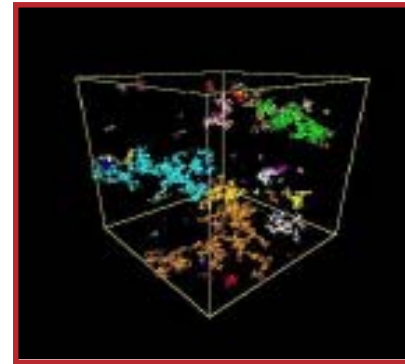


## ASSTG Members Present at SCCS Conference in Santa Fe, New Mexico

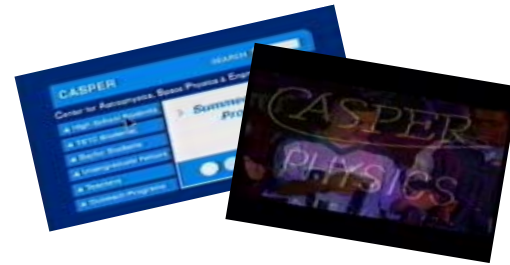
Six of CASPER's research members attended the Strongly Coupled Coulomb Systems Conference in Santa Fe, New Mexico during the first week of September, 2002. The SCCS Conference is regarded as one of the most significant meetings of theoretical, computational and experimental plasma physicists in the world and draws a large number of participants. Two poster presentations from CASPER members were accepted for display and will subsequently be included in the conference proceedings to be refereed and published in early 2003. Dr. Lorin Matthews, CASPER research scientist presented "Gravitoelectrodynamics in Saturn's F Rings: Encounters with Prometheus and Pandora" and Mr. Ke Qiao of the ASSTG group presented "Numerical Simulation and Analysis of Thermally Excited Waves in Plasma Crystals."



Box\_Tree program for studying plasma crystals

## CASPER Promotional Video and Brochure

The long-awaited CASPER video is now available in several formats for informational and recruiting purposes. CASPER contracted with KWBU to produce the digital promotional video with footage from all areas of CASPER endeavor. The video will be distributed to every high school within a six country area and highlights CASPER research, REU, RET, and High School scholars summer research programs as well as the immensely popular CASPER Physics Circus. Look for short versions of the video specific to the different areas to appear on our website soon. ([www.baylor.edu/CASPER](http://www.baylor.edu/CASPER))



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**Hypervelocity Impacts & Dusty Plasmas Lab**  
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(254) 867-DUST (fax)



## CASPER Adds Early Universe Cosmology and Strings Group (EUCOS)

CASPER has recently added a new research group to the Center, the Early Universe Cosmology & Strings Group, also known as EUCOS. The EUCOS group is directed by one of Baylor University's newest physics faculty members, Dr. Gerald Cleaver. Dr. Cleaver holds the Ph.D. in physics from Caltech and did his dissertation work in Kac-Moody Algebra and String Theory under John Schwarz. He has extensive teaching and post-doctoral experience over the last nine years and is a valuable addition to CASPER.

Also working in the EUCOS group is Baylor mathematics professor, Dr. Jeff Mitchell who holds the Ph.D. in mathematics from Cornell University. Dr. Mitchell's area of research is Lie theory and mathematical physics.

The CASPER EUCOS group has added a

postdoctoral research assistant, Mr. Tibra Ali, who is presently finishing his doctoral defense at Cambridge University in England. Mr. Ali is expected to be working with the EUCOS group in January of 2003 where he will subsequently begin working on embedding string models in M-theory.

The EUCOS group studies string theory and a more fundamental form called "M-theory." These theories attempt to explain the nature of spacetime and the particles seen in nature using fundamental building blocks called "strings" which are on the order of 10<sup>-33</sup> cm in diameter. String theory is one of the strongest candidates for a theory of quantum gravity, the unification of all the forces of nature, which is thought to govern the dynamics of the early universe.



Dr. Gerald Cleaver, Physics, Baylor University



Dr. Jeff Mitchell, Mathematics, Baylor University

## CASPER Director Appointed Vice Provost for Research, Baylor University

The director of CASPER, Dr. Truell Hyde, has been appointed to a new position, Vice Provost for Research at Baylor University. The position was created as part of Baylor University's "Ten-year Vision" for elevating the research status of the university. In his new position, Dr. Hyde will give leadership to the university's efforts to attract additional support for sponsored research, particularly scientific research. Since joining the Baylor faculty, he has taught and conducted extensive research in plasma physics, gravitoelectrodynamics, accretion shock, hypervelocity impacts, and lasers, among other topics. His research proposals have resulted in over \$25

million of funding awarded for space physics research programs.



