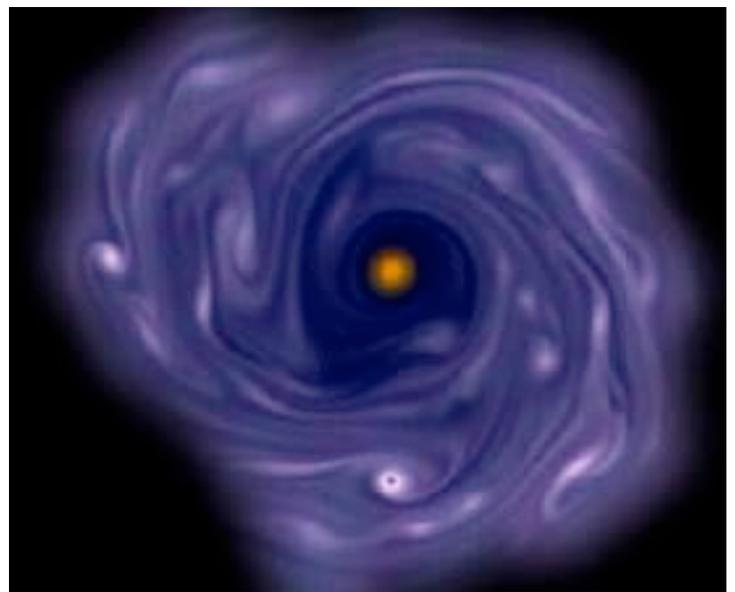
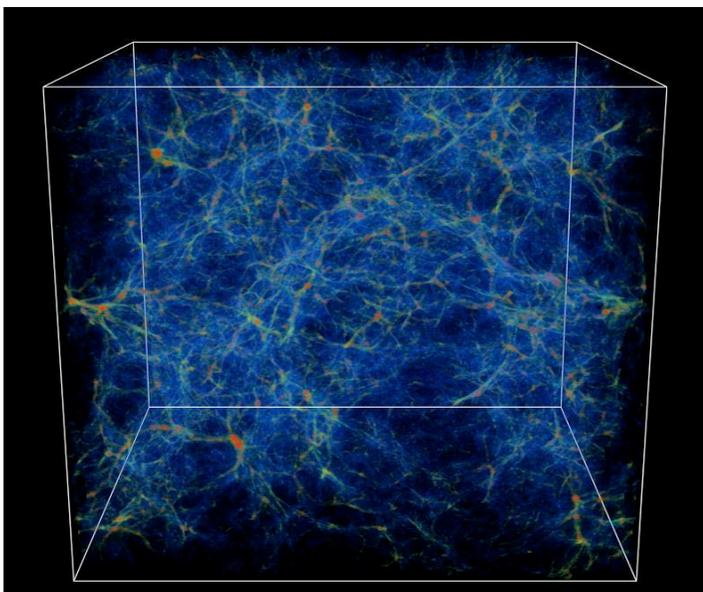
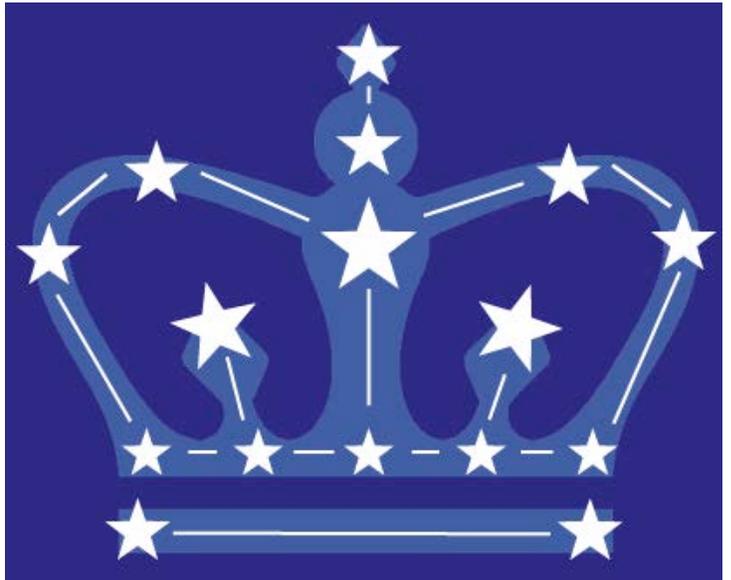


