UNH Research 2013
A digest of the year's research news from the University of New Hampshire

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Space Science

Dazzling Discoveries – Twin NASA Probes with UNH-led Instruments Aboard Mark a Year of Stellar Scientific Achievement
http://www.unh.edu/unhtoday/dazzling-discoveries

One year after its launch aboard the National Aeronautics and Space Administration’s twin Van Allen Probes, the Relativistic Electron Proton Telescope instrument (which is contained in a UNH-led Energetic Particle, Composition, and Thermal (ECT) Plasma Suite) continues to send back groundbreaking data that has changed scientists’ understanding of the Van Allen radiation belts that circle Earth. Data from the mission has fundamentally changed scientists’ understanding of the radiation belts, a harsh region of near-Earth space where “killer electrons” can travel at nearly the speed of light. Harlan Spence, director of the UNH Institute for the Study of Earth, Oceans, and Space, is lead scientist for the team that developed the ECT Plasma Suite, which accounts for six of the ten instruments onboard each of the twin Van Allen Probes.

Discover the Moon at the McAuliffe-Shepard Discovery Center

In collaboration with the National Aeronautics and Space Administration (NASA), and the McAuliffe-Shepard Discovery Center, UNH launched a new exhibit at the Center in June of 2013 titled, “Lunar Recon: Spacecraft, Craters and Cosmic Rays.” The exhibit highlights the scientific discoveries of NASA’s Lunar Reconnaissance Orbiter (LRO) mission as well as various historic aspects of lunar exploration. The LRO payload, comprised of six instruments and one technology demonstration, is providing key data to enable humans to return to the Moon. UNH scientists were part of the team for the Cosmic Ray Telescope for the Effects of Radiation (CRaTER), one of the LRO instruments. "Lunar Recon" features visual displays and hands-on activities, including a "cloud chamber" that allows visitors to see high-energy particles.

Enigmatic "Ribbon" Of Energy Discovered by NASA Satellite Explained
http://www.unh.edu/news/releases/2013/feb/ds05nasa.cfm
http://www.unh.edu/campusjournal/2013/02/enigmatic-%E2%80%9CRibbon%E2%80%9D-energy-discovered-nasa-satellite-explained

Nathan Schwadron, associate professor of physics, was the lead author on a paper published in the Astrophysics Journal that proposes a “retention theory” which may explain an astrophysical enigma that has perplexed scientists for years. Among other things, the data may reveal how magnetic fields influence our space environment.
**Harlan Spence - Tightening Our Understanding of Earth’s Radiation Belts**


Like many of Harlan Spence’s other projects supported by the National Aeronautics and Space Administration and the National Science Foundation, his current research on the Van Allen radiation belts builds on his long-running investigation of space weather. “It has very practical societal relevance,” says Spence, professor of physics and director of the UNH Institute for the Study of Earth, Oceans, and Space. “We’re a space-faring nation and world. So much of the world economy depends on space technologies that can be affected by space weather.” The knowledge gained by studying the Van Allen belts will help protect the hundreds of commercial weather, communications, and navigation satellites that must spend time in the belts as they move in their orbits. It also could be applied to other radiation environments, helping astronauts stay safe as they venture to the Moon again, to Mars, or deeper into the solar system.

**Heavenly Science: Student Balloons Video Earth Below, Space Above**

http://www.unh.edu/unhtoday/2013/07/ProjectSMART
http://www.unh.edu/campusjournal/2013/07/heavenly-science-student-balloons-video-earth-below-space-above

In 2013, UNH’s Science and Mathematics Achievement through Research Training (SMART) summer residential program for high school students celebrated its 22nd year. Student participants launched two weather balloons carrying simulated satellites to measure cosmic rays and environmental parameters. This launch tested a new no-parachute design and took informative pictures of Earth from nearly 100,000 feet up, at the edge of outer space.

**IBEX: The Little Satellite That Could, and Does**

http://www.eos.unh.edu/Spheres_0313/ibex.shtml
http://www.unh.edu/unhtoday/2013/05/ibex-little-satellite-could

As part of the National Aeronautics and Space Administration’s Interstellar Boundary Explorer (IBEX) mission, UNH’s Space Science Center researchers have spent nearly five years exploring galactic clouds and magnetic ribbons. Nathan Schwadron, lead scientist for the IBEX Science Operations Center at the UNH Institute for the Study of Earth, Oceans, and Space, is excited to make the first-ever global measurements of the heliosphere, the immense magnetic bubble that contains our solar system, solar wind, and the entire solar magnetic field that extends well beyond the orbit of Pluto. The project has already made an incredible discovery: our solar system is moving at a different speed and direction than initially thought.
Interstellar Winds Buffeting Our Solar System Have Shifted Direction

http://www.unh.edu/news/releases/2013/sep/ds05ibex.cfm
http://www.unh.edu/campusjournal/2013/09/interstellar-winds-buffeting-our-solar-system-have-shifted-direction

