Newsletter

College of Physical and Mathematical Sciences

April/May 2006

Wild Ride on Vomit Comet

BYU students conduct weightless experiment aboard NASA plane

Deseret Morning News

By: Jeremy Twitchell

May 11, 2006

NASA has a long history of christening its space vehicles and projects with noble names. So it may surprise some to look down a list of NASA-sponsored projects and see the name "Vomit Comet" jump off the page.

And although it may sound like a low-budget ride in a traveling carnival, a group of Brigham Young University students who recently rode it will tell you that the Vomit Comet is, in fact, a state-of-the-art scientific tool.

Brigham Young University Physics student Jacob Campbell

Four BYU undergraduates were able to conduct research on lasers in the zero-gravity environment created by the Vomit Comet, which is a modified KC-135 transport jet that travels in a series of high-speed arcs, creating 25-second periods of weightlessness as it goes into a free fall at the top of each arc.

The jet was used in the filming of the movie "Apollo 13" but had already drawn its infamous name from its penchant for making researchers, well, you know.

That aside, however, the students said it was an incredible experience.

"It was really very different; everything is really effortless," said Nathan Powers, who made the trip one of his last experiences as a student before graduating last month. "Everything is really easy to do, except stand up straight. Other than that, you can just push off the cabin and float across it."

Matthew Turner, Jacob Campbell and Krystle Farnsworth were the other three members of the student research team.

"I'm not sure I can explain it because it's not like anything else you've ever experienced," Farnsworth said. "It's really amazing; you're just floating, and it's like nothing else."

Farnsworth said the first two free falls were disorienting, but once she and her fellow students got used to the sensation, they were able to make the most of the next 18 "dives."

Powers declined the motion sickness pill he was offered, because he was afraid it would interfere with his concentration, a decision that had mixed results.

"When we went into our first dive, everything got flipped inside my head and it looked like everyone else was upside down," he said.

The BYU team was investigating the phenomenon of tiny, dust-size particles that become trapped in laser beams. The commonly held belief has been that heated air, caused by the beam, created convection currents that kept the particles suspended.

However, convection can only exist when gravity is present, and smaller-scale experiments had led the BYU team to believe that the particles would still be suspended in a zero-gravity environment.

When professors suggested that the students needed a longer period of zero-gravity, Powers immediately thought of the Vomit Comet, which he had been wanting to experience since learning about it in high school physics.

The team wrote a proposal last fall, was selected to participate in January, and had less than two months to design and build an experiment before taking the flight March 30.

"During those last few weeks, every hour we had, we were working on our setup and conducting our preliminary experiments," Powers said.

He also had to cut his honeymoon short — he was married just the week before his trip — but said his new wife, Stacie, was excited and supportive, and made the trip to Texas to get the NASA experience, if only from the ground.

The team's experiment concluded that particles are still trapped in laser beams at zero gravity, closing the door on one erroneous theory, but opening the door on much more work as team members now want to know why.

For Powers, that means graduate work with the world's strongest pulse laser at the University of Nebraska, where he will begin attending on scholarship in the fall. For the three remaining team members, a return trip on the Vomit Comet would be welcome.

In this issue:

BYU TO HOST 31ST ANNUAL SUMMER INSTITUTE OF APPLIED STATISTICS JUNE 21-23 IN 1170 TMCB

Early registration deadline is May 22

The topic will be **"Essential Wavelets for Statistical Applications and Data Analysis,"** featuring **Dr. R. Todd Ogden, Associate Professor of Biostatistics, Columbia University, New York.**

The same features of wavelet methodology that have led to revolutions in image processing and data compression have also spurred the development of powerful new tools for statistical data analysis. Wavelets have become an important tool in many areas of statistical application, including density estimation, time series analysis, nonparametric regression, and functional data analysis. This course will provide a basic introduction to wavelets and their practical applications to a variety of real-world situations, illustrated by analysis of simulated and real data sets.

R. Todd Ogden is Associate Professor in the Department of Biostatistics at Columbia University with a joint appointment in Psychiatry. He has been interested in wavelets and nonparametric regression for many years. Much of his current research emphasis is on various statistical methodological problems arising in the analysis of brain imaging data.

Registration deadline is June 9, 2006. Registration information for BYU faculty and students and LDS Church employees can be obtained by contacting Kathi Carter, Department of Statistics, 230 TMCB, Brigham Young University, Provo, UT 84602. e-mail: (801) 422-4506,

FAX (801) 422-0635, or see our web page http://statistics.byu.edu/summerinstitute

Jani Radebaugh's Work with Dunes on Titan

Jani Radebaugh, a faculty member in the Department of Geological Sciences, was recently recognized for her involvement in research on dunes on Titan. Radebaugh is a coauthor of an article that appeared in Science magazine, and was radio interviewed on CBC. The following article from USA Today tells Titan's latest story.

