Spring 2012

TECHNOLOGY today®

Southwest Research Institute®

San Antonio, Texas

Spring 2012 • Volume 33, No. 1

TECHNOLOGY today

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Since its founding in 1947, Southwest Research Institute (SwRI) has contributed to the advancement of science and technology by working with clients in industry and government. Performing research for the benefit of humankind is a long-held tradition. The Institute comprises 11 divisions engaged in contract research spanning a wide range of technologies.

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COVER

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About the cover
Full-scale fire tests were performed on upholstered furniture as part of a project to reduce uncertainty in determining the cause of fires.

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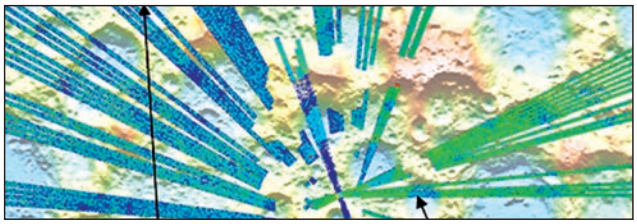

Departments

D018471

Clues from Burning Furniture

An SwRI-led study of how upholstered furniture burns will help fire investigators reduce uncertainty in determining the cause of a fire

By Marc L. Janssens, Ph.D., FSFPE

Fire investigations generally focus on two questions: Where did the fire originate and what was its cause? When the fire occurred under suspicious circumstances, the investigator's main challenge is to prove beyond a reasonable doubt that the cause was not accidental. In recent years a number of sophisticated scientific tools such as computer fire models and advanced fire test methods have made it easier to meet this challenge.

Upholstered furniture is very often involved in residential fires, either as the first item ignited or as a significant component of the fuel load. The reconstruction of residential fires, therefore, often requires reliable estimates of the heat release rate of upholstered furniture. With an official determination of cause at stake, investigators need to reduce as much as possible the uncertainty of quantifying the burning rate of upholstered furniture.

With funding from the National Institute of Justice, which is a part of the U.S. Department of Justice, a team of engineers at Southwest Research Institute (SwRI) developed guidelines for how to best estimate the burning rate of upholstered furniture and to quantify, or at least optimize, the uncertainty of the predictions.

Under ideal circumstances, for example in a hotel guest room fire, fire investigators might test items identical to those involved in the fire. Necessary data could be obtained from experiments in a furniture heat release calorimeter and small-scale flammability tests. However, even when the test articles are identical, the test data are subject to uncertainty because of measurement errors and an unknown ignition scenario.

It is usually not possible to obtain undamaged items for furniture calorimeter testing; more likely some specimens would be available for small-scale tests. The extent of small-scale testing that can be performed depends on the quantity of available material. If there is enough for cone calorimeter tests, it may be possible to predict the burning behavior of the furniture item with reasonable accuracy. More often, however, not enough material is available for cone calorimeter tests, but only for microscale combustion calorimeter tests, which provide limited information about the ignition and heat release characteristics of the material.

In a worst-case scenario, small-scale tests cannot be performed at all due to lack of funding, time or test material. Here, the best an investigator can do is to determine the general characteristics of the furniture items involved in the fire based on a detailed survey of the fire scene or interviews with people who can identify the type of furniture in the home. From that, investigators can search the literature for heat release-rate data for similar furniture items. But if the tests in the literature used an ignition scenario inconsistent with the one postulated for the fire under investigation, the use of literature data may not be justified without some adjustments. In addition,

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there are virtually no heat release-rate data in the literature for upholstered furniture that has been ignited with an accelerant. The SwRI team's study addressed guidelines for these four situations.

Addressing uncertainty

The uncertainty associated with quantifying the burning rate of upholstered furniture consists of two components: aleatory, related to uncontrolled (and uncontrollable) random effects; and epistemic, related to lack of knowledge. Aleatory uncertainty can be estimated using standard mathematical techniques. Quantifying epistemic uncertainty, which is often by far the larger of the two components, is much more difficult. Primary sources of epistemic uncertainty of the heat release rate of upholstered furniture include the lack of knowledge of the ignition scenario and limited understanding of enclosure effects.

Full-scale mockup furniture fire tests

The SwRI research team conducted a series of 79 full-scale fire tests on CAL TB 133 upholstered furniture mockups. In the first 19 tests, the furniture specimen was placed under the hood of an open furniture calorimeter. In the remaining tests, the furniture specimen was placed in a room approximately 15 feet long, 11 feet wide and 8 feet high. Construction was light wood-frame with two layers of gypsum board on the inside. The test object was placed on a scale located in a corner opposite an open doorway. The heat release rate for the specimen was measured based on the oxygen consumption technique. Thermocouples were distributed throughout the compartment and in the doorway to characterize the thermal environment in the room during the tests. Heat flux gauges were used to measure the heat flux to the floor and to the walls in the vicinity of the test specimen. Also, video and photographic documentation were obtained for every test.

Mockup cushions were constructed with either of two fabrics (flame-retardant and non-flame-retardant treated cotton) and one of six padding materials (low-density polyurethane foam, high-density polyurethane foam, CAL TB 117 compliant fire-retardant treated foam, chloroprene foam and two types of polyester fiber fill). Three ignition sources (small flame, large gas burner and liquid pool fire) and three ignition source locations (top, front bottom and back) were used.

Based on the results of the 79 mockup tests, SwRI investigators concluded the following.

The repeatability of furniture calorimeter tests with a large flame ignition source is very good. Based on four repeat tests, the coefficient of variance of the peak heat release rate at the 95 percent confidence level was approximately 8 percent. This is comparable to the measurement uncertainty of the peak heat release rate, which for most items was between 7 and 9 percent.

The time to the onset of a self-propagating fire was found to be considerably more variable in repeat tests with a small flame ignition source. Peak heat release rate was also more variable than for large-flame

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A furniture calorimeter test was performed on a CAL TB 133 three-seat sofa mockup placed directly under the hood of the oxygen consumption calorimeter.

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Cone calorimeter tests were performed on 4 x 4-inch upholstered furniture fabric-padding mockups. The microscale combustion calorimeter (not shown) was used to obtain basic ignition and heat release rate data for milligram-size specimens of furniture component materials.

ignition tests, although the effect on peak heat release rate was not as pronounced.

The heat release rate of a triple-seat sofa is very sensitive to the location on the top surface where the ignition source is applied. Peak heat release rate with a large-flame ignition source in the center was approximately 2.5 times the peak observed for ignition of one of the side cushions. A similar trend was observed for the small-flame ignition tests.

Based on a statistical analysis of a subset of the full-scale mockup data, it was determined that the ignition delay is affected primarily by the type of ignition source used, and that the peak heat release rate is affected primarily by the type of padding.

Ignition at the back of the furniture generally resulted in a shorter ignition delay but a slower fire growth rate and lower peak heat release rate.

Finally, comparison of heat release data of items tested directly under the hood of a calorimeter versus in the room indicated that enclosure effects were negligible. However, peak heat release rates in the tests under the hood were well below those required for room flashover.

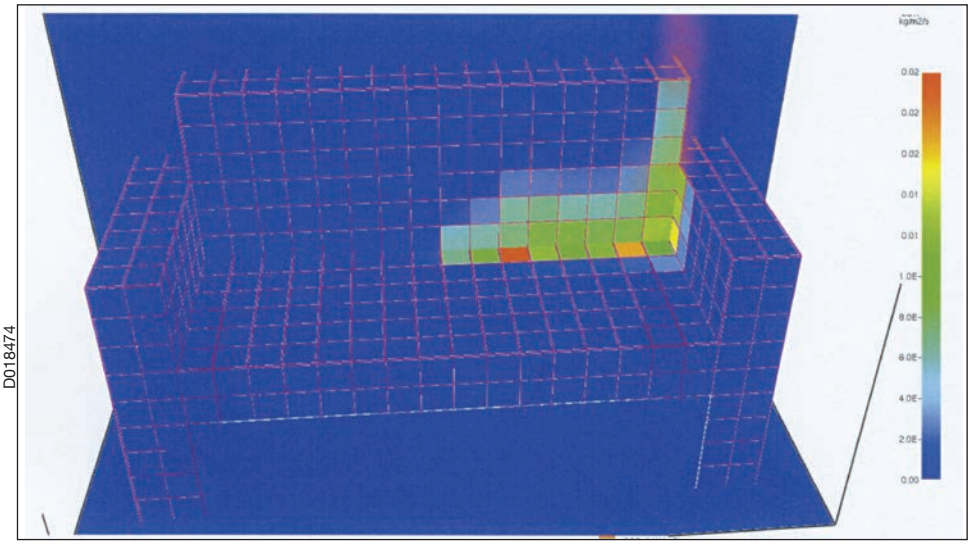
Small-scale flammability tests and computer modeling

Small-scale tests were performed to obtain fire properties of the two fabrics and six padding materials and specific fabric-padding combinations used to construct the mockups. Tests were done in the cone calorimeter and the microscale combustion calorimeter.

Based on studies conducted at the National Institute of Standards and Technology (NIST) in the early 1980s, it was observed that many upholstered furniture items have heat release rate vs. time graphs that are roughly triangular in shape; that is, where peak heat release rate is the triangle's peak and the duration of flaming combustion forms its base width. This relationship formed the basis for a simple model to predict the heat release rate vs. time of upholstered furniture. The model's advantage is that the heat release rate can be estimated based on some generic characteristics of the furniture item, the total combustible mass and the effective heat of combustion of the soft materials. Only a few milligrams of material are needed to measure the heat of combustion in the microscale combustion calorimeter. Heat of combustion can also be estimated with reasonable accuracy from tabulated values. The model was slightly modified to improve agreement between calculated and measured peak heat release rates. Two similar but slightly more sophisticated models to estimate the heat release rate of upholstered furniture based on cone calorimeter data were explored as well.

The SwRI team also investigated the NIST Fire Dynamics Simulator (FDS) field fire model to better account for the effect of the exact location of the ignition source on flame spread over the seating surface. Although it was the most advanced model, because it is based on physics rather than correlations, the FDS model has some unique challenges that resulted in consistently under-predicting the heat release rate curve.

Additionally, the team investigated the NIST zone fire model CFAST to determine how the use of the upholstered furniture burning rate models affects the accuracy of hot gas layer (HGL) temperature and heat flux estimates in the room. CFAST predicts the HGL temperature with remarkable accuracy when the measured heat release rate is specified. This implies that the accuracy of the CFAST temperature predictions for the HGL depends on how well the burning rate model predictions agree with the actual heat release rate. CFAST consistently under-predicts the heat flux to the gauges in the test room, even when the measured heat release rate curve is specified.



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This figure shows a visualization of FDS flame spread and burning rate predictions for a three-seat sofa mockup ignited in a corner with a small match-like flame.

Used furniture fire tests and modeling

A second series of full-scale tests involved 27 items selected from 22 sets of used upholstered furniture that were obtained from SwRI employees. A reduced number of cone calorimeter and microscale combustion calorimeter tests were performed on the soft component materials of the used furniture. Specimens of the padding materials were also tested to verify their noncompliance with CAL TB117.

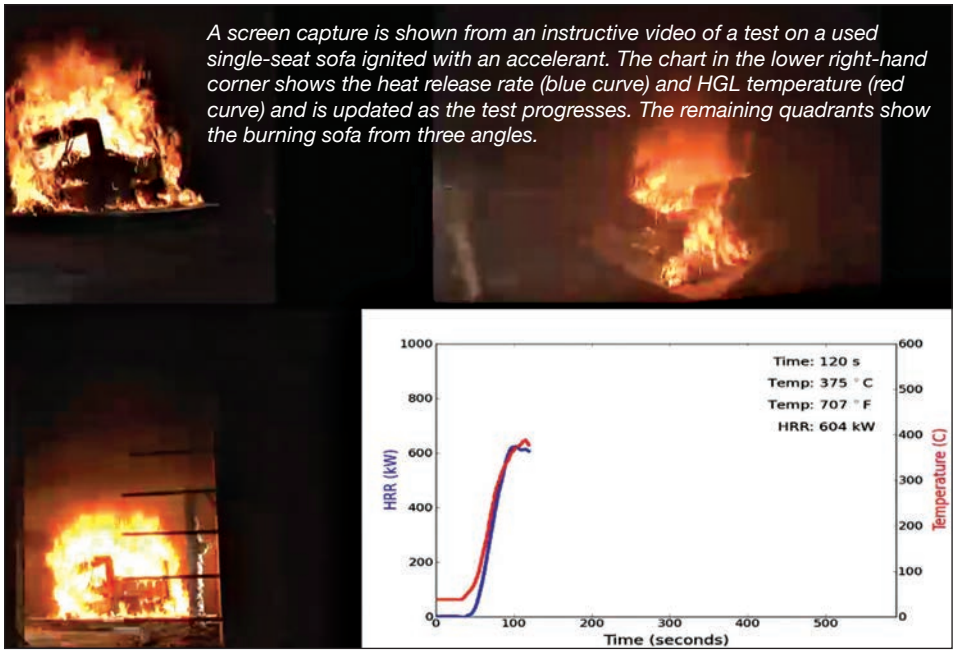
The small- and full-scale test data were used to assess the predictive capability of the models for upholstered furniture burning rates. In this case, the models generally significantly under-predicted the peak heat release rate.

Dissemination of results

Results of the SwRI study will be made available to fire investigators, including a database that can serve as a central repository for other relevant data that are now at many places in different formats. In addition, videos were created as training materials to give arson investigators the opportunity to witness the full-scale fire tests. Information on enclosure temperatures and heat release rate will help arson investigators develop an understanding of fire dynamics in upholstered furniture fires.

