The Director's Report—2005

David R. Criswell

Houston Partnership for Space Exploration [HPSE]

Dr. David R. Criswell

The purpose of HPSE is to advance any aspect of aerospace research, engineering, and applications through graduate and post-doctoral level programs at the University of Houston and the University of Houston-Clear Lake in cooperation with the NASA Johnson Space Center (JSC), Texas universities and businesses, and other organizations. The legislature of the State of Texas established the Houston Partnership for Space Exploration in 1991.

The Institute for Space Systems Operations (ISSO) is the operating agency for HPSE. UH and UHCL are also members of the Texas Space Grant Consortium (TSGC). ISSO works through TSGC on a statewide level. Dr. David R. Criswell directs ISSO and is responsible for both UH and UHCL activities. HPSE is funded under a State of Texas Line Item that allocated $287,962 in Y2005 to operations at the University of Houston. There was a one-time carry-over of $83,605 from Y2004 for a total Y2005 budget of $370,963. The State of Texas Line Item allocated $81,050 to operations at the University of Houston-Clear Lake. As reported by the faculty in the following research articles, the Y2005 ISSO State of Texas funds were leveraged by a factor of 5.8-to-1.

ISSO projects have established solid professional links between NASA, JSC, the Houston aerospace community, and UH and UHCL. ISSO provides the flexibility and resources for UH and UHCL faculty to fully participate in the rapidly evolving national space program. Since 1991, faculty supported by ISSO research funds have reported obtaining $19,500,000 of external funding and thus leveraged the research funds by 4.7-to-1 over the life of the program.

The following section summarizes Y2005 accomplishments by ISSO-supported researchers. A short synopsis of each research activity is presented within six study areas. Seed-grants selected February 28, 2006 are listed in the last section.

Summary of the 2005 Program

Primary activities of ISSO are the unique Post-Doctoral Aerospace Fellowship (PDAF) program between UH/UHCL and the NASA-Johnson Space Center and grants providing seed-level funds to UH and UHCL faculty for development of new aerospace research projects. Both PDAF and seed-grant projects are proposed to ISSO by UH and UHCL faculty and then selected through a peer review. Peer reviewers are selected from UH, UHCL, and the JSC community.

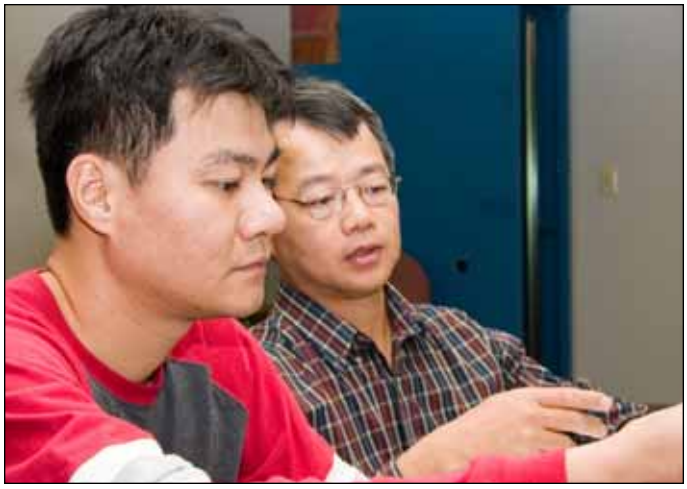
The PDAF program started in 1995. It operated through a Memorandum of Understanding between JSC and the two universities. The MOU was converted to a Space Act Agreement in early 2006. The PDAF program is currently completing the third set of post-doctoral fellows projects. Five fellowship projects were active in 2005. ISSO will request proposals for the fourth set of fellowship projects in the spring of 2006. Each Aerospace Fellow is selected and directed by a team consisting of at least one UH or UHCL faculty member and a research member of the Johnson Space Center. A fellowship appointment is for two years with a possible extension of a third and final year.

In 2005, ISSO provided $404,673 in research funds to 19 UH and UHCL faculty in support of 16 new seed-grant projects, five PDAF projects, the director's research, and program documentation. ISSO requires investigators to report results on projects for five years after completion of funding of a given project. In 2005, faculty funded in prior years and currently funded UH and UHCL faculty reported submitting 31 proposals in application for $7,300,000 of external funding. They report obtaining $2,610,000 for these proposals and proposals submitted the prior year. The 2005 ISSO State of Texas funds were leveraged by a factor of ~6. Leveraging of the 2005 funds will continue to increase as more proposals are submitted based on follow-up results of the 2005 projects.

