

# The Boston University Astronomy Department Annual Report 2013

Chair: Tereasa Brainerd

Administrator: John-Albert Moseley

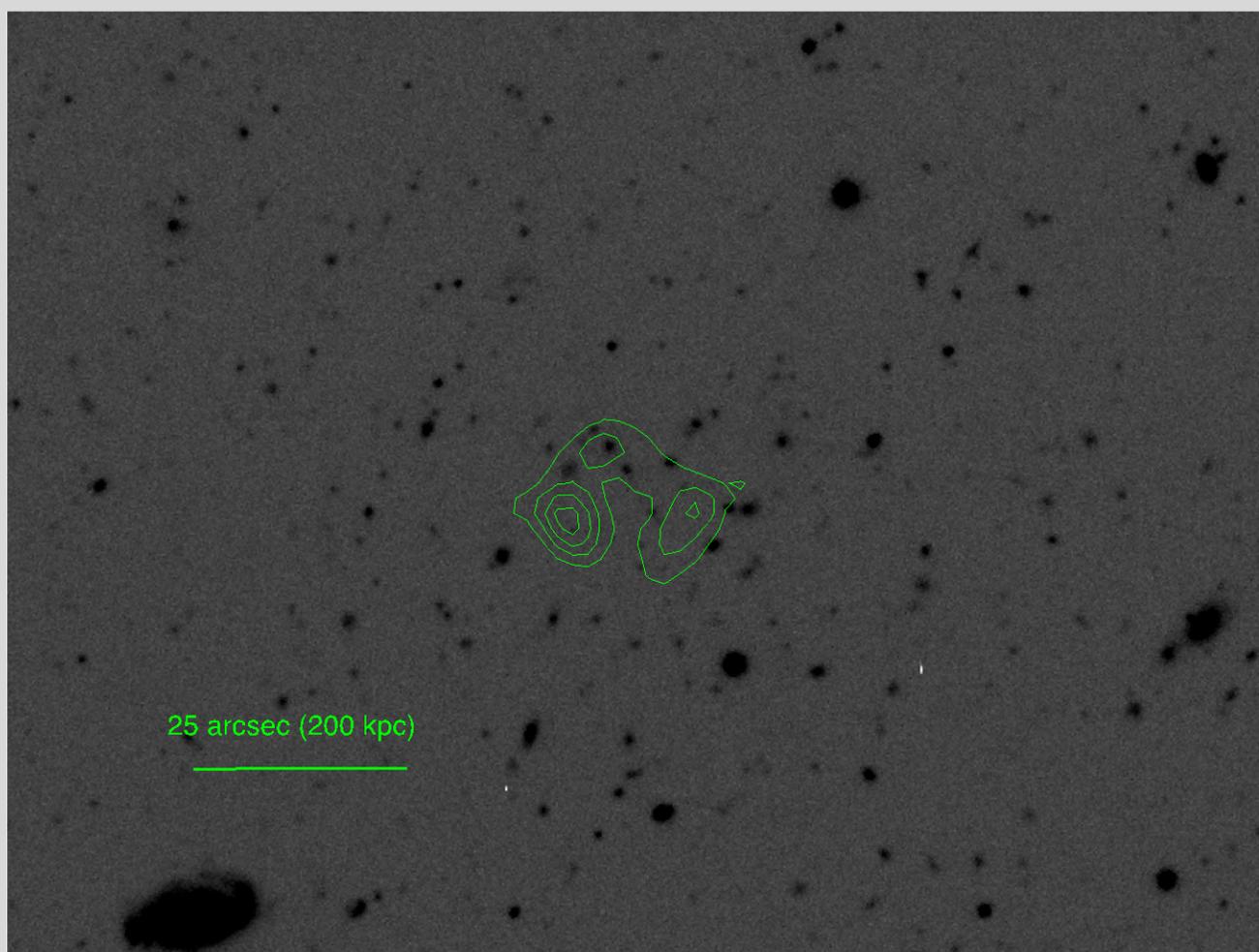


Image of an extremely distant galaxy cluster obtained with the Discovery Channel Telescope

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**Cover photo:** Optical negative image of a distant galaxy cluster obtained with the Discovery Channel Telescope (DCT) in April 2013 by Professor Elizabeth Blanton. This is one of the first science-grade images to be obtained by Boston University astronomers with the DCT. The overlaid green contours show a “bent double-lobed radio source” that was used by Professor Blanton to select objects for her distant cluster project. The radio source is located near the center of the cluster.



## EXECUTIVE SUMMARY

The Department of Astronomy teaches science to hundreds of non-science majors from throughout the university and runs one of the largest astronomy degree programs in the country. Research within the Astronomy Department is thriving, and we retain our strong commitment to teaching and service.

In Spring 2013 the Department graduated a class of 13 undergraduates with a major in astronomy, astronomy and physics, or geophysics and planetary sciences. By national standings, this was a large graduating class. Currently, 47 Boston University undergraduates major in astronomy, a large program amongst US universities. For non-majors, our recent efforts to improve our general 100-level courses and to provide interesting new course offerings have paid off well. Our 100-level enrollments in AY12-13 were 744, with the largest enrollment classes being AS100 (*Cosmic Controversies*, enrollment of 175, taught by Professor Mendillo), AS105 (*Alien Worlds*, enrollment of 228, taught by Professor West), and AS109 (*Cosmology*, enrollment of 97, taught by Professor Marscher). Our two most popular courses, AS100 and AS105, routinely close to enrollments long before the start of the semester because the classes have reached their maximum capacity.

***Enrollment in our 100-level courses in AY12-13 represents a nearly 60% increase in our enrollments compared to what they were only five years ago.***

In our graduate program, we recruited an impressive incoming class of five new students, bringing our total of new and continuing graduate students to 33. Last year five of our graduate students received their PhDs and four received their MAs. The Boston University graduate program in astronomy is also one of the largest in the country.

Two members of the junior faculty (Professor Elizabeth Blanton and Professor Merav Opher) were promoted to the rank of Associate Professor with tenure, and one member of the senior faculty (Professor Meers Oppenheim) was promoted to the rank of Full Professor. Dr. Carlos Martinis joined the faculty as a Research Assistant Professor, and we hired two new tenure-track

faculty members, Dr. Catherine Espaillat and Dr. Philip Muirhead.

Members of the Department made several noteworthy scientific contributions in AY12-13. Limited space precludes a thorough presentation of the entire research portfolio of the Department, and a more in-depth discussion of our collective research accomplishments can be found in the annual reports of the Center for Space Physics and the Institute for Astrophysical Research. Selected highlights of Boston University astronomy research in AY12-13, include:

- The first public data release and the completion of observations for the Galactic Plane Infrared Polarization Survey
- Martian surface pressure calculations in support of the safe landing of the Curiosity rover on the surface of Mars
- First science-grade observations with the Discovery Channel Telescope

The Astronomy Department had an excellent year in securing research funds through grants to its main research centers: the Center for Space Physics, the Center for Integrated Space Weather Modeling, and the Institute for Astrophysical Research. Last year Astronomy Department researchers secured federal funding through grants totaling \$28.5M, or over \$1,000,000 per faculty member, both among the highest for all units in CAS. Our faculty and research associates authored or co-authored a total of 86 refereed, scholarly papers in the disciplines' most prestigious journals.

This year marked the first science-grade observations with the Discovery Channel Telescope. A total of six science nights were used to obtain data in order to study extremely distant clusters of galaxies, measure of parallaxes of nearby low-mass stars and brown dwarfs in order to derive a luminosity function and test models of low-mass star formation, and to study weak gravitational lensing, satellite galaxies, and intracluster light in nearby clusters of galaxies.

The Astronomy Department was fortunate to benefit from new gift funding last year. A gift of \$10k from Mr.

David Katz, intended for urgent educational needs, allowed nine new computers and monitors to be purchased for the Astronomy computer lab, greatly enhancing the educational experience for our students. Further, Dr. Tian-Xing (“Tim”) Liu pledged a \$100k gift to the Astronomy Department for the construction of a dedicated remote observing facility. Dr. Liu received his PhD in Astronomy from Boston University in 1990 under the supervision of Professor Kenneth Janes. Astronomy faculty and students will use the Liu Remote Observing Center to conduct research on telescopes around the world via internet access.

Finally, thanks to generous funding from the College of Arts and Sciences, the main office of the Department of Astronomy underwent a complete renovation in summer 2012. As part of the renovation, a private office for the department administrator, a small conference room, and a secure circulation room (mail, printing, photocopying) were created. This much needed facelift was overseen by Lisa Doherty (CAS Facilities Management) and Colleen McGinty (Construction Services).

## OVERVIEW

Amongst the 37 “stand-alone” departments of astronomy in US universities, the Astronomy Department at Boston University is unusual in a number of ways. For instance, about half of our faculty members specialize in space physics research. In other universities, space physicists are typically affiliated with physics, engineering, or earth science departments. Such a large concentration of space physicists in an astronomy department makes Boston University somewhat unique. Furthermore, our graduate program is one of the nation’s largest (typically we rank in the top five in terms of the number of graduate students enrolled and PhDs awarded). Finally, our federal grant support is outstanding. In the last several years our annual grant funding and funding per faculty member is typically twice that of our closest peer institution.

The Astronomy Department, through its associated research centers (the Center for Space Physics, the Center for Integrated Space Weather Modeling, and the

Institute for Astrophysical Research), has established an impressive research record. In space physics, Boston University is a recognized leader in our core areas of space-based instrumentation, space weather, energetic particles in the near-earth environment, magnetospheric physics, and ionospheric physics. In astrophysics, Boston University’s key research areas have been star formation, galactic astronomy, active galaxies, stellar astronomy, galaxy clusters, and cosmology. With the arrival of new faculty that were hired in Spring 2013, our strengths in astrophysics will soon grow to include the formation of planets around young stars, as well as the properties of extrasolar planets and their host stars. A particular unifying strength of the department lies in astronomical surveys, particularly of the Milky Way (e.g., the H II Region Discovery Survey and the Galactic Plane Infrared Polarization Survey). Another unifying strength lies in the long-term monitoring of the photometric properties of astronomical objects (e.g., the variability of active galactic nuclei and the light emitted by stars).

## FACULTY, STAFF, AND LEADERSHIP

In AY12-13 the Department of Astronomy had twenty-three faculty members: fifteen full-time academic faculty, three research faculty, two emeritus professors, and three adjunct professors. The full list of the Department’s faculty and staff is provided in Appendix A. The astronomy faculty continues to provide outstanding service to the nation and the profession by serving on advisory committees for NASA and NSF, national observatories, learned societies, and professional journals.