Conclusion

More work is needed to refine burning rate models developed on the basis of mockup data so that they are more useful in estimating the heat release rate of actual upholstered furniture.The FDS flame spread and burning model showed the most promise because it is based on physics and not correlations. As such, it has the potential of being able to account for ignition source strength, source location and enclosure effects. However, more work is needed to address the challenges that were encountered in initial attempts at using FDS to model furniture fires. A more detailed algorithm is needed to predict opposed-flow flame spread at the sub-grid scale. Also, a better method is needed to account for thickness and heat flux effects. Until the necessary improvements have been made it is recommended that the data and findings from the study be used to guide fire investigators in conducting a sensitivity analysis to determine the most plausible ignition and fire growth scenario.



A screen capture is shown from an instructive video of a test on a used single-seat sofa ignited with an accelerant. The chart in the lower right-hand corner shows the heat release rate (blue curve) and HGL temperature (red curve) and is updated as the test progresses. The remaining quadrants show the burning sofa from three angles.

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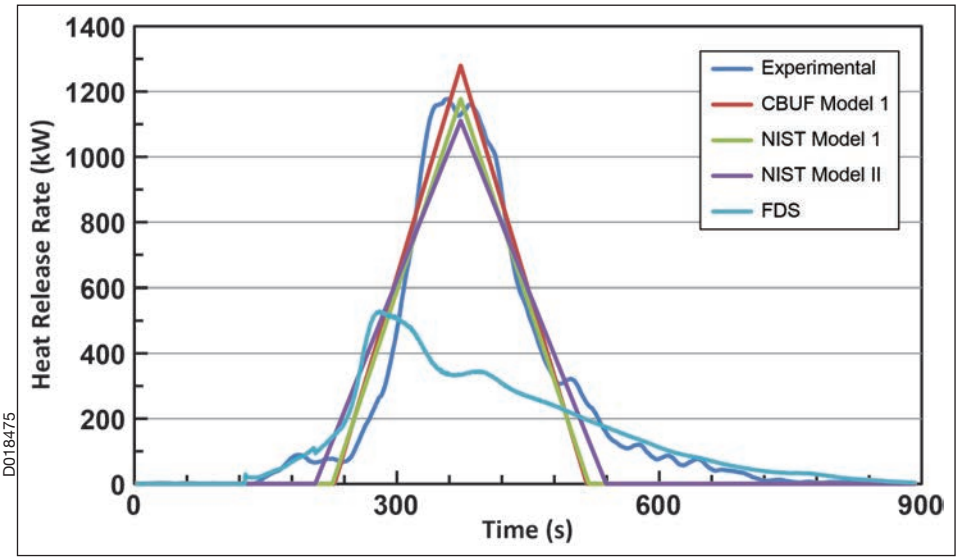

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Comparison between the measured heat release rate as a function of time for a three-seat sofa mockup and corresponding heat release rate predictions from four different upholstered furniture burning rate models.

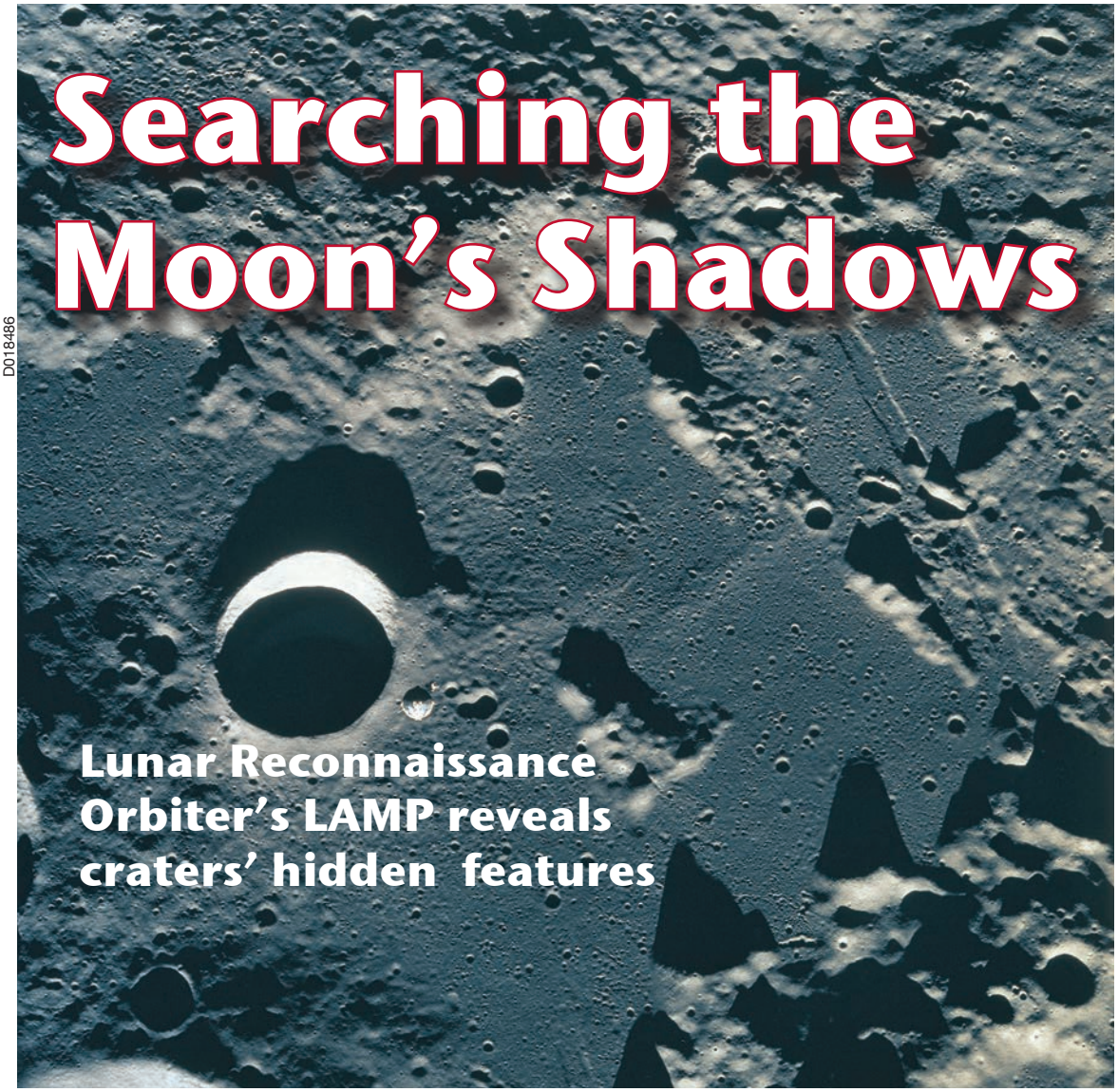
Questions about this article? Contact Janssens at (210) 522-6655 or marc.janssens@swri.org

This project was supported by Award No. 2010-DN-BX-K221, awarded by the National Institute of Justice, Office of Justice Programs, U.S. Department of Justice. The opinions, findings, and conclusions or recommendations expressed in this publication are those of the author and do not necessarily reflect those of the Department of Justice.

Acknowledgments

The author acknowledges the contributions to this research project of Research Engineer David M. Ewan of the Applied Power Division, Research Engineer Christina Gomez and Senior Research Engineer Jason P. Huczek, both of the Fire Technology Department of the Chemistry and Chemical Engineering Division, Institute Analyst Dr. Robert L. Mason of the Fuels and Lubricants Division and Research Engineer J. Marshall Sharp of the Mechanical Engineering Division, all within Southwest Research Institute; consultant Dr. Marcelo M. Hirschler of GBH International; and graduate assistant Kristopher J. Overholt of The University of Texas at Austin. The author also wants to express his gratitude to the technical and administrative support staff at the SwRI Fire Technology Department who worked on this project, to SwRI employees who provided furniture for testing, and to the National Institute of Justice for the financial support that made this research possible.

Searching the Moon's Shadows



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Lunar Reconnaissance Orbiter's LAMP reveals craters' hidden features

Maps produced by the Lyman-Alpha Mapping Project (LAMP) aboard NASA's Lunar Reconnaissance Orbiter reveal newly discovered features at the Moon's northern and southern poles in regions that lie in perpetual darkness, such as the bottoms of craters that never receive direct sunlight.

These permanently shadowed regions, or PSRs, have long been recognized as excellent cold traps, potentially capable of storing large quantities of volatiles in their soils for billions of years. Obtaining useful observations of PSRs is a challenging and difficult process, however, although it has been accomplished through passive remote sensing methods as well as the analysis of ejecta thrown up as a result of the intentional impact of the LCROSS spacecraft into such a crater in October 2009.

LAMP, developed by scientists at Southwest Research Institute (SwRI), uses a novel method to peer into PSRs, making visible what had been invisible. The instrument's ultraviolet spectrograph detects far-ultraviolet light from two faint sources in the night sky: the all-sky Lyman-alpha glow produced when hydrogen atoms from the interplanetary medium scatter the Sun's Lyman-alpha emissions, and the much fainter emissions of ultraviolet-bright stars. The reflected light from these two sources together produces only a few hundred events per second in the photon-counting LAMP instrument, so to build maps with useful signal-to-noise ratios required the careful accumulation of the observations from thousands of individual orbits by the lunar reconnaissance spacecraft. Fortunately, the LRO's polar orbit around the Moon provides for repeated observations of the permanently shadowed areas.

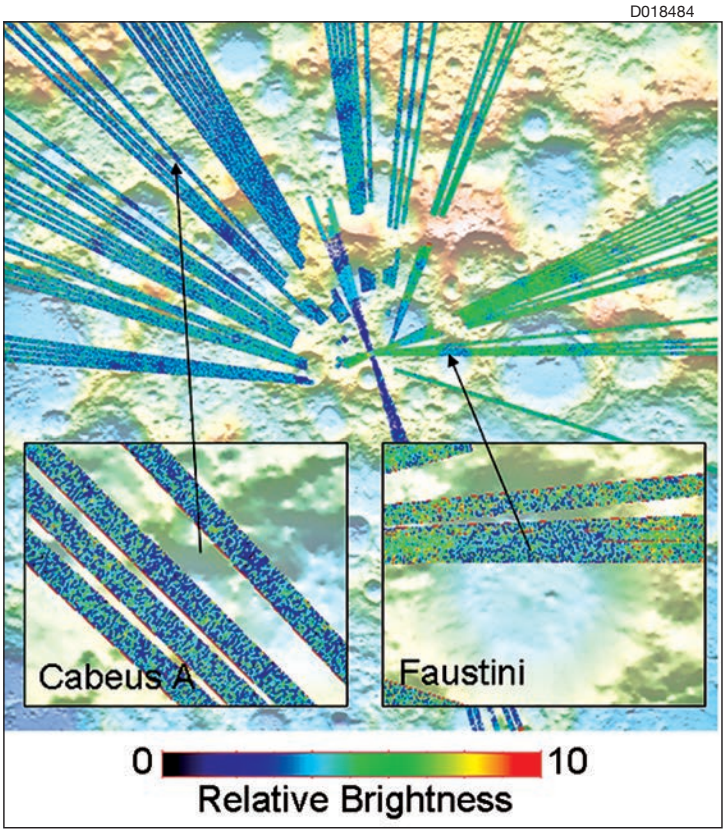
Darker, redder, wetter

The LAMP maps have shown that many PSRs are darker at far-ultraviolet wavelengths and redder than nearby surface areas that receive sunlight. The darker regions are consistent with large surface porosities — indicating "fluffy" soils — while the reddening is consistent with the presence of water frost on the surface.

While not conclusive, the LAMP results suggest that high porosity and the presence of as much as 1 to 2 percent water frost in the permanently shadowed soil of several south polar craters was consistent with their observed far ultraviolet albedos. This was unexpected, as earlier research had indicated that interplanetary medium-originated Lyman-alpha would destroy any water frost at the surface faster than it can accumulate.

The LAMP team estimates that the loss of water frost is about 16 times slower than previously had been believed. In addition, the accumulation of water frost is also likely to be highly dependent on local conditions, such as temperature, thermal cycling and even geologically recent "impact gardening" in which micrometeoroid impacts redistribute the location and depth of volatile compounds.

Finding water frost at these new locations adds to a rapidly improving understanding of the Moon's water and related species, as discovered by three other space missions through near-infrared emissions observations and found buried within the Cabeus crater by the LCROSS impactor. LAMP added to the LCROSS results by measuring hydrogen, mercury



Initial LAMP observations of the faint nightside ultraviolet brightness of the Moon are shown here as tracks overlaid on a shaded topography map of the south pole region. A permanently shadowed crater, Faustini, shows a decrease in brightness compared to surrounding regions, while the crater selected for the October 9, 2009, LCROSS impact, Cabeus A, has a more modest contrast.

and other volatile gases ejected along with the water from the permanently shaded soils of the Moon's Cabeus crater.

An even more unexpected finding by members of the SwRI team is that LAMP's technique for measuring the lunar Lyman-alpha albedo indicates higher surface porosities within PSRs, and supports the long-postulated presence of tenuous "fairy-castle"-like arrangements of surface grains in the PSR soils.

