

THE UNIVERSITY OF TEXAS AT DALLAS
WILLIAM B. HANSON CENTER FOR SPACE SCIENCES
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EARLE, GREGORY D.

Professor of Physics, Affiliated Professor of Electrical Engineering
Chairman of Graduate Physics Education

EDUCATION

B.S.E.E. Electrical Engineering (honors program), Purdue University, 1981
M.S.E. Electrical Engineering, Purdue University, 1983
Ph.D. Space Plasma Physics/Electrical Engineering, Cornell University, 1988

RESEARCH INTERESTS

Ionospheric and magnetospheric plasma composition and dynamics.
Spacecraft instrumentation for ionospheric plasma and neutral gas measurements.
Field emission devices, neural networks, and their applications in space science.

EXPERIENCE

2006- The University of Texas at Dallas, Professor, Physics
2005 - The University of Texas at Dallas, Affiliated Professor of Electrical Engineering
2001-2005 The University of Texas at Dallas, Associate Professor, Physics
1996-2001 The University of Texas at Dallas, Assistant Professor, Physics
1988-1996 Science Applications International Corporation, McLean, Virginia
Research Scientist, Laboratory for Atmospheric and Space Sciences
1983-1988 Cornell University, Research Assistant, Electrical Engineering Department
1981-1983 Purdue University, Teaching Assistant, Electrical Engineering Department

SPECIAL ACTIVITIES

National Merit Scholar, 1978
NASA Graduate Research Fellowship, 1985-1988
Physics and Engineering Collegiate Honorary Societies
NASA Management Operations Working Group, 1992-1995, 2000-2003
NASA Sounding Rocket Working Group, 1997-2000
NASA Foundations Roadmap Team, 2004-2005
Featured in Who's Who in Science Higher Education, 2004.

SOCIETIES

Institute of Electrical and Electronics Engineers
American Institute of Physics
American Geophysical Union

PUBLICATIONS

1. Spectral studies of the sources of ionospheric electric fields, G. D. Earle and M. C. Kelley, *J. Geophys. Res.*, 92, 213-224, 1987
2. Upper hybrid and langmuir turbulence in the auroral *E*-region, M. C. Kelley and G. D. Earle, *J. Geophys. Res.*, 93, 1993-1996, 1988
3. Rocket observations of current driven electrostatic ion cyclotron waves in the auroral *F*-region, G. D. Earle and M. C. Kelley, *Proceedings of the International Workshop on the Current Driven Electrostatic Ion Cyclotron Instability*, (Innsbruck, Austria, 1987), ed. R. W. Schrittwieser, pp 95-100, World Scientific, Teaneak, NJ, 1988
4. Electrostatic plasma waves and turbulence near auroral arcs, Doctoral Thesis, Cornell University, 1988
5. Ionization from soft electron precipitation in the auroral *F* region, J. LaBelle, R. J. Sica, C. Kletzing, G. D. Earle, M. C. Kelley, D. Lummerzheim, R. B. Torbert, K. D. Baker, and G. Berg, *J. Geophys. Res.*, 94, 3791-3798, 1989
6. Electron-temperature determination in space plasmas with sounding-rocket electric field booms, G. D. Earle, *Rev. Sci. Instrum.*, 60, 3076-3077, 1989
7. Large velocity shears and associated electrostatic waves and turbulence in the auroral *F* region, G. D. Earle, M. C. Kelley, and G. Ganguli, *J. Geophys. Res.*, 94, 15,321-15,333, 1989
8. Distinguishing Alfvén waves from quasi-static field structures associated with discrete aurora: Sounding rocket and HILAT satellite measurements, D. J. Knudsen, M. C. Kelley, G. D. Earle, J. F. Vickrey, and M. Boehm, *Geophys. Res. Lett.*, 17, 921, 1990
9. Observations of VHF emissions from 50-mA electron beam injections in the ionosphere that are associated with beam induced discharges, R. T. Goerke, P. J. Kellogg, S. J. Monson, R. C. Franz, R. J. Nemzek, H. R. Anderson, D. W. Potter, W. F. Denig, E. P. Szuszczewicz, and G. D. Earle, *J. Geophys. Res.*, 97, 1319-1335, 1992
10. Spectral evidence for stirring scales and two-dimensional turbulence in the auroral ionosphere, G. D. Earle and M. C. Kelley, *J. Geophys. Res.*, 98, 11,543-11,548, 1993
11. Advanced performance prediction for HF radio and radar systems, E. P. Szuszczewicz and G. D. Earle, *MILCOM-94 Proceedings*, October, 1994
12. Advanced Modeling of HF Radio Propagation, G. D. Earle and R. I. Desourdis, Jr., *IEEE Military Communications (MILCON) Proceedings*, doi: 10.1109/MILCOM.1994.473985, 1994.
13. Neural-network based development of space and laboratory plasma diagnostic instruments, P. Satyanarayana and G. D. Earle, *Computation and Neural Systems*, December, 1994
14. A neural network-based instrument for determining plasma characteristics near orbiting spacecraft,” G. D. Earle, *Intelligent Engineering Systems through Artificial Neural Networks*, ed. C. H. Dagli, pp 821, ASME Press, NY, 1995
15. An in-situ investigation of early-time multi-ion expansion processes in the *F*-region ionosphere, E. P. Szuszczewicz, G. D. Earle, T. Bateman, Z. Klos, A. Kiraga, and R. Schunk, *J. Geophys. Res.*, 101, 15719, 1996