Dr. Truell Hyde, Director of CASPER and Vice Provost for Research, Baylor University

### INSIDE THIS ISSUE:

- Research Updates
- Conferences and Presentations
- CASPER Summers 2002
- Personnel Updates
- Promotional Video and Brochure
- Physics Circus
- Grants & Publications



# CASPER Summers 2002

## CASPER and NSF Bring Undergraduates, Teachers and High School Students Under One Roof

CASPER had another successful (and very busy) summer of research and outreach. Summers at CASPER find faculty, staff, graduate students, undergraduate students, interns, high school students, and local teachers all working cooperatively on physics research and educational outreach activities. During the summer of 2002, at least 15 NSF fellows, funded through the NSF Research Experience for Undergraduates and NSF Research Experience for Teachers, joined the CASPER team. Additionally, several High School Scholars participated in laboratory research as well as attended technical classes in Laser Electro-Optics at TSTC.



CASPER NSF REU/RET Fellows - Summer 2002

## NSF REU/RET Participants, High School Scholars

### REU Participants

*Mr. Alexander Barrett*, Oklahoma Baptist University  
CASPER HIDPL/Dusty Crystals in GEC Reference Cell  
*Mr. Adam Bryant*, Vanderbilt University  
Physics/ Dr. Walter Wilcox/QCD  
*Mr. Michael Cone*, Truman State University  
CASPER ASSTG/F-ring Gravitoelectrodynamics  
*Ms. Robin Cox*, Texas State Technical College  
CASPER HIDPL/Laser Fan  
*Mr. Benjamin Dawson*, Middle Tennessee State  
CASPER HIDPL/LINAC  
*Ms. Heather Hanson*, University of West Florida  
CASPER EUCOS/String Theory  
*Mr. Michael Henry*, Baylor University  
CASPER HIDPL/CCD & GEC Reference Cell  
*Mr. Carl Morgan*, Hobart College/Columbia University  
CASPER ASSTG/Dusty Plasma Charging Models  
*Mr. David Robbins*, Penn State University  
CASPER EUCOS/String Theory  
*Mr. Scott Shields*, Cal Poly  
CASPER EUCOS/String Theory

### RET Participants

*Ms. Jeanne Allen-Beason*, Waco High School, Waco ISD  
*Mr. Mark Cross*, Waco Montessori School  
*Ms. Lillie Freeman*, Carver Academy, Waco ISD  
*Mr. Seth Johnson*, Waco Montessori School  
*Mr. Greg Jordan*, Shoemaker High School, Killeen ISD  
*Ms. ReNay Swarts*, Waco Montessori School  
*Mr. Greg Williams*, Texas Christian Academy, Waco

### High School Scholars

*Mr. Virendra Desai*, St. Thomas Episcopal School, Houston  
CASPER EUCOS  
*Mr. Nathan Skelly*, Joplin High School, Joplin, MO  
CASPER HIDPL/PZT detectors  
*Mr. Michael Taylor*  
CASPER HIDPL/PZT detectors

# CASPER Personnel Updates

## New Ph.D.s and Ph.D. Candidates

### May 2001 – Mr. Bernard Smith

Bernard Smith passed his Ph.D. qualifying exams in May of 2001 on his first attempt! As a result, he is now officially a Ph.D. candidate in physics. Congratulations, Bernie!



Bernard Smith

### December 2001 – Dr. John Vasut

John Vasut successfully defended his dissertation entitled “*Numerical Modeling of Strongly-Coupled Dusty Plasma Systems*” and graduated in December of 2001 with the Ph.D. in physics. Way to go, John!



Dr. John Vasut

### December 2002 – Dr. Ray Nazzario

Ray Nazzario defended his dissertation “*Numerical Simulations of Dust Particle Orbits Around Mars, Neptune, Ceres, Hale-Bopp and Within the Solar System*” in August of 2002. He graduated in December of 2002 with the Ph.D. in Physics. Congratulations, Ray!



Dr. Ray Nazzario

## CASPER Personnel Move to Permanently Funded Positions

**Dr. Laura Barge** and **Mr. Mike Cook** have officially moved into permanently funded positions within CASPER. Dr. Barge has the new title of Assistant Research Professor at Baylor, while Mr. Cook is now a Senior Research Technician with CASPER. **Mr. Jimmy Schmoke** was hired by CASPER as an Electronics Technician and will be working primarily in the HIDPL. Congratulations to all of you.