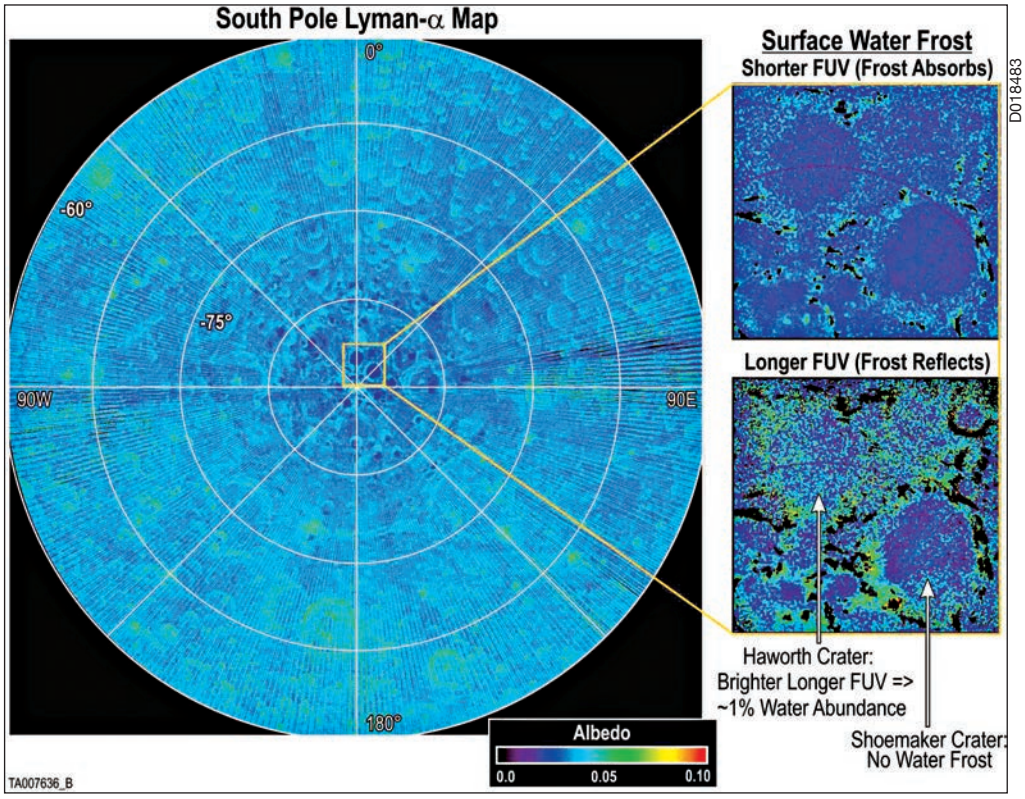
Comparisons with future LAMP maps created using data gathered from the Moon's day side will prove helpful for revealing more about the presence of water frost, as well as the surface porosities of the darker surface features observed. The LAMP team will also apply the Lyman-alpha technique elsewhere on the Moon and on other solar system objects such as Mercury.

The LRO's findings are expected to be valuable to the future consideration of a permanent Moon base. The permanently shadowed regions of the Moon are revealing themselves to be some of the most exotic places in the solar system, well worthy of future exploration. Any discovery of water frost and other resources in the area also could reduce the need to transport resources from Earth to a base at the pole.

Results of this study appear in the paper, "Far-Ultraviolet Reflectance Properties of the Moon's Permanently Shadowed Regions," by G.R. Gladstone, K.D. Retherford, A.F. Egan, D.E. Kaufmann, P.F. Miles, *et al*., published in the Jan. 7, 2012 issue of the *Journal of Geophysical Research*.

NASA Goddard Space Flight Center in Greenbelt, Md., developed and manages the LRO mission. The LRO's current Science Mission is implemented for NASA's Science Mission Directorate. NASA's Exploration Systems Mission Directorate sponsored the LRO's initial one-year Exploration Mission, which concluded in September 2010.

Questions about this article? Contact Dr. Randy Gladstone at (210) 522-3581 or randall.gladstone@swri.org. Contact Dr. Kurt Retherford at (210) 522-3809 or kurt.retherford@swri.org.



These images produced by the Lyman Alpha Mapping Project (LAMP) aboard NASA's Lunar Reconnaissance Orbiter reveal features at the Moon's northern and southern poles in the regions that lie in perpetual darkness. They show that many permanently shadowed regions, or PSRs, are darker at far-ultraviolet wavelengths (top inset) and redder than nearby surface areas that receive sunlight (bottom inset). The darker PSR regions are consistent with having large surface porosities — indicating "fluffy" soils — while the reddening is consistent with the presence of water frost on the surface.

Secrets Written in Dust

D018443-4146

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Samples of dust were collected and extracted, dissolved in liquid and placed in vials, then loaded in a gas chromatography-mass spectrometer for analysis.

Research chemists at SwRI investigated dust for its ability to retain unique source attribution profiles

By Kristin Favela, Ph.D.

As hard as they might try to hide them, criminals or terrorists may soon find that there is more than one kind of fingerprint that can be left at a crime scene. Substances as common as house dust may contain traces of the unique chemical signature of explosives, nuclear materials, drugs or chemical warfare agents. Investigators can tie an individual to these as well as other items, such as household inks and copier toners, by analyzing their source attribution profile (SAP), which consists of the chemical characteristics of the substance itself, plus any traces characteristic of its origin or its processing.

This analysis relies on a variety of analytical detection techniques that include infrared spectroscopy, scanning electron microscopy, gas chromatography-mass spectrometry, liquid chromatography-mass spectrometry, nuclear magnetic resonance and inductively coupled plasma-mass spectrometry.

Generally, the amount of analytical information collected is too extensive to manually evaluate all of the possible variables and then separate them from unrelated background signals. Multivariate pattern recognition techniques, including principal components analysis (PCA), are useful for source attribution. These techniques can be supervised (looking for an expected pattern) or unsupervised (looking for patterns to emerge). An important feature of the PCA approach is to reduce the dimensionality of the attribution profile from many different variables to three or four independent quantities.

In a recent study, research chemists at Southwest Research Institute (SwRI) investigated dust for its ability to retain source attribution profiles after chemical exposure. The goal was to demonstrate that dust can yield meaningful information for the purpose of source attribution.

Results of the study were published in "Dust as a Collection Media for Contaminant Source Attribution," in the April 2012 edition of *Forensic Science International* (Vol. 217, Issues 1-3, 39-49).

Three sources of acephate, a commercially available organophosphate insecticide used on vegetables and ornamental plants, were investigated as a proof-of-concept model and a substitute for phosphonate-containing chemical warfare agents (CWA). In addition, attribution profiles were created and tested using compounds related to CWAs. Dust was collected from a storage shed and from among particles deposited on carpet, then loaded with distinct chemical profiles using an exposure chamber and aerosolizer. After intervals of one

D018443-4113

Dr. Kristin Favela, a senior research scientist in the Chemistry and Chemical Engineering Division, is an analytical chemist who leads projects and conducts research in areas of demilitarization, homeland security, forensics, environmental chemistry and metabolomics. She is an expert in analytical mass spectrometry and has developed and validated numerous methods now routinely applied.

hour, 24 hours or 72 hours, the dust was extracted and its SAP analyzed by gas chromatography-mass spectrometry (GC-MS) and/or liquid chromatography-tandem mass spectrometry (LC-MS/MS).

Dust: It's everywhere

Dust has several advantages as a collector of SAP information. Dust is ubiquitous in the indoor environment, eliminating the need to have a specific collection device in place at the time of chemical exposure. Collecting dust is uncomplicated. In addition, dust is well documented as an efficient collector of the semivolatile and nonvolatile organic chemicals and metals present in the indoor environment. Prevalent concentrations suggest that house dust is the main source of the exposure of young children to allergens, lead and polybrominated diphenyl ethers (PBDEs). Dust is also a major in-home exposure source for pesticides, polyaromatic hydrocarbons, phthalates, alkylphenols and their ethoxylates, arsenic, cadmium, chromium, mold, endotoxin and bacteria.

Carpeting is a common dust reservoir and an efficient pesticide concentrator. Typically, pesticide concentrations in vacuumed house dust are 10 to 100 times higher than those found in outdoor surface soil.

There is also evidence that dust slows the degradation process of many chemicals as compared to exposure in the open environment. Residues from pesticides discontinued long ago in the U.S. are still found in house dust. Chlordane, banned in 1988, could still be detected in 38 percent of homes that were studied, and dichlorodiphenyltrichloroethane (DDT), discontinued in 1972, turned up in 70 percent of house dust samples collected from 1998 to 2001. Another example is the degradation over time of DDT to dichlorodiphenyldichloroethylene (DDE). The DDT-to-DDE ratio typically found in home dust samples is approximately 5 to 1, while the ratio in soil samples typically registers only about 1.5 to 1.

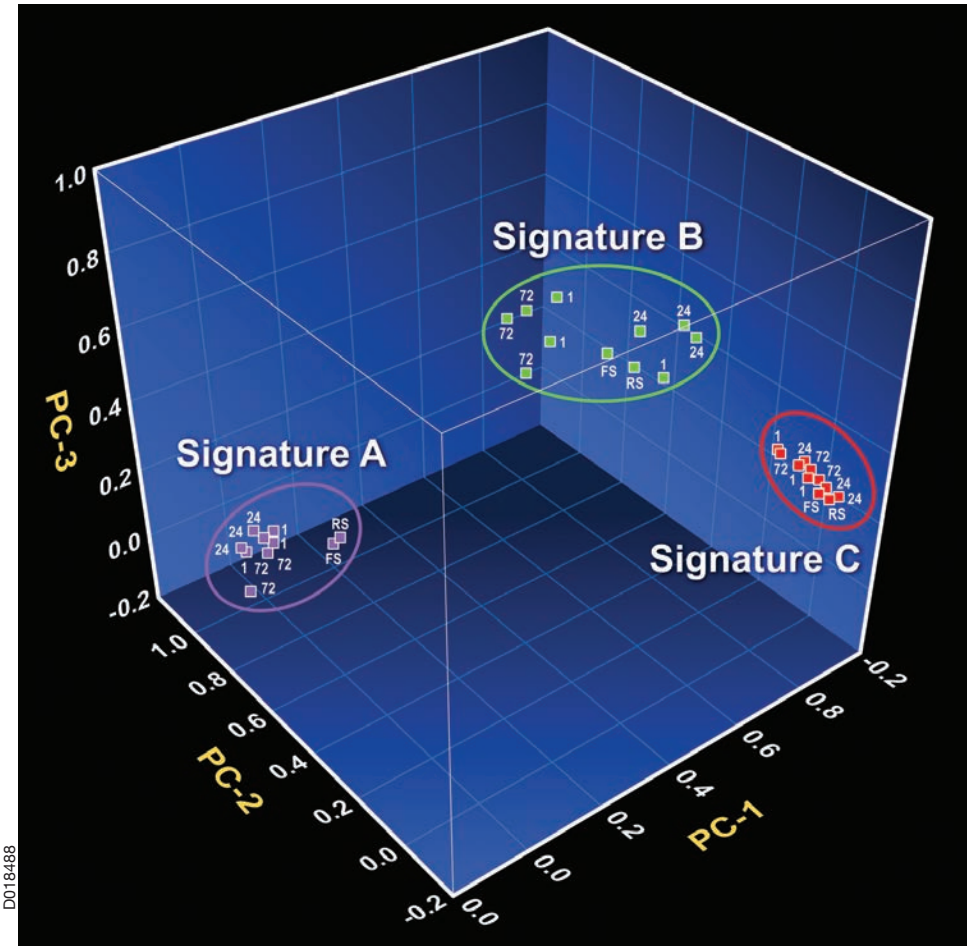
Materials and methods

An exposure chamber consisting of an 18-inch acrylic cube with an open bottom was custom-built for the project. A small fan was affixed to the inside roof of the chamber, and a fixed needle guide was installed through one of the sides of the chamber. The needle guide set the angle of the aerosolizing needle at approximately 40 degrees pointing upward toward the fan. A commercially available microsprayer was customized for the tests.

For exposure experiments approximately 4 milliliters (mL) of the diluted chemical were aerosolized and deposited on a carpet containing residual dust. A fan in the chamber served to direct the aerosol droplets toward the carpet and maintain circulation. The fan, aerosolizing needle, and inside of the exposure chamber were cleaned in between spray solutions.

Dust was collected from two storage sheds located in Pine Bluff, Ark., in quantities of approximately 100 grams from one shed and 300 grams from the other. Dust from the two sheds was blended at a 50:50 ratio for acephate experiments prior to deposition on the carpet. It was blended at a 15:85 (shed 1:shed 2) ratio and deposited onto a carpet purchased from a local hardware store.

SwRI researchers used principal components analysis (PCA) to determine the association of dust exposed to the same and different chemical sources. The results demonstrated that dust samples exposed to distinct chemical sources are clearly differentiated from one another across all collection times. Furthermore, dust samples exposed to the same source can be clearly associated with one another across all collection times. When the CWA-related compounds were subjected to elevated temperature, the signature remained stable at the 1-hour and 24-hour collections. At 72 hours and with elevated temperature, larger deviations were observed for some



Statistical analysis resulted in grouped signatures of three kinds of chemical impurities associated with dust samples containing chemicals similar to those found in chemical warfare agents.

compounds compared to a control sample. Raising the alkalinity (pH 10) also affected the profile, but to a lesser degree than elevated temperature. Overall, dust was found to be an effective medium for the *in situ* collection of source attribution profiles.