In 2005, ISSO investigators report submitting 87 professional papers, delivering 56 professional presentations and interviews, and submitting four patent application and one disclosure. Ten undergraduates participated in the research activities. Twenty master's level students and 28 doctoral students participated in ISSO research projects along with six post-doctoral fellows.

Thirty-nine UH and UHCL faculty participated in ISSO research along with 17 professors from other universities, 13 NASA researchers, and 32 from other non-profit organizations and companies. In addition to JSC, 20 other organizations participated.

- ESCG, Houston
- Harbin Institute of Technology, China



CONSULTATION—Tuan Anh Nguyen (*l.*), who earned his B.S. degree in science from the Hanoi University of Technology in Vietnam, discusses an article on "An Efficient Scheme for Authenticating Public Keys in Sensor Networks" with Prof. T. Andrew Yang (*r.*) of the University of Houston-Clear Lake.

- Integrated Micro Sensors, Inc., Houston
- Jet Propulsion Laboratory
- L-3 Communications - Titan Division
- Lawrence Berkeley Laboratory
- Polish Academy of Science
  Institute of Physics, Warsaw
- Nasser Engineering, Houston
- NASA-Langley Research Center
- Rice U. Bioengineering, Electrical and Computer Engineering
- Russian Academy of Sciences
- Laser Institute, Moscow
- Seisco
- Texas Instruments
- Tietronix, Houston
- University of Neuchatel, Switzerland
- University of Pennsylvania
- University of Singapore
- University of Texas Health Sciences Center
- Diagnostic and Interventional Imaging, Houston
- Yonsel University, S. Korea

ISSO maintains a Web site of all reports and utilizes its Web site to announce proposals and fellowship opportunities. Searching "Institute for Space Systems Operations" returns more than 900 hits on Google. Search hits were also found for all principal investigators in this report. Using various combinations of "last name, initials," "ISSO," "UH," and "UHCL" returned a total of ~1,800 relevant hits.

ISSO cooperated at UH with four colleges and Deans J. Bear (Natural Sciences & Mathematics), R. Flumerfelt (Engineering), W. E. Fitzgibbons (Technology), and R. K. Wimpelberg (Education) and with Dr. A. Ignatiev (SVEC) and the newly formulated Center for Advanced Materials (CAM). ISSO thanks them for their support in the research projects. At UHCL, ISSO worked primarily with the School of Science and Computer Engineering. Thanks are sincerely extended to Dean C. McKay.

Summary of ISSO Research Projects

Six major themes are the focus of 28 research projects funded in 2005 and the follow-up results of earlier projects:

- Autonomous Operations
- Devices and Materials
- Natural and Induced Radiation
- Search for the Origins of Life On and Beyond Earth
- Biomedical Sciences in Space
- Space Industrialization

Autonomous Operations

There is a great need for vehicles that can operate autonomously in space about facilities such as the International Space Station, in the milieu of asteroids and comets, and on planetary surfaces (Moon, Mars, etc.). Autonomous vehicles can perform inspections, exploration, and, eventually, maintenance and repairs. The Post-Doctoral Aerospace Fellowship project of Prof. E. T. Dickerson (UHCL), Dr. G. T. Arndt (NASA-JSC), Dr. J. Ni (Fellow) "UWB Tracking System Design with TDOA Algorithm for Space Applications" focuses on radar and computer systems that can enable autonomous navigation and control of a vehicle that can autonomously inspect the International Space Station and Space Shuttle. These systems employ an ultra-wideband (UWB) pulsed radar/receiver system to track the vehicle location and software that determine the time-difference of arrival (TDOA) of the UWB signals between the vehicle and transponders on the station or shuttle [pp. 19-22].

Professor Albert M. K. Cheng (UH: Computer Science) conducted a 2005 seed-grant on "Building and Verifying Fault-Tolerant Autonomous Real-Time Systems for Space Applications" [53-57,95]. Autonomous systems and their software must perform correctly for an extended period of time and make real-time decisions that meet both logical and timing requirements; they must tolerate implementation and environment-induced faults. This project focuses on (1) adding scalable fault-tolerance in the decision-making autonomy software of a real-time autonomous system and (2) augmenting the capability of formal verification strategies by providing an alternative based on scalable rule-base analysis to model checking and theorem proving. Tools and techniques are detailed and results summarized. Ms. Bin Lu based part of her dissertation research on this project. The project builds on 2004 and 2003 seed-grant projects that supported part of the Ph.D. research of Yan Wang and the M.S. research of F. Zhou and two M.S. students—S. Fang and F. Shang.

