust particles around the Moon by LDM (Lunar Dust Monitor) onboard the orbiter of the next Japanese lunar mission, M. Kobayashi, H. Ohashi, S. Sasaki, H. Shibata, T. Iwai, M. Fujii, K.-I. Nogami, M.H. Nakumura, T. Hirai, **R. Srama**, E. Gruen, Earth Planets and Space **63** 1113 (2011).

A New Inductively Driven Plasma Generator (IPG) Source, **T. Hyde**, **R. Laufer**, **G. Herdrich**, **M. Dropmann**, **S. Peters**, **L.S. Matthews**, **M. Cook**, **J. Schmoke**, Bulletin of the American Physical Society (APS) **56** (2011).

A salt-water reservoir as the source of a compositionally stratified plume on Enceladus, F. Postberg, J. Schmidt, J. Hillier, S. Kempf, **R. Srama**, Nature **474** 620 (2011).

A semi-adaptive compact splitting method for the numerical solution of 2-dimensional quenching problems, **M. Beauregard**, **Q. Sheng**, Appl. Math. Comput. **218** 1240 (2012).

A short note on the asymptotic stability of certain oscillation-free eikonal splitting schemes, **Q. Sheng**, S. Guha, L.P. Gonzalez, Appl. Math. Lett. 2012 (in press).

Agglomeration of Dust Particles in the Lab, **L.S. Matthews**, **J. Carmona-Reyes**, **V. Land**, **T.W. Hyde**, AIP Conf. Proc. **1397** 397 (2011).

An immersed boundary method wall model for high-Reynolds number channel flow over complex topography, **W. Anderson**, Int. J. Numer. Meth. in Fluids. 2012 (submitted).

Analytic surgery of the zeta function, **K. Kirsten**, P. Loya, Commun. Math. Phys. **310** 181 (2012).

Bose-Einstein condensation on product manifolds, **K. Kirsten**, G. Fucci, J. Phys. A: Math. Theor. **44** 332002 (2011).

Cassini dust stream particle measurements during the first three orbits at Saturn, H.-W. Hsu, S. Kempf, F. Postberg, M. Trieloff, M. Burton, M. Roy, G. Moragas-Klostmeyer, **R. Srama**, Journal of Geophysical Research-Space Physics **116** A08213 (2011).

Charging and coagulation of dust in protoplanetary plasma environments, **L.S. Matthews**, **V. Land**, **T.W. Hyde**, Astrophysical Journal **744** 8 (2012).

Classification of the FRW universe with a cosmological constant and a perfect fluid of the equation of state, T. Ha, Y.Q. Huang, **Q.Y. Ma**, **K.D. Pechan**, T.J. Renner, Z.B. Wu, G.A. Benesh, **A. Wang**, Gen. Relativ. Grav. **44** 1433 (2012).

Compositional mapping of planetary moons by mass spectrometry of dust ejecta, F. Postberg, E. Gruen, M. Horanyi, S. Kempf, H. Krueger, J. Schmidt, F. Spahn, **R. Srama**, Z. Sternovsky, M. Trieloff, Planetary and Space Science **59** 1815 (2011).

Determination of the levitation limits of dust particles within the sheath in complex plasma experiments, **A.V. Douglass**, **V. Land**, **K. Qiao**, **L.S. Matthews**, **T.W. Hyde**, Phys. Plasmas **19**, 013707 (2012).

Dust particle charge in plasma with ion flow and electron depletion near plasma boundaries, **A.V. Douglass**, **V. Land**, **L.S. Matthews**, **T.W. Hyde**, Physics of Plasmas **18** 083706 (2011).

Dust trajectory sensor: Accuracy and data analysis, J. Xie, Z. Sternovsky, E. Gruen, S. Auer, N. Duncan, K. Drake, H. Le, M. Horanyi, **R. Srama**, Review of Scientific Instruments **82** 105104 (2011).

Eikonal decomposition methods for fast computations of beam propagations, **Q. Sheng**, S. Guha and L. P. Gonzalez, Eng. Comptat. **29** 4 (2012).

General covariant Horava-Lifshitz gravity without projectability condition and its applications to cosmology, T. Zhua, F.W. Shu, Q. Wu, **A. Wang**, Phys. Rev. D **85** 044053 (2012).

General relativity limit of Horava-Lifshitz gravity with a scalar field in gradient expansion, A.E. Gumrukcuoglu, S. Mukohyama, **A. Wang**, Phys. Rev. D **85** 064042 (2012).