Conclusions

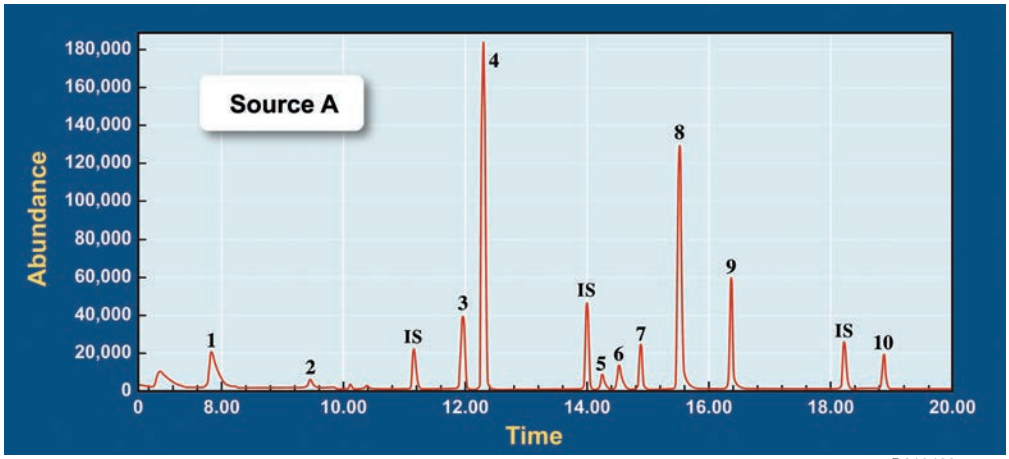
Dust was chosen as a collector medium because it is known to absorb, concentrate and preserve toxic chemicals such as pesticides and polyaromatic hydrocarbons. Results for the systems investigated in this study (acephate and CWA-related compounds) confirm that the fidelity of the SAP is maintained to the extent that, in most cases, PCA correctly grouped the exposed dust according to source.

Extraction methodology was not studied, but developing a universal dust-extraction method that is well-suited for capturing compounds with a range of polarities would improve confidence associated with matching dust extracts to their corresponding source chemicals. If the source chemical is available, extraction efficiency can be measured empirically and the dust extract data corrected accordingly.

The SwRI team demonstrated that the SAP is tolerant to some degree of variability in the analytical data, depending on the extent of underlying differentiation in the sources. In the systems used for the study, most of the variability among the different sources is attributable to three or four individual compounds, and peaks with large relative abundances will influence the PCA results more than those with smaller relative abundances.

A modestly variable analytical response of a compound that has a relatively low abundance, or does not vary significantly among different source chemicals, affects the PCA results only marginally. In a field situation, collecting replicate samples at different time points can be useful to determine which compounds demonstrate a high level of variability as a function of time. Compounds that are determined to be inherently unstable are ultimately not as meaningful and can be excluded from the PCA.

This process of feature selection is important not only in separating the meaningful profiles from those that are variable, but also from those that can be attributed to the background or to other unrelated sources. In practice, background signals can be identified by analyzing a source of dust that has been protected from chemical exposure. Pre-exposure dust, such as that inside a vacuum cleaner found at the scene,



Different impurity profiles (numbered) appear after chemical analysis of two different sources of the same chemical, in this case acephate, an organophosphate pesticide. Note that the relative abundances for the impurities differ, and some impurities, such as No. 3, appear in one sample and not the other.

D018443-4069

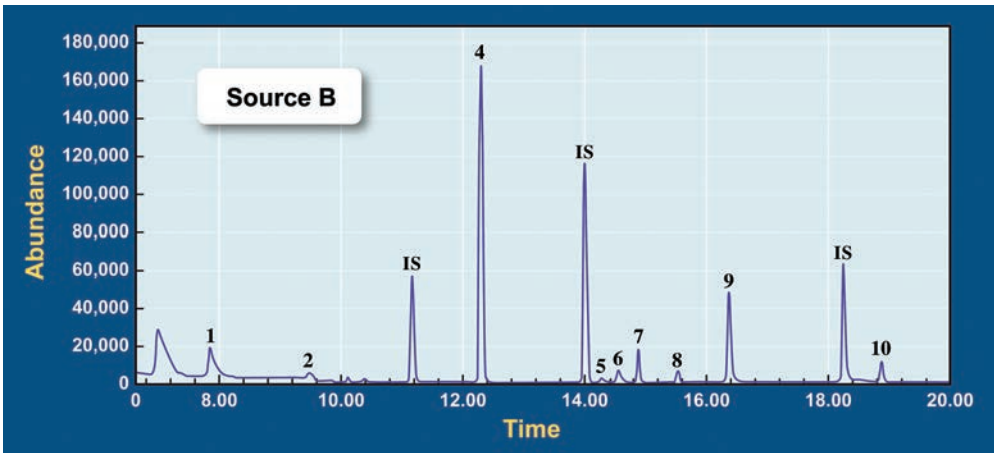
Bill Williamson, a senior research scientist in the Chemistry and Chemical Enginering Division, prepares the gas chromatography/ mass spectrometer instrument for a sample analysis.

is an example of a protected background source.

The SwRI team demonstrated that dust is a promising medium for collecting source-attribution profiles, but some variables still need to be studied. Dust composition and properties can vary widely depending on geographical location and the immediate environment, and the effects of these differences should be studied. Humidity levels also could contribute to the degradation of some chemicals. Furthermore, particle size may play a role in the differential concentration of chemicals. Previous studies have shown that the concentrations of pesticides and polyaromatic hydrocarbons in house dust are much higher among the small inhalable and respirable particles than on larger particles. Despite these remaining areas of study, many variables likely can be mitigated through proper sample collection, storage, preparation and data processing.

The end result is intended to enhance forensic investigations such that samples taken at the scene of a crime or terrorist incident may be collected and analyzed in the laboratory to identify certain unique attributes of the chemicals used to create the incident. Those attributes can then be compared to the chemical signatures of samples of dust collected elsewhere, such as from the home or office of a suspect in the incident. The discovery of significant similarities between the two could be the key to solving what otherwise might be a very difficult criminal investigation.

Questions about this article? Contact Favela at (210) 522-4209 or kristin.favela@swri.org.



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Acknowledgments

The author gratefully acknowledges the contributions to this project of Dr. Jonathan A. Bohmann, a senior research scientist in the Microencapsulation and Nanomaterials Department and William S. Williamson Jr., a senior research scientist in the Environmental and Demilitarization Technology Department, both within the Chemistry and Chemical Engineering Division at Southwest Research Institute. Funding for this project was provided by the Science and Technology Directorate, U.S. Department of Homeland Security.

Aiming for the Stars


D01848677

An SwRI-led team examined the potential for a balloon-borne telescope to acquire and track celestial targets

By Eliot F. Young, Sc.D.

A launch crew prepares a helium balloon (in background) and the instrumented payload gondola for a nighttime launch.

D018478 Courtesy Near Space Corporation

One reason why the Hubble Space Telescope captures the world's imagination with stunning images of our solar system and beyond is the clarity of its images, unimpeded by the effects of atmospheric turbulence. All ground-based telescopes, even the world's largest, located near the 14,000-foot summit of Hawaii's Mauna Kea, are at best halfway to space in terms of the atmosphere that remains overhead. These large telescopes can compete with Hubble in infrared wavelengths, where sophisticated adaptive optics systems can compensate for the distortions caused by the atmosphere, but in visible wavelengths, the Hubble stands alone in its ability to provide clear images with resolutions approaching 1/20th of an arcsecond.

The Hubble Space Telescope represents a significant national resource, both in terms of demand and the cost of its deployment. With the end of NASA's space shuttle program, Hubble is also a time-limited resource, no longer a facility that can be serviced in its low-Earth orbit. Southwest Research Institute (SwRI) planetary scientists and engineers have been investigating less expensive alternatives, such as training astronaut-scientists to use small telescopes onboard spacecraft or launching remote-controlled telescopes on brief, suborbital flights atop sounding rockets.

Space telescope on a budget

An effort led by SwRI scientists and engineers has attempted to bypass the limitations of both expensive orbital platforms and short-term sounding rockets by exploring the feasibility of sending a medium-sized telescope to the very edge of space, at relatively low cost, beneath a balloon capable of long-duration flight. NASA's Balloon Program Office regularly flies large payloads up to 8,000 pounds to altitudes of 120,000 feet for missions lasting from days to several weeks. These payloads operate above 99.5 percent of the Earth's atmosphere, in conditions essentially devoid of turbulence-induced imaging degradation. A simple, inexpensive one-meter telescope in the stratosphere would outperform every ground-based telescope in the visible regime, any night of the year — provided it can reliably acquire and track its target in the sky. Therein lies the key challenge for balloon-based telescopes: A balloon cannot be steered or oriented in a fixed direction, and the payload dangling beneath it can only be stabilized to the degree allowed by its tracking system.

The SwRI-led team began its study of a potential stratospheric balloon-borne telescope by examining the performance

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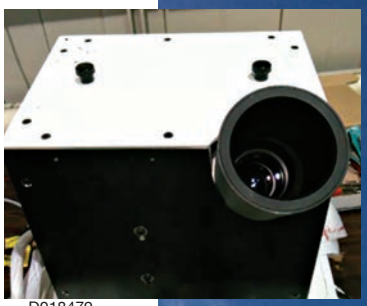
Dr. Eliot F. Young is a principal scientist in the Space Studies Department in SwRI's Space Science and Engineering Division. He is a planetary scientist who, in addition to his research on cold, icy objects in the outer solar system, including Pluto and the Kuiper Belt, also works to develop small, portable observing systems that can be deployed to observe eclipses around the world.

of the systems that would point a 1- or 2-meter telescope and track its targets. The problem generally consists of two parts: assessing the pointing error, and correcting it. Developing a stratospheric platform that can acquire visible wavelength imagery with 0.1 or 0.05 arcsecond resolution is of widespread importance. The goal of the project was to evaluate an existing star tracker as an optical reference source for a balloon-borne pointing error signal. The ST5000 is a star tracker developed at the University of Wisconsin and used in NASA's sounding rocket payloads. To demonstrate the ST5000's suitability for pointing balloon-borne telescopes, the team decided to fly the tracker on a stratospheric balloon. The flight was to address four basic questions: Would the ST5000 work from 120,000 feet? How would it perform? What angular rates of motion might cause it to fail? And finally, could the ST5000 track stars in daytime as well as at night?

With a grant from NASA's Astrophysics Research and Analysis Program (APRA), the SwRI researchers acquired a 500,000-cubic-foot balloon from a commercial provider. The payload consisted of an ST5000 and its enclosure, along with lithium-ion batteries, two phone modems, a VHF data radio and antenna, a solid-state data logger and digital video recorder, an upward-looking video camera, GPS receivers and the required elements of any balloon payload of this size: beacons, a parachute and several redundant termination systems. The entire payload was encased in 2-inch-thick closed-cell foam, with "legs" to serve as crush pads on landing.

Because the balloon would loom above the payload, the star tracker could not be pointed directly upward; researchers instead oriented it at a fixed elevation angle of 50 degrees (although the angle could not be truly "fixed," because the entire payload gondola was suspended from a 26-foot web harness that was subject to pendulum-like swinging motion).

The balloon was flown beginning at 1:30 a.m. on May 6, 2011, from Madras, Ore. The flight profile called for a two-hour ascent to altitude, a two-hour float beginning at 3:30 a.m. and ending around sunrise, and then a continued observation into the morning to assess the level of sky background light that would cause the tracker to lose its stars. The lack of stabilization in azimuth or elevation made for additional risk for the experiment in terms of whether the payload would experience serendipitous periods of stillness that would let the ST5000 acquire and track stars, and whether it could identify a star field and provide a pointing solution. Because the balloon platform undergoes slow twists in azimuth and pendulum swings in elevation, payload motion had to be modeled to assess the expected noise level in the pointing signal.



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Performance summary and conclusions

During a tracking sequence, the ST5000 system returned yaw and pitch values relative to the orientation at the beginning of the sequence. If the platform were held motionless, the standard deviation in the yaw and pitch signals would tell the quality of the tracker's pointing signal directly. However, because the balloon platform undergoes twists and swings, one representative pointing record indicated several modes in payload motion: a coarse twisting mode with a period close to three or four

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A star tracker telescope (inset) was mounted, along with communications and navigation electronics and batteries, in a balloon-borne gondola.

minutes, a faster mode with a period near 11 seconds, and an even faster mode with a period close to 3.6 seconds. The expected period of a simple 26-foot pendulum is 5.7 seconds, but the harness consisted of four lines with different separations in two axes and the balloon itself effectively added length to the pendulum motion.

The team was interested in determining the fastest angular rate of motion that the ST5000 can accommodate before losing track. Results indicated that the maximum rate of motion before failure was 0.51 degree per second.

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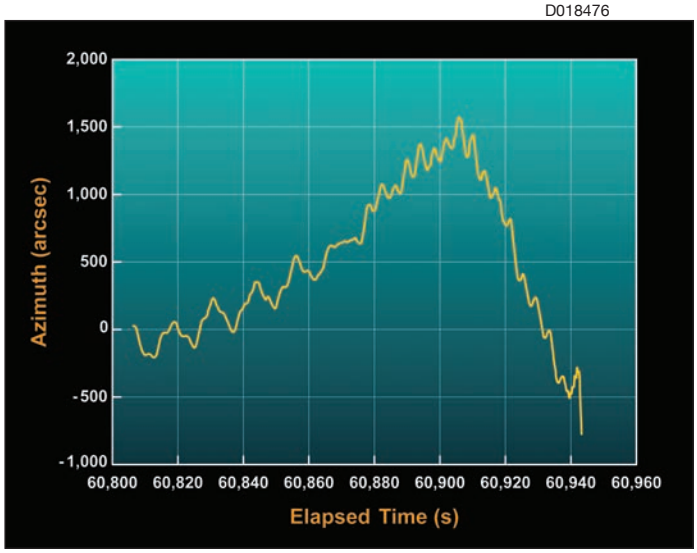

The azimuthal angle of the star tracking scope recorded over a two-minute period indicates a slow twisting mode, along with higher frequencies due to pendulum modes, which, when filtered out, leave errors at the half-arcsecond level.