### *Promotions and Tenure*

Professor Meers Oppenheim was promoted to the rank of full Professor in Spring 2013. Professor Oppenheim joined Boston University in 1998. He has taught undergraduate courses on the solar system for both astronomy majors and non-science majors, as well as introductory solar and space physics for astronomy majors. At the graduate level he has taught plasma physics and ionospheric physics. His research interests include computational and theoretical space plasma physics, dynamics of the E-region ionosphere and the

electrojet, particle-wave interactions in the auroral ionosphere and magnetosphere, and the physics of meteor trails.



**Professor Meers Oppenheim**

Professor Elizabeth Blanton was promoted to the rank of Associate Professor with tenure in Spring 2013. Professor Blanton joined Boston University in 2004. She has taught undergraduate courses on stars and galaxies for astronomy majors and non-science majors, and she has also taught in the Core Curriculum natural sciences course CC105. At the graduate level she has taught introductory astrophysics. Her research interests include clusters of galaxies, radio galaxies, optical and near-infrared observational astronomy, and high-energy astrophysics.



**Professor Elizabeth Blanton. Image credit: Vernon Doucette**

Professor Merav Opher was promoted to the rank of Associate Professor with tenure in Spring 2013. Professor Opher joined Boston University in 2011. She has taught undergraduate courses on stars and galaxies for non-science majors. At the graduate level she has taught heliospheric physics, computational astrophysics, and introduction to professional astronomy. Her research interests include computational and theoretical plasma physics in space and astrophysics, the interaction of the solar system with the interstellar medium, the solar wind, shocks in the lower solar corona, and T-Tauri and Solar-like stars.

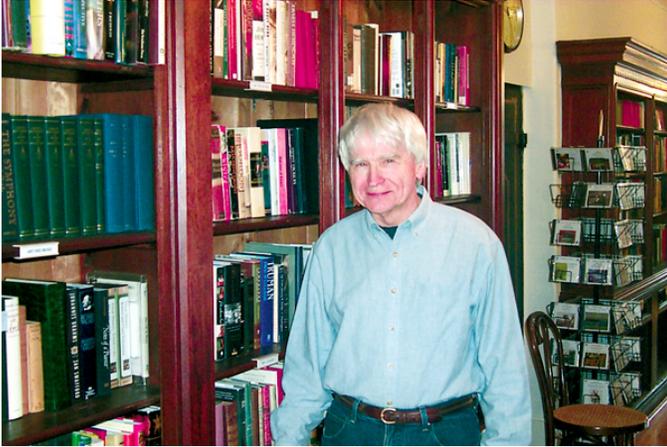


**Professor Merav Opher. Image credit: Kevin Ma**

### ***Professor Emeritus***

Research Professor George Siscoe joined the Department of Astronomy and the Center for Space Physics in 1993 as a Research Professor. A pre-eminent scholar in the field of space physics, Professor Siscoe has published over 300 articles on his research, which includes space plasma physics, geospace environment modeling, space weather, and understanding magnetospheric structure and behavior through numerical simulations. Professor Siscoe was named a Fellow of the American Geophysical Union (AGU) in 1987 and he was honored as the AGU's second Van Allen Lecturer in 1991. He served as the Editor of the *Journal of Geophysical Research* from 1978 to 1981, an Associate Editor of the *Journal of Geophysical Research* from 1971 to 1973, and an Associate Editor of *Reviews of Geophysics and Space Sciences* from 1972 to 1974. He has served on numerous advisory panels and committees for NASA, AGU, and the NRC. Professor Siscoe became an Emeritus Professor in Fall 2012. His

latest enterprise is The Old Professor's Bookstore in Belfast, ME, which he owns and operates with his wife, Research Professor Nancy Crooker. The Old Professor's Bookstore was highlighted by the Midcoast Beacon in 2009 (<http://bangordailynews.com/2009/05/20/the-midcoast-beacon/professorrsquos-bookstore-a-rare-find>).



**Professor Emeritus George Siscoe in The Old Professor's Bookstore (Belfast, ME). Image credit: Walter Griffin**

### ***Honors and Awards***

The Research Corporation for Science Advancement selected Professor Andrew West as a 2013 Cottrell Scholar. The Cottrell Scholars program recognizes early career faculty in research universities who are carrying out groundbreaking research and who are also leading undergraduate teaching improvements. An award of \$75,000 is given to each Cottrell Scholar for an innovative research proposal as well as innovative teaching ideas. The title of Professor West's proposal for the Cottrell scholarship is *Extracting Excellence from Traditionally-Underrepresented Populations: Constraining the Formation of Low-Mass Dwarfs and BU Pre-MaP*.

Professor West was also awarded a \$783,585 five-year CAREER grant from the National Science Foundation for his proposal entitled *CAREER: A Census of Very Low-Mass Stars and Brown Dwarfs in the Local Neighborhood*. The NSF Faculty Early Career Development (CAREER) program offers the NSF's "most prestigious awards in support of junior faculty who exemplify the role of teacher-scholars through outstanding research, excellent education and the integration of education and research within the context

of the mission of their organizations." Professor West's CAREER award will support observations with the Discovery Channel Telescope to measure parallaxes of nearby low-mass stars and brown dwarfs to derive a luminosity function and test models of low-mass star formation. It will also support the BU Pre-MaP program that Professor West started in Fall 2012 (see Undergraduate Education below).

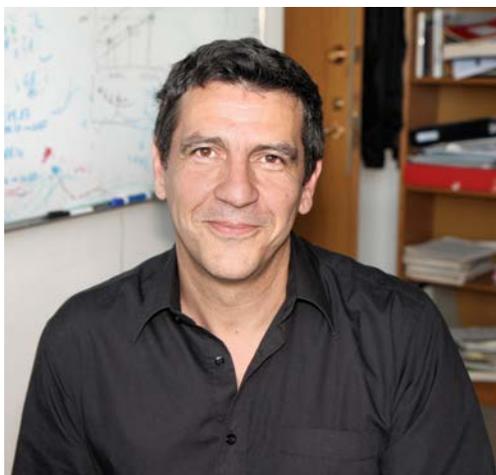


**Professor Andrew West**

### ***New Research Faculty***

Dr. Carlos Martinis joined the faculty as a Research Assistant Professor in July 2012. Professor Martinis received his undergraduate degrees in Physics from the Universidad Nacional de Tucuman in Argentina (Bachillerato in 1994; Licenciado in 1996). He received his MA in Astronomy from Boston University in 2001 and his PhD in Astronomy from Boston University in 2006. Professor Martinis' research interests include equatorial and low latitude electrodynamics, optical and GPS diagnostics of ionospheric irregularities, and the study of ionospheric conjugate processes at low and mid-latitudes using all-sky imagers. The all-sky optical imagers that Professor Martinis uses in his work are built in-house and are distributed worldwide.

In addition to doing front-line research, Professor Martinis has also graciously stepped in to help with the teaching mission of the department when we have been short-staffed. He taught AS866 (Space Physics Journal Club) in 2010, AS414 (Solar and Space Physics) in 2011, and AS102 (The Astronomical Universe) in 2013.



**Research Professor Carlos Martinis**

Postdoctoral Fellowship in Astronomy & Astrophysics at the Harvard-Smithsonian Center for Astrophysics. She is currently a NASA Carl Sagan Postdoctoral Fellow at the Harvard-Smithsonian Center for Astrophysics. Her research focuses on understanding planet formation around young stars, particularly by characterizing the "footprints" that baby planets leave behind as they form. She is an expert in observational astronomy over a wide range of the electromagnetic spectrum, including radio, optical, and near infrared observations. Dr. Espaillat's research program is ideally suited to the Discovery Channel Telescope and she expects to be a major user of the telescope during her career at Boston University. Dr. Espaillat will join the faculty in August 2013. In AY13-14 she will teach an advanced graduate course on her research specialty

### *New Faculty Hires*

The Astronomy Department was fortunate to hire two new tenure-track Assistant Professors in Spring 2013, Dr. Catherine Espaillat and Dr. Philip Muirhead. Professor Thomas Bania chaired the faculty search committee that identified these outstanding individuals from a pool of nearly 180 applicants.



**Dr. Catherine Espaillat**

Dr. Catherine Espaillat received her BA in Astronomy from Columbia University in 2003 and her PhD in Astronomy & Astrophysics from the University of Michigan in 2009. Immediately following her graduation from the University of Michigan, Dr. Espaillat held a National Science Foundation



**Dr. Philip Muirhead**

Dr. Philip Muirhead received his BS with concentrations in Astronomy & Astrophysics and Physics from the University of Michigan in 2005 and his PhD in Astronomy and Space Sciences from Cornell University in 2011. While at Cornell he was involved in the construction of two facility-class astronomical instruments for ground-based telescopes: the MIRC instrument on the CHARA Array and the TripleSpec Spectrograph on the Palomar 5-meter Hale Telescope. His PhD thesis instrument, TEDI, for the Palomar Hale telescope, strongly influenced the direction of future ground-based instrumentation and is the motivation for a facility-class instrument that he intends to build for the Discovery Channel Telescope. The planned instrument

is a high-resolution near-infrared spectrograph called HiJaK. After receiving his PhD, Dr. Muirhead became a postdoctoral scholar at the California Institute of Technology, where he conducted a survey of planet-hosting stars discovered by NASA's Kepler Mission. The HiJaK spectrograph that Dr. Muirhead intends to build for the Discovery Channel Telescope will make the telescope a unique facility in the world, allowing high-resolution spectroscopy to be done in a part of the electromagnetic spectrum where few such observations currently exist. In addition to building instruments for the Discovery Channel Telescope, Dr. Muirhead will be a major user of the telescope, conducting detailed studies of the physical properties of cool stars that host extrasolar planets. Dr. Muirhead will join Boston University as a Hubble Postdoctoral Fellow in July 2013, and will begin his faculty appointment in July 2014.

## RESEARCH AND SCHOLARSHIP

The Department of Astronomy, through its affiliated research units, the Center for Space Physics (CSP), the Institute for Astrophysical Research (IAR), and the Center for Integrated Space Weather Modeling (CISM), has a robust and thriving research program. Every member of the faculty maintains a research program through external sponsored funding. Publication of scientific results continued at a brisk pace in the top journals of our fields.

### Overall Summary

The Department's research accomplishments for 2012-2013 are substantial. Just a few research projects are highlighted below in order to illustrate the breadth and strength of our research programs. Additional science highlights can be found in the annual reports for the Center for Space Physics and the Institute for Astrophysical Research.