Generalized Lawson criterion for magnetic fusion applications in space, D. Petkow, R. Gabrielli, **G. Herdrich**, **R. Laufer**, **H.-P. Roeser**, Fusion Engineering and Design **87** 30 (2012).

Hardy inequality and heat semigroup estimates for Riemannian manifolds with singular data, **K. Kirsten**, M. van den Berg, P. Gilkey, G. Grigor'yan, Commun. Part. Diff. Equat. **37** 885 (2012).

Heat kernel coefficients for Laplace operators on the spherical suspension, **K. Kirsten**, G. Fucci, Commun. Math. Phys. 2012 (submitted).

Heat trace asymptotics and the Gauss-Bonnet theorem for general connections, **K. Kirsten**, C.G. Beneventano, P. Gilkey, E.M. Santangelo, J. Phys. A: Math. Theor. 2012 (submitted).

Heat trace asymptotics with singular weight functions II, **K. Kirsten**, M. van den Berg, P. Gilkey, Journal of Geometric Analysis **21** 870 (2011).

Higher harmonics of the magnetoplasmon in strongly coupled Coulomb and Yukawa systems, T. Ott, M. Bonitz, **P. Hartmann**, Z. Donkó, Phys. Rev E **83** 046403 (2011).

Highly efficient miniaturized inductively heated plasma source for space environmental plasma simulation, **G. Herdrich**, **R. Laufer**, **M. Dropmann**, **S. Peters**, D. Puckert, H. Fulge, S. Fasoulas, **T.W. Hyde**, Advances in Space Research 2012 (submitted).

Instabilities in Yukawa Liquids, M. Rosenberg, G.J. Kalman, **P. Hartmann**, Contrib. Plasma Phys. **52** 70 (2012).

Large-eddy simulation of atmospheric boundary layer flow over fluvial-like landscapes using a dynamic roughness model, **W. Anderson**, P. Passalacqua, F. Porte-Agel, C. Meneveau, Boundary-Layer Meteorol **144** 263 (2012).

Mass spectrometry of impact fragmented polymers: The role of target properties, E.M. Mellado, K. Hornung, **R. Srama**, J. Kissel, S.P. Armes, S. Fujii, International Journal of Impact Engineering **38** 486 (2011).

Multimodal characteristics of a piezoelectric lead zirconate titanate element impacted with iron particles having velocities above 20 km/s, T. Miyachi, M. Fujii, N. Hasebe, O. Okudaira, S. Takechi, S. Minami, M. Kobayashi, T. Iwai, E. Gruen, **R. Srama**, N. Okada, Advances in Space Research **48** 570 (2011).

On the stability of an oscillation-free ADI method for highly oscillatory wave equations, **Q. Sheng**, W. Sun, Comm. Computat. Physics. **12** 1275 (2012).

SARIM PLUS – Sample Return of Comet 67P/CG and of Interstellar Matter, **R. Srama**, H. Krueger, T. Yamaguchi, T. Stephan, M. Burchell, A. T. Kearsley, V. Staerken, F. Postberg, S. Kempf, E. Gruen, N. Altobelli, P. Ehrenfreund,V. Dikarev, M. Horanyi, Z. Sternovsky, J. D. Carpenter, A. Westphal, Z. Gainsforth, A. Krabbe, J. Agarwal, H. Yano, J. Blum, H. Henkel, J. Hillier, P. Hoppe, M. Trieloff, S. Hsu, A. Mocker, K. Fiege, S. F. Green, A. Bischoff, F. Esposito, **R. Laufer**, **T.W. Hyde**, **G. Herdrich**, S. Fasoulas, A. Jaeckel, G. Jones, P. Jenniskens, E. Khalisis, G. Moragas-Klostermeyer, F. Spahn, H. U. Keller, P. Frisch, A. C. Levasseur-Regourd, N. Pailer, K. Altwegg, C. Engrand, S. Auer, J. Silen, S. Sasaki, M. Kobayashi, J. Schmidt, J. Kissel, B. Marty, P. Michel, P. Palumbo, O. Vaisberg, J. Baggaley, A. Rotundi, **H.-P. Roeser**, Experimental Astronomy **33** 723 (2012).

Shear Viscosity of Liquid-Phase Yukawa Plasmas from Molecular Dynamics Simulations on Graphics Processing Units, Á. Budea, A. Derzsi, **P. Hartmann**, Z. Donkó, Contrib. Plasma Phys. **52** 194 (2012).

Solving degenerate quenching-combustion equations by an adaptive splitting method on evolving grids, **M. Beauregard**, **Q. Sheng**, Computers and Structures 2012 (under final revision).