16. Advanced high-frequency radio communication, Chapter 2, ed. R. Desourdis, Artech House Publishing, Norwood, MA, 1996
17. A comparative study of *in-situ* and remote intermediate layer measurements against wind model predictions of vertical ion drift, G. D. Earle, R. L. Bishop, Q. Zhou, and S. P. Wallace, *J. Atmos. Terr. Phys.*, *60*, 1313, 1998
18. Ion layer separation and equilibrium zonal winds in midlatitude sporadic-E, G. D. Earle, T. J. Kane, R. F. Pfaff, and S. R. Bounds, *Geophys. Res. Lett.*, *27*, 461, 2000
19. Observations of an Intermediate Layer During the El Coqui Dos Campaign, R.L. Bishop, G.D. Earle, *et al*, *J. Geophys. Res.*, *105*, 24,963, 2000.
20. Descending layer variability over Arecibo, G. D. Earle, R. L. Bishop, and S. A. Collins, S. A. Gonzáles, and M. P. Sulzer, *J. Geophys. Res.*, *105*, 24951, 2000.
21. Inferred Vertical Ion Drifts Associated with Intermediate Layers, R.L. Bishop, G.D. Earle, *et al.*, *J. Atmos. Solar Terr. Phys.*, *64*, 1471-1477, 2002.
22. Metallic Ion Transport Associated with Midlatitude Intermediate Layers, R.L. Bishop and G.D. Earle, *J. Geophys. Res.*, *108*, 1019, D01 10.129/2002JA09411, 2003.
23. A Novel Empirical Study of the Photoelectric Effect in Thin Gold Films. G.D. Earle, B.L. Copp, J.H Klenzing, and R. L. Bishop, *Am. J. Phys.*, *71*, 766, 2003.
24. Ongoing Miniaturization Efforts for Ion and Neutral Vector Velocity Instruments, G. D. Earle, Paper No. SSC03-X-2, *AIAA Conf. proceedings on Small Satellites*, Aug. 2003.
25. Relative concentrations of molecular and metallic ions in midlatitude intermediate and sporadic E layers, P. A. Roddy, G. D. Earle, C. M. Swenson, C. G. Carlson, and T. W. Bullett, *Geophys. Res. Lett.*, *31*, L19807, doi:10.1029/2004GL020604, October 2004.
26. Sequential observations of the local neutral wind field structure associated with E-region plasma layers, R. L. Bishop, G. D. Earle, M. F. Larsen, C. M. Swenson, C. G. Carlson, P. A. Roddy, C. Fish, and T. W. Bullett, *J. Geophys. Res.*, *110*, AO4309, doi: 10.1029/2004JA010686, April, 2005.
27. Electron confinement on magnetic field lines, M. Goeckner, G. D. Earle, L. Overzet, and J. Maynard, *IEEE Trans. On Plasma Science*, *33*, p. 436, doi 10.1109/TPS.2005.844960, April, 2005.
28. Tungsten-rhenium filament lifetime variability in low pressure oxygen environments, G. D. Earle, R. Medikonduri, N. Rajagopal, V. Narayanan, and P. A. Roddy, *IEEE Trans. On Plasma Science*, *33*, 1736, doi 10.1109/TPS.2005.856413, 2005.
29. A global study of nighttime midlatitude topside spread echoes, G. D. Earle, A. M. Musumba, and J. P. McClure, *J. Geophys. Res.* *111*, A11306, doi: 10.1029/2006JA011614, 2006.
30. Arecibo observations of ionospheric perturbations associated with the passage of tropical storm Odette, R. L. Bishop, N. Aponte, G. D. Earle, M. Sulzer, M. F. Larsen, and G. Peng, *J. Geophys. Res.* *111*, A11320, doi: 10.1029/2006JA011668, 2006.
31. The composition and horizontal homogeneity of E-region plasma layers, P. A. Roddy, G. D. Earle, C. M. Swenson, C. G. Carlson, and T. W. Bullett, *J. Geophys. Res.*, *112*, doi:10.1029/2006JA011713, 2007.