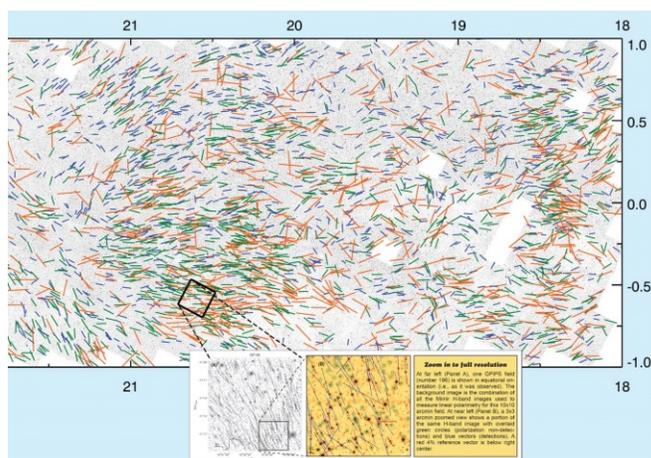
### *Galactic Plane Infrared Polarization Survey*

The Galactic Plane Infrared Polarization Survey (GPIPS) was designed to carry out the largest survey to date of stellar polarizations in the Milky Way, providing unprecedented insight into the magnetic field of our home galaxy. The survey was carried out by Professor

Dan Clemens and his students using the Mimir instrument on the Perkins Telescope. Observations for the survey began in June 2006 and concluded in June 2013. The data were collected over approximately 350 nights and include nearly 2 million images obtained with Mimir. GPIPS is a prime example of the type of astronomy that simply cannot be carried out on national or international facilities because of both instrumentation and telescope access limitations. GPIPS is the type of unique, large project that is ideally matched to university teams and university-provided resources, leveraging Federal support. It is due to the vision of the College of Arts and Sciences to invest in our partnership with Lowell Observatory in the operation of the Perkins Telescope, as well as the support of NSF, NASA and the Keck Foundation, that allowed this unique survey to be carried out.



Graduate students Jordan Montgomery (left), Lauren Cashman (center), and Sadia Hoq (right) in front of the 40-foot long GPIPS poster at the January 2013 AAS meeting.

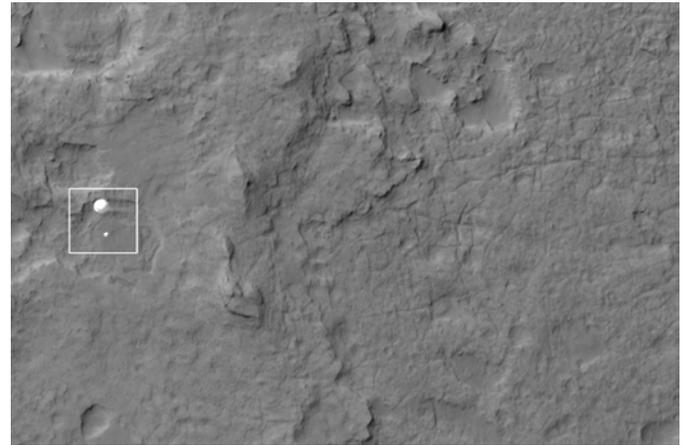


Zoom-in on a portion of the GPIPS banner at the January 2013 AAS meeting. The banner shows an image of the field (gray scale) with overlaid stellar polarization vectors (colored sticks)

In August 2012, the first public release of a portion of the GPIPS data went live on web, hosted by Boston University fileservers. In January 2013, the GPIPS team became a formal meeting exhibitor at the American Astronomical Society meeting in Long Beach, CA,

displaying a 40'x3' foot banner of the GIPS stellar polarization and image data. Even with the 40 foot format, only 10% of GIPS data could be displayed, since the density of the full information would have rendered the banner completely black! As an exhibit, the GIPS banner was up and seen by AAS attendees throughout the entire 5-day meeting. The banner and the GIPS project were featured in a Sky and Telescope article

(<http://www.skyandtelescope.com/news/Mapping-the-Milky-Way-187458841.html>) written by Dr. Monica Young (GRS, Astronomy PhD 2010).



Orbital image of Curiosity descending to the Martian surface on its parachute

### *Atmospheric Drag Calculations Supporting the Mars Science Laboratory Landing*

The Mars Science Laboratory is a robotic space probe mission that successfully landed the Curiosity rover on the surface of Mars in August 2012. Curiosity landed safely on Mars after “seven minutes of terror” passing through the Martian atmosphere. In order to land safely, Curiosity had to decelerate from speeds of several kilometers per second and reach zero speed exactly upon touching down on the surface. In order for Curiosity's landing system to land the rover safely at the correct location, NASA needed to predict the atmospheric conditions at the time of landing accurately. An especially important component to the prediction was the surface pressure, which reflects the total mass of the atmosphere above the landing site. This is influenced by season (since the atmosphere of Mars starts to freeze onto the planet's poles), height (since pressure drops as you move upwards), and weather. Professor Withers supported NASA's Curiosity mission by developing predictions of surface pressure from a database of many scattered measurements. He is currently analyzing measurements made by Curiosity during its landing to test how accurate his predictions were.

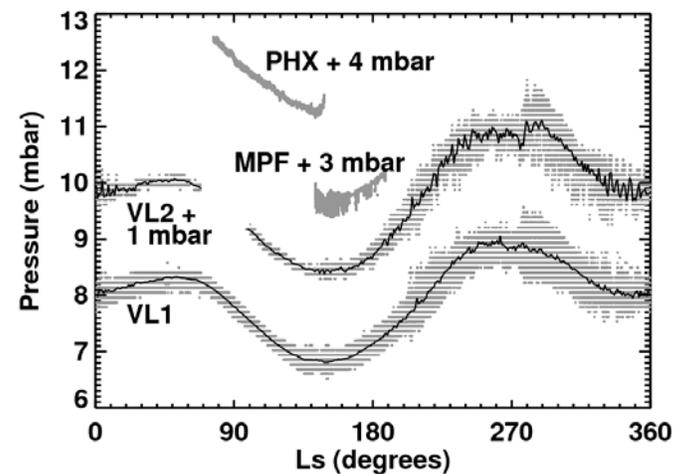
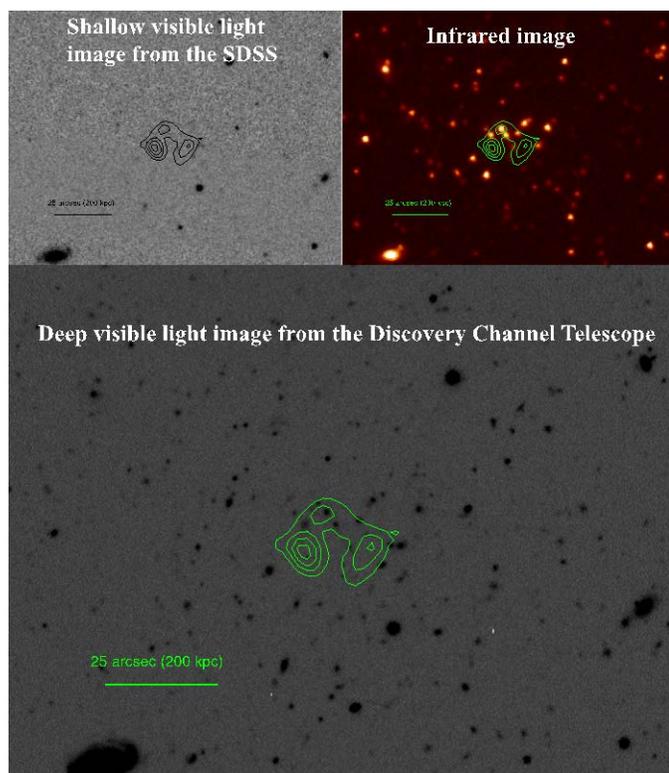


Figure 1 from Withers (2012): Surface pressure measurements (grey dots) from four Mars landers. Pressure offsets have been applied to several datasets to improve the clarity of this figure. Coarse digitization of the Viking Lander 1 and 2 measurements is apparent. The black lines through the VL1 and VL2 measurements indicate the diurnal mean surface pressure.

### *Images of Distant Galaxy Clusters with the Discovery Channel Telescope*

In April 2013 Professor Elizabeth Blanton began a long-term project to obtain optical (visible light) images of extremely distant clusters of galaxies with the Discovery Channel Telescope. The galaxy clusters in her study are so distant that, when imaged, one is looking back in time over roughly half the age of the universe, long before the earth was formed. Few such galaxy clusters are currently known to astronomers, yet it is crucially important to discover and to study them because of their potential power to constrain theories of the formation

and evolution of massive structure in the universe after the Big Bang.



**Composite image of a region of sky, centered on a distant galaxy cluster. Top left: shallow optical image from the Sloan Digital Sky Survey in which the galaxy cluster cannot be seen. Top right: infrared image obtained with the Spitzer space telescope in which the galaxy cluster can be seen clearly. Bottom: deep optical image obtained with the Discovery Channel Telescope in which the galaxy cluster can be seen clearly. In all cases the central contours show the radio light image of a “bent radio source” that was used as part of the selection process for Professor Blanton’s distant cluster project.**

In order to locate likely candidates for distant galaxy clusters, Professor Blanton and her collaborators are using bent, double-lobed radio sources as signposts. Such radio sources are typically found within clusters of galaxies. If a shallow, visible light image of the region of sky nearby a bent, double-lobed radio source does not obviously show the presence of a galaxy cluster, then it is likely that the cluster is very distant (and is, therefore, too faint to appear in a shallow image). Using a combination of deep visible light imaging with the Discovery Channel Telescope and infrared imaging with the Spitzer space telescope, Professor Blanton is discovering new, extremely distant galaxy clusters. The combination of the visible and infrared detections shown in the figure below indicate that the galaxy cluster in the

image is so distant that the light we observe from it has been traveling across the universe for close to 6.5 billion years (i.e., a length of time that is close to half the age of the universe, and greater than the age of the earth itself).

### **Research Funding**

The Astronomy Department is highly successful in raising research funds. Compared with other science departments at Boston University, for the past several years the Astronomy Department has had the largest annual grant income (\$11.7 M in FY2004, \$12.6 M in FY2005, \$11.2 M in FY2006, \$14.1 M in FY2007, \$19.7 M in FY2008, \$21.2 M in FY2009, \$31.8 M in FY 2010, \$27.2 in FY 2011, \$29.9 in FY2012, and \$28.5M in FY2013). This accomplishment is even more impressive considering the small size of our faculty. Indeed, the average grant income raised per faculty member (both research and teaching faculty) in the Astronomy Department is over \$1,000,000. A complete list of new and continuing grants can be found in the annual reports for the Center for Space Physics and the Institute for Astrophysical Research.