Jimmy Schmoke, Electronics Technician, CASPER



Dr. Laura Barge, Assistant Research Professor, Baylor University



Mike Cook, Senior Research Technician, CASPER

## CASPER Interns

Several of our interns graduated over the past year or so and have accepted or are seeking positions in industry throughout the country. Grayson Cooke is working with Raytheon in southern California, Teddy Border has been hired by Lawrence Livermore Laboratories, and Donald Huston is in the process of interviewing for positions. We also want to welcome our newest CASPER interns, Robin Cox, Mike Davis, Dan Dunham, and Vielka Santiago who are working in the HIDPL and Kim Orr who is working with the Physics Circus. Welcome to CASPER!

**Congratulations** to Mr. Michael Henry for being awarded a NASA Texas Space Grant Consortium Undergraduate Fellowship for 2002–2003.

## In Memory Of . . .

CASPER mourns the loss of William (Drew) Herren, former CASPER intern and TSTC LET student. Both Drew and his wife, Mindy, were killed over the Christmas 2001 break as a result of an auto collision. Our deepest sympathy and prayers go their family and friends during this difficult time.

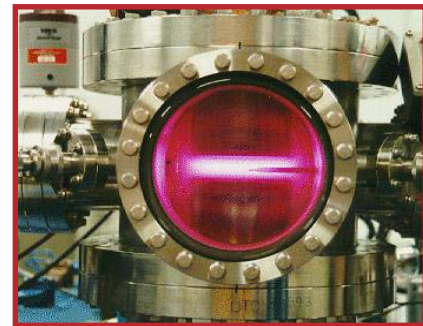


# CASPER Research Updates

## Coulomb Crystals Detected at Hypervelocity Impacts and Dusty Plasmas Laboratory

Experimental researchers at CASPER's HIDPL (Hypervelocity Impacts and Dusty Plasmas Laboratory) have reached an important milestone in their efforts to study dusty plasmas: the first coulomb crystal has been seen in the GEC Reference cell.

When asked the significance of seeing coulomb crystals, Dr. Lorin Matthews, Senior Research Scientist and Experimental Group manager says, "Seeing crystals in the lab means that we can now get down to work! We were especially happy to see that the first thing we had theorized should occur (particles with a size distribution forming behaving as a liquid), did occur." And as Ph.D. student Bernie Smith says, "It's gratifying to know that we haven't been spinning our wheels for the last two years for naught."