There is a long-standing and increasing need for multiple spacecraft that fly in formation about planets, moons, and other bodies as well as through deep space. Such formations can enable high resolution measurement of gravitational fields, resolution of space-time events in the solar wind, ultra-long baseline interferrometry, and many other needs. Professors Heidar Malki (UH: Engineering Technology), Leang-San Shieh (UH: ECE), and H. J. Lee (UH: ECE) examined "PWM Control of Formation Flying Space Vehicles" through pulse-width-modulated (PMW) analog tracking systems and associated non-linear control systems. They examined the advantages of converting from analog to digitally-based control methods [73-75]. Professor Malki also provided a progress report on the 2004 ISSO seed-grant "A Neural-Network-Based Approach for Control of Vibration in a Black Hawk Helicopter" [115].

A major goal of computer science is for computers to understand human language (Natural Language) and to respond accurately to human speech. Professor H. Al-Mubaid (UHCL: Computer Science) received a 2005 seed-grant for "Natural Language Interface Models for Fast Responsiveness Applications." He focuses on computer tools that efficiently identify the ambiguities of human words in sentences using "word prediction" techniques [41-44,94]. Data sets from Reuters Wire Service, Medline, and Security and Exchange Commission filings were used to test the natural language interface.

Professor Al-Mubaid also received a 2005 mini-grant for in-depth examination of "A Text-Mining Technique for Literature Profiling and Automatic Extraction of Information from Biomedical Literature" [45-49]. The project developed a new technique for term identification and classification. It was tested against text abstracts in PubMed that contain over 14 million biomedical abstracts.

Professors T. Andrew Yang and S. Davari (UHCL: Computer Science and Mathematics) report the results of new work on their 2004 ISSO seed-grant in the "Development of Wireless Stations for Distributed Field Operations" [125]. Four new publications have resulted from their on-going efforts to determine and test the key parameters and metrics for robost distributed wireless networks.

Devices and Materials

Professors T. L. Harman (UHCL: Computer Engineering) and F. K. Tittel (Rice University: Electrical and Computer Engineering) with Dr. J. C. Graf (JSC: Crew and Thermal Systems) completed a six-year program of joint research devoted to the development and application of advanced laser technology for monitoring contaminants within air and water streams. In 2005, Post-Doctoral Aerospace Fellow Dr. Y. Bakhirkin completed the joint UHCL-Rice University project "Development of Quantum-Cascade Laser Biosensor Technology." He focused on the development of new types of real-time gas sensors based on continuous wave and pulsed quantum cascade lasers. The lasers are used in systems for medical diagnostics, environmental monitoring, and industrial process control [27-32]. Professor Harman focused on the software needed for analysis of the data.

The efficient absorption and/or radiation of heat is critical to the operation and lifetime of space systems. Passive heat-management systems with low mass per unit of heat-flow are highly desirable. Professor A. Bensaoula (UH: Center for Advanced Materials) and Dr. A. Carreno (Aerospace Fellow) report on the "Development of Micro-Column Arrays (MCA) for Thermal Management Applications" [15-18]. They coordinate the project with Dr. B. Mayeaux (JSC: Materials and Process Branch), Dr. A. Alemu (new Fellow), and Prof. R. Pillai (UH: Electrical and Computer Engineering). They are creating metallic surfaces that are densely covered by tiny pyramids formed from the original surface materials. Laser beams are used to vaporize the original surface; vacuum and temperature conditions are controlled so that the material reforms itself into arrays of pyramidal structures. The arrays produce a surface of low reflectance and high emission of thermal radiation. This work evolved from the 2004 ISSO mini-grant proposal "Micro-Column Arrays (MCA) for Thermal Management of Spacecraft Environments" [99-100] that produced a new externally funded grant from the Department of Defense in 2005.

Professor A. Bensaoula and Dr. Chris Boney also initiated a 2005 mini-grant project "Investigation of III-Nitride Materials for Space-Based Solar Cells" [50-52]. Mr. Joseph Clement conducted a portion of his graduate degree work at UH on this research. The III-Nitride materials may enable solar cells that are extremely resistant to space radiation and provide higher lifetime conversion efficiency than other semiconductors. In particular, UH researchers are modeling solar cells based on Indium-Gallium-Nitride thin films formed under a range of growth and doping conditions.

Fuel cells can chemically combine hydrogen and oxygen to output electric power. Conversely, solar cells can provide electric power to operate fuel cells in reverse and separate water into hydrogen and oxygen. It is critical that the internal membranes of fuel cells not become contaminated. Professor J. Y. Lu (UHCL: Chemistry) explores the development of new types of metal-organic framework (MOF), composed, in part, of nanofibers, to remove contaminants from the working fluids of fuel cells. Refer to "Contaminants Removal from Fuel Cells for Aerospace Applications" [72,96].