Spectral determinants and zeta functions of Schrödinger operators on metric graphs, **K. Kirsten**, J.M. Harrison, C. Texier, J. Phys. A: Math. Theor. **45** 125206 (2012).

Spectral methods in quantum field theory and quantum cosmology, **K. Kirsten**, G. Esposito, G. Fucci, A.Yu. Kamenshchik, J. Phys. A: Math. Theor. 2012 (submitted).

Static electromagnetic fields and charged black holes in general covariant theory of Horava-Lifshitz gravity, K. Borzou, K. Lin, **A. Wang**, JCAP **02** 025 (2012).

Stream particles as the probe of the dust-plasma-magnetosphere interaction at Saturn, H.-W. Hsu, F. Postberg, S. Kempf, M. Trieloff, M. Burton, M. Roy, G. Moragas-Klostermeyer, **R. Srama**, Journal of Geophysical Research-Space Physics **116** A09215 (2011).

Strong Coupling Effects in Binary Yukawa Systems, G.J. Kalman, Z. Donkó, **P. Hartmann**, K.I. Golden, Phys. Rev. Lett. **107** 175003 (2011).

Systematic Investigations of the Free Fermionic Heterotic String Gauge Group Statistics: Layer One Results, D. Moore, **J. Greenwald**, T. Renner, M. Robinson, C. Buescher, M. Janas, G. Miller, S. Ruhnau, **G. Cleaver**, Modern Physics Letters A **26** 2411 (2011).

The Casimir effect for conical pistons, **K. Kirsten**, G. Fucci, JHEP **03** 16 (2011).

The Casimir effect for generalized piston geometries, **K. Kirsten**, G. Fucci, Int. J. Mod. Phys. A **27** 1260008 (2012).

The influence of monomer shape on aggregate morphologies, **J. Perry**, **E. Gostomski**, **L.S. Matthews**, **T.W. Hyde**, Astronomy and Astrophysics, **539** A99, (2012).

The spectral zeta function for Laplace operators on warped manifolds of the type $I \times_f N$, **K. Kirsten**, G. Fucci, Commun. Math. Phys. 2012 (submitted).

Books:

High Resolution Optical Satellite Imagery, I. Dowman, K. Jacobsen, G. Konecny, **R. Sandau**, Latheronwheel, Chaithness, Scotland; Whittles Publishing; 2012.

Symmetry and the Standard Model, R. Robinson, K. Bland, **G. Cleaver, J. Dittmann**, M. Serna. New York, NY: Springer; 2011.

Book Chapters:

Implications of new trends in small satellite development, M. D'Errico, E. Gill, A. Moccia, **R. Sandau**. In: K.-U. Schrogl, S. Pagkratis, B. Baranes, eds. Yearbook on Space Policy 2009/2010. Springer Wein New York; 2011.

Universe and Multiverse, **Cleaver G.** In: Haarsma D, Hoezee S, eds. Delight in Creation: Scientists Share Their Work in the Church. Grand Rapids, MI: Calvin Press; 2012

Presentations:

Anisotropic scalings and a theory of quantum gravity, **A. Wang**, 2012: Annual Meeting of Chinese Gravitational Physics and Astrophysics. Datong, Shanxi, China.

Casimir energies and forces in the presence of background potentials, **K.Kirsten**, 2011: Quantum Vacuum Workshop, Oklahoma University, Norman, OK, USA.

Casimir forces in the presence of background potentials, **K. Kirsten**, 2011: Tenth Conference on Quantum Field Theory under the Influence of External Conditions, Benasque, Spain.

Dynamic surface roughness model for LES of atmospheric boundary layer flow over multi-scale terrain with power-law height spectra, C. Meneveau, **W. Anderson**, 2012: Proc. of European Geosciences Union, General Assembly, Vienna, Austria.

Elimination of Spin-0 Gravitons in Horava's Gravity without Projectability Condition, **A. Wang**, 2012: Testing Gravity with Astrophysical and Cosmological Observations. Kashiwa, Japan.

Evaluation of passive admixture interfacial trasnfer coefficient relations during LES of ABL flow over self-similar, fractal topography, **W. Anderson**, 2012: Proc. of American Meteorological Society, 20th Symp. on Boundary Layers and Turbulence, Boston, MA.

Large-eddy simulation of atmospheric boundary layer flow over multiscale topographies with a dynamic surface draf model, C. Meneveau, **W. Anderson**, 2011: American Geophysical Union, Fall Meeting, San Fransisco, CA.

LES of atmospheric boundary layer flow over fluvial-like anisotropic topography with a dynamic surface drag mode, **W. Anderson,** C. Meneveau, 2011: American Phys. Soc. Division of Fluid Dynamics, Baltimore, MD.