Results obtained during the flight allowed the team to answer the four questions posed regarding the tracker's potential to serve as a guidance device for balloon-borne telescopes in the Earth's stratosphere.

Would the ST5000 work on a stratospheric balloon platform? Yes. Even with no active platform stabilization, the payload motion was often benign enough to allow the ST5000 to track and identify star fields. In conjunction with a coarse pointing system, the ST5000 could easily provide an error signal to a telescope on target.

At what level would the tracker perform? While it is difficult to separate the motion of the gondola from the performance of the ST5000, the results indicated that the residual scatter in the pointing signals represents the noise level in the tracker's pitch and yaw signals. Filtering out the relatively slow motions of the gondola at frequencies below 1 Hz leaves residual tracking errors at the 0.5 arcsecond level, comparable to the performance on sounding rockets.

What rates of motion would cause the ST5000 to fail to track? Based on rates of rotation observed just before tracking failed, the team calculated that the tracker can operate with motion rates less than 0.5 degree per second. Finally, although models indicated that the ST5000 might be able to track during early daytime, it could not acquire stars beginning at twilight, about 30 minutes before sunrise at altitude. Some stars in grab frames were visible by eye, suggesting that a combination of a red filter and a background light subtraction scheme might extend daytime performance. The observed test performance was surprising, because the team's model of the scattered background light suggested that the flux of background photons decreases by a factor of two for every 5 kilometers of altitude. At float altitudes of 35 kilometers, the sky brightness should be less than 1 percent of the value at sea level.

The tracking telescope succeeded in capturing images of stars during the test flight.

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Future efforts

The fact that the ST5000 worked at nighttime was no surprise; it has worked from space and from the ground. The quality of the pointing signal was commensurate with results from sounding rockets; however, the diffraction level for a one-meter telescope is 0.125 arcsecond. To control a fine steering mirror at the diffraction limit, one needs an error signal at least that good. The balloon-borne ST5000 was close, but still too coarse (errors of 0.24 arcsecond for pitch signal, 0.53 arcsecond for yaw signal) to provide the sole pointing reference for a balloon-borne one-meter telescope.

A new detector and improved foreoptics are being developed to improve the tracker's pointing accuracy and to enable daytime operation. Daytime capability is key for many balloon-borne experiments, especially because NASA's longest flights take place over Antarctica during the December-to-February time frame. Eventually, SwRI planetary scientists hope to use balloons to make extended observations of Venus, Mercury, comets and other daytime targets.

Questions about this story? Contact Young at (303) 546-9670 or eliot.young@swri.org.

Acknowledgments

This work was funded by NASA's Astrophysics Research and Analysis (APRA) Program. The author gratefully acknowledges coinvestigators Jeffrey Percival and Kurt Jaehnig (University of Wisconsin); Russell Mellon (Equinox Interscience); Jack Fox (consultant); and Tim Lachenmeier, Brian Oglevie and Matt Bingenheimer (Near Space Corporation). Results of this study appear in *"Sub-Arcsecond Performance of the ST5000 Star Tracker on a Balloon-Borne Platform,"* Young, *et al.,* published in the proceedings of the IEEE Aerospace Conference, March 2012.

TECHNICS

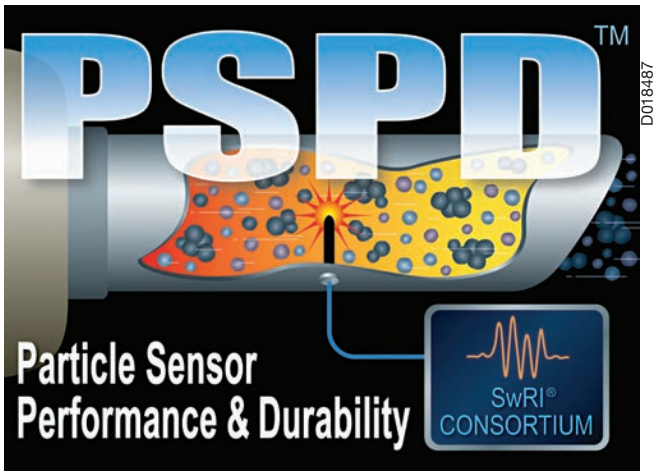
Brief notes about the world of science and technology at Southwest Research Institute

SwRI launches Particle Sensor Performance and Durability consortium

Southwest Research Institute (SwRI) has launched a cooperative research consortium to investigate the performance and durability of particle sensors designed for onboard diagnostics and diesel engine emissions control.

Sensors that trigger an engine malfunction illumination light (MIL) or a fault code when particle emissions exceed a certain threshold downstream of an exhaust diesel particle filter (DPF) will soon be required to meet California Air Resources Board and U.S. Environmental Protection Agency onboard diagnostics regulations. Particle sensors assess how well particle filters keep particulate matter from being emitted to the atmosphere, in compliance with emissions regulations.

While many potentially usable sensors available in the marketplace today target onboard diagnostics and engine-control applications, more knowledge is needed about how these particle sensors perform in engine-exhaust applications where temperature, flow and particle characteristics change under different engine operating conditions.



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The Particle Sensor Performance and Durability (PSPD) consortium will investigate how particle sensors perform under different exhaust parameters, including temperature, velocity, size distribution, number and mass concentration. Particle sensors are expected to become a critical onboard diagnostic (OBD) component for detecting particle emissions failure from downstream of an exhaust DPF. However, it is equally critical that these sensors prove they can perform their tasks before they are launched on a commercial scale. SwRI will capitalize on its knowledge and expertise in the area of engine and particle science and technology to conduct this work.

"Before particle sensors are installed on vehicles in large numbers, we need to get a great deal more information on how effective they are in measuring particulate matter," said Dr. Imad A. Khalek, a senior program manager in SwRI's Engine, Emissions and Vehicle Research Division who leads the newly formed consortium. "This consortium will help the industry determine whether certain particle sensors are sensitive to changes in particle size, number, surface area, volume, mass, charge and morphology. It will also help determine how durable and repeatable they are in the harsh exhaust environment."

Test data produced by the consortium will free resources of orignal equipment manufacturers, allowing them to concentrate on product development rather than performing particle-sensor assessments.

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Marty named vice president of SwRI's Fuels and Lubricants Research Division

Steven D. Marty has been promoted to vice president of the Fuels and Lubricants Research Division at Southwest Research Institute. He was previously director of the Fuels and Lubricants Technology Department.


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Marty became an SwRI staff member in 1991 after receiving his undergraduate degree in mechanical engineering.

During his more than 20 years at SwRI, he has been involved in lubricants research for gear, automatic transmission and hydraulics, as well as fuels research and fleet testing for both commercial and military applications.

He became manager of the Specialty Fluids Section in 1999 and assistant director of the Fuels and Lubricants Technology Department in 2001. He was named department director in 2003.

As director, his responsibilities included the U.S. Army Tank Automotive, Research, Development and Engineering Center (TARDEC) Fuels and Lubricants Research Facility, a government-owned, contractor-operated facility responsible for supporting the warfighter's needs as regards present and future fuels and lubricants.

In his new role as vice president, he will oversee a staff of more than 400 employees in four departments responsible for one of the Institute's long-established programs, serving clients worldwide.

Marty holds a bachelor's degree in mechanical engineering from the Milwaukee School of Engineering and a master's degree in mechanical engineering from The University of Texas at San Antonio. He is a registered professional engineer in the state of Texas.

Marty is a member of the Association of the United States Army, the National Defense Industrial Association, the Society of Automotive Engineers, the American Society for Testing and Materials, and the Tau Beta Pi Engineering Honor Society.

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New IBEX data show heliosphere's long-theorized bow shock is missing

New results from NASA's Interstellar Boundary Explorer (IBEX) reveal that the bow shock, widely accepted by researchers to precede the heliosphere as it plows through tenuous gas and dust from the galaxy, does not exist.

According to a paper published in the journal *Science* online, the latest refinements in relative speed and local interstellar magnetic field strength prevent the heliosphere, the magnetic "bubble" that cocoons Earth and the other planets, from developing a bow shock. The bow shock would consist of ionized gas or plasma that abruptly and discontinuously changes in density in the region of space that lies straight ahead of the heliosphere.

"The sonic boom made by a jet breaking the sound barrier is an earthly example of a bow shock," said Dr. David McComas, principal investigator of the IBEX mission and assistant vice president of the Space Science and Engineering Division at Southwest Research Institute (SwRI). "As the jet reaches supersonic speeds, the air ahead of it can't get out of the way fast enough. Once the aircraft hits the speed of sound, the interaction changes instantaneously, resulting in a shock wave."

For about a quarter century, researchers believed that the heliosphere moved through the interstellar medium at a speed fast enough to form a bow shock. IBEX data have shown that the heliosphere actually moves through the local interstellar cloud at about 52,000 miles per hour, roughly 7,000 miles per hour slower than previously thought — slow enough to create more of a bow "wave" than a shock.

"While bow shocks certainly exist ahead of many other stars, we're finding that our Sun's interaction doesn't reach the critical threshold to form a shock, so a wave is a more accurate depiction of what's happening ahead of our heliosphere — much like the wave made by the bow of a boat as it glides through the water," said McComas.

Another influence is the magnetic pressure in the interstellar medium. IBEX data, as well as earlier Voyager observations, show that the magnetic field is stronger in the interstellar medium requiring even faster speeds to produce a bow shock. Combined, both factors now point to the conclusion that a bow shock is highly unlikely.

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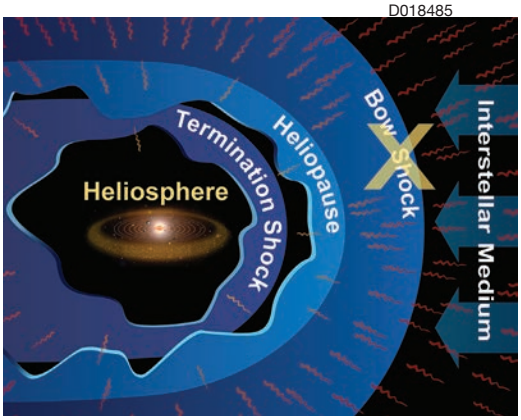

The IBEX team combined its data with analytical calculations and modeling and simulations to determine the conditions necessary for creating a bow shock. Two independent global models — one from a group in Huntsville, Ala., and another from Moscow — correlated with the analytical findings.

"It's too early to say exactly what this new data means for our heliosphere. Decades of research have explored scenarios that included a bow shock. That research now has to be redone using the latest data," says McComas. "Already, we know there are likely implications for how galactic cosmic rays propagate around and enter the solar system, which is relevant for human space travel."

IBEX's primary mission has been to image and map the invisible interactions occurring at the outer reaches of the solar system. Since its launch in October 2008, the spacecraft has also shed new light on the complex structure and dynamics occurring around Earth and discovered neutral atoms coming off the Moon.

Scientists from SwRI; Moscow State University; the Space Research Centre of the Polish Academy of Sciences; University of Bonn, Germany; University of Alabama, Huntsville; and University of New Hampshire were all involved in this study. The paper, "The Heliosphere's Interstellar Interaction: No Bow Shock," was published May 10 in the journal *Science* online, at the Science Express website.

IBEX is the latest in NASA's series of low-cost, rapidly developed Small Explorer space missions. Southwest Research Institute in San Antonio leads the IBEX mission with teams of national and international partners. NASA's Goddard Space Flight Center in Greenbelt, Md., manages the Explorers Program for NASA's Science Mission Directorate in Washington.

Contact McComas at (210) 522-5983 or david.mccomas@swri.org.

SwRI joins international technology innovation alliance in China

Southwest Research Institute (SwRI) has signed an agreement to join Weichai's International Technology Innovation Alliance for Internal Combustion Engine Reliability, organized by Weichai Power Co. Ltd., of China.

The alliance will serve as a communications platform on innovative technology to improve engine reliability and related research and development capabilities.

"Joining the alliance is a great opportunity to expand our presence in China with one of the largest engine manufacturers in the country," said Bruce Bykowski, vice president of SwRI's Engine, Emissions and Vehicle Research Division. "Engine and vehicle development in China is growing at a rapid pace. This alliance should help Weichai address issues in engine development to better serve their market needs."

Weichai's main product line comprises 10- and 12-liter heavy-duty engines. Weichai also has divisions that make truck transmissions and heavy-duty trucks. To fuel international expansion plans, the company is currently building a technology center near Chicago.

SwRI uses a multidisciplinary approach to engine design and development. It conducts research and development in areas including combustion, engines, emissions, transmissions and vehicles. It is internationally known for its fuels and lubricants activities, including components and fluids for on-road, off-road, rail and water-borne transportation systems as well as recreational vehicles and stationary power equipment.