Professors D. Keith Hollingsworth and L. Witte (UH: Mechanical Engineering) have developed a system that speeds up the acquisition of data on thermal radiation from dust-coated surfaces in the atmosphere and also under vacuum conditions characteristic of the Moon and Mars [68-71]. "The Effect of Martian Dust on Radiator Performance" is a seed-grant project performed primarily within the Space Vacuum Chamber of the JSC-Energy Systems Branch. Mr. Ashley Higgins conducted a portion of his graduate work under this project. An invention disclosure has been filed on a method to uniformly deposit dust on multiple test coupons within the vacuum chamber.

Professor M. Gorman (UH: Physics) received an equipment grant in 2005 for a "Unique High Speed Camera System for Studying the Pulsating Dynamics of Premixed Flames." The funds were to replace a ruined micro-channel plate of a high-speed electronic camera. The new plate enables low-light patterns of unstable combustion of hydrocarbons mixed with air and oxygen to be captured at a frame-rate of 250 Hz [66-67].

BIOCHEMISTRY—Johnathan Siefert, research assistant in biological and biochemical laboratories, focuses study upon differences between strains of species in a research team headed by Dr. George Fox exploring species in outer space.

Professor J. B. Dabney (UHCL: Systems Engineering) reports on the fifth year of seed-grant support for "Real-Time Active Loading of Piezoelectric Ultrasonic Motors for Simulating Space Robotics Applications" [61-63]. Piezoelectric ultrasonic motors have the potential of high-precision control of mechanical devices at low speed without the use of magnetic fields. However, there are major control challenges at low-speed. NASA-JSC provided $100,000 of funding in 2004 for this research.

Power conditioning equipment used in space vehicles contributes to the total vehicle mass, reliability, and cost. Professor W. Shireen (UH: Electrical/Electronics Technology) received the 2004 ISSO seed-grant "An AC-DC-AC Converter with Smaller DC-link capacitor for Space Power Distribution Systems." Prof. Shireen and graduate student S. Vanapalli have demonstrated an experimental digital signal processor that enables the use of less massive DC-link capacitors for the same electric power output as traditional equipment [123-24].

Nano-materials are being explored as new additions to existing commercial products. Professor V. Hadjiev (UH: Center for Advanced Materials) provides an update to his 2004 seed-grant project "Raman Scattering Test of Mechanical and Sensor Properties of Advanced Nanocomposites" [108,127]. He continued his examination of the possibility of reinforcing cyanoacrylate (major component of Super Glue) by the addition of single wall nanotubes. Dr. Keesu Jeon based a portion of his dissertation research on this project. Dr. Jeon is now a post-doctoral fellow at Florida State University in the Department of Chemical and Biochemical Engineering.

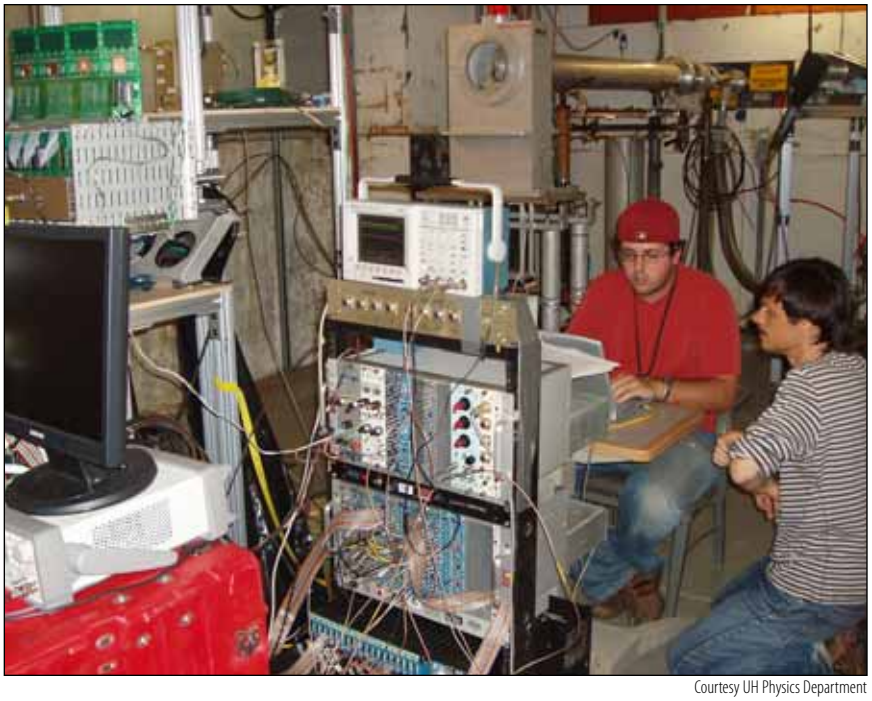
Professor LieJune Shiau (UHCL: Mathematics) worked with Professor R. Glowinsky and NASA-JSC engineers on "Computational Methods in Non-Smooth Mechanics: Applications To Dry Friction Constrained Motions" [88,96]. Mathematical models and software are important to the control of large robotic arms and similar devices that must be controlled to a high-level of position accuracy. A small business entity, Nasser Enginering, participated in the project.