Saharan sand dunes found on Saturn's moon Titan

USA Today

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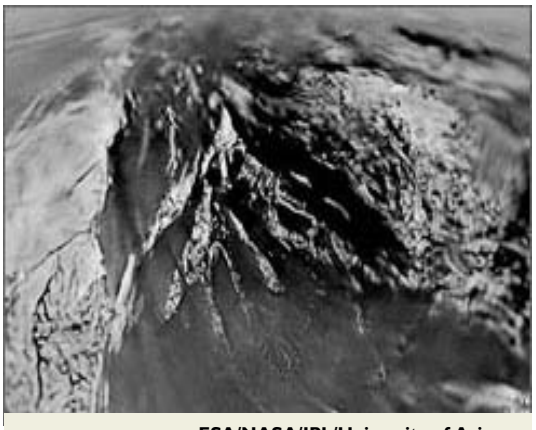
By Sara Goudarzi

May 4, 2006

The pictures, captured by the Cassini spacecraft as it flew by Titan last October and released Thursday, show sand dunes at Titan's equator much like those in the Sahara desert.

"It's bizarre," said Ralph Lorenz of University of Arizona's Lunar and Planetary Laboratory. "These images from a moon of Saturn look just like radar images of Namibia or Arabia."

On Earth, all wind is ultimately a result of heat differences produced by sunlight that warms the planet unevenly. Scientists have long assumed Titan is too far from the Sun to have solar-driven surface winds powerful enough to cause sand dunes.



ESA/NASA/JPL/University of Arizona

New video of Titan shows surface features of Saturn's largest moon. Here, a hill that was probably carved by methane rain.

But they have more recently learned that Saturn's powerful gravity creates tidal effects in Titan's thick atmosphere. This tidal force, almost 400 times greater than that of Earth's moon tugging at our oceans, dominates near surface winds on Titan and sculpts dunes that are up to 330 feet high.

Rows of sand

The new images, revealed in the May 5 issue of the journal *Science*, are evidence that these dunes were built from winds that blow in one direction before switching to another and then back to the first direction and so on.

The tides cause wind to change direction as they drive winds toward the equator, Lorenz said.

This back and forth pattern cause the sand dunes to build up in long parallel lines.

These tidal winds combined with Titan's west-to-east zonal winds create dunes aligned nearly west-to-east everywhere except close to mountains, which alter wind direction.

Scientists also thought that the dark regions on Titan's equator were in fact seas of liquid ethane that trap sand. But the images reveal something different.

"If you look at the dunes, you see tidal winds might be blowing sand around the moon several times and working it into dunes at the equator," Lorenz said. "It's possible that tidal winds are carrying dark sediments from higher latitudes to the equator, forming Titan's dark belt."

Sand formation

The sand on Titan might have formed when liquid methane rained and eroded the ice bedrock.

Although it doesn't rain frequently on Titan, when it does rain it really pours. Energetic rain that triggers flash floods may be a mechanism for making sand, Lorenz said.

The sand could also have come from organic solids produced by photochemical reactions in Titan's atmosphere.

"It's exciting that the radar, which is mainly to study the surface of Titan, is telling us so much about how winds on Titan work," Lorenz said. "This will be important information for when we return to Titan in the future, perhaps with a balloon."

Oil and water do mix

BYU students go to sea to study future oil fields

By Tad Walch

Deseret Morning News; Aug 9, 2005

PROVO — Summer vacation is a bit like an Indiana Jones adventure for some Brigham Young University geology students — they visit exotic places and search for buried treasure.

Take Anne Dangerfield, a senior from Green Bay, Wis., for example.

Last year, she was a dinosaur detective searching for fossils in a quarry at Dinosaur National Monument. If a dusty quarry near Vernal doesn't sound exotic, her two field trips this summer certainly were.

First, she went with 25 other students to Florida and the Bahamas, where they swam with professors through waters that someday could contain rich oil fields. The insights they gleaned could help them land lucrative jobs exploring for oil for some of the world's largest companies.

And this week, Dangerfield is swimming and hiking in Hawaii for a volcanism- and ore-deposits class. "It's mostly hiking around Kilauea," she says, nonchalantly.

Kilauea is an active, erupting volcano.

Dangerfield plans to pursue a master's degree, and if she decides to work in the oil and gas industry, she might find personal treasure, too, because of the demand for experts who can find new oil fields.