In September of 2013, results based on four decades of data from 11 different spacecraft were published in Science. Co-authored by Eberhard Möbius, an astrophysicist who is UNH’s principal scientist for the National Aeronautics and Space Administration’s Interstellar Boundary Explorer mission, the results have revealed that particles in our solar system may have changed direction in the past 40 years. This discovery will help scientists pinpoint our location within the Milky Way and provide deeper insight into the sun’s heliosphere.

Metamorphosis of Moon's Water Ice Explained

http://www.unh.edu/campusjournal/2013/06/unh-scientists-help-explain-metamorphosis-moon%E2%80%99s-water-ice

Andrew Jordan, research scientist in the UNH Institute for the Study of Earth, Oceans, and Space, was the lead author of an article titled “The Formation of Molecular Hydrogen from Water Ice in the Lunar Regolith by Energetic Charged Particles,” published in the Journal of Geophysical Research in June of 2013. The article presents results from NASA’s Lunar Crater Observation Sensing Satellite mission and shares information about how radiation can change the chemistry of ice, even in one of the solar system’s coldest regions: a permanently shadowed crater on the moon.

LunaCats Rocket to Third Place in NASA Competition

http://www.unh.edu/unhtoday/2013/06/lunacats
http://www.unh.edu/news/releases/2013/may/bp30luna.cfm
http://www.unh.edu/campusjournal/2013/05/unh-lunacats-rocket-third-place-nasa-robot-mining-competition

A robot created by nine former and current UNH students took third place in the National Aeronautics and Space Administration’s Lunabiotics Mining Competition, held at the Kennedy Space Center in May of 2013. Competing with 50 other teams from across North America, the UNH LunaCats’ remote controlled excavator named MOOSE (Magically Optimized Outer Space Excavator) mined for simulated regolith, a substance found on planetary bodies throughout the solar system.
Moon Radiation Findings May Reduce Health Risks to Astronauts
http://www.unh.edu/news/releases/2013/jun/ds11nasa.cfm
http://www.unh.edu/campusjournal/2013/06/moon-radiation-findings-may-reduce-health-risks-astronauts

A team of researchers from the Space Science Center in the UNH Institute for the Study of Earth, Oceans, and Space and the Southwest Research Institute reported data from the National Aeronautics and Space Administration’s Lunar Reconnaissance Orbiter (LRO) that could help reduce health risks to people on future space missions. UNH’s Nathan Schwadron co-authored an article in the American Geophysical Union journal Space Weather that explains how lighter materials such as plastics can shield spacecraft against radiation hazards, replacing the traditionally-used aluminum which can be both heavy and costly.

NASA Probes Detect "Smoking Gun" to Solve Radiation Belt Mystery
http://www.unh.edu/campusjournal/2013/07/nasa-probes-detect-%E2%80%9Dsmoking-gun%E2%80%9D-solve-radiation-belt-mystery

New observations have shown that the Van Allen radiation belts, two regions of high-energy particles in Earth’s magnetic field, are less stable than initially thought. Scientists such as UNH astrophysicist Harlan Spence are now closer than ever to understanding where, when, and how electrons are energized within the belts.

North by Southwest – SwRI and UNH Collaborate on New Space Science Department
http://www.eos.unh.edu/Spheres_1113/swri.shtml
http://www.unh.edu/news/releases/2013/mar/bp11swri.cfm

The Southwest Research Institute (SwRI), headquartered in San Antonio, Texas, and UNH have worked together on numerous research projects over many years. So it was a natural next step for the two entities to find a way to work in proximity for major projects. In March of 2013, SwRI and UNH signed a five-year agreement that will enable research collaborations on opportunities in astrophysics, earth and ocean sciences, and complex space missions. The agreement calls for SwRI to open a new department – the SwRI Earth, Oceans, and Space (SwRI-EOS) Department – at UNH’s Durham campus. The department will be led by Roy Torbert, professor of physics and director of the UNH Space Science Center.
The Sky’s the Limit
http://www.eos.unh.edu/Spheres_1113/smart.shtml

Project SMART (Science and Mathematics Achievement through Research Training) is a UNH summer program that encourages high school students to participate in “real” science outside of the traditional classroom setting. Students build satellite components and collect and analyze environmental and satellite performance data. One notable project is the ever-expanding balloon work, which launches cameras into the sky to collect pictures and data. Among many other accomplishments, the summer 2013 balloon launch assisted in research on gamma-ray detector technology that will be essential for future space missions.