Columbia University  
Department of  
**Astronomy**



“Astronomy compels the soul  
to look upwards and leads us from  
this world to another” - Plato



# TABLE OF CONTENTS

<b>The Astronomy Department.....</b>	<b>3</b>
<b>The Graduate Program.....</b>	<b>4</b>
<b>Facilities.....</b>	<b>6</b>
<b>Faculty Bios.....</b>	<b>7</b>
<b>Public Outreach.....</b>	<b>12</b>
<b>Faculty Research.....</b>	<b>14</b>

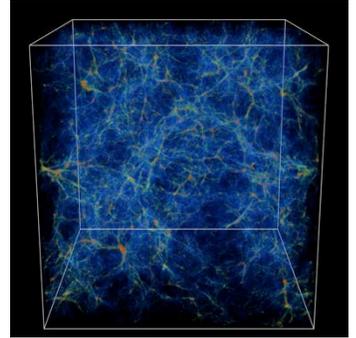
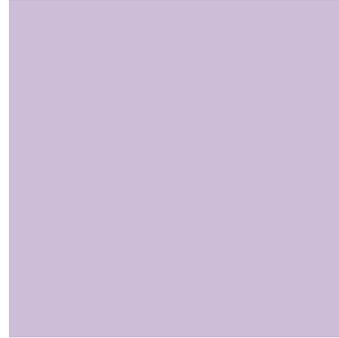
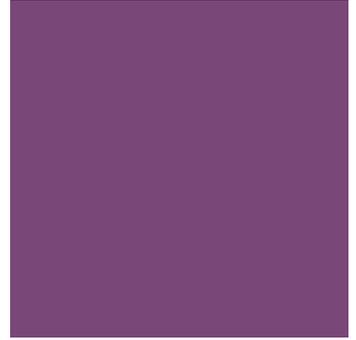


# Astronomy Department

## Columbia University

Located in New York City, Columbia University offers a graduate program in astronomy and astrophysics with a primary focus on the development of research skills. The goal of this program is to produce creative and independent scientists who will advance the frontiers of our discipline, educate the next generation of astronomers, and engage the public in our endeavor to understand the Universe. Our community includes faculty, researchers, and students in Astronomy and Astrophysics at Columbia University, Barnard College, NASA's Goddard Institute for Space Studies, the American Museum of Natural History and the Simons Center for Computational Astronomy all of whom are pursuing a wide range of theoretical, computational, observational, and experimental research.

# THE GRADUATE PROGRAM



The graduate program for the Ph.D. is designed to foster the intellectual and professional development of our students. To this end, graduate students are fully integrated into all of our Department's activities.

The primary goal of the program is to cultivate the ability to perform original, independent research. Shortly after arrival on campus, incoming students choose their first faculty-guided research project. In the first two years, each student will work with two different faculty members in two distinct areas of astronomy. Many students submit the results of these research projects for publication in professional journals. Instead of a traditional qualifying exam, research exams are held at the completion of the first and second year. Our course requirements are designed to impart the knowledge necessary for research in astronomy. The culmination of this two years of preparation comes in the form of a dissertation proposal presented before a committee in the third year. The remaining part of the graduate student's career is devoted to completing a seminal piece of original research.



Another important aspect of the Columbia Astronomy Department's graduate program is the development of teaching skills. After a year of apprenticeship, graduate students in their second and third years design and teach their own introductory astronomy laboratory courses for undergraduates. Additionally, graduate students may choose to become involved with our extensive outreach programs in New York City, or with the education and exhibition activities at the American Museum of Natural History.

