



# ASTROPHYSICAL AND PLANETARY SCIENCES

Fall 2010

University of Colorado at Boulder

## Letter from the Department Chair

APS Alumni, Colleagues and Friends,

As August has arrived and classes have recently begun, it's a great time to mentally bring you back to Boulder. I am proud to provide this new APS department newsletter. We want to keep you connected to APS — and we want to hear from you.

Recently, the National Research Council's Astro2010 Decadal Survey of Astronomy and Astrophysics endorsed CCAT (25m sub-millimeter-wave telescope) as a key research initiative for the next ten years. CU-Boulder is an essential partner in this planned \$110 million telescope at 18,400 feet in the Chilean Andes that will probe distant galaxies and stellar nurseries.

APS students and faculty continue to receive recognition for their research and teaching. Juri Toomre was named a 2009 College of Arts & Sciences Professor of Distinction and won the Hazel Barnes Prize, the most prestigious award for faculty on the CU-Boulder campus. Daniel Baker, Space Studies Board member and chair of the Committee on Solar and Space Physics, was awarded the 2009 James A. Van Allen Space Environments Award for excellence and leadership in space research from the

American Institute of Aeronautics and Astronautics (AIAA), and has been elected to the U.S. National Academy of Engineering. Dan also received the 2010 CU-Boulder Distinguished Research Lectureship Award. Assistant Professor Rosalba Perna won the biennial SIGRAV Prize — one of the most prestigious Italian prizes for young astrophysicists — for her work on neutron stars, black holes, and gravitational lensing.

For complete stories on these awards as well as briefings on Jason Glenn and the Herschel Space Observatory, Larry Esposito and the Lander Mission to Venus, and John Bally and the Bolocam Galactic Plane Survey, please visit our website at <http://aps.colorado.edu/>.

We continue to promote and accomplish excellence in teaching, research and outreach in our communities. We hope you are proud of your APS CU-Boulder affiliation. Let me hear from you about your activities and feedback. I can be reached at [mitch@jila.colorado.edu](mailto:mitch@jila.colorado.edu).

Sincerely,

Mitch Begelman

APS Department Professor and Chair

### Recent Student Awards

#### Undergraduate

AAS Chambliss Prize

Erin Macdonald

McCray Scholarship

Sara Simon

CO Science Scholarship

Sara Simon

#### Graduate

Cooke Fellowship

Jason Henning

NSF Graduate Research Fellowship

Julia Kamenetzky

Devin Silvia

Sam Skillman

NASA Earth and Space

Science Fellowship

Licia Ray

Stuart Robbins

Eric Schindhelm

NASA Graduate Student

Researchers Program

Robbie Citron

Richard Urata

Chancellor's Award for

Excellence in STEM

Education

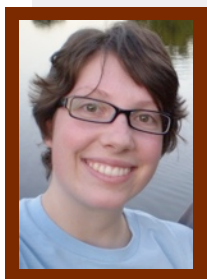
Colin Wallace

### Recent Faculty Awards

|                |                                                                                                                                                     |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| Fran Bagenal   | Boulder Faculty Assembly Excellence in Research, Scholarly and Creative Work Award                                                                  |
| Daniel Baker   | AIAA James A. Van Allen Space Environments Award<br>National Academy of Engineering inductee<br>CU-Boulder Distinguished Research Lectureship Award |
| Jack Burns     | AAAS Fellow<br>NASA's Exceptional Public Service Medal                                                                                              |
| Rosalba Perna  | Provost's Faculty Achievement Award<br>Italian Society of General Relativity and Gravitational Physics (SIGRAV) Prize                               |
| Nick Schneider | Boulder Faculty Assembly Excellence in Teaching Award                                                                                               |
| Mike Shull     | Professor of Distinction (College of Arts and Sciences)                                                                                             |
| John Stocke    | Invited guest at the Vatican Year of Astronomy celebration                                                                                          |
| Juri Toomre    | Professor of Distinction (College of Arts and Sciences)<br>Hazel Barnes Prize                                                                       |