32. A new satellite-borne neutral wind instrument for thermospheric diagnostics, G. D. Earle, J. H. Klenzing, P. A. Roddy, W. A. Macaulay, M. D. Perdue, and E. L. Patrick, *Rev. Sci. Instrum.*, 78, 114501, 2007.
33. Satellite-based measurements of gravity wave-induced midlatitude plasma density perturbations, G. D. Earle, A. M. Musumba, and Sharon L. Vadas, *J. Geophys. Res.*, 113, doi: 10.1029/2007JA012766, 2008.
34. Errors in ram velocity and temperature measurements inferred from satellite-borne retarding potential analyzers, J. H. Klenzing, G. D. Earle, and R. A. Heelis, *Physics of Plasmas*, 15, June, 2008.
35. A statistical study of midlatitude spread F at Wallops Island, Virginia, P. Bhaneja, G. D. Earle, R. L. Bishop, T. W. Bullett, R. Redmon, and J. Mabie, accepted for publication in *J. Geophys. Res.*, 113, 2008.

Note: From 1991-1995 Dr. Earle worked primarily on DoD classified research projects that could not be published in the open literature.

RECENT INVITED TALKS

- Campaign Mode Science – What You Don't Learn in Graduate School, *NSF CEDAR Conference*, Longmont, Colorado, June, 2002.
- Miniaturized Science Instrumentation for Future Small Satellite Missions, *AIAA Conference on Small Satellites*, Logan, Utah, July, 2004.
- Space Science at UTD, *40th Anniversary McDermott Library Lecture*, 2004.
- Instrumentation for Neutral Wind Measurements in Near-Earth Space, *Baylor University Physics Colloquium*, March, 2004.
- Seasonal and Longitudinal Dependences of Midlatitude Topside Spread-F Echoes, *NSF conference on Coupling, Energetics, and Dynamics of Atmospheric Regions (CEDAR)*, Santa Fe, New Mexico, June, 2006.
- New Technologies for Satellite-Borne Space Science Instrumentation, *Baylor University*, March, 2008.
- The New C/NOFS Neutral Wind Instruments: Laboratory and Flight Validation, *International Symposium on Equatorial Aeronomy*, Crete, Greece, May, 2008.

RECENT CONTRIBUTED CONFERENCE TALKS AND POSTER PRESENTATIONS

Dr. Earle and his students and collaborators regularly contribute oral and poster presentations to the National Science Foundation's CEDAR Conference, and to the semi-annual American Geophysical Union (AGU) conference. Some recent presentations are listed below as examples:

1. Spatial and Temporal Variability of Nighttime Midlatitude Intermediate Layers, P. A. Roddy, G. D. Earle, M. F. Larsen, R. L. Bishop, C. M. Swenson, C. Carlson, and T. W. Bullett, *NSF CEDAR Conference*, Santa Fe, NM, June, 2005.