As has been the case in past years, the majority of our research was supported by grants and contracts from three major federal agencies: the National Science Foundation, NASA, and the Office of Naval Research.

### **Peer-Reviewed Publications**

The Department’s faculty, research associates, and students continue to publish in the leading journals of our disciplines and to present their results at national and international meetings. This activity not only disseminates major new research results, but also helps to keep the Department’s research prominent within our respective communities. Members of the Astronomy Department and its affiliated research centers published 86 articles in refereed journals during the reporting period.

### **DISCOVERY CHANNEL TELESCOPE**

#### ***First Light Gala***

After 10 years of planning and building, Lowell Observatory completed the construction of the

Discovery Channel Telescope in 2012. The end of construction and the first use of the telescope to observe the heavens was marked by a “First Light Gala” in Flagstaff, Arizona on July 21, 2012. Dean Virginia Sapiro and Professor Scott Solberg (SED) joined members of the Astronomy Department faculty at the Gala dinner. This special evening of congratulations and celebration featured a keynote address by Astronaut Neil Armstrong. In the 1960’s Lowell Observatory played a key role in helping NASA to determine the best lunar landing sites for the Apollo missions, including Apollo 11, the mission for which Mr. Armstrong served as the Crew Commander, successfully landing a vehicle on the moon for the first time in history.



**Astronaut Neil Armstrong delivering the keynote address at the DCT First Light Gala (07/21/2012)**

### ***First DCT Science Nights***

After much anticipation, BU astronomers enjoyed the first six science nights on the DCT between February 2013 and June 2013. The initial science programs include a search for extremely distant clusters of galaxies (Professor Elizabeth Blanton), measurements of parallaxes of nearby low-mass stars and brown dwarfs to derive a luminosity function and test models of low-mass star formation (Professor Andrew West), and studies of weak gravitational lensing, satellite galaxies, and intracluster light in nearby clusters of galaxies (Professor Tereasa Brainerd).

## **UNDERGRADUATE EDUCATION**

*Director of Undergraduate Studies:*  
*Professor Dan P. Clemens*

Nearly 800 undergraduate students enrolled in Astronomy courses in AY12-13. Of these, 744 were enrolled in our suite of 100-level courses for non-science majors. The Astronomy Department has three distinct suites of courses to serve Boston University students:

**1. Astronomy for non-science majors.** Undergraduate non-science majors at Boston University usually take our 100-level courses in order to fill the natural science distribution requirement. Since astronomy is rarely part of the high school curriculum, these courses offer an attractive opportunity for students wishing to experience a new field of science.

**2. Core Curriculum and Kilachand Honors College.** The Astronomy Department plays a key role in the Core Curriculum Natural Sciences course CC105 by providing two or three faculty members each year. About 200 students per year enroll in CC105. Professor Michael Mendillo also teaches a seminar on the history of the planet Pluto for the Kilachand Honors College.

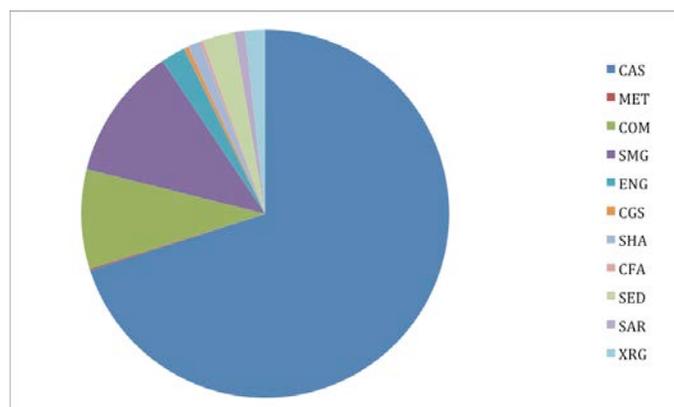
**3. Astronomy for majors.** Our 200-400 level courses provide a rigorous technical education for students wishing to pursue a career in astronomy or a related field. Approximately one third of our majors go on to graduate school in astronomy or physics. Those students who enter the workforce immediately after graduation have gained important skills in problem solving, mathematics, and physics. Many of these students find jobs in which skills in data analysis are highly sought after.

### **Divisional Studies Courses**

In terms of the number of students, the department’s largest teaching mission by far is to offer courses designed to satisfy CAS divisional study requirements and similar requirements within the other undergraduate schools and colleges of the University.

We currently offer six such 100-level courses. Two of these, AS101 (*The Solar System*) and AS102 (*The Astronomical Universe*), are broad survey courses that carry laboratory credit. The other four, AS100 (*Cosmic Controversies*), AS105 (*Alien Worlds*), AS107 (*Life Beyond Earth*), and AS109 (*Cosmology*) are more focused, topical courses that do not carry laboratory credit. In AY12-13 we offered seven sections of our 100-level courses: two sections of AS101, two of AS102, and one each of AS100, AS105, and AS109.

#### Composition of 100-level Astronomy Classes by College, AY12-13



The chart above illustrates the breakdown by college/school of undergraduates enrolled in 100-level astronomy courses. The total enrollment was 744 in AY12-13. Of the students taking these courses, approximately 70% (521) were CAS students and 30% (223) were students from other schools and colleges.

#### AY12-13 Highlights in Undergraduate Teaching: AS105, BU Pre-MaP, and AS107

**AS105:** Amongst the year's highlights in undergraduate teaching was the continued growth of AS105 (*Alien Worlds*). *Alien Worlds* is a relatively new course that Professor Andrew West developed in order better serve the interests of BU's undergraduate non-science majors. The course has received rave reviews from the students and has generated a "buzz" on campus and beyond. In only 3 offerings, *Alien Worlds* has "gone viral", growing from an enrollment of 40 in Spring 2011 to an enrollment of 229 in Fall 2012. This is the first time in four decades that the enrollment in an introductory astronomy course at BU has exceeded 200 students (the previous course was taught by Professor Gerald Hawkins, the "decoder" of Stonehenge). *Alien Worlds*

explores the planets within our own solar system, planets that orbit stars other than the sun, the history of space exploration, and the possibility of extraterrestrial life. The course has become so popular with BU's students that the Fall 2012 section had nearly closed out by the time incoming freshman were allowed to register. *Alien Worlds* has been featured in BU Today (<http://www.bu.edu/today/2011/one-class-one-day-alien-worlds/>), the BU Daily Free Press (<http://dailyfreepress.com/2011/10/31/class-on-alien-worlds-ranked-one-of-%E2%80%98craziest%E2%80%99/>), a YouTube video (<http://www.youtube.com/watch?v=GtrpGRwi78Y>), and a "CAS Presents" video (<http://www.bu.edu/buniverse/view/?v=DYBj17A>). The Huffington Post named *Alien Worlds* one of the "10 Craziest College Classes" ([http://www.huffingtonpost.com/her-campus/the-10-craziest-college-c\\_b\\_966560.html](http://www.huffingtonpost.com/her-campus/the-10-craziest-college-c_b_966560.html)).

**BU Pre-MaP:** In Fall 2012, Professor West started a pilot BU Pre-Majors Program (or Pre-MaP), which is modeled after the University of Washington Pre-Majors in Astronomy Program (UW Pre-MAP) that he helped to develop as a graduate student. His course was offered as part of the optional "First Year Experience" (FYE) program in CAS. As a significant part of Professor West's Pre-MAP (or Pre-MaP) model, first-year students are engaged in a research project with a faculty or graduate student mentor, and they learn many of the skills that are needed to be successful in science.

For Professor West's pilot Pre-MaP FYE at BU, students were identified from matriculating first-year rosters and were invited to apply to the program. Demographic information from student records was used to specifically invite underrepresented minorities, women and first-generation college students who had expressed interest in majoring in a physical science to apply for the program. The final pilot program had five students enrolled and Professor West thinks it's safe to say that it was the most diverse single class population at BU in Fall 2012 (consisting of 3 women, 2 men, 2 students with Native American heritage, 1 student with Latino heritage, and two first-generation college students). Professor West's Pre-MaP students were engaged in

research with professors, postdocs, and advanced graduate students in the Astronomy Department. In future years, Professor West plans to expand the program to 12–16 students per year, and the research mentors will be drawn from multiple departments in the physical sciences (i.e., not just Astronomy).



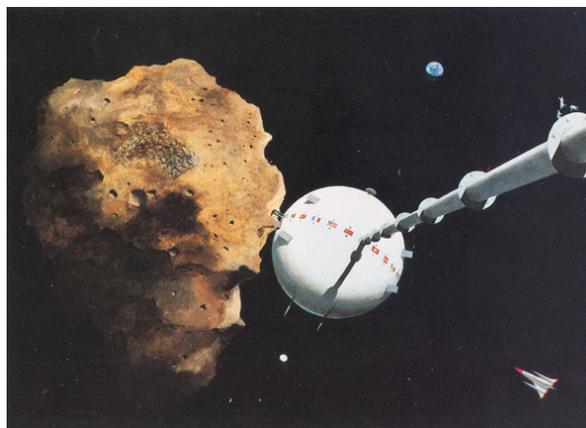
**BU Pre-MaP field trip to the Discovery Channel Telescope. Left to right: Melissa Hunter (CAS Astronomy 2016), Tyler Butler (ENG 2016), Professor West, Angela Massey (CAS Astronomy 2016), and Frank Schwamborn (ENG 2016). Not pictured: Kelley Ducey (CAS Astronomy 2016).**

Similar to the UW Pre-MaP program, Professor West's Pre-MaP FYE at BU uses weekly seminars to introduce freshman students to BU and to the college environment. His program discusses ways to be successful in and out of the classroom, highlights the importance of peer mentoring and cohort building, and serves as a mechanism to introduce first-year students to research skills. The Pre-MaP students learn the basics of computer programming, lab notebook preparation, proposal writing, basic data analysis, and error propagation. In teams of two, the Pre-MaP students select (with assistance) a research mentor and work with him/her on an original research project. The criterion that students work in teams has proven to be an essential element of cohort building in the UW Pre-MaP program and, so, Professor West has also adopted it for the BU Pre-MaP. While the formal BU Pre-MaP seminar was only held during the Fall semester, Professor West encouraged his students to continue their research programs under the support of the BU

Undergraduate Research Opportunities Program (UROP) in Spring semester.