Natural and Induced Radiation

The Mars Odyssey spacecraft carried an experiment, MARIE, that detected high speed particles emitted by the sun. MARIE was not fully calibrated before launch. Professor Lawrence Pinsky (UH: Physics) and Dr. T. L. Wilson (JSC: Earth Sciences and Solar System Exploration) have significantly increased its post-flight level of calibration to energetic protons. They achieved this increase by applying a software package, FLUKA, developed at CERN to model the passage of high energy particles through matter. MARIA data can now be used to study the connections between solar wind proton events detected at Odyssey and their origin on the sun [119-20].

Professor Pinsky also received a 2005 seed-grant to support acquisition of data on the interactions of carbon, aluminum, iron, and copper atoms over an energy range of 100 million to 5 billion electron volts per nucleon with matter. These data will allow higher calibration of a computer model (FLUKA, developed at CERN) used to predict the interactions of solar and galactic cosmic rays with structures and people in space. This work was carried out at the Alternating Gradient Synchrotron (AGS) at Brookhaven National Laboratory as part of the NASA–Space Radiation Shielding Measurement Consortium [University of California–Lawrence Berkeley Laboratory, Brookhaven National Laboratory, UH, NASA-Marshall Space Flight Center]. The preliminary report is titled "Initiating the Detector Deployment for a Currently Planned NASA Accelerator Measurement" [80-82]. Measurements utilized silicon strip detectors provided by Professor E. V. Hungerford (UH: Physics). UH Physics graduate student N. Elkhayari is utilizing this data as a portion of his Ph.D. research.

Professor L. Shih (UHCL: Computer Engineering] provides a follow-up report "High-Performance Martian Space Radiation Mapping" [121-22] on recent results from an earlier seed grant described in the 2004 ISSO *Annual Report*. The NASA Langley Research Center utilizes a computer code HZETRN (high-Z and energy transport code) to predict the radiation environment induced at the surface of Mars by solar and galactic cosmic rays. HZERTN was originally created to operate in FORTRAN on a VAX computer and later run on Sun Sparc 5 systems. Professor Shih and colleagues are revising the software to operate much faster on modern computer clusters and Field Programmable Gate Arrays (FPGA). A FPGA is a type of logic chip with thousands of gates that can be programmed. A preliminary, non-optimized FPGA module showed a 200-to-600 time speed over the speed of equivalent HZETRN routines running on Sun Sparc 5 systems. NASA-LRC plans this year on transferring the revised software to a development version of the HZERTN code and soon, thereafter, to production software. The code may also be useful in accelerating FLUKA software.



Courtesy UH Physics Department

BROOKHAVEN—Alternating Gradient Synchrotron (AGS) run last July at the Brookhaven National Lab in New York. Students involved in the project were Matt Lebourgeois (*l.*), UH undergraduate student-at the time, now a graduate student at the University of California-San Diego, and Anton (Toni) Empl (r.), UH post-doctoral student, normally stationed at CERN.

Search for the Origins of Life On and Beyond Earth

I found the book *Oxygen—the Molecule that Made the World* (Oxford UP, 2002, 384pp.) by Professor Nick Lane to be an exceptionally interesting review of the development of human understanding of oxygen, oxygen's history over geological time, the role of oxygen in the proliferation of life, and how life has resisted, from the first, the destructive actions of oxygen on the living cell. Professor Lane notes on page 157 that Woese and Fox (G. E. Fox: UH: Biology and Biochemistry) introduced "one of the great paradigm shifts in biology." He explains, "A little-known group of prokaryotes, most of which inhabited extreme environments such as hot springs and hypersaline lakes, confounded all expectations when their ribosomal RNA was analyzed. The analyses showed that they shared little more with the bacteria than the absence of a nucleus." Professor Fox continues this line of research in the 2005 ISSO seed-grant "Early Origins of Genetic Systems" [64-65,95]. Results illustrate a key role for the ribosomal machinery as a source and sink of useful proteins or protein domains throughout the early development of living cells.