2. Laboratory Validation of the Ram Wind Sensor for the CINDI Mission of Opportunity, J. H. Klenzing, G. D. Earle, P. Mahaffy, E. Patrick, and R. A. Heelis, AGU Meeting, New Orleans, LA, May, 2005.
3. Seasonal and Longitudinal Dependences of Midlatitude Topside Spread-F Echoes, NSF conference on Coupling, Energetics, and Dynamics of Atmospheric Regions (CEDAR), Santa Fe, New Mexico, June, 2006.
4. Seasonal and longitudinal statistics on mid-latitude topside spread echoes observed by the ISS-B satellite, American Geophysical Union meeting, Baltimore, MD, May 2006.
5. Multi-platform investigation of midlatitude spread F over Wallops Island, American Geophysical Union Spring Meeting, Acapulco, Mexico, May, 2007.
6. Modeling plasma interactions with space-borne instrumentation, NSF CEDAR conference, Santa Fe, NM, June 2007.
7. A statistical ionosonde study of midlatitude spread F, NSF CEDAR conference, Santa Fe, NM, June 2007.
8. Modeling plasma interactions with biased grids in space-borne instrumentation, APS Plasma Physics Conference, Orlando, FL, July, 2007.
9. Modeling photon interactions with light-sensitive instrumentation, SPIE International Symposium on Remote and In-situ Sensing, Florence, Italy, September, 2007.
10. Rocket and ionosonde studies of midlatitude Spread F, NSF CEDAR conference, Midway, Utah, June 2008.
11. In-situ evidence of nighttime plasma density perturbations produced by gravity waves, International Symposium on Equatorial Aeronomy, Crete, Greece, May, 2008.
12. Errors in the inference of plasma parameters from retarding potential analyzer measurements in space, International Symposium on Equatorial Aeronomy, Crete, Greece, May, 2008.

FUNDING HISTORY (AT UT DALLAS)

Principal Investigator Funding:

- Completion of Sounding Rocket 21.114, NASA, 5/14/96, 3 years, \$203 K
- Development and Testing of a MEMS-based Neutral Wind Meter, SAIC, 7/15/96, 2 years, \$52 K
- Predicting Spread F via Neural Network Analysis of DMSP Data, NSF, 6/1/99, 3 years, \$149 K
- Development and Demonstration of a Robust MEM Pressure Transducer, NASA, 5/1/97, 3 years, \$204 K
- Electronics Package, SAIC, 4/6/98, 1 year, \$6 K
- Summer support for undergraduate through NSF REU program, summer 1999, \$4 K
- A Sequential Rocket Investigation of Winds and Plasma Layers in the Nighttime E Region, NASA, 2/22/00, 3 years, \$788 K
- Development of a Ram Wind Sensor for Planetary Thermospheric Studies, NASA, 2/1/01, 4 years, \$998 K
- Investigation of Mid-Latitude Spread F Associated with Terrestrial Weather Systems, NASA, 2/28/05, 3 years, \$1.4 M
- Optimization of a Ram Wind Sensor for Planetary Thermospheric Studies, NASA GSRP, 9/1/05, 3 years, \$72 K

- Development of a Sensor to Measure the Ram Component of the Neutral Wind from an Orbital Platform, NASA, 3/1/06, 4 years, \$521 K
- CEDAR: Atmosphere/Ionosphere Coupling in the Creation of Topside Spread Echoes, NSF, 10/1/05, 3 years, \$212 K.
- Electromagnetic Propulsion Study, BAE Systems, 3/1/07-8/31/08, \$25 K.

Co-Investigator Funding:

- Ion Mass Spectrometer for Sporadic E Studies, NASA, 7/3/96, 3 years, \$218 K
- Sensor Development for in-situ Thermospheric Neutral Wind Measurements, USAF, 5/17/00, 3 years, \$1.9 M
- Development of a Plasma Teaching Laboratory, NSF, 10/1/00, 3 years, \$840 K
- Coupled Ion Neutral Dynamics Investigation, NASA, 12/1/00, 7 years, \$9.5 M
- Ion Drift and Electric Field Investigation for the Neutral-Ion Coupling Explorer (NICE), Phase A Study, NASA, 8/1/08, 1 year, \$15K

Pending Proposals:

- CubeSat Transition-height EXperiment and Atmospheric Surveyor (CubeSat TEXAS), submitted to NSF in May 2008, 3 years, \$439K (principal investigator).
- CEDAR: Seasonal and Gravity Wave Influences on Midlatitude Spread F, submitted to NSF in May 2008, 3 years, \$228K (principal investigator).
- Ion Drift and Electric Field Investigation for the Neutral-Ion Coupling Explorer (NICE), NASA, 7 years, \$17.5M (co-investigator).
- Global Ion-Neutral Coupling Study, AFOSR, 3 years, \$292K (principal investigator).