In addition to leading the Pre-MaP seminars and coordinating the program, Professor West accompanied his students on several class field trips. The Pre-MaP students viewed original science documents at the Boston Public Library (including works by Galileo, Newton, and a first edition by Copernicus) and they also visited the Harvard Natural history museum. In addition, they participated in an astronomical observing run using the 1.8-m Perkins Telescope at Lowell Observatory in Flagstaff, Arizona, a trip that was funded by the BU CEIT and the NSF.

**AS107:** In order to better serve our non-science majors, Professor Bania developed a new course, AS107 (*Life Beyond Earth*) in Fall 2012. AS107 will explore the formation of planets and their suns, the growth of planetary civilizations, the existence of finite planetary resources to support civilizations, interstellar travel and space colonization, and the scientific search for extraterrestrial life. The core theme of AS107 is as follows. *About 10% of the planets in our Milky Way galaxy are similar to the earth in both size and material composition. The same physical laws operate everywhere, so extraterrestrial life may be both common and technologically advanced. Given this, **where is everybody?*** AS107 satisfies the CAS Natural Sciences non-laboratory general education requirement, and has no pre-requisite courses. It will be offered for the first time in Fall 2013.



**Artist's conception of the mining of an asteroid, one of the topics covered in AS107 (*Life Beyond Earth*).**

### The Core Curriculum and Kilachand Honors College

In the spirit of promoting a true liberal arts education, the Astronomy Department is committed to providing excellent science education to both science and non-science majors.

Since many CAS students choose to meet their science education requirements through the Core Curriculum, the Department provides a significant commitment to the physical science component of the Core, CC105. One of our own faculty members, Professor Alan Marscher, developed CC105 and he served as the course coordinator for many years. Professor James Jackson has served as course coordinator for CC105 for eleven years, and he has continued the long tradition of Astronomy Department service and leadership in this important program. The Astronomy Department provides as many additional faculty members to this course as our other teaching commitments allow. Typically, the Astronomy Department commits two or three lecturers per year to CC105. In AY12-13, Professors Jackson, Blanton and Marscher staffed CC105.

The University also offers a program that provides a broad, interdisciplinary, liberal arts experience in a series of smaller seminar courses through the Kilachand Honors College. In Fall 2012, Astronomy Professor Michael Mendillo taught a KHC freshman seminar course entitled "*The Pluto Saga: How Do You Become a Planet and Stay a Planet?*" for the third year in a row.

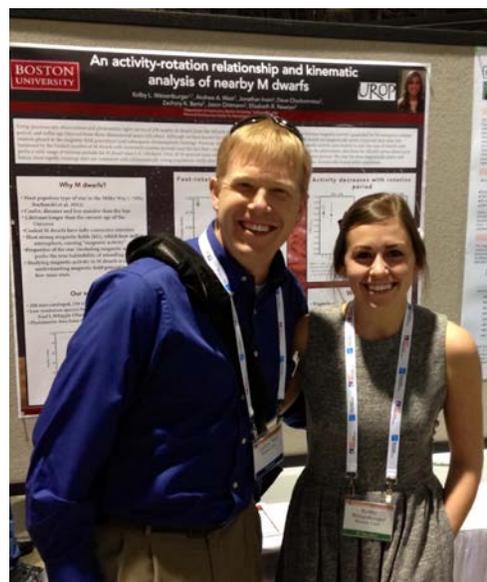
### Undergraduates Concentrating in Astronomy

The Department continues to have one of the largest and strongest undergraduate majors programs in astronomy in the country. In terms of bachelor's degrees awarded in astronomy, Boston University ranks seventh amongst PhD-granting departments in the US with an average of ten graduates per year, behind University of California Berkeley (27), University of Colorado Boulder (18), University of Washington (16), Florida Institute of Technology (12), Michigan State University (12), and the University of Wisconsin Madison (11).

The graduating class of AY12-13 consisted of a large class of 13 students; 8 received BAs in Astronomy &

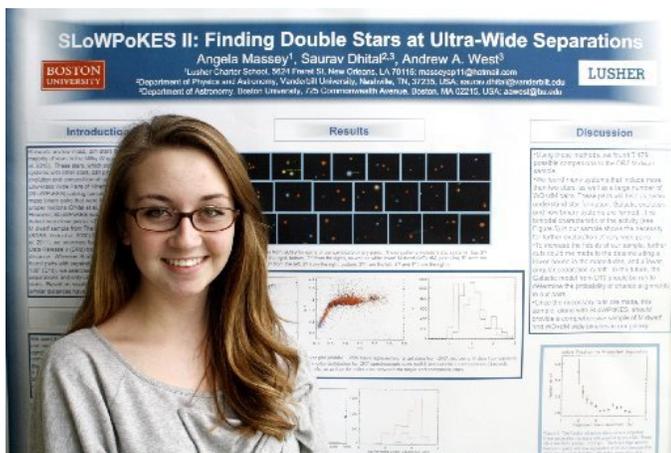
Physics, 4 in Geophysics & Planetary Sciences, and 1 in Astronomy. Current enrollments indicate that we will graduate ten or more undergraduate students per year for the foreseeable future. A list of our graduating class is provided in Appendix B.

Many of our undergraduate majors are actively engaged in research programs and are winning awards for their research and academic achievements. For example, in AY12-13 BU junior Kolby Weisenberger received a Chambliss Astronomy Achievement Student Award for the research poster that she presented at the January 2013 meeting of the American Astronomical Society. Kolby was also awarded the Claire Boothe Luce Scholarship and she won a BU UROP "Symposium Attendees" prize. Professor Andrew West is Kolby's research advisor.



**Professor Andrew West and Kolby Weisenberger in front of Kolby's award-winning research poster at the January 2013 AAS meeting in Long Beach, CA**

Freshman Angela Massey was awarded the Buck Scholarship and was also named to Gambit's *40 Under 40 - 2012* list of New Orleans high achievers (<http://www.bestofneworleans.com/gambit/gambits-40-under-40-2012/Content?oid=2093013>). When she was a high school junior Angela worked for Professor Andrew West as a summer intern, and she has continued her research with Professor West since matriculating at BU.



**Angela Massey (CAS Astronomy & Physics 2016) presenting a poster on her research with Professor West as part of the RISE program. Angela was a high school junior at the time (summer 2011). She matriculated at BU in Fall 2012.**



**Trey Wenger (CAS Astronomy & Physics 2012)**

Undergraduate student Trey Wenger (CAS Astronomy & Physics 2012, *Summa Cum Laude*) was awarded the prestigious Jefferson Fellowship for graduate studies at the University of Virginia (UVa) on the basis of his outstanding undergraduate academic record, as well as the research he carried out with Professor Thomas Bania on the chemical properties of the hot gas that surrounds young stars. The Jefferson Fellowship (<http://www.jeffersonscholars.org/graduate-program/the-jefferson-fellowship/>) is the premier graduate fellowship at UVa and is used to “attract PhD, MBA and JD candidates who show outstanding achievement and the highest promise as scholars, teachers, public servants, and business leaders in the United States and beyond.” Candidates compete for the Fellowships at a weekend event at UVa that includes interviews and formal presentation by the candidates on their research. The Fellowship provides a living stipend of \$30,000 to \$35,000 per year (renewable for five years), research funds up to \$7,500, full tuition remittance, and health insurance.

### ***Boston University Astronomical Society (BUAS)***

The Boston University Astronomical Society (BUAS) is a group that consists mostly of undergraduate majors in astronomy and related fields. The BUAS members are dedicated to extending their interest in astronomy to the community at large, and all students and members of the general public are welcome to join the BUAS, regardless of their educational pursuit or astronomical background. A typical weekly meeting of the BUAS usually includes either a short lecture on a topic related to basic astronomy knowledge or current events in astronomy, watching a documentary on an astronomy or space sciences related subject, and/or helping out as telescope operators at the weekly Wednesday public observing nights at the Coit Observatory. Over the course AY12-13, the BUAS inaugurated the 12" Dobsonian telescope that was designed and built by BUAS members over the past several years. The Society also took a few trips off campus. One trip took them to the planetarium at the Museum of Science in Boston, and another was the Society's annual trip up to Cumberland, Maine for some dark sky observing. BUAS is dedicated to public outreach. In addition to helping out with the weekly public observing nights, BUAS also set up a table at the "SET in the City" event at BU where BUAS members answered questions and presented demonstrations to local high school students interested in pursuing a career in science, engineering, or technology. In AY12-13 undergraduate senior Trey Wenger served as the President of BUAS.

## Undergraduate Advising

Advising of students who are majoring, or intending to major, in one of the programs offered by the department is overseen by the Director of Undergraduate Studies, Professor Dan Clemens.

Since the course schedule for majors in astronomy is highly structured, advising must begin with the incoming class, sometimes even before they arrive on campus. Thus, freshman advising during the summer is critically important. We also carefully monitor possible freshman majors during the first few days of classes in the fall to make sure all are taking the appropriate classes. We often recruit and advise highly qualified students from the Core and our 100-level offerings; in recent years we have had growing success with identifying excellent scholars and introducing them into our program through these courses. Students who decide during their sophomore year to major in astronomy provide us with our biggest advising challenges, but the numbers are small enough that each case can be dealt with carefully on an individual basis.

We attempt to assign as many students as possible to the same faculty advisor over their entire time at BU. This provides much needed continuity for the students, but requires faculty to be more aware of advising issues at all stages of our program. Every faculty member who was on campus during both semesters of AY12-13 acted as an undergraduate student advisor.

## GRADUATE EDUCATION

*Director of Graduate Studies: Professor Meers  
Oppenheim*

*Director of Graduate Admissions: Professor Paul  
Withers*

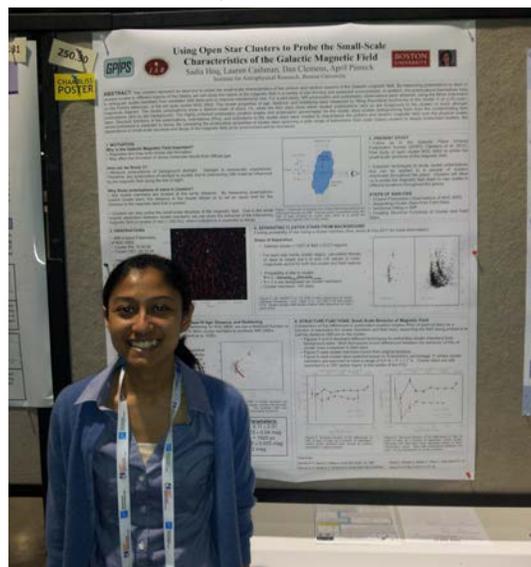
### Graduate-level Astronomy

Our graduate program trains the next generation of astrophysicists and space physicists. Because of our department's strong concentration in space physics research, our graduate students are all required to take elementary courses in both astrophysics and space

physics. After passing the qualifying exams, a student may choose advanced courses in either field.