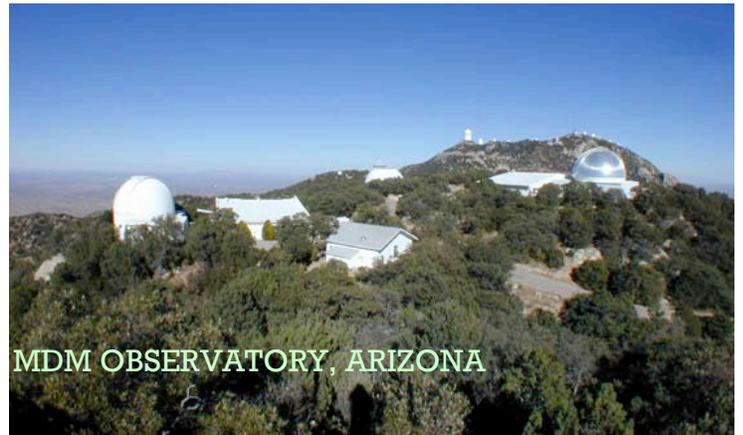
We are proud to report that several of our recently graduated students have gone on to earn prestigious postdoctoral fellowships (including the Hubble, Sagan, Chandra, and Einstein Fellowships), and that many of our alumni hold permanent positions at top research institutions world-wide (see <http://www.astro.columbia.edu/directory/former> for a complete listing of graduates over the past twenty years).



# FACILITIES

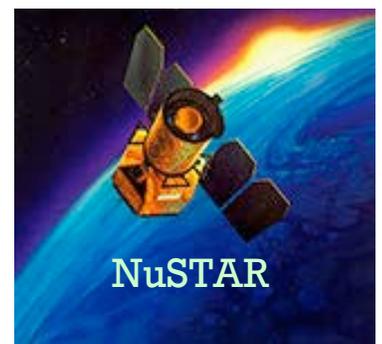
The Astronomy Department is a partner in the MDM Observatory Consortium with a 25% share of the 1.3-meter McGraw-Hill telescope and the 2.4-meter Hiltner telescope on Kitt Peak in Arizona. Graduate students doing observational research receive a large fraction of the 150 nights per year of observing time on the two telescopes. In addition, the Observatory provides an ideal opportunity for designing, building, testing, and using innovative optical and near-IR instrumentation developed in our laboratories. We are also part of the Palomar Transient Factory and the LSST Collaboration.

The Columbia Astrophysics Laboratory, a joint endeavor involving the Astronomy and Physics Departments, has extensive experience in the design and construction of new astronomical instruments for rocket, satellite and balloon missions, as well as ground-based telescopes. Facilities at our Nevis site include laboratories and equipment for testing and assembling experiments, an electronics shop, and an instrument machine shop. In addition, there is a fully equipped machine shop available for student use in the Pupin Building and additional laboratories for instrument development. Current projects include NuSTAR (the first hard X-ray imaging satellite launched in 2012), millimeter receivers for Cosmic Microwave Background experiments, instrumentation for the Laser Interferometer Gravity-wave Observatory, UV instrumentation, laboratory astrophysics, and CCD cameras.



Every week two invited speakers give separate Physics and Astronomy colloquia. The Astronomy Department also holds Thursday seminars, a journal club, astro-ph coffee, and a Pizza Lunch every Tuesday where attendees can informally learn about research activities in the Department.

The Astrophysics Laboratory and Astronomy Department maintain a large network of workstations and each student is assigned a private computer on arrival. Additionally, the Department maintains three computing clusters capable of completing complex simulations of astrophysical phenomena and is an affiliate of the new Simons Center for Computational Astrophysics.





# FACULTY BIOS



**MARCEL AGÜEROS (Assistant Professor)**

Professor Agüeros received his B.A. in Astronomy from Columbia University before earning an M.Phil in Physics from the University of Cambridge (UK) and his Ph.D. in Astronomy from the University of Washington. He was a National Science Foundation Astronomy and Astrophysics Post-doctoral Fellow in the Columbia Astrophysics Laboratory for four years before joining the faculty. He is also the Director of Columbia's Bridge to the Ph.D. Program in the Natural Sciences.