GEC Reference Cell to study Coulomb Crystals at the HIDPL

## Recent CASPER Publications

- "Coagulation in Dust Clouds Immersed in Transient Plasma Environments," L. Barge and T.W. Hyde, submitted to *Advances in Space Research*.
- "Digital Imaging and Analysis of Dusty Plasmas," C.M. Boesse, M.K. Henry, T.W. Hyde, and L.S. Matthews, submitted to *Advances in Space Research*.
- "Parameter Space Investigations of Free Fermionic Heterotic Models," G. Cleaver, accepted for publication in *Proceedings of String Phenomenology 2002*.
- "String Cosmology: A Review," G. Cleaver, submitted to *Advances in Space Research*.
- "Flat Directions in Left-Right Symmetric String Derived Models," G. Cleaver, D. Clements, and A. E. Faraggi, *Physical Review D*, 65 (2002).
- "On The Possibility of Optical Unification in HAHE-Based Free Fermionic Heterotic Models," G. Cleaver, V. Desai, H. Hanson, J. Perkins, D. Robbins, and S. Shields, accepted for publication in *Phys. Rev. D*.
- "Phenomenology of Non-Abelian Flat Directions in a Minimal Superstring Standard Model," G. Cleaver, A. E. Faraggi, D. V. Nanopoulos, and J. W. Walker, *Nuclear Physics B*, 620 (2002).
- "Ratio of Quark Masses in Duality Theories," G. Cleaver, and K. Tanaka, submitted to *Modern Physics Letters*.
- "Effects of Protoplanetary Perturbations of Systems of Planetismals," B.D. Lindsay, K.W. Orr, T.W. Hyde, and L. Barge, submitted to *Advances in Space Research*.
- "Effects of Planetesimal Perturbations on the Motion of Protoplanets," B.D. Lindsay, T.W. Hyde, and L. Barge, submitted to *Advances in Space Research*.
- "Charged Grains in Saturn's F-Ring: Interaction With Saturn's Magnetic Field," L.S. Matthews and T.W. Hyde, submitted to *Advances in Space Research*.
- "Gravitoelectrodynamics in Saturn's F-Rings: Encounters with Prometheus and Pandora," L. Matthews and T.W. Hyde, accepted for publication in *Journal of Physics A*.
- "Asymptotic Expansions of Hermite Functions on Lie Groups," J. Mitchell, *Potential Analysis*, 17 (2002).
- "Asymptotic Behavior in Heat Kernel Analysis on Manifolds," J. Mitchell, accepted for publication in *Contemporary Mathematics*.
- "Coherent States on Spheres," J. Mitchell and B. Hall, *Journal of Mathematical Physics*, 43 (2002).
- "The Large Radius Limit for Coherent States on Spheres," J. Mitchell and B. Hall, *Mathematical Results in Quantum Mechanics*, 155-162, CMS Conf. Proc., 307, Amer. Math. Soc., Providence, RI, 2002.
- "Dust Grain Orbital Behavior Around Ceres," R. Nazzario, T.W. Hyde, and L. Barge, submitted to *Advances in Space Research*.
- "Numerical Simulation and Analysis of Thermally Excited Waves in Plasma Crystals," K. Qiao and T.W. Hyde, accepted for publication in *Journal of Physics A*.
- "Numerical Simulation and Analysis of Thermally Excited Waves in Plasma Crystals," K. Qiao and T.W. Hyde, submitted to *Advances in Space Research*.
- "Dusty Plasma Correlation Function Experiment," B. Smith, J. Vasut, T.W. Hyde, L. Matthews, J. Reay, M. Cook, and J. Schmoke, submitted to *Advances in Space Research*.
- "Finite Coulomb Crystal Formation," J. Vasut, T.W. Hyde, and L. Barge, submitted to *Advances in Space Research*.

## RECENT CASPER Proposals & Awards

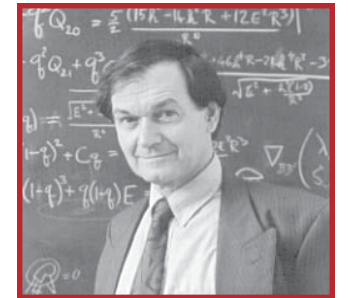
- Quantum Optics Initiative**  
Principal Investigator Proposal Investigation, Technical, Cost and Management Plan Submitted in Response to a Request from the Office of Naval Research (November, 2002) • **FUNDED**
- Waco Community Network TIF Proposal**  
TIF Proposal Investigation, Technical, Cost and Management Plan Submitted in Response to a Request from the State of Texas (June, 2002) • **FUNDED**
- CASPER VAL / P.Circus Proposal**  
Principal Investigator Proposal Investigation, Technical, Cost and Management Plan Submitted in Response to a Request from the Sid Richardson Foundation (August, 2002)
- Baylor HPNC Proposal**  
Principal Investigator Proposal Investigation, Technical, Cost and Management Plan Submitted in Response to a NSF ANI - Network Infrastructure Program Announcement (May, 2002) • **FUNDED**
- CASPER MSP Proposal**  
Principal Investigator Proposal Investigation, Technical, Cost and Management Plan Submitted in Response to a NSF MSP Program Announcement (April, 2002)
- Sun Marching Grant Program**  
Matching equipment grant proposal to Sun Microsystems - April, 2002 • **FUNDED**
- Evergreen Mechanical Systems**  
Principal Investigator Proposal Investigation, Technical, Cost and Management Plan Submitted in Response to a DOE Request (March, 2002)
- Dirac Centenary Conference**  
Principal Investigator Proposal Investigation, Technical, Cost and Management Plan Submitted in Response to a NSF01-159 Program Announcement (February 1, 2002) • **FUNDED**
- TSTC Technologies Institute: A Closing the Gap College Mentor Program**  
Co-Principal Investigator Proposal Investigation, Technical, Cost and Management Plan Submitted in Response to a THECB Perkins NOI for 2001-2002 (November, 2001)
- Parameter Space Investigations of Heterotic Strings**  
Principal Investigator Proposal Investigation, Technical, Cost and Management Plan Submitted in Response to a NSF ANI - Submissions for the Division of Physics Announcement 02-139(25 September, 2002)
- Parameter Space Investigations of Heterotic Strings**  
Principal Investigator Proposal Investigation, Technical, Cost and Management Plan Submitted in Response to a DOE High Energy Physics Outstanding Junior Investigator Award Announcement 02-26(01 November, 2002)