Professors Fox and R. C. Willson (UH: Chemical Engineering), Dr. D. L. Pierson (JSC: Microbiology Lab), and Dr. Viktor Stepanov (UH: Fellow) have completed two years of the post-doctoral project "The Effect of Modeled Microgravity on Microbial Gene Expression" [23-26]. They grow bacteria, such as *S. Typhimurium* and *E. coli* MG1655, in low shear rotating environments that simulate some aspects of a zero-gravity environment. The cell-envelopes of bacteria are found to adjust to stagnant nutrient conditions that result from the low shearing of liquid about the cells that, under normal terrestrial gravity, would bathe the cells in new liquid. These deprived cells express different genes from normal conditions and from each other. The team received support from Professor Y. Folfanov (UH: Computer Science) and several students in performing the statistical analyses of the data from the microarrays used in these studies. Summaries may be found of additional results of research conducted in the first year of the existing Post-Doctoral Aerospace Fellowship project along with results from two prior seed-grant projects in 2004 and 2003 [103-04].

A long-standing objective of NASA is to determine the existence or not of life on Mars. The two Viking crafts that landed on Mars in 1976 sampled soils and returned ambiguous data. A few meteors discovered on the Antarctic ice have been proven to be from Mars. In particular, Dr. David McKay and colleagues have argued that Allan Hills 84001 contains ancient fossilized nano-organisms. Dr. John H. Miller (UH, Physics & TCSAM) and Dr. D. S. McKay work with Dr. J. A. Jones (JSC), Dr. J. Wosik (UH, ECE and TCSUH), and Dr. David Warmflash (PDA Fellow) to develop new means of detecting life within Martian soils and rocks. The fellowship project "Martian Soil Biosensors Based on Dielectric Spectroscopy" is in its second year [33-38]. Dr. D. Nawarathna earned his Ph.D. degree in 2005 from the University of Houston under this program. F. Karouia (JSC) is now engaged in a Ph.D. program at UH. In 2005, the group also completed a mini-grant project that conducted "Low-Frequency Dielectric Spectroscopy of Martian Soil Samples" [116-18,126].

The research group led by Dr. Miller also conducted the 2005 seed-grant project "Electromagnetic Probes of Biological Molecular Motors" [76-79] in direct support of reported fellowship research. Electric fields across cell membranes vibrate in response to various physiological processes such as membrane pumps. New minimal invasive techniques are deployed to monitor these vibrations from a few hertz to the order of 1 kHz. The ability to non-invasively monitor active physiological processes *in vivo* is of potential importance for biophysics, biomedicine, and pharmaceutical development.

Professor J. Wosik (UH: Computer & Electric Engineering) is working with Professor J. Miller (UH: Physics), Dr. D. S. McKay (JSC), and Dr. D. Warmflash (ISSO: Fellow) on three new techniques to characterize the magnetite crystals found in Martian meteorites. The 2005 ISSO seed-grant had been awarded for "Magnetic Microscopy Studies of Magnetotactic Fossils on Martian Meteorite ALH84001 and Related Earthbound Analog Systems" [89-92]. Microwave techniques include (a) an open confocal resonator, (b) a high-spatial resolution near-field microscopy probe, and (c) ferromagnetic resonance. These techniques can measure the permittivity, permeability, and conductivity of both solid state and biological samples at the microscopic level.

Professor I. N. Rothman (UH: English) edits the ISSO *Annual Report* and also conducts research into the literature of the 17th and 18th centuries with a focus on the writings of Daniel Defoe. ISSO supported his investigation last year into "Science and Invention in Literature—Divergent Views of Daniel Defoe and Jonathan Swift" [83-87]. Dr. Rothman notes the contrasting attitudes toward the emerging fields of science and the practical arts of Defoe and Swift. Defoe admired, analyzed, and promoted these new human accomplishments and their potential for human advancement. Swift treated similar topics and their proponents with sarcasm and disdain. These contrasting approaches are evident today in public and literary response to efforts to explore and develop the resources of our solar system.