LES of the atmospheric boundary layer responding to fractal-like topography, **W. Anderson**, P. Passalacqua, 2012: Proc. of American Meteorological Society, 20th Symp. on Boundary Layers and Turbulence, Boston, MA.

Overview of quantum gravity at Lifshitz point, **A. Wang**, 2012: Testing Gravity with Astrophysical and Cosmological Observations. Kashiwa, Japan.

Roughness temporal response in a turbulent thermal boundary layer, S. McClain, S. Mart, **W. Anderson**, 2012: Proc. of American Inst. of Aero. and Astro., 6th Flow Control Conf., New Orleans, LA.

The Casimir effect and its mathematical implications, **K. Kirsten**, 2012: Conference on Mathematical structures in quantum systems and applications, Benasque, Spain.

Vacuum energy of Schrödinger operators on metric graphs, **K. Kirsten**, J.M. Harrison, 2011: Proceedings of the Tenth Conference on Quantum Field Theory under the Influence of External Conditions, International Journal of Modern Physics: Conference Series.

Invited talks:

A Low-cost, Modular, Miniaturized In-situ Measurement Instrument for Sub-millimeter Detection, **A. Wolf**, **R. Laufer**, **R. Srama**, **T.W. Hyde**, **H.-P. Roeser**, 61. Deutscher Luftund Raumfahrtkongress, Berlin, Germany, September 10-12, 2012 (accepted).

A Modular, Miniaturized, Low-mass In-situ Dust Detector for Piggyback Payload Opportunities on Small Spacecraft, Landers and Rovers, **A. Wolf**, **R. Laufer**, **R. Srama**, **G. Herdrich**, E. G. Lightsey, C. Wiedemann, **T.W. Hyde**, **H.-P. Roeser,** 63rd International Astronautical Congress (IAC), Naples, Italy, October 1-5, 2012 (accepted).

A New Inductively Driven Plasma Generator (IPG), **M. Dropmann**, **G. Herdrich**, **T.W. Hyde**, **R. Laufer**, **H. Koch**, **C. Gomringer**, **S. Peters**, **L. S. Matthews**, **M. Cook**, **J. Schmoke**, 13th Workshop on the Physics of Dusty Plasma, Waco, TX, USA, May 20-23, 2012.

A simple approach to the public acceptance of technological projects, R.A. Gabrielli, **G. Herdrich**, **R. Laufer**, C. Koppel, D. Valentian, R. Blott, C. Ferrari, C. Bruno, F. Jansen, **H.-P. Roeser**, 63rd International Astronautical Congress (IAC), Naples, Italy. October 1-5, 2012 (accepted).

*About the impact of small satellite technology on capacity building in East Asia***, R.Sandau,** The 1st IAA Regional Far East Meeting, Hanoi, Vietnam October 10, 2011.

Invited Talks, Continued

An affordable paradigm of hitchiker lunar and planetary spacecraft for exploration and commerce, D. Dunlop, **R. Laufer**, 63rd International Astronautical Congress (IAC), Naples, Italy. October 1-5, 2012 (accepted).

Anisotropic scalings and Horava's theory of quantum gravity, **A. Wang**, IPMU, University of Tokyo, Kashiwa, Japan, July 6, 2011 and UT Arlington, Arlington, TX, USA, October 26, 2011.

Anisotropic scalings and Horava-Lifshitz theory of quantum gravity: An updated review, **A. Wang**, Institute for Advanced Physics & Mathematics, Zhejiang University of Technology, Hangzhou, China. June 15, 2011.

Anisotropic scalings Horava's theory of quantum gravity: current status, **A. Wang**, Baylor University, Waco, TX, USA. August 31, 2012.

Applications of non-linear programming for Lunar Mission BW-1 trajectory optimisation to further missions, R. Shimmin, B. Cazzolato, V. Wheatley, **R. Laufer**, **H.-P. Roeser**, 62nd International Astronautical Congress (IAC), Cape Town, South Africa, October 3-7, 2011.

ARMADILLO – A Demonstration for a Cis-Lunar Exploration Mission to the Kordylewski Clouds, **R. Laufer**, E. G. Lightsey, **R. Srama**, **G. Herdrich**, W. Tost, C. Wiedemann, E. Chester, H. Hill, G. D. Earle, T. Henderson, **R. Sandau**, **H.-P. Roeser**, **L.S. Matthews**, **T.W. Hyde**, 62nd International Astronautical Congress (IAC), Cape Town, South Africa, October 3-7, 2011.