**JAMES H. APPLGATE (Professor)**

Professor Applegate received his B.S. in Astrophysics from Michigan State University and his Ph.D. in Physics from SUNY at Stony Brook. He was a Bantrell Research Fellow at the California Institute of Technology, and is a previous chair of the Astronomy Department at Columbia.



**GREG BRYAN (Professor)**

Professor Bryan received his B.Sc. in physics from the University of Calgary (Canada) and his Ph.D. from the University of Illinois. He received a Hubble Fellowship, Lyman Spitzer Fellowship, and an NSF Career Grant. He also received the Leverhulme Trust Prize for "outstanding young researchers." He was a faculty member in the Physics Department at Oxford for three years before coming to Columbia University.

**ZOLTAN HAIMAN (Professor)**

Professor Haiman received a Physics B.S. degree from MIT, and attended graduate school in Cambridge, UK, and at Harvard University, where he received a Ph.D. in Astronomy in 1998. He was chosen as one of Popular Science Magazine's Brilliant 10 young scientists in 2002 and received the New York Academy of Sciences Blavatnik Award in 2010. He was a Hubble Fellow at Princeton and a postdoc in the theory group at Fermilab before joining the Columbia faculty.



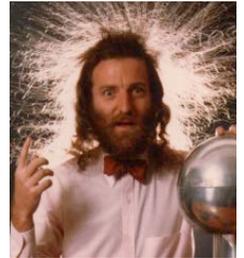


**JULES P. HALPERN (Professor)**

Professor Halpern received his B.S. from MIT and his Ph.D. from Harvard University. He was a research fellow in Astronomy at the California Institute of Technology before becoming an Astronomy professor at Columbia University. He is a winner of the AAS Rossi Prize.

**DAVID HELFAND (Professor)**

Professor Helfand received his B.A. from Amherst College, and an M.S. in Physics Ph.D. in Astronomy from the University of Massachusetts. He has also been a visiting scientist at the Danish Space Research Institute and the Sackler Distinguished Visiting Astronomer at Cambridge. He has been a professor in both Physics and Astronomy at Columbia, and was Chair of Astronomy for 18 years. He recently returned from an extended leave during which he served as President & Vice Chancellor of a highly innovative new institution he helped to design, Quest University Canada, and as President of the American Astronomical Society.



**KATHRYN JOHNSTON (Professor, Chair)**

Professor Johnston received undergraduate degree from the University of Cambridge in Maths and her Ph.D. in astronomy and astrophysics from UC-Santa Cruz. She was a member of the Institute for Advanced Study at Princeton, and then an assistant professor at Wesleyan University, where she was a recipient of an NSF CAREER Award. She joined the Columbia Astronomy faculty in 2006, and is currently the Chair of the Department.

**DAVID KIPPING (Assistant Professor)**

Professor Kipping received his B.A. and M.Sc. in Natural Sciences from Cambridge University, after which he earned his Ph.D. in Astrophysics at University College London. He spent six years at the Harvard-Smithsonian Center for Astrophysics, first as a predoc during his graduate studies and then as a Sagan and Menzel fellow before coming to Columbia. He was recently named as one of Popular Science magazine's "Brilliant Ten" young scientists.



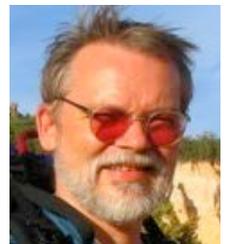
**JERRY OSTRIKER (Professor)**

Professor Ostriker received his B.A. from Harvard University and his Ph.D. from the University of Chicago working under Prof. Chandrasekhar. Following postdoctoral work at Cambridge University he joined the faculty at Princeton for 44 years, serving as Department Chair for much of the time and as Provost of the University from 1995-2001. He was Plumian Professor at Cambridge for the ensuing three years before returning to Princeton and then moving to Columbia in 2012. He is a member (and Treasurer) of the National Academy of Sciences and winner of the 2015 Gruber Cosmology Prize along with many other honors.