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Southwest Research Institute's Canup elected member of National Academy of Sciences


D018951

Dr. Robin Canup, associate vice president of the Space Science and Engineering Division at Southwest Research Institute (SwRI) and head of SwRI's Boulder, Colo. office, was elected a member of the National Academy of Sciences for her excellence in original scientific research. Membership in the NAS is one of the highest honors given to a scientist or engineer in the United States. Canup will be inducted into the Academy next April during its 150th annual meeting in Washington.

Canup was elected along with 83 others. Currently, there are 2,152 active NAS members. Notable members have included Alexander Graham Bell, Thomas Edison, Albert Einstein, Robert Oppenheimer and Orville Wright. Nearly 200 living Academy members have won Nobel Prizes.

"This is a great honor for Robin and a great honor for Southwest Research Institute," said Dr. Jim Burch, vice president of SwRI's Space Science and Engineering Division. "Robin's research has contributed vastly to a better understanding of the formation of our solar system."

Canup, who joined SwRI in 1998, is well known for her significant contributions to planetary sciences, most notably her studies concerning the formation of planets and their satellites, including her research that demonstrated a single impact from a Mars-sized object could have produced the Earth-Moon system.

Currently, she is a principal investigator for NASA's Origins of Solar Systems and Lunar Advanced Science and Exploration Research Programs, and is a co-investigator in the SwRI-led Center for Lunar Origin and Evolution, one of seven teams of NASA's Lunar Science Institute.

She has received several honors during her career, including the American Astronomical Society Division for Planetary Sciences' Harold Urey Prize (2003) and the American Geophysical Union's Macelwane Medal (2004).

Canup holds a bachelor's degree in physics from Duke University and a master's degree and doctorate in astrophysical, planetary and atmospheric sciences from the University of Colorado at Boulder.

The National Academy of Sciences is a private, nonprofit honor society of distinguished scholars engaged in scientific and engineering research, dedicated to furthering science and technology for the general welfare. Established in 1863, NAS has served to "Investigate, examine, experiment and report upon any subject of science or art" whenever called upon to do so by the government. For more information, visit *www.nasonline.org*.

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Ward named Fellow of American Academy of Arts and Sciences

D018121

Dr. William R. Ward, an Institute scientist in the Planetary Science Directorate at Southwest Research Institute, has been named a Fellow of the American Academy of Arts and Sciences. The 2012 class of inductees includes leaders from academia, business, public affairs, the humanities and the arts. Academy members contribute to Academy publications and studies of science and technology policy, energy and global security, the humanities and culture, and education. As a theoretical dynamicist, Ward has a long history in developing the theory of planet/disk interactions and the resulting migration of planetary orbits, as well as in the formation and dynamical evolution of planetary and satellite systems. He has published more than 100 papers on these and related topics.

Ward is particularly known for helping to formulate the giant impact theory of lunar formation, discovering the oscillations in Mars' polar axis that drive strong martian climate variation over time, and discovering numerous aspects of the complex and subtle dynamical interactions between young planetary objects and gaseous or particle disks.

"William Ward has made many fundamental contributions to our understanding of how planets and satellites form and dynamically evolve," says Dr. Robin Canup, associate vice president of the Planetary Science Directorate. "Multiple aspects of planetary science would be very different today were it not for his groundbreaking research."

Other inductees of the Academy's class of 2012 include Robert P. Colwell, chief architect of Intel's Pentium microprocessors; George F. Bass, a pioneer in underwater archeology; film icons Clint Eastwood and Mel Brooks; U.S. Secretary of State Hillary Rodham Clinton; and Amazon founder Jeff Bezos.

Ward holds bachelor's degrees in mathematics and physics from the University of Missouri (Kansas City) and a doctorate in planetary sciences from the California Institute of Technology. The Division for Planetary Sciences of the American Astronomical Society awarded him the prestigious Kuiper Prize in planetary sciences in 2011. He also received the Brouwer Award from the AAS Division on Dynamical Astronomy in 2004. He is a Fellow of the American Geophysical Union and the American Association for the Advancement of Science.

Ward will be inducted Oct. 6, 2012, at the Academy's headquarters in Cambridge, Mass.

Contact Ward at (303) 546-9670 or ward@boulder.swri.edu.

Technical Staff Activities

Publications

Allegrini F., M. Bzowski, M.A. Dayeh, R. DeMajistre, M.I. Desai, H.O. Funsten, S.A. Fuselier, P.H. Janzen, M.A. Kubiak, D.J. McComas, D.B. Reisenfeld, N. Schwadron and R. Vanderspek. "Exploring the Time Dispersion of the IBEX-Hi Energetic Neutral Atom Spectra at the Ecliptic Poles." *The Astrophysical Journal Letters,* Vol. 749, No. 2, (2012): L41, doi:10.1088/2041-8205/749/2/L41.

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Alger, T., B. Mangold, C. Roberts and J. Gingrich. "The Interaction of Fuel Anti-knock Index and Cooled EGR on Engine Performance and Efficiency." Paper presented at the 2012 SAE World Congress, Detroit, April 2012.

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Allison, T.C. "Reciprocating Compressor Valves." Paper presented at the Striker Communications Compressor and Piping Pulsation Workshop, San Antonio, March 2011.

Allison, T.C. and L.J. Goland. "An FEA-Based Acoustic Fatigue Analysis Methodology." Paper presented at the ANSYS Regional Conference: Engineering the System, Houston, September 2011.

Amann, M. and T. Alger. "Lubricant Reactivity Effects on Gasoline Spark Ignition Engine Knock." Paper presented at the 2012 SAE World Congress, Detroit, April 2012.

Amann, M., T. Alger, B. Westmoreland and A. Rothmaier. "The Effect of Piston Crevices and Injection Strategy on Low-speed Pre-ignition in Boosted SI Engines." Paper presented at the 2012 SAE World Congress, Detroit, April 2012.

Anderson, C.E. Jr., I.S. Chocron and R.P. Bigger. "Constitutive Characterization and Simulations of Penetration into Thick Glass Targets." Paper presented at the 26th International Conference and Exposition on Advanced Ceramics and Composites, Daytona Beach, Fla., January 2012.

Avery, P. and R. Garcia. "Distributed Control in Multi-vehicle Systems." Paper presented at the 2012 Society 3rd International Multi-Conference on Complexity, Informatics and Cybernetics, Orlando, Fla., March, 2012.

Baldor, S.A., P.B. Wood, A.R. Bertrand and D.P. Goes. "A Software Adaptation Layer for Supporting Multiple SpaceWire Plug-and-Play Standardizations." Paper presented at the International SpaceWire Conference 2011, San Antonio, November 2011.

Barth, E.L., W.M. Farrell and S.C.R. Rafkin. "Electric Field Generation in Martian Dust Devils." Paper presented at the European Planetary Science Congress and Division for Planetary Sciences (EPSC-DPS) Joint Meeting 2011, Nantes, France, October 2011.

Barth, E.L., W.M. Farrell and S.C.R. Rafkin. "Modeling Electric Field Generation in Martian Dust Devils." Paper presented at the 43rd Lunar and Planetary Science Conference, The Woodlands, Texas, March 2012.

Bartley, G.J., C.J. Chadwell, T.M. Kostek and R. Zhan. "SCR Deactivation Kinetics for Model-Based Control and Accelerated Aging Applications." Paper presented at the 2012 SAE World Congress, Detroit, April 2012.

Bartley, G.J. and T.M. Kostek. "SCR Deactivation Study for OBD Applications." Paper presented at the 2012 SAE World Congress, Detroit, April 2012.

Bartley, G.J. and C.A. Sharp. "Brief Investigation of SCR High Temperature N_2O Production." Paper presented at the 2012 SAE World Congress, Detroit, April 2012.

Technical Staff Activities

Basagaoglu, H., S. Allwein, S. Succi, R. Montellano, H. Dixon and Z. Feng. "Combined Experimental and Numerical Analysis for Targeted Deliveries of Submicron- to Micron-size Particles in Complex Geometries." Paper presented at the American Society of Mechanical Engineers (ASME) 2011 International Mechanical Engineering Congress and Exposition, Denver, November 2011.

Bayless, A.J., G.R. Gladstone, J.Y. Chaufray, K.D. Retherford, A.J. Steffl, S.A. Stern and D.C. Slater. "The Nightglow Spectrum of Jupiter as Seen by the Alice UV Spectrograph on New Horizons." Paper presented at the European Planetary Science Congress and Division for Planetary Sciences (EPSC-DPS) Joint Meeting 2011, Nantes, France, October 2011.

Bayless, A.J., K.D. Retherford, G.R. Gladstone, S.A. Stern, A.F. Egan, P.F. Miles, J.W. Parker, D.E. Kaufmann, D.G. Horvath, T.K. Greathouse, M.H. Versteeg, A.J. Steffl, J. Mukherjee, M.W. Davis, D.C. Slater, P.M. Rojas, P.D. Feldman, D.M. Hurley, W.R. Pryor and A.R. Hendrix. "Lunar Reconnaissance Orbiter (LRO) Lyman-Alpha Mapping Project (LAMP) Maps of the Permanently Shaded Regions (PSR) at the Lunar Poles." Paper presented at the American Astronomical Society Meeting, Austin, Texas, January 2012.

Beissel, S.R. and T.J. Holmquist. "Numerical Convergence of Ballistic Impacts with Ceramic Targets." Paper presented at the 36th International Conference and Exposition on Advanced Ceramics and Composites, Daytona Beach, Fla., January 2012.

Boice, D. "Coma Models of Comet 103P/Hartley 2 for NASA's EPOXI Spacecraft Encounter." Paper presented at the 11th Asian-Pacific Regional IAU Meeting, Chiang Mai, Thailand, July 2011.

Boice, D. "Modeling Comet 103P/Hartley 2 for the Deep Impact Extended Investigation (DIXI)." Paper presented at the European Planetary Science Congress and Division for Planetary Sciences (EPSC-DPS) Joint Meeting 2011, Nantes, France, October 2011.

Boice, D. "Physical and Chemical Processes in Cometary Comae." Paper presented at the Workshop on Comet Taxonomy, Annapolis, Md., April 2011.

Boice, D. "The Plasma Environment of Comet 19P/Borrelly During the Deep Space 1 Encounter." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Boice, D. and P. Reiff. "Young Engineers and Scientists (YES) — Engaging Teachers in Space Research." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Boice, D. and A. de Almeida. "Prospects for Phosphorus-bearing Molecules in Cometary Comae." Paper presented at the 43rd Lunar and Planetary Science Conference, The Woodlands, Texas, March 2012.

Boice, D. and A. de Almeida. "Where is the Phosphorous in Comets?" Paper presented at the Astrobiology Science Conference, Atlanta, April 2012.

Boice, D. and S. Martinez. "A Physico-Chemical Model of Comet C/2004 Q2 (Machholz)." Paper presented at the Asia Oceania Geosciences Society (AOGS) Meeting, Taipei, Taiwan, August 2011.

Bougher, T., I.A. Khalek, C. Laroo and D. Bishnu. "Determination of the PEMS Measurement Allowance for PM Emissions Regulated under the Heavy-duty Diesel Engine In-use Testing Program." Paper presented at the 2012 SAE World Congress, Detroit, April 2012.

Boyd, J. "Data Integrity/Data Defensibility/ Ethics Training." Paper presented at the 94th TWUA Annual School, Texas Water Utilities Association, Corpus Christi, Texas, March 2012.

Boyd, J. "Ethics in Auditing for the Quality Professional and the Auditee." Paper presented at the 28th SQA Annual Meeting and Quality College, Miami, April 2012.

Boyd, J. "A Good GXP CAPA Program Will Ensure Out of Specification Compliance." Paper presented at the 28th SQA Annual Meeting and Quality College, Miami, April 2012.

Boyd, J., C. Bens and C. Allman. "EPL Archives, Ethics, Misconduct and Fraud, Oh My!" Paper presented at the 28th SQA Annual Meeting and Quality College, Miami, April 2012.

Boyd, J. and B. Galt. "Process Mapping to Increase Auditing Quality and Effectiveness." Paper presented at the 28th SQA Annual Meeting and Quality College, Miami, April 2012.

Boyd, J., N. Lechtman and M.Trapani. "GMP Creep Into GLP." Paper presented at the 28th SQA Annual Meeting and Quality College, Miami, April 2012.

Boyd, J., R. Siconolfi and C. Bens. "BCSS Beyond Compliance Specialty Section, Continual Quality Improvement – Expanding the QA Toolbox Training." Paper presented at the 28th SQA Annual Meeting and Quality College, Miami, April 2012.

Branyon, D. and D. Simpson. "Application of Miller Cycle to the Scuderi Split Cycle Engine (by Turbocharging with a Downsized Compressor Cylinder)." Paper presented at the 2012 SAE World Congress, Detroit, April 2012.

Bredbenner, T.L., R.L. Mason, L. Havill, E. Orwoll and D.P. Nicolella. "Investigating Fracture Risk Classifiers Based on Statistical Shape and Density Modeling and the MrOS Data Set." Paper presented at the 2012 Orthopaedic Research Society (ORS) Annual Meeting, San Francisco, February 2012

Brown, M. "End-to-End Solutions for the Commercial Adoption of V2X Technology." Paper presented at the V2X for Auto Safety & Mobility USA 2012, Novi, Mich., March 2012.

Buckingham, J. "The TV Guide to Volunteering in the ASA." Paper presented at the 2012 American Statistical Association (ASA) Inaugural Conference on Statistical Practice, Orlando, Fla., February 2012.