### Overview

Our graduate program remains vigorous. Of the thirty-nine PhD-granting astronomy programs in the country, ours is above average in terms of the number of students and in the number of PhDs awarded. Our graduate students continue to win student awards at national scientific conferences as well as highly competitive fellowships. For example, at the January 2013 meeting of the American Astronomical Society, graduate student Sadia Hoq was awarded a Chambliss Astronomy Achievement Student Award for her research poster entitled *Using Open Star Clusters to Probe the Small-Scale Characteristics of the Galactic Magnetic Field*. Sadia's PhD research advisor is Professor Dan Clemens. In addition, Jan Marie Andersen received the Svante Arrhenius Astrobiology Award for her presentation at the European Astrobiology Network Association and Antonia Savecheva-Tasseva was awarded the NASA Jack Eddy Postdoctoral Prize Fellowship. Jan Marie's research advisor is Professor Andrew West. Antonia's primary PhD research advisor was Dr. Ed DeLuca at the Harvard-Smithsonian Center for Astrophysics, and she was co-advised at BU by Professor West.



**Sadia Hoq in front of her prize-winning poster paper at the January 2013 AAS meeting in Long Beach, CA**

A survey of our graduates who earned PhDs in the past decade reveals a remarkable degree of overall professional success. A significant fraction of our PhD

recipients hold faculty and leadership positions at major research institutions. In AY12-13, five of our students were awarded PhDs and four were awarded MAs



**May 2013 PhD Hooding Event. Left to right: Professor Jeffrey Hughes, Dr. Christopher Mendillo, Dr. Kamen Kozarev, Dr. Joshua Wing, and Professor Elizabeth Blanton**

In AY12-13 we added five new students to our graduate student population, resulting in a total of 33 new and continuing students. Every graduate student is fully supported as either a teaching fellow or research assistant for the full 12 months. Teaching Fellows and Research Assistants are listed in Appendix A.

### **Graduate Student Recruitment**

Graduate student recruitment is critical to maintaining a vigorous graduate program. Competition for the best graduate students among the top schools is intense, and we expend considerable effort in attracting the best students to Boston University for their graduate studies. In AY12-13 we were successful in recruiting five students of very high quality into our PhD program. In AY12-13 the chair of the graduate admissions committee was Professor Paul Withers. A list of our incoming graduate students is provided in Appendix A.

### **Graduate Advising**

Professor Meers Oppenheim, Director of Graduate Studies (DGS), oversaw the advising of graduate students. Incoming graduate students are advised by the DGS, who continues to be their primary advisor until they select a research supervisor (usually no later than their first summer of graduate study). After this

selection, the research advisor provides their primary advice. Nevertheless, all graduate student registrations are countersigned by the DGS to ensure that students register for the appropriate courses, especially as they prepare for the written component of the PhD qualifying examination. The DGS continues to monitor students' progress throughout their graduate career, ensuring that they are making significant progress toward their degrees, and are satisfying all departmental, college, and university requirements.

### **Summer School on Plasma Processes in Space Physics**

In August 2012, Professor Merav Opher hosted a one-week summer school on plasma processes in space physics as part of her NSF CAREER award. This intensive 30-hour summer school was attended by 27 PhD students and 3 postdoctoral scholars. The summer school included lectures by scholars in the field, as well as computer lab work. Topics included an overview of space physics, reconnection in the sun, heliosphere and magnetosphere, turbulence in the solar wind, plasma processes in helioseismology, kinetic plasma physics in the ionosphere, plasma processes in the magnetosphere, auroral ionospheric plasma processes, and experiments in reconnection (see <http://www.bu.edu/csp/plasma-summer-school-2012>). In addition, the last day of the summer school featured a special women's panel discussion on strategies for a successful career in the physical sciences. Following on the success of the 2012 summer school, Professor Opher hopes to continue to offer similar summer schools in future years.



**Participants in the 2012 Plasma Processes in Space Physics Summer School**

## COMMUNITY LIFE

### Colloquium series

Weekly seminar series in both Astrophysics and Space Physics are held throughout the academic year. These are run as graduate seminar courses by members of the department faculty, and are financed in part by the Astronomy Department. The majority of our weekly speakers give standard, research-based colloquia, but on occasion we bring in speakers to give enriching, non-standard talks during the scheduled colloquium time. In AY12-13, our speakers included Dr. James Ulvestad (Director of the Division of Astronomical Sciences at the National Science Foundation), who spoke on the significant challenges to ground-based astronomy due to current federal budgetary restrictions; Dr. William Saturno (BU Department of Archaeology), who spoke on the role of astronomy in 8<sup>th</sup> Century Maya Society; and Dr. Richard Feinberg (Press Officer for the American Astronomical Society), who spoke on how astronomers can best interact with the public media. The lists of speakers in both seminar series are provided in Appendix C.

### Musical Events

Two annual highlights are our musical events that feature performances by members, family and friends of the Astronomy Department: “Astronomy Unplugged”, an informal, intimate concert of popular contemporary music, and our “Musical Soiree”, a formal concert of classical music held each spring in the Tsai Performance Center. These open concerts build *esprit de corps* within the Department and are enjoyed by many more from within the larger BU community.



Members of the Astronomy Department, Center for Space Physics, and Institute for Astrophysical Research performing at the 2013 Musical Soiree in the Tsai Performance Center

## OUTREACH

Many members of the Department of Astronomy participate in various outreach activities on a regular basis. Below are just a few highlights of our outreach efforts in AY12-13.

Our most prominent outreach effort is our series of Public Open Nights that are held every clear Wednesday night at the Coit Observatory on the rooftop of the CAS building. This program is run by our observatory manager, Quinn Sykes along with members of the BU Astronomical Society, and draws hundreds of visitors annually from the Greater Boston area. The quality of this popular program and other special events is limited by, and indeed ever threatened by, the poor physical state of the Coit Observatory.

Quinn Sykes and a number of volunteers also participated in community outreach at art museums in the greater Boston area last year. In July, Quinn and graduate student Michael Pavel hosted a public star party on the harbor deck of Boston’s Museum of Contemporary Art in conjunction with an exhibit that featured astronomy-related art by Josiah McElheny. In addition, Quinn and graduate students Jordan Montgomery and Karen Williamson were guest

speakers at the Isabella Stewart Gardner Museum's "Gardner After Hours" event on September 20, held in conjunction with the opening of *The Great Bare Mat and Constellation* exhibition

[http://www.gardnermuseum.org/contemporary\\_art/exhibitions/past\\_exhibitions/great\\_bare\\_mat\\_and\\_constellation](http://www.gardnermuseum.org/contemporary_art/exhibitions/past_exhibitions/great_bare_mat_and_constellation) . At this event Quinn and the students hosted an informal question and answer session about astronomy and provided a telescope for public viewing of the stars.

On June 20, 2013 Quinn also hosted a field trip of K2 and 5<sup>th</sup> grade students from the Saint Columbkille school at the Coit Observatory.



**Students and teachers from the Saint Columbkille school visiting the Coit Observatory on the roof of the CAS building.**

In April 2013 Professor Merav Opher participated in the *Big Ideas for Busy People (2013)* series at the Cambridge Science Festival. This is a series in which scientists who are thinking "out of the box" explain their ideas in timed 5-minute sessions. Professor Opher's contribution on her group's work on the heliosphere can be found at <http://www.youtube.com/watch?v=Np78sHrjAx4> . The Department of Astronomy had also hoped to participate in the Cambridge Science Festival by offering a *Sidewalk Astronomy* public sky viewing from Marsh Plaza and the Coit Observatory on National Astronomy

Day (April 20, 2013). Regrettably, this was the day following the shelter-in-place order from Governor Deval Patrick in association with the manhunt for Boston Marathon bombing suspect Dzhokhar Tsarnaev. In consideration for the safety of the general public, the Cambridge Science Festival cancelled the event. We hope very much to offer this event in conjunction with the Cambridge Science Festival in 2014.

As an exhibitor at the January 2013 meeting of the American Astronomical Society, the GPIPS team (Professor Dan Clemens and graduate students Lauren Cashman, Sadia Hoq, and Jordan Montgomery) was offered the opportunity to participate in an organized outreach to LA area middle and high schools, predominantly from disadvantaged or minority communities. Pupils came to the meeting and were treated to a set of short talks and hands-on exercises linked to the exhibit booth science contents. The GPIPS team ran one of these talk/exercise stations, meeting with about 50 students and helping them gain familiarity with terrestrial magnetism (by their making take-home electromagnets) and galactic magnetism (by a detailed explanation of our GPIPS banner).

Professor Tereasa Brainerd continued her work as a member of the advisory board for Science for the Public (SftP) (<http://www.scienceforthepublic.org>), a grassroots Boston-Cambridge based organization that is dedicated to science education for adults, rather than the typical K-12 outreach focus that is so common. As part of SftP's series of videocasts entitled *Contemporary Science Issues and Innovations*, Professor Jeffrey Hughes spoke on camera with SftP's director, Dr. Yvonne Stapp, about solar magnetic storms and space weather. His videocast for SftP can be viewed at <http://www.scienceforthepublic.org/cosmos/solar-magnetic-storms-and-space-weather> .

Our partnership with Lowell Observatory in the operation of the Discovery Channel Telescope offers exciting opportunities for cross-college collaborative efforts in the area of STEM education and outreach. In the past year, we have worked with the School of Education (SED) to develop an outreach program that will publicly engage communities that are

underrepresented in science and science education. A major milestone in this effort was the submission of a \$250k NSF Pathways grant proposal entitled *Pathways: Science Programs in Astronomy for the Advancement of Community Education (SPAACE)* (PI: Professor Donald DeRosa, SED; Co-Is: Professor Andrew West, CAS; Professor Peter Garik, SED; and Mr. Nicholas Gross, CAS). If selected for funding, this grant will support the creation of “locally accessible and culturally relevant informal science experiences; develop a diversified project team consisting of community members, scientists, and educators based on the principles of mutual learning; design informal science experiences that inspire, inform, and compel participation in informal science education experiences; [and] increase participation in informal science experiences within communities that typically do not access traditional informal science resources.”