**Sara Simon**, an undergraduate in APS with a second major in physics, recently won a McCray Scholarship and the 2010 Colorado Science Scholarship from the College of Arts and Sciences. Sara is a dedicated and academically outstanding student interested in pursuing an academic career as a professor and has, in preparation, participated in the CU Learning Assistant program, effectively acting as a teaching assistant for large introductory physics classes. Sara also works in APS Asst. Prof. Nils Halverson's research group, building instrumentation to test millimeter-wavelength detectors which will be used to study the Cosmic Microwave Background. She intends to make this project into a senior honors thesis this year. In her work, she sets a positive example for others in the field, and helps make CU more

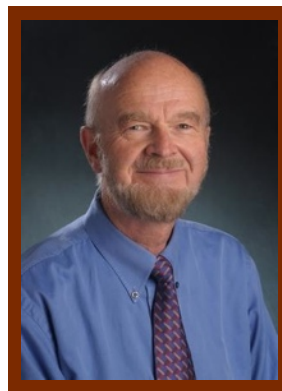
attractive for women and men alike to contribute to instrumentation in astrophysics.



**Prof. Juri Toomre** of the Astrophysical and Planetary Sciences (APS) department received two awards this academic year. In Fall 2009, Juri joined APS professor Mike Shull in being named Professor of Distinction in the College of Arts & Sciences. In Spring 2010, he was awarded the Hazel Barnes Prize, the largest and most prestigious single faculty award funded by the University of Colorado at Boulder. These awards are designed to recognize tenured faculty members who are not only outstanding teachers, but who also have distinguished records in research and scholarship.

Educated at MIT and University of Cambridge (Marshall Scholar), Juri is a Fellow of JILA and the most senior member of the APS department faculty. He is an internationally eminent solar physicist and fluid dynamicist, an expert on the oscillations of the Sun, astrophysical turbulence, and dynamo generation of magnetic fields. His current work is primarily in stellar astrophysics with an emphasis on how turbulent convection within stars is able to build the complex magnetic fields that pervade the universe.

Juri's research group, involving APS graduate students and postdocs and an international crew of collaborators, has been studying how magnetic dynamo action deep within the Sun can produce the 22-year cycles of sunspots and their remarkable patterns of eruptions. The turbulent convection occupying the outer 30% just below the



solar surface, coupled to the differential rotation it produces, is able to build strong magnetic fields within the conducting plasma that makes up a star. These cyclic fields can then erupt through the solar surface.

Juri's group has developed major 3D simulations to examine this phenomenon.

Their cutting-edge supercomputing modeling is revealing many of the elements involved in such global dynamo action, showing that complex wreaths of magnetic fields can be built even amidst the intense convective pummeling, quite unlike what was previously anticipated. These can wax and wane in strength and even flip their sense cyclically, which is providing new paths to be pursued in studying stellar dynamos.

Many aspects of such studies are aided and guided by helioseismology, which uses sound waves within the Sun to probe large-scale flows and differential rotation deep beneath the surface. Helioseismology's latest advance is the recent launch of the Solar Dynamics Observatory with three major instruments, including EVE built by CU's LASP, that will provide continuous Doppler and magnetic imaging of the full disk at high resolution. Juri has been actively engaged in helioseismology from its outset, and he will be involved in the continued interaction between observations and computational theory, sorting out how stars build their rich magnetic fields.

**Jason Henning**, recipient of this year's Cooke Fellowship in the APS department, is a fourth-year graduate student in APS. He works with APS Asst. Prof. Nils Halverson on developing new millimeter-wavelength detectors which will be used to conduct measurements of polarization in the Cosmic Microwave Background (CMB). The CMB is thought to contain a very subtle polarization signature from gravitational waves generated by an explosive instant of initial growth called inflation. A new type of polarization-sensitive detector is being developed to measure this signature of inflation, in a collaboration between Halverson's group and groups at NIST, the University of Chicago, Princeton University, and the University of Michigan. Jason has been conducting laboratory tests of prototype detectors, testing how efficiently they absorb light. Jason is currently working on the mechanical design for a prototype array of about 50 detectors. For his PhD thesis work, he will help develop and test detector arrays that will be incorporated on a new 800-pixel polarization-sensitive array camera for the South Pole Telescope in Antarctica. Jason will help deploy the new instrument to the South Pole in Fall 2011 and analyze the resulting data from the telescope, in search of the elusive polarized signature of inflation and clues to the origin of the Universe.