# CASPER Conferences & Presentations

## Penrose Delivers Campus Lecture on Quantum Mechanics

Sir Roger Penrose delivered a campus lecture on "Why We Need an Improved Quantum Mechanics" on Sept. 30 in the Cashion fifth floor conference room. Roger Penrose is the Emeritus Rouse Ball Professor of Mathematics at the University of Oxford and Francis and Helen Pentz Distinguished Professor of Physics and Mathematics, Penn State University, USA. He has received a number of prizes and awards including the 1988 Wolf Prize (which he shared with Stephen Hawking for their understanding of the universe), the

Royal Society Royal Medal, the Dirac Medal, and the Albert Einstein prize. His 1989 book *The Emperor's New Mind* became a best-seller and won the 1990 (now Rhone-Poulenc) Science Book Prize. He has research interests in many aspects of geometry and has made significant contributions to the theory of non-periodic tilings, to general relativity theory, and to the foundations of quantum theory. The lecture, free and open to the public, was sponsored by CASPER, the departments of physics, mathematics, engineering and computer science, neuroscience and philosophy, and the Vice Provost for Research.



Dr. Roger Penrose was knighted for his outstanding contributions to mathematics.

## Margaret (Peggy) Shea Gives Lecture on Space Weather and Archeology

Peggy Shea recently presented a joint CASPER/Physics Seminar on her research in cosmic radiation and solar terrestrial phenomena.

Peggy Shea was awarded the Waldo E. Smith Medal at the AGU Fall Meeting Honors Ceremony, which was held on December 8, 1998, in San Francisco, California. The medal recognizes extraordinary service to geophysics.

Peggy not only has had a remarkable personal research career, but she has also expended an enormous amount of energy facilitating the research of oth-

ers, especially within the international community. Not only is she a prodigious publisher, authoring or coauthoring over 300 papers, but she is also a prodigious editor, editing more reports, proceedings, and journals than AGU would grant me room to mention. Moreover, even though she has spent most of her career doing basic research for the U. S. Air Force, she was so highly regarded in the Soviet Union that she was a recipient of their Academy of Sciences' Commemorative medal honoring 100 Years of International Geophysics.



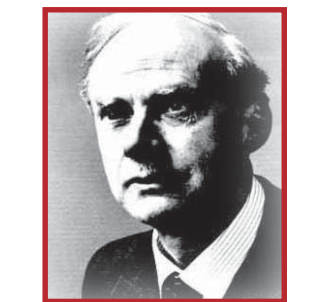
Dr. Peggy Shea was awarded the Waldo E. Smith Medal

## Dirac Conference Held in October 2002

Baylor University held the Dirac Conference from September 30 through October 2, sponsored by the Vice Provost for Research, the National Science Foundation, CASPER, the Baylor University Department of Physics and others. The Dirac Conference held in honor of the centenary of the birth of 1933 Nobel Prize Winner Paul Dirac was an interdisciplinary evaluation of Dirac's contributions to the methodology and progress of twentieth century physics. In addition to considering Dirac's impact on present

research at the frontiers of theoretical physics, Dirac's approach to problem-solving and theory construction was also studied.

Scheduled speakers included Sir Roger Penrose of Oxford University, John Polkinghorne of Cambridge University, Gordon Kane of the University of Michigan and Laurie Brown of Northwestern University. Thank you to all the CASPER faculty and students who helped make the Dirac Conference a huge success.



Dr. Paul Dirac, 1933 Nobel Prize Winner

## COSPAR 2002/LPSC XXXIII/Advances in Space Research

**COSPAR 2002** - Members from the ASSTG, HIDPL, and EUCOS research groups had 11 oral and poster presentations accepted at the bi-annual international space conference in Houston in October 2002. The presentations from the ASSTG, EUCOS and HIDPL groups, covered research areas from string theory to dusty plasmas and gravitoelectrodynamics. All submissions will be published in the reference journal *Advances in Space Research*.

**LPSC XXXIII** - Two research papers from the ASSTG group were accepted for presentation at the Lunar and Planetary Science Conference held in Houston in March of 2002.

Truell Hyde, Ray Nazzario, and Bruce Lindsay presented their results at this annual international meeting of scientists.