"Our students going into oil and gas right now are getting nearly $70,000 to start, plus they'll sometimes get a $5,000 or $6,000 signing bonus with a master's degree," geology professor Tom Morris said.

They should be helped by what they saw on this summer's trip to the Florida Keys and off Andros Island in the Bahamas.

Oil is formed when creatures die and create organic-rich sediment that over centuries is buried to a depth of 8,000 to 10,000 feet, Morris said. There, it is heated until it generates crude oil, which migrates from what has become organic-rich rock into reservoir-quality rocks like the reef systems studied by the BYU students.

Nearly 50 percent of the world's oil and gas reserves come from underground reservoirs formed in what are called carbonate, or limestone, rocks. The field trip was designed in three parts to allow the students to visualize how the rocks are formed and how they become oil reservoirs.

"You can teach a class, but if you spend a good eight days like we did and really internalize and study the things we show the students, they really have a great concept of carbonate sedimentation," Morris said.

The group first observed panels of fossils from an ancient ocean reef unearthed in an old limestone quarry at Florida's Windley Key Fossil Reef Geological State Park. That experience prepared them for the next day's swim over a living reef.

"We go look at the modern to understand the ancient, the rock record," Morris said.

The BYU team snorkeled at Jolter's Cay off Andros Island in the Bahamas, where carbonate rocks are being formed. The shoals at Jolter's Cay are covered with ooids, spherical white sands that are really carbonate grains formed by the rippling waves and the tides. Once those sand grains get buried deep enough, the sediment can become rock and serve as a reservoir.
Geologists call it a "carbonate factory."

"There are ripples forever, as far as the eye can see, for 15 miles," said Ashley Dalrymple, a senior from Gendora, Calif.

"To see that current and understand the energy it takes to make things like that was amazing."

Dangerfield said seeing the carbonate factory alive and running was invaluable.

"If you know what they look like before they're liquefied and turned into rock and you've seen the different stages, it can help you make decisions once you're faced with an outcrop of carbonate rock, looking for oil."

Mark A. Philbrick

Brigham Young University student Liz Zobell swims above a coral reef during a trip to the Florida Keys and Andros Island in the Bahamas.

The students paid about $600 to go on the trip. The other half of the cost was picked up by the W.K. Hamblin Global Geology fund, founded by a former BYU professor who wanted students to experience the world's best geological sites.

The students also used the university's new 3-D visualization lab. The lab allows students to use a computer and 3-D glasses to explore massive blocks of subsurface, where they can observe fault planes and other dramatic geological phenomenon.

"It's just a fantastic tool in interpreting and exploring for oil and gas," said BYU carbonate petrologist Scott Ritter, who led the field trip.

Between the classroom, the 3-D lab and the summer vacations in the field, BYU students learn how to sniff out new pockets of oil, Morris said.

"There's an old saying in the oil and gas exploration business that oil is found not by any mechanical means but by new ideas, that it's found in the minds of geologists."

New interface helps unmanned aerial vehicles perform search and rescue

BYU department of computer science

April 18, 2006

BYU Computer Science Professor, Michael Goodrich, discussing research with Master's student,

The Human-Centered Machine Intelligence Lab in the Computer Science Department is working in conjunction with the MAGICC Lab in the College of Engineering and Technology to create an unmanned aerial vehicle to assist in search and rescue efforts. The lab is producing an innovative interface that combines video, altitude, tilt, terrain, and compass in an intuitive single-view interface.

Interface users see a silhouette of the plane flying amidst computer-generated terrain. The screen shows real-time video footage projected below the plane so that users can easily spot lost individuals. The terrain and video tilt with the plane, allowing the user to experience the movement of the flight and see the plane in the context of the environment.

Joseph Cooper, the Master's student who built the interface, says that many typical interfaces divide these elements into different screens, causing the user to have to keep track of several separate data points at a time. His goal in creating the interface was to fit the presentation into a single, straightforward model that would be intuitive for a typical user.

The Utah County Sherriff Office's search and rescue crews use dogs, climbing gear, kayaks, and other equipment to cover the versatile terrain. The plane will be a valuable addition to these tools, giving the searchers a birds-eye view of miles of landscape. The plane can go a distance of four miles from the control device, allowing rescuers to sweep large areas of land faster than ever before.

The plane and interface will be field-tested in mock search and rescue scenarios as part of a project funded by the National Science Foundation. Cooper says that it may be several more years until the UAV system is ready to be used in the field, but the research they are doing today is an important step toward its development.

Researchers in the MAGICC lab are currently developing innovative airframe and camera servo devices that will significantly enhance search and rescue efforts. Collaboration between the two groups will create a system appropriate for the unpredictable conditions associated with the field.