Third Radiation Belt Discovered With UNH-led Instrument Suite
http://www.unh.edu/news/releases/2013/feb/ds28belt.cfm
http://www.unh.edu/campusjournal/2013/03/third-radiation-belt-discovered-unh-led-instrument-suite

A transient third radiation belt of high-energy particles was seen for the first time with help from UNH scientists. The National Aeronautics and Space Administration’s Van Allen Probe mission utilizes a high-powered telescope which is part of the Energetic Particle, Composition, and Thermal Plasma instrument suite led by UNH researchers. Data from the suite will contribute to understanding how electrons move at the speed of light and penetrate ions in space. Results already are allowing scientists to refine and confirm their theories on radiation belt dynamics.

On Aug. 31, 2012, a giant prominence on the sun erupted, sending out particles and a shock wave that traveled near Earth. This event may have been one of the causes of a third radiation belt that appeared around Earth a few days later, a phenomenon that was observed for the very first time by the newly-launched Van Allen Probes. This image of the prominence before it erupted was captured by NASA’s Solar Dynamics Observatory (SDO).

Credit: NASA/SDO/AIA/Goddard Space Flight Center

UNH Research Helps Unravel Mysteries of Earth’s Radiation Belts
http://www.unh.edu/news/releases/2013/12/ds04vanallen.cfm#ixzz2pvHpj0Jv
http://www.unh.edu/campusjournal/2013/12/unh-research-helps-unravel-mysteries-earth%E2%80%99s-radiation-belts

Harlan Spence, director of the UNH Institute for the Study of Earth, Oceans, and Space and professor of physics, is the principal scientist for the UNH-led Energetic Particle, Composition, and Thermal Plasma (ECT) instrument suite being used by the National Aeronautics and Space Administration’s Van Allen Probes mission. Data from the ECT has increased understanding of the complex dynamics of particle acceleration, which will help scientists make better predictions of space weather conditions and offer better protection to commercial and telecommunications satellites.

The twin Van Allen Probes were launched on August 30, 2012 into elliptical, near-equatorial orbits around the Earth. Remarkably, rather than seeing just the well-known two-belt structure, the mission found almost immediate evidence of the clear three-belt structure portrayed in green in this diagram.

Credit: Andy Kale, University of Alberta
UNH Scientists Document, Quantify Deep-Space Radiation Hazards

In a special issue of the journal *Space Weather*, scientists from UNH and their colleagues have published findings measured by a UNH-led detector aboard the National Aeronautics and Space Administration’s Lunar Reconnaissance Orbiter. The research addresses radiation hazards that astronauts may encounter on deep space missions. UNH’s Cosmic Ray Telescope for Effects of Radiation (CRaTER) radiation detector’s seminal measurements provide quantified radiation hazard data from lunar orbits and can be used to calculate radiation dosage from deep space to airline altitudes. These data will be critical for determining if long missions outside low-Earth orbit can be accomplished with acceptable risk.

UNH Scientists Launch "CubeSats" into Radiation Belts
http://www.unh.edu/campusjournal/2013/12/unh-scientists-launch-%E2%80%9Ccubesats%E2%80%9D-radiation-belts

Twin pint-sized satellites, built in part at the UNH Space Science Center by Ph.D. student Alex Crew, were launched into orbit from Vandenberg Air Force Base in California on December 5, 2013. The Focused Investigations of Relativistic Electron Burst Intensity, Range, and Dynamics (FIREBIRD) satellites will collect data that will ultimately allow engineers to design satellites for telecommunications, weather monitoring and prediction, and other uses that can better withstand the high-energy radiation they encounter. Funded by the National Science Foundation, FIREBIRD was among ten other CubeSats that shared a ride into space on a rocket dedicated to a larger mission, allowing these small, low-cost satellites to be put into space much more quickly than typical satellite missions.

UNH to Celebrate 10 Years of Showcasing Undergrad Science Research
http://www.unh.edu/news/releases/2013/apr/ds17urc.cfm

As part of the campus-wide Undergraduate Research Conference, UNH hosted the 10th annual Interdisciplinary Science & Engineering Symposium (ISE) in April 2013. ISE allows students to convey complex research in a coherent format and to explain their research projects to attendees and judges. Topics addressed by the students’ research projects include the Earth, the environment, biology, computer and physical sciences, mathematics, and statistics. In addition to showcasing the work of a record number of student participants, the 2013 event also honored faculty and staff who have been essential to the success of ISE over the years.