ARMADILLO – A Demonstration for Low-Cost In-Situ Investigations of the upper Atmosphere of Planetary Bodies, **R. Laufer**, G. Lightsey, **G. Herdrich**, **R. Srama**, G. D. Earle, C. Wiedemann, E. Chester, H. Hill, T. Henderson, **R. Sandau**, **M. Dropmann**, **S. Peters**, **H.-P. Roeser**, **L. Matthews**, **T. Hyde**, Poster, 8th International Planetary Probe Workshop (IPPW-8), Portsmouth, VA, USA, June 6-10, 2011.

Cosmology in Horava-Lifshit theory of quantum gravity, **A. Wang**, UT Dallas, Dallas, TX, USA. November 11, 2011.

Development of a Modular Miniaturized In-Situ Measurement Instrument for Dust Research, **A. Wolf**, **R. Laufer**, E.G. Lightsey, **G. Herdrich**, **R. Srama**, **H.-P. Roeser**, **T.W. Hyde**, 13th Workshop on the Physics of Dusty Plasma, Waco, TX, USA, May 20-23, 2012.

Development of a Pitot Probe for Diagnostic Applications in the Dusty Plasma Environments Created by the Inductively-Heated Plasma Generator IPG6-B, **H. Koch**, **M. Dropmann**, **G. Herdrich**, **M. Cook**, **J. Schmoke**, **R. Laufer**, **T.W. Hyde**, 13th Workshop on the Physics of Dusty Plasma, Waco, TX, USA May 20-23, 2012.

Elimination of Spin-0 Gravitons in Horava's Gravity without Projectability Condition, **A. Wang**, Baylor University, Waco, TX, USA. March 26, 2012.

Horava-Lifshtiz Gravity: An Overview, **A. Wang**, State University of Rio de Janeiro, Brazil, South America. Series: June 5, 12, 14, 19, 2012.

Horava's Quantum Theory of Gravity at Lifshitz Fixed Points, **A. Wang**, State University of Sao Paulo, Brazil, South America. June 20, 2012.

Horava's Theory of Quantum Gravity at Lifshitz Point: A Layman's View, **A. Wang**, Texas A&M University, Commerce, TX, USA. February 23, 2012.

In-Situ Dust Measurements by a Lunar Lander, **R. Srama**, S. Kempf, Z. Sternovsky, E. Gruen. K. Fiege, M. Horanyi, G. Moragas-Klostermeyer, H. Krueger, **R. Laufer**, Y. Li, A. Mocker, F. Postberg, **H.-P. Roeser**, 39th Committee on Space Research (COSPAR) Scientific Assembly, Mysore, India. July 14-22, 2012 (accepted).

In-Situ Sub-Millimeter Space Debris Detection Using Cubesats, K.M. Brumbaugh, H.C. Kjellberg, E.G. Lightsey, **A. Wolf**, **R. Laufer**, 35th Annual American Astronautical Society Guidance and Control Conference, Breckenridge, CO, USA, February 3-6, 2012.

Multi Wall Carbon Nano Tubes as Material for a Space Elevator on the Moon, **J.A. Carmona Reyes**, **S. Peters**, **G. Herdrich**, **R. Srama**, **J. Schmoke**, **M. Cook**, **L. Matthews**, **R. Laufer**, **T.W. Hyde**, 43rd Lunar and Planetary Science Conference (LPSC), The Woodlands, TX, USA, March 19 – 23, 2012 and the 13th Workshop on the Physics of Dusty Plasma, Waco, TX, USA, May 20-23, 2012.

Numerical simulation of turbulent flows responding to fractal-like topographies, **W. Anderson**, CASPER Seminar Series, Baylor University, Waco, TX, USA. March 30, 2012.

Ongoing studies of atmospheric turbulence responding to environmental topography and the use of high-performance computing, **W. Anderson**, High Performance Computing Across Texas (HiPCAT), Spring Meeting, Baylor University, Waco, TX., USA April 27, 2012.

Invited Talks, Continued

Overview of Horava's quantum gravity at Lifshitz point, **A. Wang**, Baylor University, Waco, TX, USA. February 26, 2012.

Piezo Dust Detector (PDD) – A Modular Miniaturized In-Situ Measurement Instrument for Dust Research, **A. Wolf**, **R. Laufer**, G. Lightsey, **G. Herdrich**, **R. Srama**, **H.-P. Roeser**, **T.W. Hyde**, 43rd Lunar and Planetary Science Conference (LPSC), The Woodlands, TX, USA, March 19-23, 2012.