Biomedical Sciences in Space

It is well established that some aspects of human physiology change when a person lives under zero-gravity conditions in space. Professor G. Gunaratne (UH: Physics) provides a progress report on his 2004 ISSO seed-grant "A Theoretical Analysis of Vibrational Modes Aimed at their Use as Measures of Bone Damage" (105-07,126). He conducted research with Chamith Rajapakse who completed his doctoral research at UH in 2005 and is now a post-doctoral fellow in the Department of Radiology at the University of Pennsylvania. They applied modern seismic techniques to deduce the existence of long micro-cracks in the trabecular portion of bones, the inner soft layer, that lead to fractures. Professor Gunaratne is collaborating with Professor M. Liebschner (Rice U.: Bioengineering) who is developing an instrument to measure bone structure.

Professor C. S. Layne (UH: Health and Human Performance) directed a 2001–2003 Post-Doctoral Aerospace Fellowship project that was reported in the 2004 and 2005 ISSO annual reports. His report on "Voluntary Muscle Contractions in Advance of Mechanical Foot Stimulation To Enhance Neuromuscular Reflex Responses" summarizes the research, publications, and presentations since Y2004 [109-14]. Drs K. Forth and A. Abercromby both participated on this project and earned their doctoral degrees at the University of Houston. They now both work at NASA-JSC. Dr. Forth is as post-doctoral fellow in the Neurosciences Laboratory, and Dr. Abercromby is employed in the Anthropometrics Laboratory. They found that the application of mechanical foot stimulation can be used to elicit and enhance neuromuscular activity of the triceps surae muscles and thereby attenuate the neuromuscular degradation experienced during prolonged bedrest and during extended stays in microgravity.

Professor Mark S. F. Clarke (UH: Health and Human Performance) and Dr. Daniel L. Feeback (NASA-JSC) conducted the 2005 ISSO seed-grant "Validation of a Novel Micro-Capillary Array Fluid Collection Technology for Determination of Biomarkers of Bone Metabolism in Human Sweat" [58-60,95]. This study contributed to their earlier Post-Doctoral Aerospace Fellowship project on the same general topic. Bone loss is associated with proteins released into the blood. Trace amounts of these proteins are present in sweat. Clarke and Feeback have identified methods to detect and quantify these microscopic quantities of tracer proteins within a day of their release. These techniques may well prove useful both in space and on Earth for clinical monitoring of bone loss.

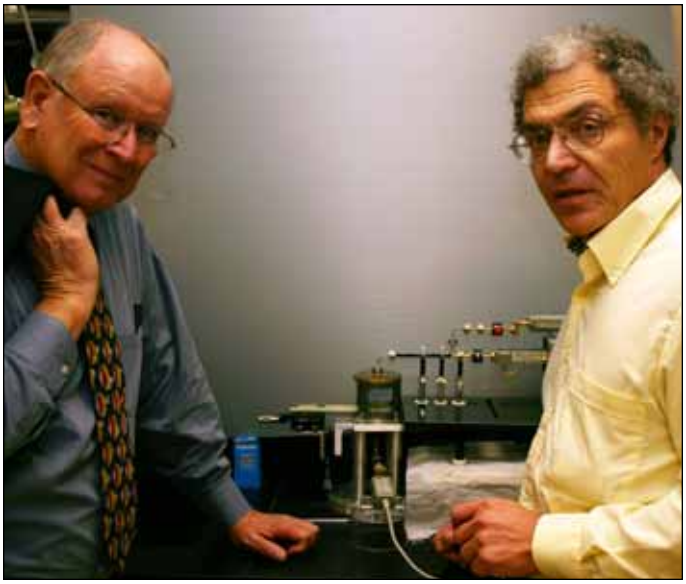
Professor G. D. Boetticher (UHCL: Computer Science) provides updates on the 2004 seed-grant project "A Recursive Application of a Support Vector Machine for Protein Spot Detection in 2-Dimensional Gel Electrophoresis" [102] that enabled Mr. M. Sasika to obtain an M.S. degree in 2005. Professor Boetticher also provides an update on the 2004 seed-grant project "Impact of Chromosome Lineage upon Genetic Program Modeling" [102]. The last project may lead to better techniques for mining of large databases in the aerospace and biomedical fields.

Texas Space Grant Consortium (TSGC)

The University of Houston is a charter member of the Texas Space Grant Consortium in assocation with The University of Texas at Austin and Texas A&M University at College Station. In acknowledgment of its national objectives, the UH Office of the Provost supported the UH charter membership. However, the Office of the Vice Provost of Research has directed ISSO and the Space Vacuum Epitaxy Center to pay the $30,000 of the annual membership for the University of Houston from State Line Item funds. This significantly reduces the ability of ISSO to fund UH seed-grants and Post-Doctoral Fellowship projects.