SERVICE ACTIVITIES AT UT DALLAS

Departmental Service

- Graduate and undergraduate level curriculum development committees (1996-present). These committees have restructured, renamed, and reorganized our teaching activities to address inconsistencies, incorporate the suggestions of student groups, and better prepare our students for the GRE exam.
- Co-chair of the graduate curriculum committee, 2004-2008.
- Physics Department Graduate Admissions Committee, 2006-present.
- Initiated the Applied Masters Program in the Physics department. This new degree program currently has about 10 students enrolled, and approximately 20 have graduated since the program's inception.
- Academic advisor to all students in the MSAP program (2004-present). This involves advising active students on elective and core courses, suggesting changes to the website, updating the curriculum matrix that students use as a program guide, and answering questions from potential students who are seeking information prior to applying for the MSAP degree. Maintain contacts with local industries to establish internships (Texas Instruments, Dallas Semiconductor, Signal Logic, Cisco Systems, Zyvex).
- Chair of the search committee (#2060) in 2003 that resulted in offers being tendered to two new physics faculty candidates: Dr. Phillip Anderson from the Aerospace Corporation, and Dr. George Hajj from the NASA's Jet Propulsion Laboratory. Dr. Anderson has since been hired as an associate professor. Negotiations between the

NS&M Dean and Dr. Hajj broke down due to salary issues.

- Search committee to fill an advertised position for a theoretical physicist in 2004/2005 (search chaired by W. Rindler). This search resulted in one new-hire at the assistant professor level.
- SPS faculty advisor (1998-2000).

Broader University Service

- Two terms on the Academic Senate (second term in progress)
- One year of service on the Distance Learning Committee, 1998.
- One year of service on Provost Wildenthal's Academic Infrastructure Committee. Responsible for redesigning, purchasing, and developing work orders for installation of a new projector, lecturn consoles, lighting system, and "movie" screen for the the Kusch Auditorium, 2000.
- Committee on Educational Policy, 2006-2007.
- Athletic Advisory Board, 2005-2007.
- Search committee to hire a new women's basketball coach, 2006.
- UTD Clean Room Committee within the EE department, 2002-2004.
- Tenure/promotion review committees for Professors Jin Liu, Murat Torlak, Mustapha Ishak-Boushaki, Phillip Anderson, and Inga Musselman.
- Outside chair for Ph. D. dissertation defenses for 6 students in ECE and in Geosciences.
- Graduated 3 Ph. D. students, currently supporting 3 others, supervising 5 dissertations.
- Served on Ph. D. and M.S. committees for over 25 students, not including those I supported.
- SACS accreditation committee, 2005-2007.

SUPPORTED/MENTORED STUDENTS

*Dr. Earle has served on over 25 M. S. and Ph. D. committees during his tenure at UT Dallas; these are **not** listed here. In addition, he has provided financial support and/or mentoring for a substantial number of graduate and undergraduate students, as summarized below:*

Rebecca Bishop - supported as an RA for 4 years while obtaining her Ph. D. under Dr. Earle. Rebecca graduated in 2001 and is currently employed at the Aerospace Corporation.

Patrick Roddy - supported as an RA for 3 years while working toward his Ph. D. under Dr. Earle. Patrick graduated with his Ph. D. in 2005, and was then supported for two years as a post-doc under Dr. Earle. He is now a full time employee of the Air Force Research Laboratory at Hanscom AFB.

Anthony Musumba – supported for 5 years while working on his Ph. D. under Dr. Earle. Tony graduated in 2008 and is currently working at Bismarck State College in North Dakota.

Jeffrey Klenzing - Currently supported as an RA while working toward his Ph. D. in Space Sciences under Dr. Earle. Jeff will graduate in December of 2008.

Preeti Bhaneja - Currently working toward her Ph. D. under Dr. Earle, supported as an RA on a grant from the NSF.

Russell Stoneback - self supported student working toward his Ph. D. under the joint tutelage of Drs. Earle and Heelis.

Robert Haaser - Ph. D. student under Dr. Earle, working on neutral wind data analysis from the CINDI mission of opportunity.

Ryan Davidson - Ph. D. student under Dr. Earle, working on optimization of the ram wind sensor instrument for future satellite missions.

Mike Adams - undergraduate working under Dr. Earle as an assistant to Ryan Davidson.

Caleb Dean, Clark Summer scholar working under Dr. Earle on design and construction of a railgun system.

Suzy Stillman – Undergraduate student learning Matlab for application to space science data analysis.

Brandyn Lee – Clark Summer scholar working on the railgun system with Caleb Dean.