Prospects of remote sensing with small satellites, **R. Sandau**, Keynote Speaker, 4th CSA-IAA Conference on Advanced Space Technology, Shanghai, China. September 5-8, 2011.

Setup of a Side-Arm Technology and Diagnostics at IPG6-B to Create Different Plasma Densities for Investigations in Dusty Plasma Environment, **C. Gomringer**, **M. Dropmann**, **S. Peters**, **G. Herdrich**, F. Hammer, **M. Cook**, **J. Schmoke**, **R. Laufer**, **T.W. Hyde**, 13th Workshop on the Physics of Dusty Plasma, Waco, TX, USA, May 20-23, 2012.

Setup of an Inductively-Heated Plasma Generator and Diagnostics to Build a Hybrid Plasma Simulation Facility for Complex Space Environment Investigations, **M. Dropmann**, **C. Gomringer**, **H. Koch, S. Peters**, **G. Herdrich**, **M. Cook**, **J. Schmoke**, **R. Laufer**, **L. Matthews**, **T.W. Hyde**, 43rd Lunar and Planetary Science Conference (LPSC), The Woodlands, TX, USA, March 19-23, 2012.

Outreach publications:

Universe and Multiverse, **Cleaver G**, The Forum: BioLogos website. 2012 Available at: http://biologos.org/blog/author/cleaver-gerald.

Small satellite payload design – Approach and examples, **R. Sandau**, The 4th CSA-IAA Conference on Advanced Space Technology, Shangai, China, September 5-8, 2011.

Small satellites – A tool for capacity building in Africa, **R. Sandau,** The 4th African Leadership Conference on Space (ALC), Mombase, Kenya September 26-28, 2011.

*Status of small satellite technology for monitoring of the environment***, R. Sandau,** The Second IAA Workshop on Coordination and Cooperation for Global Environmental Impact, Beijing, China. September 2-3, 2011.

*Status of small satellite missions for monitoring the environment***, R.Sandau,** The 1st IAA Regional Far East Meeting, Hanoi, Vietnam, October 10, 2011.

The Earth Micro- and Submicro-Particle Environment, **R. Srama**, E. Gruen. H. Krueger, **R. Laufer**, **H.-P. Roeser**, 39th Committee on Space Research (COSPAR) Scientific Assembly, Mysore, India, July 14-22, 2012 (accepted).

Zeta functions everywhere, **K. Kirsten**, Baylor University, Waco, TX, USA. January 28, 2011 and University of Texas at Austin, Austin, TX, USA. February 11, 2011.

CASPER JOB OPENING

Assistant Director of Research (CASPER)

Position description

The position will provide research support and project direction in complex plasma, space plasma, IPG plasma and other related fields. The position will also provide administrative support for projects across all of CASPER and as such, may at times work with almost any of CASPER's faculty or staff. The successful applicant will be provided the rank of assistant, associate or full research professor depending on past experience, and will report directly to the center director.

Qualifications

The successful candidate will hold the Ph.D. degree and exhibit an exemplary research record in theoretical and/or experimental plasma physics or a related area. Solid administrative skills and a proven ability to work well within a large research team setting are required.

More information

To learn more about this opportunity or to begin the application process, visit the CASPER website, located at http://www.baylor.edu/casper and click "Job Opportunities."

13th Workshop on the Physics of Dusty Plasma

May 20-23, 2012, Waco, Texas

The 13th Workshop on the Physics of Dusty Plasma (WPDP), sponsored by CASPER, the National Science Foundation, and the Office of the Vice Provost for Research at Baylor University, was held in Waco, Texas, May 20-23, 2012.

The workshop series is an internationally renowned, well-attended conference involving topics of direct interest to the NSF and other federal funding agencies. WPDP meetings have been held since 1986, with recent meetings held in Boulder, Colorado (2009) and Williamsburg, Virginia (2006).

Drs. Truell Hyde, Lorin Matthews, Victor Land, and René Laufer served as the local organizing committee. The program committee consisted of Drs. Truell Hyde (CASPER), Lorin Matthews (CASPER), Victor Land (CASPER), René Laufer (CASPER), Gregor Morfill (Max Planck Institute for Extraterrestrial Physics), Peter Hartmann (CASPER and the Hungarian Academy of Sciences) and Jeremiah Williams (Whittenberg University).

The field of Dusty Plasmas has experienced exponential growth over the past two decades with much of this growth fueled by the fundamental research opportunities within classical plasma physics afforded by dusty plasmas and the economic impact such research represents, particularly given the role plasma physics plays in modern technology.