To find out about other projects in the Human-Centered Machine Intelligence Lab, visit the website at http://research.cs.byu.edu/~hcmi/. You may access the MAGICC Lab's website at http://www.et.byu.edu/groups/magicc.

New and Re-appointed Department Chairs

Spring 2006

Beginning Spring 2006, several of the departments in our college appointed new chairs and associate chairs. Two departments, Mathematics Education and Physics and Astronomy re-appointed their department chairs. We congratulate and recognize each of them.

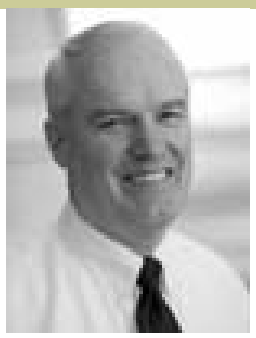
Mathematics

Ty Jarvis, Department Chair

Kening Lu, Associate Chair

Michael Dorff, Associate Chair

Mathematics Education



Gerald M. Armstrong, Department Chair

Statistics

Del Scott, Department Chair

Scott Grimshaw, Associate Chair

Physics and Astronomy

Scott D. Sommerfeldt, Department Chair

BYU Math Contest lists 2006 winners

Y News

The Brigham Young University Department of Mathematics recently hosted its first annual math contest consisting of ten mathematics questions with varying difficulty.

The contest, open to all undergraduate students, awarded cash prizes to the top five winners of the 25 participants.

The math department plans to continue the contest on an annual basis each spring.

For more information about the math contest, visit math.byu.edu/~doud/Contest.html.

Contest winners include the following students:

- 1st Place — Michael Griffin, a freshman in mathematics, received $250
- 2nd Place — Edison Yu Yang, a sophomore in mathematics, received $200
- 3rd Place — Chul-Woo Lee, a junior in electrical engineering, received $150
- 4th Place — Christopher Challis, a senior in statistics, received $100
- 5th Place — Nickolas Andersen, a junior in mathematics, received $50

College Publications

Chemistry

April 2006

S.P. Ziemer, T.L. Niederhauser, E.M. Woolley, "Thermodynamics of Complexation of Aqueous 18-Crown-6 with Rubidium and Cesium Ions: Apparent Molar Volumes and Apparent Molar Heat Capacities of Aqueous (18-Crown-6 + Rubidium Chloride) and (18-Crown-6 + Cesium Chloride) at Temperatures (278.15 to 393.15) K, at Molalities (0.02 to 0.33) mol · kg^{-1}, and at the Pressure 0.35 MPa," *J. Chem. Thermodynamics*, **38** 323-336 (2006).

E.H. Meyer, S. Goya, O. Akbari, G.J. Berry, P.B. Savage, M. Kronenberg, T. Nakayama, R.H. DeKruyff and D.AT. Umetsu, "Glycolipid Activation of Invariant T Cell Receptor NK T Cells is Sufficient to Induce Airway Hyperreactivity Independent of Conventional $CD4^+$ T Cells," *PNAS*, **103** (8), 2782-2787 (2006).

Y. Xiang, Y. Liu, M.L. Lee, "Ultrahigh Pressure Liquid Chromatography Using Elevated Temperature," *J. Chromatogr.*, **1104,**198 (2006).

Y. Xiang, Y. Liu, S.D. Stearns, A. Plistil, M.P. Brisbin and M.L. Lee, "Pseudolinear Gradient Ultrahigh-Pressure Liquid Chromatography Using an Injection Valve Assembly, *Anal. Chem.***78,** 858 (2006).

L. He., L. Yang, and S.L. Castle, "Synthesis of the Celogentin C Right-Hand Ring," *Org. Lett*., **8**(6), 1165-1168 (2006).

V.I. Lutskii, A.S. Gromova, E.A. Khamidullina and N.L. Owen, "Structural Studies and Biological Activity of Plant Triterpenoids from the *Thalictrum* Genus," *Chem. Natural Compounds*, **41**, 117-140 (2005).

O.V. Neretina, A.S. Gromova, V.I. Lutskii, A.A. Semenov, I.A. Ushakov and N.L. Owen, "Dactylin and Lonicerin from the Aerial Part of *Hedysarum setigerum*," *Chem. Natural Compounds*, **41**, 602-603 (2005).

E.A. Khamidullina, A.S. Gromova, V.I. Lutsky, and N.L. Owen, "Natural Products from Medicinal Plants: Non-alkaloidal Natural Constituents of the *Thalictrum* Species," *Natural Products Reorts.*, **23**, 117-120 (2006).