Burrahm, R. "Automotive Engineering." Paper presented at the Association of Management Annual Conference, San Antonio, August 2011.

Buzulukova, N., M.C. Fok, E.C. Roelof, J.A. Redfern, J. Goldstein, P.W. Valek and D.J. McComas. "Low Altitude Emission Dynamics in Substorms." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Bzowski, M., M.A. Kubiak, E. Moebius, P.A. Bochsler, T. Leonard, D. Heirtzler, H. Kucharek, G.B. Crew, J.M. Sokol, M. Hlond, N.A. Schwadron, S.A. Fuselier and D.J. McComas. "New Neutral Interstellar Helium Flow Parameters Based on IBEX-Lo Observations." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Caldwell, J. M. "Lean Thinking Applied to the Quarry Process." Paper presented at the Quarry Academy 2011, San Antonio, November 2011.

Cheng, X.G., "Development of Amorphous Nanosilver-Chitosan-Collagen Biomaterial as an Antimicrobial Haemostatic Wound Healing Dressing." Paper presented at the MRS Fall Meeting, Boston, November 2011.

Cheng, X.G., B. Antebi and J. Ling. "Electrochemical Aligned Collagen Sheet Cultured with Mesenchymal Stem Cells (MSCs) for Potential Skin Tissue Regeneration Applications." Paper presented at the Tissue Engineering and Regenerative Medicine International Society (TERMIS), Houston, December 2011.

Cheng, X.G., S. Desai, G. Gutierrez, S.T. Wellinghoff, G. Rossini and H. Yu. "Biological Performance of Biodegradable 3D Coated Mg Alloy Bone Scaffold." Paper presented at the Corrosion Conference, Salt Lake City, March 2012.

Cheng, X.G., T. Bredbenner and S. Desai. "Wrapped and Coated Cylindrical Mg Alloy Successfully Repaired Critical Size Bone

Technical Staff Activities

Defect." Paper presented at the Orthopaedic Research Society (ORS) Meeting, San Francisco, February 2012.

Cheng, X.G. and S. Desai. "Preparation of Nanoparticle-containing Aligned Collagen Fibers for Dense Connective Tissue Repair and Regeneration." Paper presented at MRS Fall Meeting, Boston, November 2011.

Cheng, X.G., V. Poenitzsch and R. Bezios. "Controlled Assembly of Carbon Nanotubes with Collagen Using a Novel Electrochemical Process." Paper presented at the MRS Fall Meeting, Boston, November 2011.

Chiang, K.T. and L. Yang. "An Innovative Distributed Node Electrode System for Corrosion Monitoring of Concrete Rebars." Paper presented at the Corrosion 2012 National Association of Corrosion Engineers (NACE) Conference, Salt Lake City, March 2012.

Chocron, I.S., C.E. Anderson Jr., A.E. Nicholls and K.A. Dannemann. "Compression Tests of Boron Carbide and Silicon Carbide Under Moderate Confinement." Paper presented at the 36th International Conference and Exposition on Advanced Ceramics and Composites, Daytona Beach, Fla., January 2012.

Choudary, A., H. Coan, D.P. Nicolella, J. Curran, M. Carless, S. Kumar, J. Kent, L. Almasy, H. Goring, J. Blangero, M. Mahaney and L. Havill. "Genome-wide Transcriptional Profiling Implicates Inflammatory Genes LRP8, IL10RA, LDLR, and PLA2G2 in Osteoarthritis." Paper presented at the 2012 ORS Annual Meeting, San Francisco, February 2012.

Clark, G.B., F. Allegrini, F.J. Crary, P. Louarn, D.J. McComas, C.J. Pollock, P.W. Valek and S. Weidner. "Characterizing the Response of Juno's JADE-E Energy Analyzers in the Presence of Jupiter's Strong Magnetic Field." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Coan, H., A. Choudary, D.P. Nicolella, T. Dyer, J. Curran, M. Carless, K. Kumar, J. Kent Jr., L. Almasy, J. Goring, J. Blangero, M. Mahaney, and L. Havill. "GWAS of Osteoarthritis Biomarkers Serum Hyaluronic Acid and Cartilage Oligomeric Matrix Protein Implicates FOXN4, ETV6, KIAA1217, ZNF521, and CSGALNACTI." Paper presented at the 2012 Orthopaedic Research Society (ORS) Annual Meeting, San Francisco, February 2012.

Conrad, C.A. and K. Davidian. "Industry Structural Analysis of the Emerging Commercial Suborbital Research Market." Paper presented at the Next-Generation Suborbital Researchers Conference, Palo Alto, Calif., February 2012.

Cornell L.E., X.G. Cheng, J. Ong and P.J. Hornsby. "Aligned Carbon Nanotube-Collagen Fibers and Their Use in Guiding Neuron Progenitor Cell Growth." Paper presented at the Tissue Engineering and Regenerative Medicine International Society (TERMIS), Houston, December 2011.

Dante, J.F. "Effect of Relative Humidity on Time of Wetness and Corrosion." Paper presented at the NACE Corrosion Conference, Salt Lake City, March 2012.

Dayeh, M.A. "Imaging the Edge of Our Solar System." Paper presented at the IEEE Power and Energy Society Meeting, Austin Chapter, Austin, Texas, January 2012.

Dayeh, M.A. "Plasma Sheet Structure as Observed by IBEX." Paper presented at the Interstellar Boundary Explorer Science Team Workshop, Physikzentrum, Bad Honnef, Germany, March 2012.

Dayeh, M.A. "Spectral Properties of ENA Sky Maps and the Effects of Fast and Slow Solar Wind." Paper presented at the Interstellar Boundary Explorer Science Team Workshop, Physikzentrum, Bad Honnef, Germany, March 2012.

Dayeh, M.A., F. Allegrini, M.I. Desai, R. DeMajistre, H.O. Funsten, P.H. Janzen, D.J. McComas, B.M. Randol, D.B. Reisenfeld, N.A. Schwadron and R. Vanderspek. "Investigating the Polar Spectra in IBEX's ENA Sky Maps." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Dayeh, M.A., D.J. McComas, F. Allegrini, B. DeMajistre, M.I. Desai, H.O. Funsten, P. Janzen, G. Livadiotis, B.M. Randol, D.B. Reisenfeld, N.A. Schwadron and R. Vanderspek. "Investigating the Polar Spectra in IBEX's Global ENA Sky Maps." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

DeForest, C.E. and T.A. Howard. "Imaging the Solar Wind in the Corona and Heliosphere." Paper presented at the From the Heliosphere Into the Sun Meeting, Bad Honnef, Germany, February 2012.

DeForest, C.E., T.A. Howard and W.H. Matthaeus. "Imaging the Turbulent Solar Wind with STEREO/SECCHI." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Demajistre, R., R.B. Decker, H.O. Funsten, P.H. Janzen, S.M. Krimigis, D.J. McComas, D.B. Reisenfeld, E.C. Roelof, N.A. Schwadron, and R. Vanderspek. "The 2010 Transient Events in the Heliosheath – Comparing the Observations of IBEX and the Voyagers." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Desai M.I., F.A. Allegrini, M.A. Dayeh, R. DeMajistre, H.O. Funsten, J. Heerikhuisen, P.H. Janzen, D.J. McComas, N. Pogorolev, N.A. Schwadron and R. Vanderspek. "Spectral Properties of Energetic Neutral Atoms Measured by IBEX and their Implications for the Microphysics of the Termination Shock." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Desai, M.I., M.A. Dayeh, R.W. Ebert, G, Li, C.W. Smith and G.M. Mason. "Understanding the Physical Links Between Energetic Storm Particle (ESP) Events and Large Gradual Solar Energetic Particle (SEP) Events." Paper presented at the 11th Annual International Astrophysics Conference, Space Weather: The Space Radiation Environment, Palm Springs, Calif., March 2012.

Dinwiddie, C.L., R.N. McGinnis, D.E. Stillman, R.E. Grimm and K.L. Bjella. "Late-Winter Phase State of Water in the Great Kobuk Sand Dunes, Alaska, and Testable Hypotheses for a Perching Mechanism." Paper presented at the 5th Mars Polar Science Conference, Fairbanks, Alaska, September 2011.

Dinwiddie, C.L., S.A. Stothoff and M. Necsoiu. "A Slope Stability Hazard Ranking Algorithm and Case Study for Permafrost Terrain." Paper presented at 2nd Symposium on Mountain and Arid Land Permafrost, Ulaanbaatar, Mongolia, August 2011.

Ebert, R.W., F. Allegrini, M.A. Dayeh, M.I. Desai, J.M. Jahn, R. Michell, K. Ogasawara and M. Samara. "Potential Science Targets Using Suborbital Spacecraft." Paper presented at the Next-Generation Suborbital Researchers Conference, Palo Alto, Calif., February 2012.

Ebert, R.W., M.A. Dayeh, M.I. Desai and G.M. Mason. "CIR-Associated Suprathermal Helium Ion Enhancements at 1 AU: Evidence of Local Acceleration at the Compression Region Boundary." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Edwards, S.M. and W.C. Flannigan. "ROS-Industrial — Accelerating Research to Applications." Paper presented at the Robotics Industries Association Annual Industry Forum, Orlando, January 2012.

Elliott, H.A., J.M. Jahn, D.J. McComas and C.J. Henney. "Statistical Analysis of Solar Wind Parameters Relevant to Space Weather Predictions." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Evans, P.T. "Technology Readiness for Randomized Bin Picking Solutions." Paper presented at the 2012 Performance Metrics for Intelligent Systems Workshop, Hyattsville, Md., March 2012.

Technical Staff Activities

Evans, P.T. and G.R. Bartlett. "Concept Development and Basic Fabrication Techniques." Paper presented at the Alamo Inventors Meeting, San Antonio, April 2012.

Feng, M. and J. Erwin. "Hydrotreating of Bio-oils to Jet Fuels: An Overview." Paper Presented at the 2012 AIChE Spring Conference, Houston, April 2012.

Feng, M. and C.K. Tan. "Glycerol to Oxygenates and Chemicals in Supercritical Fluids." Paper presented at the 2012 AIChE Spring Conference, Houston, April 2012.

Flannigan, W.C. "Industrial Robotics: Recent Advancements in Sensing, Software, Mobility, and Safety that are Driving Innovation." Paper presented at the International Association of Drilling Contractors (IADC) Drilling Systems Automation Workshop, San Diego, March 2012.

Flannigan, W.C. "Laser-based Paint Removal for Sustainable Maintenance." Paper presented at the 2011 Defense Manufacturing Conference (DMC), Anaheim, Calif., November 2011.

Frisch, P.C., A. Berdyugin, R. Demajistre, H.O. Funsten, D.J. McComas, M. Magalhaes, V. Piirola, D.B. Reisenfeld, N.A. Schwadron, J.D. Slavin, D. Seriacopi and B. Andersson. "Interstellar Magnetic Field: Comparing Directions from the IBEX 'Ribbon' and Stellar Polarizations." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Frisch, P.C., A. Berdyugin, R. Demajistre, H.O. Funsten, M. Magalhaes, D.J. McComas, V. Piirola, D.B. Reisenfeld, N.A., Schwadron, J.D. Slavin and B. Andersson. "The Nature of the Local Interstellar Magnetic Field from IBEX and Polarization Data." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Fuselier, S.A., F. Allegrini, H.O. Funsten, A.G. Ghielmetti, G. Gloeckler, D. Heirtzler, P.H. Janzen, H. Kucharek, D.J. McComas, E. Moebius, T.E. Moore, S.M. Petrinec, M. Quinn, D.B. Reisenfeld, L.A. Saul, J. Scheer, N.A. Schwadron, K.J. Trattner, R. Vanderspek and P. Wurz. "IBEX Heliospheric Neutral Atom Energy Spectra Between 0.01 and 6 keV." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Garcia-Hernandez, A.J. and K. Brun. "Natural Gas Pipeline System Optimization." Paper presented at the *Hidrocarburos del Congreso Internacional*, Guadalajara-Jalisco, Mexico, February 2012.

Gladstone, G.R., K.D. Retherford, S.A. Stern, A.F. Egan, P.F. Miles, M.H. Versteeg, D.C. Slater, M.W. Davis, J.W. Parker, D.E. Kaufmann, T.K. Greathouse, A.J. Steffl, J. Mukherjee, D.G. Horvath, P.M. Rojas, P.D. Feldman, D.M. Hurley, W.R. Pryor and A.R. Hendrix. "The Moon's Permanently Shadowed Regions as Observed by Lunar Reconnaissance Orbiter (LRO) Lyman Alpha Mapping Project (LAMP) Instrument." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Glenar, D., T. Stubbs, S.A. Stern, K.D. Retherford, P.D. Feldman, et al. "Optical Scattering by Lunar Exospheric Dust: What Could be Learned from Lunar Reconnaissance Orbiter (LRO) Lyman Alpha Mapping Project (LAMP) and Lunar Atmosphere Dust Environment Explorer Ultraviolet Spectrograph?" Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Goldstein, J., P.W. Valek, D.J. McComas and J.A. Redfern. "TWINS Observations of Ring Current Anisotropy." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Grimes, E.W., J.C. Denison Jr., J.J. McCord, J.D. Perez, J. Goldstein, D.J. McComas, P.W. Valek and B.J. Anderson. "Ring Current Pressure Profiles During Geomagnetic Storms as Observed by TWINS." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Hamilton, V.E., M.L. McDowell, J.A. Berger, S.L. Cady and L.P. Knauth. "Linking Spectral Features with Composition, Crystallinity, and Roughness Properties of Silica and Implications for Candidate Hydrothermal Systems on Mars." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Hamilton, V.E. and A.D. Rogers. "Martian Surface Geochemistry From MGS TES: Evidence of Global-scale Dissolution of Olivine from Basalts." Paper presented at the 2011 Goldschmidt Conference, Prague, Czech Republic, August 2011.