The objectives of the 13th workshop were to 1) provide a review of recent advancements in the field of complex plasma, 2) define new/existing outstanding issues and research challenges, and 3) strengthen engagement between the field of complex plasma and other research related disciplines.

Participants presented more than seventy posters and papers at the conference, which was well represented internationally with almost half of these presentations being given by international participants. CASPER members presenting research included Jorge Carmona-Reyes, Michael Cook, Angela Douglass, Christoph Gomringer, Truell Hyde, Helmut Koch, Jie Kong, Victor Land, Lorin Matthews, Ke Qiao, Jimmy Schmoke and Alex Wolf.

The highlight of the conference was the conference excursion and dinner held at Homestead Heritage, where participants were able to observe local craftsmen at work in making pottery, weaving, woodworking and blacksmithing. Participants also had the opportunity to take open carriage rides to a scenic overlook, and enjoy all of the grilled steak they could eat to the tunes of a live bluegrass band.

For more information, visit the workshop website at: http://www.baylor.edu/wpdp2012/home.php.

Workshop on Dust and Grains in Low Gravity and Space Environment

Sponsored by ESA / ESTEC
April 2-4, 2012, Noordwijk, The Netherlands

Drs. Lorin Matthews and Victor Land were invited to speak at the first workshop on the physics of Dust and Grains in Low Gravity and Space Environment, held April 2-4, 2012. The workshop was sponsored by the European Space Agency (ESA) and held at the European Space Research and Technology Centre (ESTEC) in Noordwijk, The Netherlands.

The workshop brought together experts in the fields of astronomy, rheology, space missions, grain charging, aggregation, optical and acoustic diagnostic techniques, and astronomical objects with the goal of identifying open research questions which would benefit from a broad interdisciplinary effort. The workshop was very successful in helping to form potential collaborations and plans are being made to continue the workshop on a yearly basis.

Many of the presentations given at the conference can be found online at http://congrexprojects.com/11m24/programme.

39th European Physical Society Conference on Plasma Physics / 16h International Congress on Plasma Physics

Sponsored by EPS / ICPP
July 2-6, 2012, Stockholm, Sweden

Dr. Truell Hyde presented a paper entitled "Collective Phenomena in Extended Vertical Chains within Dusty Plasma" at the 39th European Physical Society Conference on Plasma Physics / 16h International Congress on Plasma Physics held July 2-4. The international conference was sponsored by the European Physical Society (EPS) and held in Stockholm, Sweden. EPS conferences have been held since 1966 while ICPP conferences have been held since 1980.

The conference covered the fields of basic, space and astrophysical plasmas, magnetic confinement fusion plasmas, low temperature and dusty plasmas and inertial fusion and beam plasmas. Almost 25% of the papers presented were categorized to be in the field of dusty plasmas, making this conference one of the most influential in the field. Special sessions were also held on the future of plasma physics and ITER experimental fusion reactors.

Former REU fellow building career in planetary science

When he's not teaching, researching, or mentoring students, on planetary science, Dr. Sayanagi enjoys playing trumpet, drums and keyboard.

Dr. Kunio M. Sayanagi participated in the Baylor REU program during the summer of 1999, where he worked on developing an N-body simulation code under CASPER Director Dr. Truell Hyde. Following his REU fellowship, he completed his bachelor's degree at Juanita College in Pennsylvania, majoring in liberal arts with emphases in physics, applied math and computer science. He earned his Ph.D. in 2007 from the University of Arizona, writing his dissertation on numerical simulations of the global atmospheric dynamics of Jupiter and Saturn.

Sayanagi completed postdoc fellowships at the University of Louisville, Caltech and UCLA. During his time at UCLA, he earned his first research grant while still finding time to play trumpet, drums, keyboards in a band called Dangerous Alien. The band was featured in the movie "Piled Higher and Deeper," a live-action adaptation of the popular online comic strip by Jorge Cham.

In addition to his research, Sayanagi has taken on a number of other service and advocacy roles. While working as a postdoc, he became the youngest panelist on the National Academy's Planetary Science Decadal Survey, which makes recommendations to NASA and the NSF on their research priorities. He also became a leading voice in the postdoc community, serving as executive chair of the Caltech Postocs Association and later as the vice president of advocacy at UCLA's Society of Postdctoral Scholars.

In January of this year, Sayanagi became an assistant professor of planetary science at Hampton University in Virginia. He recently received his second research grant, and this semester he will be supervising a graduate student and a postdoc.

Astronomy experience helps former RET participant land job at South Pole research station

Shelly Hynes, a two-time participant in Baylor's Research Experience for Teachers program, recently began a new job as science and technical project support supervisor at the Amundsen-Scott South Pole Station through the Antarctic Support Contract awarded to Lockheed Martin.