## Herschel Space Observatory Opens Final Window in the Electromagnetic Spectrum to Astronomers

On May 14, 2009, the European Space Agency launched the *Herschel Space Observatory*. With its 3.5-m diameter primary mirror (the largest in orbit), *Herschel* is enabling some of the first detailed submillimeter observations of distant, high-redshift galaxies, resolved nearby galaxies, and regions of star formation in the Milky Way. Ground-based observations are impossible over much of this spectral band because water vapor and ozone make Earth's atmosphere opaque.

*Herschel* carries three science instruments on board, observing the 60 – 670  $\mu\text{m}$  range. Professor Jason Glenn of APS and CASA is one of two U.S. Co-Investigators of the Spectral and Photometric Imaging Receiver (SPIRE). Current members of his group analyzing *Herschel* data are postdocs Alex Conley and Naseem Rangwala, and APS graduate students Tim Ellsworth-Bowers and Julia Kamenetzky.

The adjacent figure is an image of the galaxy M74, demonstrating the sub-

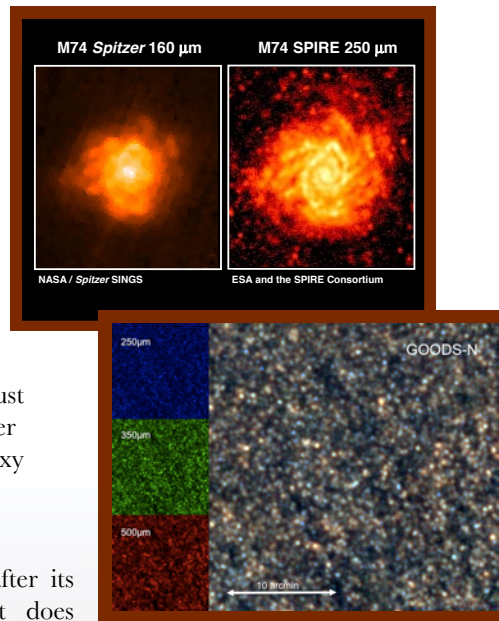
stantial improvement in angular resolution of *Herschel* compared to the *Spitzer* Space Observatory. The second figure, of the extragalactic GOODS-N region, shows that the sky is extremely rich in submillimeter-emitting galaxies. The galaxies, unresolved with SPIRE's 18-35" (FWHM) beams, are seen by their thermal dust emission, characteristically at temperatures of a few  $\times 10$  K, heated primarily by star formation. The most nearby and warmest galaxies appear blue, while the most distant and coolest ones appear red.

Prof. Glenn's group has performed a statistical fluctuation analysis of the SPIRE map shown, and others, to determine the underlying galaxy number count distribution. The derived galaxy number count distribution does not match models from the literature, indicating that substantial theoretical work must be done to explain the submillimeter galaxy population in models of galaxy

formation. Prof. Glenn plans to give the APS colloquium on early *Herschel* results on August 30, 2010.

*Herschel*'s expected cryogenic lifetime is another 2 to 2.5 years and a current call for proposals is open.

More information on *Herschel* can be found at <http://sci.esa.int/science-c/www/area/index.cfm?fareaid=16> and <http://www.esa.int/csaMI/Herschel/index.html>.