#### **FUNDRAISING OTHER THAN RESEARCH GRANTS**

The Astronomy Department was fortunate to benefit from new gift funding in the past year. In January 2013 the gift of \$10,000 from Mr. David S. Katz (CAS’80, LAW’85) allowed the purchase of nine new computers and monitors for the Astronomy computer lab (housed in CAS Room 606). Mr. Katz’ gift to CAS was intended to be used for urgent educational needs, and the Department is extremely grateful that the replacement of these computers was enabled through Mr. Katz’ generosity to the College. The new machines in Room 606 replaced unreliable, 10-year old machines that had reached the end of their useful lifetimes and have greatly enhanced the educational experience for our students.



**Professor Paul Withers (right) and students Catherine Sullivan (foreground) and Gerard Lawler (background) working with the new computers in the Astronomy Computer Lab**

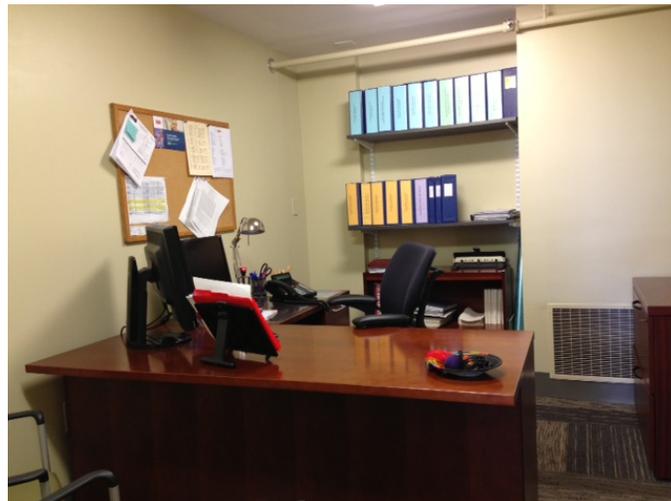
In May 2013, Dr. Tian-Xing (“Tim”) Liu returned to Boston University to pledge a gift of \$100,000 to the Astronomy Department for the construction of a dedicated remote astronomical observing center. Dr. Liu received his PhD in Astronomy from Boston University in 1990 under the supervision of Professor Kenneth Janes. The Liu Remote Observing Center will be used by Astronomy faculty and students to conduct research on telescopes around the world via remote (internet) access. The Department welcomed Dr. Liu back to campus with a signing ceremony in CAS Room 500 on May 9. It was a pleasure for the Department to have this opportunity to reconnect with one of our graduates. We look forward to the construction of the remote observing center, as well as future visits of Dr. Liu to campus as his travel schedule allows.



**Dr. Tian-Xing (“Tim”) Liu (center), with Professor Kenneth Brecher (left) and Professor Kenneth Janes (right)**

## FACILITIES AND INFRASTRUCTURE

Thanks to generous funding from the College of Arts and Sciences, the main office of the Department of Astronomy underwent a complete renovation in summer 2012. As part of the renovation, a private office for the department administrator, a small conference room, and a secure circulation room (mail, printing, photocopying) were created. This much needed facelift was overseen by Lisa Doherty (CAS Facilities Management) and Colleen McGinty (Construction Services).



**New Astronomy Administrator's office**



**Renovation of the Astronomy main office. Image shows the space that was converted into a small conference room and the administrator's office.**



**New Astronomy conference room**

As grateful as the department is for the office renovation that took place this year, need remains for further renovations. These additional renovations are necessary for the success of our undergraduate teaching mission. Our greatest needs are a complete refurbishment of the Coit Observatory, as well as CAS Rooms 521 and B04. CAS Rooms 521 and B04 are the primary spaces in which we teach all of our "day time" laboratories, and Room 521 in particular is likely to be the most run down teaching laboratory in the entire College. Its state of disrepair is far worse than any typical high school laboratory, and this directly impacts our ability to offer first-rate laboratory experiences to undergraduates (both majors and non-majors). The Coit Observatory's continued state of squalor has been noted annually by previous Chairs of the Astronomy Department. The Observatory's state of disrepair also directly impacts our ability to offer first-rate observational astronomy laboratories to undergraduates (both majors and non-majors).

## LOOKING TO THE FUTURE

The coming year promises exciting changes with the integration of our new faculty members and their research programs into the department. Lowell Observatory has continued to work towards full science operations with the Discovery Channel Telescope, and we expect that significantly more nights on the DCT will be devoted to BU science programs in AY13/14. We

expect that Drs. Espaillat and Muirhead, in particular, will join the ranks of BU astronomers who are actively using the DCT for their research programs.

Even as we look forward to these exciting changes, we also note that, with the departure of four senior faculty members over the past several years, we have lost critical intellectual strength in the field of space physics (and particularly in space hardware).

The recent National Academy of Science decadal survey reports by the Astronomy, Planetary, and Space Science communities set the scientific agenda for research areas

that are deemed important and worthy of growth in the coming decade and into the future. In response to these reports, and in order for the Department of Astronomy to remain at the forefront of research in planetary and space physics, it is vital that we add faculty expertise in these areas. Since pioneering research in astronomy and space physics is driven by observations, it is important that we hire a new faculty member who is actively involved in current and future ground- or space-based instrumentation.

## **APPENDIX A: Faculty, Staff, and Graduate Students**

**Chair:** Associate Professor Tereasa Brainerd

**Associate Chair:** Professor John Clarke

**Director of Graduate Studies:** Associate Professor Meers Oppenheim

**Director of Undergraduate Studies:** Professor Dan Clemens

**Department Administrator:** Mr. John-Albert Moseley

### **Faculty**

Thomas Bania, Professor of Astronomy. AB, Brown University; MS, PhD, University of Virginia

Elizabeth Blanton, Associate Professor of Astronomy. AB, Vassar College; Ma, MPhil, PhD, Columbia University

Tereasa Brainerd, Associate Professor of Astronomy. BSc, University of Alberta; PhD, The Ohio State University

Kenneth Brecher, Professor of Astronomy. BS, PhD, Massachusetts Institute of Technology

Supriya Chakrabarti, Adjunct Professor of Astronomy. BE, University of Calcutta; MS, PhD, University of California, Berkeley

John Clarke, Professor of Astronomy. BS, Denison University; MA, PhD, John Hopkins University

Dan Clemens, Professor of Astronomy. Bs, BS, University of California; MS, MS, PhD, University of Massachusetts

Timothy Cook, Adjunct Professor of Astronomy. BA, John Hopkins University, PhD, University of Colorado

Nancy Crooker, Research Professor of Astronomy. BA, Knox College; MS, PhD, University of California, Los Angeles

Theodore Fritz, Professor of Astronomy, Professor of Electrical and Computer Engineering, Professor of Aerospace and Mechanical Engineering. BA, Virginia Polytechnic Institute; MS, PhD, University of Iowa.

W. Jeffrey Hughes, Professor of Astronomy. BSc, PhD, University of London

James Jackson, Professor of Astronomy. BS, Pennsylvania State University; PhD, Massachusetts Institute of Technology

Kenneth Janes, Emeritus Professor of Astronomy. AB, Harvard College; MS, San Diego State University; MA, MPhil, PhD, Yale University

John Lyon, Research Professor of Astronomy. ScB, Brown University; PhD, University of Maryland

Alan Marscher, Professor of Astronomy. BS, Cornell University; PhD, University of Virginia

Carlos Martinis, Assistant Research Professor of Astronomy. BS, Universidad Nacional de Tucuman; MA, PhD, Boston University

Michael Mendillo, Professor of Astronomy, Professor of Electrical and Computer Engineering. BS Providence College; MA, PhD, Boston University

Merav Opher, Associate Professor of Astronomy. BS, PhD, University of Sao Paulo

Meers Oppenheim, Professor of Astronomy. BS, PhD, Cornell University

George Siscoe, Emeritus Professor of Astronomy. BS, PhD, Massachusetts Institute of Technology

Harlan Spence, Adjunct Professor of Astronomy. BA, Boston University; MS, PhD, University of California, Los Angeles

Andrew West, Assistant Professor of Astronomy. BS, Haverford College; MS, PhD, University of Washington

Paul Withers, Assistant Professor of Astronomy. BA, MS, Cambridge University; PhD University of Arizona

### **Department Staff**

David Bradford, Systems Manager

John-Albert Moseley, Department Administrator

Jeffrey Sanborn, Associate Systems Manager

Quinn Sykes, Observatory Manager

**Astronomy Graduate Students During 2012-2013**

<b>Name</b>	<b>Affiliation</b>	<b>Title</b>
Jan Marie Anderson	IAR	RA
Dolon Bhattacharyya	CSP	RA
Matthew Camarata	IAR	RA
Carol Carveth	CSP	RA
Lauren Cashman	IAR	RA
Meredith Danowski	CSP	RA
Kathryn Fallows	CSP	RA
Daniel Feldman	AST	TF
Zachary Girazian	CSP	RA/TF
Dustin Hickey	CSP	RA/TF
Sadia Hoq	IAR	RA/TF
Paul Howell	IAR	N/A
Mason Keck	AST	TF
Kamen Kozarev	CSP	RA
Chad Madsen	CSP	RA/TF
Michael Malmrose	IAR	RA
Majd Matta	CSP	RA

<b>Name</b>	<b>Affiliation</b>	<b>Title</b>
Christopher Mendillo	CSP	RA
Adam Michael	AST	TF
Jordan Montgomery	IAR	RA
Dylan Morgan	IAR	RA
Danielle Pahud	CISM	RA
Rachel Paterno-Mahler	IAR	RA
Michael Pavel	IAR	RA
Patricio Sanhueza-Nunez	IAR	RA/TF
Antonia Savcheva-Tasseva	CSP	RA
Carl Schmidt	CSP	RA
Laura Sturch	IAR	RA
Christopher Theissen	IAR	RA
Karen Williamson	AST	TF
Joshua Wing	IAR	RA
Matthew Young	AST	TF
Mark Zastrow	AST	TF

**Incoming Graduate Students (Fall 2013)**

<b>Name</b>	<b>Undergraduate Institution</b>
Paul Dalba	UC Berkeley
Emmet Golden-Marx	Brown University
Brandon Harrison	Boston University
Phillip Phipps	North Carolina State University
Mark Veyette	University of Washington

**APPENDIX B: 2012/13 Astronomy Graduates****DOCTORATE**

<b>Name</b>	<b>Thesis Title</b>
Kamen Kozarev	“Coronal Shock Acceleration and Heliospheric Transport of Solar Energetic Protons”
Christopher Mendillo	“Scattering Properties of Dust in Orion and the Epsilon Eridani Exoplanetary System”
Michael Pavel	“Magnetic Fields in the Milky Way: Near-Infrared Polarimetry”
Antonia Savcheva-Tasseva	“The Evolution of Solar Sigmoidal Active Regions”
Joshua Wing	“A Multi-Wavelength Study of Galaxy Clusters Hosting Radio Sources”