She will spend four months at the South Pole each year supervising research associates and directing a laboratory.

Prior to her new position, Hynes was an Albert Einstein Distinguished Educator Fellow at the NSF Office of Polar Programs. In that role, she was stationed at the McMurdo Research Station on the coast of Antarctica, where she performed outreach to schools in Louisiana and Oklahoma.

Shelly Hynes stands at the Earth's southernmost point. Hynes splits time between the Amundsen-Scott South Pole Station and her home in Colorado.

Hynes also traveled to Greenland as part of the Joint Science Education Program, a collaborative, diplomatic effort between the U.S., Greenland and Denmark. There, she led a field school program which teamed students from the three countries for a cultural exchange while conducting polar research with scientists in the field near Kangerlussuaq, Greenland.

Hynes credits her Baylor RET summers with helping her to gain experience in visible and radio astronomy, which she says were important factors in helping her land her new job.

"South Pole science is mostly astronomy of various flavors (South Pole Telescope, BICEP2, IceCUBE, Askaryan) with some upper atmosphere, aurora and magnetosphere research thrown in for good measure," she says.

Former CASPER research scientist accepts position at Dutch physics research foundation

An update from Dr. Victor Land

After moving back to the Netherlands in the first week of June, I started my job as a program officer at the Foundation for Fundamental Research on Matter (FOM), which coordinates and finances fundamental physics research in the Netherlands.

In a way, this ends my roughly eight-and-a-half-year-long career as a scientist in the field of complex plasma physics, the last four of which I happily spent at Baylor within CASPER. In another way, it allows me to contribute to science in a broader sense in the Netherlands and inevitably on an international scale as well.

Despite the "fundamental" in FOM, more and more physics research is geared towards providing an application that is beneficial to society. The process through which fundamental research results in beneficial applications, typically through interactions with industry, is called "valorisation", which is one of the topics I am involved in.

What can FOM do to maximize valorisation, without diminishing scientific freedom and fundamental research? How can we help FOM researchers when they start up new businesses? How do we set our patent policy? How can we attract industries for the research capabilities within the Dutch physics field? How can we encourage researchers to think about application perspectives? These questions can be quite challenging, especially when a research project is on string theory, quantum gravity, or detecting elementary particles at CERN.

Another aspect of my job involves serving as secretary to one of the advisory committees to the FOM's executive board. I work with a committee in the sub-field of phenomenological physics, which comprises all systems that show macroscopic behavior which depends on the microscopic interactions between the constituents within the systems. Think of complex fluids, plasmas, but also material sciences and soft condensed matter. I make sure that the information to and from the committee keeps flowing.

The committee plays an important role in checking the progress in research projects within the field, but also observes the international playing field and provides future directions, while alerting the executive board about future research possibilities.

Finally, within each sub-field FOM receives research proposals that need to be evaluated. It is the responsibility of every program officer to oversee this process and also to look for and contact international referees. This can be a very interesting process because we contact referees from all over the world and every society has different ways of doing things. Referee reports coming from, for instance, Germany, Japan, or the United States can be completely different, and every time these reports need to be judged on their value for the reviewing process as a whole.

Overall, there are a lot of new aspects of physics research to think and learn about and I get a very broad overview of all the people involved. It is pretty good to be back in Holland!

For more information about FOM, please visit:
http://www.fom.nl/live/english/home.pag

Graduations

Angela Douglass successfully defended her dissertation, *Fundamental Physics within Complex Plasmas*, and graduated from Baylor with a Ph.D. in Physics in May 2012.

Brandon Doyle graduated from Baylor with a B.S. in Physics in August 2012.

Kimberly Orr graduated from Baylor with a B.S. in Astronomy in May 2012.

Jonathan Perry successfully defended his thesis and graduated from Baylor with an M.S. in Physics in August 2012.

Anne Zandstra successfully defended her dissertation, *The impact of an informal science program on students' science knowledge and interest*, and graduated from Baylor with a Ph.D. in Education in May 2012.

Zhuanhao (Victor) Zhang successfully defended his dissertation, *Fundamental particle and wave dynamics in dusty plasmas*, and graduated from Baylor with a Ph.D. in Physics in August 2012.

Babies

Lennart Felix Kruschwitz was born January 28, 2012 to Claudia and Hans Kruschwitz. He weighed 7 lbs, 14 oz and was 20.5" long.

Lennart is the first grandchild of Hans-Peter Roeser, director of the Institute of Space Systems, CASPER's partner center at the University of Stuttgart.

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