May 2006

S.P. Ziemer, T.L. Niederhauser, E.D. Merkley, J.L. Price, E.C. Sorenson, B.R. McRae, B.A. Patterson, M.L. Origlia-Luster, and E.M. Woolley, "Thermodynamics of Proton Dissociations from Aqueous Glycine at Temperatures from 278.15 to 393.15 K, Molalities from 0 to 1.0 mol · kg^{-1}, and at the Pressure 0.35 MPa: Apparent Molar Heat Capacities and Apparent Molar Volumes of Glycine, Glycinium Chloride, and Sodium Glycinate," *J. Chem. Thermodynamics*, **38**, 467-483 (2006).

S.W. Grant, K. Zhu, Y. Zhang, and S.L. Castle, "Stereoselective Cascade Reactions that Incorporate a 7-*exo* Acyl Radical Cyclization," *Org. Lett.*, **8**, 1867-1870 (2006).

L.B. Bhuiyan, C.W. Outhwaite, and D.J. Henderson, "A Modified Poisson-Boltzmann Analysis of the Capacitance of the Electric Double Layer at Low Temperatures," *J. Chem. Physics*, **123**, article no. 034704 (2006).

Trokhymchuk, I. Nezbeda, J. Jirsak, and D.J. Henderson, "Hard Sphere Radial Distribution Function Again," *J. Chem. Physics*, **123**, article no. 024501 (2005).

Computer Science

J.K. Howlett, T. W. McLain, and M. A. Goodrich. Learning Real-Time A* Path Planner for Unmanned Air Vehicle Target Sensing. *AIAA Journal of Aerospace Computing, Information, and Communication*. Volume **3**, Number 3, pp. 108-122, March 2006.

C. W. Nielsen and M. A. Goodrich. Comparing the Usefulness of Video and Map Information in Navigation Tasks. In *Proceedings of the 2006 Human-Robot Interaction Conference*. March 2006, Salt Lake City, Utah.

A. Steinfeld, T. Fong, D. Kaber, M. Lewis, J. Scholtz, A. Schultz, and M. Goodrich. Common Metrics for Human-Robot Interaction. In *Proceedings of the 2006 Human-Robot Interaction Conference.* March 2006, Salt Lake City, Utah.

J. A. Atherton, B. Hardin, and M. A. Goodrich. Coordinating a Multi-Agent Team Using a Multiple Perspective Interface Paradigm. *In Proceedings of the AAAI 2006 Spring Symposium: To Boldly Go Where No Human-Robot Team Has Gone Before*. March 2006, Palo Alto, California. Palo a lot californi

Rimer, M. and Martinez, T. R., Classification-Based Objective Functions, *Machine Learning Journal*, vol. **63**, no. 2, pp. 183-205, 2006.

Rimer, M. and Martinez, T. R., CB3: An Adaptive Error Function for Back-propagation Training, to appear in *Neural Processing Letters*, 2006.

Giraud-Carrier, C., and Martinez, T. R., A Constructive Incremental Learning Algorithm for Binary Classification Tasks, to appear in *Proceedings of SMCals*/06, 2006.

College Publications

Mathematics

April 2006

J. Humphreys, B. Sandstede, and K. Zumbrun, "Efficient computation of analytic bases in Evans function analysis of large systems," *Numerische Mathematik,* DOI 10.1007/s00211-006-0004-7, (2006).

S. Humphries and C. Krattenthaler, "Trace identities from identities for determinants," *Linear Algebra and Its Applications*, **411**, 328-242 (2006).

J. S..Chahal, "Foundation of Basic Arithmetic ," *Resonance: Journal of Science Education*, **11**:1, 8-20 (2006).

D. Doud and M. Moore, "Even icosahedral Galois representations of prime Conductor," *Journal of Number Theory*, **118**, 62-70 (2006).

Physics & Astronomy

B. J. Taylor, "A rigorous statistical test for the existence of supermetallicity in F, G and K dwarfs", *Monthly Notices of the Royal Astronomical Society*, **368**, 1880-1884 (2006).

Statistics

May 2006

Thurston, G. D., Ito, K., Mar, T., Christensen, W. F., Eatough, D. J., Henry, R. C., Kim, E., Laden, F., Lall, R., Larson, T. V., Liu, H., Neas, L., Pinto, J., Stotzel, M., Suh, H., and Hopke, P. K., ``Workshop on Source Apportionment of Particulate Matter Health Effects--Intercomparison of Results and Implications," *Environmental Health Perspectives,* 113, 1768 -1774 (2005).

Fields, P. J., "On the Use and Abuse of Microsoft Excel," *Foresight: The International Journal of Applied Forecasting,* 3:46-47, (2006).