Harris, J.N., M. Aranguren, X.G. Cheng, B. Antebi and J. Ling. "Collagen and Polycaprolactone Composite Scaffold for Tissue Engineering." Paper presented at the Tissue Engineering and Regenerative Medicine International Society (TERMIS), Houston, December 2011.

Harris, J., M. Feng and R. Zhan. "Computational Fluid Dynamics Modeling of Different Structured Reactor Packing for Process Intensification." Paper presented at the 2012 AIChE Spring Conference, Houston, April 2012.

He, X. "Corrosion of Titanium Grades 7 and 29 under Dripping of Seepage Water." Paper presented at the NACE International Conference, Salt Lake City, March 2012.

He, X., T. Ahn and T. Sippel. "Corrosion of Borated Stainless Steel in Water and Humid Air." Paper presented at the NACE International Conference, Salt Lake City, March 2012.

Hooper, D.M. and K.J. Smart. "Morphometric Analysis of a Subset of Landslides in Valles Marineris, Mars." Paper presented at the 43rd Lunar and Planetary Science Conference, The Woodlands, Texas, March 2012.

Hooper, D.M., C.L. Dinwiddie, R.N. McGinnis, K.J. Smart and M.M. Roberts. "Debris Flow Gullies at the Great Kobuk Sand Dunes, Alaska: Implications for Analogous Features on Mars." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Hooper, D.M., C.L. Dinwiddie, R.N. McGinnis, K.J. Smart and M.M. Roberts. "Observations of Debris Flows at the Great Kobuk Sand Dunes, Alaska: Implications for Analogous Features on Mars." Paper presented at the 43rd Lunar and Planetary Science Conference, The Woodlands, Texas, March 2012.

Howard, T.A., C.E. DeForest, A.A. Reinard and S.J. Tappin. "Flux Ropes and Small-scale Interplanetary Transients — New Revelations From STEREO/SECCHI." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Hurley, D., R. Gladstone, K.D. Retherford, S.A. Stern, P. Feldman, W. Pryor, K. Hibbitts, C. Ernst, R. Vervack, et al. "Toward Understanding the Distribution and Abundance of Volatiles at the Lunar Poles." Paper presented at the NASA Lunar Science Forum, Moffett Field, Calif., July 2011.

Jackson, W., C. Lam, X. Shi, H. Huang, A. Cochran and D. Boice. "Spectral Simulation Analysis of the Keck HIRES Data from the Deep Impact Encounter." Paper presented at the AOGS Meeting, Taipei, Taiwan, August 2011.

Jahn, J.M., M.A. Dayeh and H.A. Elliott. "Midtail Response to Solar Wind Energy Input: A Cross-Sectional View." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Jahn, J.M., M.A. Dayeh and H.A. Elliott. "The Dynamic Plasmasheet." Paper presented at the Interstellar Boundary Explorer Science Team Workshop, Physikzentrum, Bad Honnef, Germany, March 2012.

Janzen, P.H., R. Demajistre, H.O. Funsten, D.J. McComas, D.B. Reisenfeld and N.A. Schwadron. "Noise, Backgrounds, and Efficiency of the IBEX-Hi Sensor over Time." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Killough, R.L. "Challenges in Securing and Utilizing Space Assets." Paper presented at the Cyber Applications for Space Session of the Air Force Space Command Cyber Vision 2025 Summit, Peterson AFB, Colo., March 2012.

Technical Staff Activities

Killough, R.L. "Smart Grids, Smart Sensors, and Smart Phones." Paper presented at Texas Tech University Electrical and Computer Engineering for Graduate Students, Lubbock, Texas, February 2012.

Kirchoff, M.R., K.M. Sherman and C.R. Chapman. "Preliminary Results on the Evolution of Small Crater Populations on the Moon." Paper presented at the Early Solar System Bombardment II Workshop, Houston, February 2012.

Klar, R.A., D.P. Goes, P.B. Wood and S.A. Baldor. "Performance of SpaceWire Plug-and-Play Protocols." Paper presented at the International SpaceWire Conference 2011, San Antonio, November 2011.

Laiche, E.C. and N. Amir. "Tube Inspection Using Acoustic Pulse Reflectometry — A Detailed Evaluation." Paper presented at the ASNT Spring 2012 Conference, Dallas, March 2012.

Leonard, T., E. Moebius, P.A. Bochsler, M. Bzowski, S.A. Fuselier, D. Heirtzler, M.A. Kubiak, H. Kucharek, M.A. Lee, D.J. McComas, L.A. Saul, N.A. Schwadron, X. Wu and P. Wurz. "Maximum Likelihood Fitting of the Interstellar Neutral Gas Flow as Observed by IBEX for Comparison with Analytical Modeling." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Livadiotis, G. and D.J. McComas. "Non-equilibrium Transitions of Heliospheric Plasma." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Loomis, J.G. "White Hat Hacking the Smart Grid." Paper presented at the Embedded Systems Conference Silicon Valley, San Jose, Calif., March 2012.

Martinez, J. and J. Rodriguez. "SunGuide Reversible Lanes Implementation." Paper presented at the Institute of Transportation Engineers Student Chapter Meeting at Florida International University, Miami, March 2012.

Mason, G.M., M.I. Desai and G. Li. "Solar Cycle Heavy Ion Abundance Variations in CIRs." Paper presented at the 11th Annual International Astrophysics Conference, Space Weather: The Space Radiation Environment," Palm Springs, Calif., March 2012.

McClung, R.C. and V. Bhamidipati. "An Investigation of Small-crack Effects in Various Aircraft Engine Rotor Materials." Paper presented at the 2012 Propulsion-Safety and Affordable Readiness (P-SAR) Conference, Jacksonville, Fla., March 2012.

McClung, R.C., Y.D. Lee, K.S. Chan, M.P. Enright and S. Fitch. "Methods for Temperature Effects in Probabilistic Damage Tolerance Analysis." Paper presented at the 2012 Propulsion-Safety and Affordable Readiness (P-SAR) Conference, Jacksonville, Fla., March 2012.

McComas, D.J. "A Brief Summary of IBEX Observations of the Heliospheric Interaction." Paper presented at the Cosmic Ray Anisotropy Workshop 2011, University of Wisconsin, Madison, Wis., October 2011.

McComas, D.J. "IBEX Mission Update: New Discoveries and a New Orbit." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

McComas, D.J. "The Interstellar Boundary Explorer (IBEX)." Paper presented at the American Association of Physics Teachers 2012 Conference, Ontario, Calif., February 2012.

McComas, D.J. "Update on IBEX and the Outer Boundary of the Space Radiation Environment." Paper presented at the 11th Annual International Astrophysics Conference, Palm Springs, Calif., March 2012.

McComas, D. J., F. Allegrini, M. Bzowski, P. Frisch, M.A. Dayeh, R. DeMajistre, H.O. Funsten, S.A. Fuselier, P. Janzen, M.A. Kubiak, E. Moebius, D.B. Reisenfeld and N.A. Schwadron. "Our Evolving Heliosphere: The First Three Years of IBEX Observations." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

McGrath, M.A., X. Jia, P.D. Feldman, D.F. Strobel, K.D. Retherford and J. Saur. "Aurora on Ganymede." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Meldolesi, R. "Scuderi Split Cycle Engine: Air Hybrid Vehicle Powertrain Simulation Study." Paper presented at the 2012 SAE World Congress, Detroit, April 2012.

Mitchell, D.G., D.J. McComas, H.O. Funsten and M.A. Dayeh. "Remote Imaging of the Magnetotail Current Sheet Using Energetic Neutral Atoms: A Search for Dawn-Dusk Asymmetry in Apparent Intensity." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Mitchem, S.C. "Factoring User Experience into Mobile Application Security." Paper presented at the Spring 2012 Software Assurance Forum, McLean, Va., March 2012.

Moebius, E., P.A. Bochsler, M. Bzowski, H.O. Funsten, S.A. Fuselier, D. Heirtzler, M.A. Kubiak, H. Kucharek, M.A. Lee, T. Leonard, D.J. McComas, L.A. Saul, N.A. Schwadron, D. Valovcin, X. Wu and P. Wurz. "Observation of Secondary O in the Interstellar Neutral Gas Flow with the Interstellar Boundary Explorer (IBEX)." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Necsoiu, M., D. Hooper, C. Dinwiddie, N. Longépé, S. Leprince, S. Stothoff and R. McGinnis. "Contributions to Monitoring Permafrost Landscapes Using ALOS Satellite Data: Calibration Requirements For ALOS-2." Paper presented at the 2nd Symposium on Mountain and Arid Land Permafrost, Ulaanbaatar, Mongolia, August 2011.

Necsoiu, M., M. Lewis, J. Parra, S. Ackley, B. Weissling and P. Hwang. "Antarctic Sea Ice Thickness from Surface Elevation: A Multi-Sensor Approach." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Ni, Q.W. and S. Chen. "Assessment of Effect of Matrix Metalloproteinase-9 on the Growth of Mice Teeth." Paper presented at the American Society of Mechanical Engineers (ASME) Summer Bioengineering Conference (SBC 2011), Farmington, Pa., June 2011.

Nicolella, D.P., T.D. Eliason, W.L. Francis and B.J. Bichon. "Dynamic Finite Element Modeling of Knee Mechanics." Paper presented at the 2012 Orthopaedic Research Society (ORS) Annual Meeting, San Francisco, February 2012.

Ogasawara, K., S.A. Livi, M.I. Desai, F. Allegrini and D.J. McComas. "The Potential Capability of Solid State Devices to Detect Suprathermal Solar-wind Plasmas." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Osidele, O., R. Green and A. Sun. "Impacts of Climate and Land Use Change on Streamflow and Nutrient Loading in the Arroyo Colorado Watershed in Southern Texas." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Ostrowski, G., G.D. Neely, C.J. Chadwell and P. Wetzel. "Downspeeding and Supercharging a Diesel Passenger Car for Increased Fuel Economy." Paper presented at the 2012 SAE World Congress, Detroit, April 2012.

Pan, Y., X. He, L. Tipton, R. Einziger and H. Gonzalez. "Development and Evaluation of Cask Demonstration Options." Paper presented at the Extended Storage and Transportation Collaboration Program Meeting, Charlotte, N.C., December 2011.

Payan, A., C. Paty and K.D. Retherford. "Uncovering Local Magnetospheric Processes Governing the Variability of Ganymede's Aurora Using 3-D Multi-Fluid Simulations of Ganymede's Magnetosphere." Paper presented

at the Magnetospheres of the Outer Planets Meeting, Boston, July 2011.

Payan, A., C. Paty, K.D. Retherford and B. Bonfond. "Using 3-D Multi-Fluid Simulations to Investigate the Periodicity of the Auroral Brightness at Ganymede and its Dependence on Precipitating Particle Temperatures." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Perez, J.D., A. Blumenthal, E. Lauritson, E.W. Grimes, J. Goldstein, D.J. McComas, P.W. Valek and V. Angelopoulos. "Ring Current Energy Spectra During Geomagnetic Storms as Observed by TWINS." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Perez, T., H. Xie, A. Sun and O. Osidele. "Developing Land-Use, Land Cover Maps for the Arroyo Colorado Study Area for 2001 and 2008." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Peterson, J.G., N. Schwadron, C. Reno, J.P. Carrico Jr., K. Fairchild, R. Vanderspek and R. DeMajistre. "Science Operation for the Orbit Change on the Interstellar Boundary Explorer (IBEX) Mission." Paper presented at the IEEE Aerospace Conference, Big Sky, Mont., March 2012.

Pogorelov, N.V., S.N. Borovikov, R.W. Ebert, J. Heerikhuisen, T. Kim, I.A. Kryukov, S.T. Suess, S.T. Wu and G.P. Zank. "Data-driven Modeling of the Heliosphere." Paper presented at the 2011 AGU Fall Meeting, San Francisco, December 2011.

Pravec, P., P. Scheirich, D. Vokrouhlicky, A.W. Harris, P. Kusnirak, K. Hornoch, D.P. Pray, D. Higgins, A. Galad, J. Vilagi, S. Gajdos, L. Kornos, J. Oey, M. Husarik, W.R. Cooney Jr., J. Gross, D. Terrell, R. Durkee, J. Pollock, D. Reichart, et al. "Anisotropic Distribution of Orbit Poles of Binary Asteroids." Paper presented at the EPSC-DPS Joint Meeting, Nantes, France, October 2011.

Putzig, N.E., B.A. Campbell, R.J. Phillips and M.T. Mellon. "SHARAD Sounding and Surface Roughness of Once and Future Mars Landing Sites." Paper presented at the 43rd Lunar and Planetary Science Conference, The Woodlands, Texas, March 2012.

Rafferty, W.J. "Partnering Opportunities." Paper presented at the Winning Small Business Innovation Research (SBIR)/Small Business Technology Transfer (STTR) Awards Event, San Antonio, December 2011.

Rafkin, S.C.R. "Non-local Deep Transport in Terrestrial Planetary Atmospheres: Earth, Mars, Venus, and Titan." Paper presented at the EPSC-DPS Joint Meeting, Nantes, France, October 2011.

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