## Understanding Mars with MAVEN

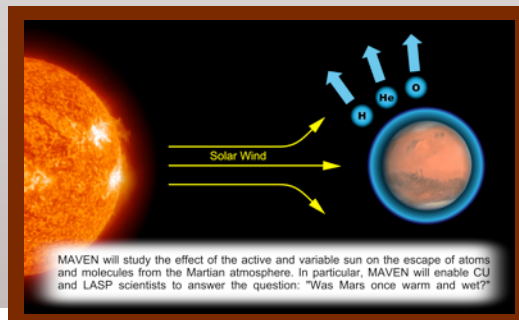
Tasked by NASA with a mandate to examine the evolution of the Martian atmosphere over deep time, MAVEN, the Mars Atmosphere Volatility and EvolutionN mission, will launch in 2013 and revolutionize our understanding of the upper atmosphere of Mars. Key observations will be made of escaping atmospheric constituents, which in tandem with simultaneous observations of the solar input will allow for examination of the response of Mars' atmosphere to the variable sun.

One possibility is that MAVEN will observe escape from Mars' upper atmosphere. Such escape occurs readily at Venus, where all of the hydrogen once present in the form of water has left its oxygen behind, drifting to the upper atmosphere where it merged with the solar wind and was stripped from its planetary home. What water Venus had early in its planetary history has been almost completely lost. Venus' lack of a magnetic field would have exacerbated this effect; at Earth the magnetic field shields the upper atmosphere from the bulk of solar-driven escape and mitigates atmospheric loss.

At Mars, the story may have been similar. Geological evidence for the presence of water on early Mars abounds, but water on present Mars is scarce. Was Mars once Earthlike? How much water did

Mars have just after its formation? What does this tell us about the possibility for life on the planet? MAVEN will provide a framework for answering these questions, examining how the escape of atoms from the atmosphere is influenced by the activity of the Sun. Such an examination will allow project scientists to extrapolate Mars' atmospheric loss back in time to the era of a faint early sun, when an energetic solar wind may have been responsible for increased atmospheric loss. During this era, Mars may have been doubly unlucky, losing its primordial magnetic field while simultaneously facing a dramatic increase in the power of the solar wind.

Bruce Jakosky is the mission's principal investigator, leading a team of faculty, staff, and students from a broad cross-section of CU's academic departments. Many of MAVEN's instruments will be manufactured at LASP (including two instruments being led by APS Profs. Nick Schneider and Bob Ergun), continuing CU's strong tradition of science planning, instrument design, and mission operations management. Understanding the atmospheric evolution of Mars will enable planetary scientists to obtain a more complete picture of whether Mars is, or was, suitable for life.





Left: CU students work on the \$1.3M Near-Infrared Camera for 3.5m APO telescope

Center: Students in an introductory astronomy course explore extrasolar planet detection using a Lego orrery (photo credit: Casey Cass)

Right: Science on a Sphere exhibit at CU's Fiske Planetarium (photo credit: Casey Cass)

## APS Welcomes Your Support this Year

As alumni and friends, if you believe in the value of your CU-Boulder degree as well as the work of the APS Department, consider making your gift of support this year to APS.

Please know that state funding for Colorado schools and colleges is becoming even slimmer: it accounted for a mere ~3% of CU-Boulder's budget in 2010. Private gifts are essential to APS's continued success in research and in recruiting and retaining talented faculty and students. To ensure excellence in teaching, learning, research and outreach, please consider making your gift this fall to the APS Department.

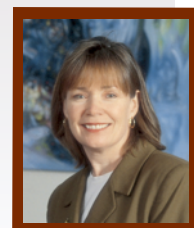
Here are specific areas where you can make a difference:

[Astronomy Learning Enhancement Fund \(0122483\)](#)

[Susan E. Wesley Undergraduate Scholarship \(150749\)](#)

[Astrophysics Graduate Fellowship Fund \(0154304\)](#)

You can make a gift easily through the CU Foundation <http://www.cufund.org/give-now/> or APS website <http://aps.colorado.edu/>. If you have questions or need further assistance, contact Pat Sullivan, Sr. Director of Development, University of Colorado Foundation, at [pat.sullivan@cufund.org](mailto:pat.sullivan@cufund.org) or (303) 541-1475.



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