The ISSO Director is an associate director of TSGC and on the Board of Directors. The UH campus representative in 2005 was the SVEC director. A faculty member of the University of Houston-Clear Lake represents that campus.

In 2005, TSGC awarded $31,000 to UH students and faculty in response to requests for fellowship and scholarship announcements and requests for research proposals. There were no awards to UHCL faculty or students.



MICROSCOPY—Dr. David Criswell (*l.*), ISSO Director, stands at the scanning tip microwave microscope (STMM) developed in the laboratory of Dr. Jarek Wosik (*r.*), research professor in the Texas Center for Superconductivity (TCSUH). The device has been developed to achieve micron-level resolution combined with high sensitivity. It will allow the non-destructive testing and analysis of any surface that needs characterization of high spatial resolution impedence.

TSGC Fellowships
Geffert Sandra (UH) $5,000
Singh Cynthia Hanson (UH) $5,000

TSGC Scholarships
Sardi Giancarlo (UH) $1,000

New Investigators Program
Pradeep Sharma, assistant professor, (UH: Mechanical Engineering and Physics) "Novel Size-Effects in the coupled Mechanical Deformation and Opto-Electronic Behavior of Quantum Dots and Wires," $10,000.

Ji Chen, assistant professor, (UH: Electrical and Computer Engineering) for "An Efficient Full-Wave Framework for Future Micro and Nano Electronic Devices Modeling/ Simulation," $10,000. (*On-going*)

Projects for Y2006
In January 2006, ISSO received 29 seed-grant proposals from UH and UHCL faculty that requested $240,000 for UH and $108,500 for UHCL. An ISSO peer review panel of members from UH, UHCL, and NASA-JSC evaluated the 19 proposals from UH faculty and 10 from UHCL faculty. ISSO awarded the following four UH faculty members a total of $57,740 and five UHCL faculty $54,990.

Bensaoula, A. (UH: Natural Sciences and Mathematics, Center for Advanced Materials) Micro-Integrated Super Broadband Stellar Simulator Optical Calibration Source

Cheng, A. (UH: Natural Sciences and Mathematics, Computer Science) Optimizing Quality-of-Service in Adaptive Optics Systems and Other (m, k)-Firm Real-Time Spacecraft Control Systems

Dabney, J. B. (UHCL: Science and Computer Engineering, Computer Engineering) Prototype Micro-Manipulator for Space Robotics Applications

Fox, G. (UH: Natural Sciences and Mathematics, Biology and Biochemistry) *Bacillus pumilus* SAFR-032: A Model for Planetary Protection Research

Garrison, D. (UHCL: Science and Computer Engineering, Physics) Origin of Structure in the Early Universe from Gravitations Radiation

Lu, J. Y. (UHCL: Science and Computer Engineering, Chemistry) Superior Adsorbents for Aerospace Applications

Shiau, L. (UHCL: Science and Computer Engineering, Chemistry) Computational Methods in Non-Smooth Mechanics: Application to Dry Friction Constrained Motions

Shih, L. (UHCL: Science and Computer Engineering, Computing & Mathematics) Efficient space radiation computation with parallel FPGA

Song, G. (UH: Engineering, Mechanical) Innovative Intelligent Adaptive-Passive Damping of a Space Trus Using Fail-Safe Magneto Rheological (MR) Fluid Dampers

Project funding must be complete by August 31, 2006. Each investigator is required to submit proposals for external funding and their first progress report by January 2007. Those reports will appear in the 2006 ISSO *Annual Report*. They also commit to providing a short up-date for five years on all proposals, papers, presentations, students, collaborators, and organizations that participate in research welling out of the seed-grant funding.

The Peer Review panel recommended another 10 projects, totaling $120,400, they considered worthy of funding. However, sufficient funds were not available.

ISSO anticipates announcing in March 2006 a new request for proposals from UH and UHCL faculty and JSC researchers for the fourth set of Post-Doctoral Aerospace Fellowship projects. The new projects could begin as soon as September 1, 2006.

Invitation to Read the 2005 Report
State of Texas funding of the Houston Partnership for Space Exploration enables extensive research among UH and UHCL researchers and researchers at the NASA-Johnson Space Center. UH and UHCL faculty leveraged this state funding by a factor of 5.8 in 2005 and a factor of 4.7-to-1 since the establishment of HPSE in 1991.

This document contains reports on all projects conducted in 2005 and provides results of reported work that ISSO has supported since 2001.

This report is also available online at <http://isso.uh.edu>.