**MASTER OF ARTS**

<b>Name</b>	<b>Advisor</b>
Zachary Girazian	Paul Withers
Kathryn Fallows	Paul Withers
Lauren Cashman	Dan Clemens
Mark Zastrow	Kenneth Janes

**BACHELOR OF ARTS**

<b>Name</b>	<b>Concentration</b>
Shannon Boyle	Astronomy and Physics
Nicholas Grapsas	Geophysics and Planetary Sciences, magna cum laude
Rachel Hetlyn	Geophysics and Planetary Sciences
Marc Kornbleuth	Astronomy and Physics, with honors
Angela Marusiak	Geophysics and Planetary Sciences
Kevin-Druis Merenda	Astronomy and Physics; Mathematics
Kevin O’Hara	Astronomy and Physics
Akshata Sahasrabudhe	Astronomy
Ian Santagata	Astronomy and Physics; Computer Science
Kyle Schluns	Astronomy and Physics
Jessica Stellmann	Geophysics and Planetary Sciences, cum laude
Trey Wenger	Astronomy and Physics, summa cum laude
Bertie Wright	Astronomy and Physics

## APPENDIX C: Seminar Series

### Space Physics Seminar Series, 2012/2013

<b>Date</b>	<b>Title</b>	<b>Speaker/Affiliation</b>
6-Sep	Imaging Saturn's Magnetosphere: Solar Wind-Driven and Rotational Dynamics on the Large Scale	Donald Mitchell, JHU Applied Physics Laboratory
13-Sep	Nonlinear Resonant Circuit Models of Space Plasma Physics	Paul Bernhardt, Naval Research Laboratory
21-Sep	Beyond Hot Jupiters: Exploring the Diversity of Exoplanet Atmospheres	Heather Knutson, Caltech
27-Sep	Cold Ion Flow From the Polar Ionosphere	Stein Haaland, Max-Planck Institute
4-Oct	The Lakes of Titan	Jason Soderblom, MIT
11-Oct	The Small Satellite Program at BU	Theodore Fritz, Boston University
18-Oct	Ionospheric Oxygen Ion Outflows in Magnetosphere-Ionosphere Coupling	Andrew Yau, University of Calgary
25-Oct	The Solar Bow Shock Revisited: Is it a slow shock?	Bertalan Zieger, Boston University CSP
1-Nov	Aurora on Ganymede	Melissa McGrath, NASA/MSFC
8-Nov	Taking the Measure of Mercury's Magnetosphere: Energetic Electrons and MESSENGER Mission	Ralph McNutt, JHU Applied Physics Laboratory
15-Nov	The Magnetosphere as a System	George Siscoe, Boston University
17-Jan	AE9, AP9 and SPM: New Models for Radiation Belt and Space Plasma Specification	Gregory Ginet, MIT Lincoln Laboratory
24-Jan	Solar Wind-Magnetospheric Coupling	Brian Walsh, NASA/GSFC
31-Jan	The Variability of the Near Space Environment due to Lower Atmosphere Forcing	Hanli Liu, UCAR
7-Feb	Stormtime Plasma Redistribution: Geospace Processes and Effects	John Foster, MIT/Haystack Observatory
14-Feb	A Model of the Chromosphere: Heating, Structures and Convection	Paul Song, UML
21-Feb	Thirty-five Years in Space and Counting: Voyager 1 at the Border with the Galaxy	Tom Krimigis, JHU Applied Physics Laboratory
22-Feb	Titan from the Inside Out	Jonathan Lunine, Cornell University
28-Feb	Solar Wind – Magnetosphere – Ionosphere Interactions	Eftyhia Zesta, NASA/GSFC
7-Mar	Early Science Results from the NASA Van Allen Probes Mission RBSP-ECT Instrument Suite	Harlan Spence, University of New Hampshire
21-Mar	Patterns in the Solar Wind	Nancy Crooker, Boston University
28-Mar	Assessing Dynamical Properties of the Atmosphere, Ionosphere, and Magnetosphere using Ground-Based Incoherent Scatter Radar	Mike Nicolls, Southwest Research Institute
4-Apr	Space Weather Impacts on Geostationary Communication Satellites: Telemetry Data Mining	Kerri Cahoy, MIT
11-Apr	Exploring Saturn's Earth-like Moon	Ellen Stofan, University College London
25-Apr	Profound Change of the Near-Earth Radiation Environment During Solar Superstorms	Yuri Shprits, MIT

## Astrophysics Seminar Series, 2012/2013

<b>Date</b>	<b>Title</b>	<b>Speaker/Affiliation</b>
10-Sep	The Event Horizon Telescope: Observing Black Holes with Schwarzschild Radius Resolution	Shep Doeleman, Haystack Observatory
17-Sep	The Galactic Center 130 GeV line: WIMP or artifact?	Doug Finkbeiner, Harvard-Smithsonian CfA
21-Sep	Beyond Hot Jupiters: Exploring the Diversity of Exoplanet Systems	Heather Knutson, Caltech
24-Sep	How to Make a Milky Way: The Continuing Story	Jay Lockman, NRAO
1-Oct	Super Earths and Life	Dave Latham, Harvard-Smithsonian CfA
15-Oct	Feedback Large and Small: Multi-Epoch Constraints on AGN Outflows	Daryl Haggard, Northwestern University
22-Oct	Opportunities and Challenges in Federal Ground-Based Astronomy	James Ulvestad, NSF AST Director
5-Nov	The James Webb Space Telescope and Active Galactic Nuclei	Jane Rigby, GSFC/JWST
12-Nov	The Stratospheric Observatory for Infrared Astronomy: Status and Recent Highlights	John Vaillancourt, USRA/SOPHIA
19-Nov	The Submillimeter CCAT Telescope: As high as you can drive a truck	Riccardo Giovanelli, Cornell University
26-Nov	Keeping Time with the Cosmos: The Role of Astronomy in 8 <sup>th</sup> Century Maya Society	Bill Saturno, BU Dept. of Archaeology
3-Dec	Measuring the Cosmos	Mark Reid, Harvard-Smithsonian CfA
10-Dec	Massive Star Formation in the Era of Herschel and WISE	Loren Anderson, West Virginia University
28-Jan	What can large samples of low-mass stars tell us about the Galaxy, the habitability of exoplanets and the evolution of stellar dynamos?	Andrew West, Boston University
4-Feb	Brains, Ateries, Sea Monsters, and the Future of Astronomy	Alyssa Goodman, Harvard University
11-Feb	The Galactic Plane Infrared Polarization Survey (GPIPS): Early Science	Dan Clemens, Boston University
19-Feb	Dust Reddened Quasars: A Transitional Phase in Quasar/Galaxy Co-Evolution	Eilat Glikman, Yale University
25-Feb	Photodynamics: Revealing the Secrets of the Lowest-Mass Planets and Stars	Joshua Carter, Harvard-Smithsonian CfA
4-Mar	The Star Formation in Radio Survey: GBT Findings and Initial Results with the Jansky VLA	Eric Murphy, OCIW
18-Mar	Tracking Planet Footprints in Dusty Disks	Catherine Espaillat, Harvard-Smithsonian CfA
26-Mar	Small Stars with Small Planets and Big Consequences	Philip Muirhead, Caltech
2-Apr	The Invisible, Large Reservoirs of Gas Around Galaxies	Jessica Werk, UC Santa Cruz
22-Apr	Epoch of Reionization Studies with the Murchison Wide Field Array	Jaqueline Hewitt, MIT
29-Apr	A Scientist's Guide to Interacting with the Media: Who, What, Where, Why, and How	Richard Feinberg, AAS Press Officer

## APPENDIX D: Accounts Income Expenditures

### Operating Budget (20-201)

Category	Amount	Percent of FY13 Income
Operating Budget	\$56,760	100%
<b>Total Income</b>	<b>\$56,760</b>	<b>100%</b>

Category	Amount	Percent of FY13 Expenditures
Work Study	\$5,065	9%
Supplies	\$9,589	17%
Telecom	\$5,275	9%
Postage	\$118	0%
Contracted Services	\$3,585	6%
Reproduction and Printing	\$5,400	10%
Books & Periodicals	\$132	0%
Travel	\$11,052	20%
Meeting Expenses	\$6,662	12%
Facilities	\$3,907	7%
IS&T	\$2,250	4%
Minor Equipment	\$3,275	6%
<b>Total Expended</b>	<b>\$56,760</b>	<b>100%</b>

### IDC Return (20-201-1021-9)

Category	Amount	Percent of FY13 Income
FY12 IDC forward	\$13,579	10%
8% IDC	\$118,923	90%
<b>Total Income</b>	<b>\$132,502</b>	<b>100%</b>

Category	Amount	Percent of FY13 Expenditures
Minor Equipment	\$9,874	8%
Supplies	\$6,494	5%
Travel	\$7,112	5.5%
Meeting Expenses	\$10,677	8%
IS&T	\$1,357	1%
Telecom	\$641	0.5%
CSP IDC operating	\$49,270	38%
IAR IDC operating	\$45,000	34%
<b>Total Expended</b>	<b>\$130,435</b>	<b>100%</b>

**Kilachand Honors College Funding**

<b>Category</b>	<b>Amount</b>	<b>Percent of FY13 Income</b>
UHC	\$10,000	100%
<b>Total Income</b>	<b>\$10,000</b>	<b>100%</b>

<b>Category</b>	<b>Amount</b>	<b>Percent of FY13 Expenditures</b>
Replacement Instructor Payroll (Sarah McGregor, AS101 Fall 2012)	\$7,000	70%
Display and computer in CAS Room B04	\$3,000	30%
<b>Total Expended</b>	<b>\$10,000</b>	<b>100%</b>

**W. F. Gilman Astronomical Fund (99250000579)**

<b>Category</b>	<b>Amount</b>	<b>Percent of FY13 Income</b>
FY12 forward	\$3,053	83%
Revenue	\$621	17%
<b>Total Income</b>	<b>\$3,674</b>	<b>100%</b>

<b>Category</b>	<b>Amount</b>	<b>Percent of FY13 Expenditures</b>
Optical equipment	\$311	22%
Optiplex desktop	\$1,081	78%
<b>Total Expended</b>	<b>\$1,392</b>	<b>100%</b>