Charles Mire – Applied MS student in physics who graduated in 2006. Currently enrolled in the Ph. D. program at the University of Wollengong, Australia.

James Gaughan - mentored on a senior research project to improve teaching methodology and audio-visual aids in Phys 3325, fall 2006.

Tanya Phillips - mentored on a summer research project during her senior year at UT Dallas in 2006. A poster on this work was presented at the annual NSF CEDAR meeting, where it received special honors as the outstanding undergraduate poster at the conference. She is now a graduate student in atmospheric sciences at the University of Colorado.

Narasimhan (Sameer) Venkatraman - supported as an RA for 2 years while obtaining his M.S. in Electrical Engineering. He graduated in the spring of 2000, and now works at Texas Instruments.

Veeraraghavan Narayanan - supported as an RA by Dr. Earle for one semester before dropping out to accept full-time employment at TI.

Rajesh Medikonduri - supported as an RA by Dr. Earle for one year while obtaining his MS in Applied Physics, he will graduate in December 2005. He is now supported through a full-time job at Dallas Semiconductor.

Nithin Rajagopal - supported as an RA by Dr. Earle for one summer while working on a project to measure emitter lifetimes in oxygen. He began full time employment at SignalLogic Corporation in the fall of 2005.

Jim Huffman – Ph. D. student who worked for Dr. Earle for about one year before changing advisors. Eventually graduated under Dr. Cunningham.

Gregg Eberhardt – Ph. D. student who briefly worked under Dr. Earle; later dropped out of UTD.

Beatrice Rasmussen – Ph. D. student who was supported by Dr. Earle as an RA for one year before dropping out of the program. She is now a lecturer in the Physics department.

Richard Manderscheid – Ph. D. student who was supported by Dr. Earle as an RA for one year before dropping out. Currently works at Cisco Systems in Plano.

Rupit Patel – MS/Ph. D. student who briefly worked under Dr. Earle on a project involving MEM devices. Dropped out to work at TI.

Rusty Koonce – Mentored by Dr. Earle on his senior project, involving neural network-based pattern recognition.

Michael Cameron – Mentored by Dr. Earle on a graduate level special topics course regarding a photoelectric effect enhanced field emitter.

William Fadgen – Mentored by Dr. Earle on his senior project to study the process flow related to the fabrication of microtip arrays on optic fibers.

Masayuki Kondo – Mentored by Dr. Earle on a project to refurbish a scanning electron microscope in Dr. Earle's laboratory in the EE department.

Jason Koesters – Mentored by Dr. Earle on a project to build an electric field experiment for use in the EE department's graduate laboratory course in the plasma research and teaching laboratory.

Mike Menefee – Mentored by Dr. Earle on a special topics project to build an autonomous underwater vehicle for a national competition in August 2005.

Usbaldo Friare, Jr. – Mentored by Dr. Earle through the LSAMP minority undergraduate program. Usbaldo worked during the summer of 2004 on a project to analyze data from a sounding rocket instrument.

Valerie Liang – High school student mentored by Dr. Earle in the summer of 2004 through the TAMS program. She worked on a computer algorithm to trace magnetic field lines through the Earth's ionosphere.

Mimi Liu and Jonathon Rose – Two high school students mentored by Dr. Earle in the summer of 2005 through UTD's Academic Excellence Program. They worked with Mike Menefee (see above) on the UAV project, and also built some physics lecture demonstrations for Dr. Earle.

Justin Boland – Mentored by Dr. Earle on a microtip emitter fabrication project.

Kelly Drake – Mentored by Dr. Earle on a special topics course in physics.

Jamaal Granger – Mentored by Dr. Earle on a special topics course in physics.

Kevin Afghani – Supported by Dr. Earle on a summer NSF REU project to refurbish an ionosonde system at Wallops Island, VA.

Jeff Klenzing and Brian Copp – Mentored by Dr. Earle through the Clark Program in the summer prior to their freshman year at UTD. They worked on a project to build a vacuum system and then use it to measure the photoelectric effect in thin films. This work was later published in the *American Journal of Physics*, 2003.

Michael Casavant – Supported by Dr. Earle in 1996 on a summer project to set up a vacuum system.

Colby Lemon – Supported by Dr. Earle in 1996 on a summer project to build a vacuum system.

Tae Son – Supported by Dr. Earle in 1996 on a summer project to build a vacuum system.