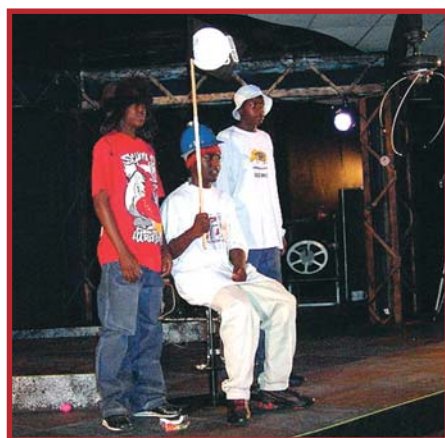
**Advances in Space Research Publications** - Seven papers from the ASSTG group were recently published in the peer-reviewed journal *Advances in Space Research*. The papers cover the CASPER research areas of dusty plasma charging processes, coagulation in dusty plasmas, formation of coulomb crystals and dust particle orbits around planets and protoplanetary migration. The impact rating for *Advances in Space Research* is now second out of all journals in aerospace science.



# “Mysteries of the Universe” Draws a Galactic Crowd

## Science Theater

CASPER presented the latest version of the Physics Circus during April and May of 2002. “Mysteries of the Universe,” under the direction of Dr. Laura Barge and the technical design of Mr. Mike Cook, provided participating students and teachers with a journey they could never forget. Participating students learned about black holes, galaxies and the four forces of nature as they traveled through wormholes (virtual ones, that is) in the Science Theater. They also discovered how cold the universe really is with liquid nitrogen demonstrations and learned how to map the heat of their bodies using a thermographic camera. Mr. Tim Poertner of MCC designed the stage and lighting for the Science Theater, and Mr. Willie Hudson of TSTC did the multimedia production. Both of these talented people created the “other-worldly” setting which makes the Science Theater a production like none other. One of the highlights of the Science Theater is our high-tech laser light show, designed by CASPER’s own Mr. Jerry Reay. Good work from the entire CASPER team!



Cohort students from WISD are able to directly interact with physics demonstrations on stage in the Science Theater.



Area student experiences changes in center-of-gravity with balancing hangers.

## Physics Fun House

The purpose of the Physics Fun House is to engage students in hands-on science in a non-threatening environment with equipment built by CASPER’s own technicians and interns. The students are free to explore a sensorial experience with the sights, sounds and motion of basic physics principles presented in an engaging, inviting atmosphere. Baylor physics students and TSTC interns are present



A collapsible sphere is expanded to many times its size to model the expanding universe.

## Egg Bungee Contest

“The CASPER Physics Circus would not be complete without some sort of egg contest. Our students have come to expect it and ask what we are doing with eggs this year when they walk in the door” quips Dr. Laura Barge. So true to form, Physics Circus 2002 had an egg contest. The Egg Bungee Contest.

Student groups were given a pair of pantyhose and an egg. They had to construct a device to safely deliver the raw egg connected by pantyhose “bungee strips” from a fall between 5 and 10 feet. The only trick to the contest was they could not test the bungee cords with the actual egg. They had to use an equivalent weight of marbles during testing. If the egg bungee stretched to within one inch of the floor without hitting, the team was declared a winner. We had an “egg-ceptional” performance by many participating teams!

to engage students using various demonstrations along with answering questions.

Students participating in CASPER’s “Mysteries of the Universe” Physics Circus were able to tour a completely new Physics Fun House interactive exhibit hall where they learned “first-hand” about the four forces of nature, played with black holes and watched a nine-foot model of the expansion of the universe.



Stretching a rubber sheet demonstrated the warping of spacetime around massive stars.



First, see how much your bungee cord stretches.

Second, try the experiment with the equivalent weight of marbles (so the egg is not ruined during trial falls).

Lastly, try it with the egg and hope it doesn’t break!

## Physics Fix-Its

Participating students had the opportunity to visit various technologies at TSTC and perform hands-on activities. Student groups lined up to practice soldering in Biomedical Equipment Technology, made “liquid nitrogen ice cream” in Chemical Technology and tried their hands at airbrushing in Auto Collision and Maintenance Technology, to name a few. This was an excellent opportunity for students to see technical careers close up!



Students make ice cream using liquid nitrogen in the Chemical Technology activity.



WISD students try their hand behind the controls of a real airplane on the TSTC runway.



This group was able to program the movements of a robotic arm in Electrical Computerized Control Systems and Robotics.