**FRITS PAERELS (Professor)**

Professor Paerels received his Ph.D. from the University of Utrecht (Netherlands). He was a research scientist at Columbia before becoming a Senior Scientist of SRON Space Research Laboratory in the Netherlands. He is currently serving as the director of undergraduate studies.





**JOSEPH PATTERSON (Professor)**

Professor Patterson received his B.A. in History of Science from Harvard University and his Ph.D. in Astronomy from the University of Texas. He has also been a 250<sup>th</sup> Anniversary Distinguished Teaching Professor at Princeton University and a research scientist at the Smithsonian Astrophysical Observatory in Cambridge, Massachusetts.



**MARY PUTMAN (Associate Professor)**

Professor Putman received her B.S. in Astronomy and Physics from University of Wisconsin-Madison and her Ph.D. in Astronomy and Astrophysics from the Australian National University (Mt. Stromlo Observatory). She has received a Hubble Postdoctoral Fellowship, the Elizabeth C. Crosby Award, an NSF Award, Cottrell Scholarship, and an NSF CAREER Award. She is now a Clare Boothe Luce Associate Professor at Columbia University.



**DAVID SCHIMINOVICH (Associate Professor)**

Professor Schiminovich received his B.S. in Mathematics and Physics from Yale University and his Ph.D. from Columbia University. Before his return to Columbia as a professor in 2004, he was a postdoctoral research fellow at Caltech and a visiting research scientist at Yale. Since 1997 he has been a lead scientist on the Galaxy Evolution Explorer (GALEX) project. He is co-Director of the Columbia Astrophysics Laboratory and Vice-Chair of Astronomy



**EDWARD A. SPIEGEL (Professor Emeritus)**

Professor Spiegel received his B.A. from UCLA and his Ph.D. from the University of Michigan. He held research positions at Princeton University, NYU, and Cambridge University; he also held faculty positions at UC Berkeley and at NYU before joining the faculty at Columbia. He is the Rutherford Professor emeritus in the Astronomy Department.



**JACQUELINE VAN GORKOM (Professor)**

Professor Van Gorkom received her Ph.D. in Astronomy from the Kapteyn Institute in Groningen, Holland. She was a scientist at the Jansky Very Large Array of the National Radio Astronomy Observatory in New Mexico for eight years, before joining the Columbia faculty.

Over the years, she held visiting appointments at the Raman Research Institute in India, Princeton University, Berkeley, and the Kapteyn Institute. She also served as a chair of the department for seven years, and is now the Rutherford Professor of Astronomy.





## AFFILIATED FACULTY

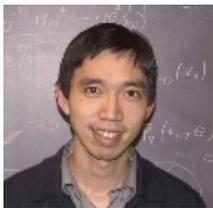


**ELENA APRILE (Professor, Physics)**

Professor Aprile received her “Laurea” from the University of Naples, Italy, and her Ph.D. from the University of Geneva, Switzerland. She is the leader of the XENON experiment that is designed to detect dark matter.

**ANDREI BELOBORODOV (Professor, Physics)**

Professor Beloborodov received his M.Sc. from the Moscow Institute of Physics and Technology and his Ph.D. from Lebedev Physical Institute. Prior to joining the Columbia faculty, he was a post-doctoral fellow at the Canadian Institute for Theoretical Astrophysics.



**LAM HUI (Professor, Physics)**

Professor Hui received his B.A. from UC Berkeley and his Ph.D. in Physics from MIT. He held postdoctoral positions at Fermilab and at the Institute for Advanced Study in Princeton, and was a faculty member at the University of Chicago and at Fermilab before becoming an associate professor of Physics at Columbia.

**CHUCK HAILEY (Pupin Professor, Physics)**

Professor Hailey received his B.A. from Cornell University and his Ph.D. from Columbia University. He was a research scientist and later a program leader for Astrophysics in the Physics Department at Lawrence Livermore National Laboratory; he also worked at KMS Fusion, Inc. as a senior research scientist before joining the Columbia faculty. He is co-PI of the NuSTAR mission and is co-Director of the Columbia Astrophysics Laboratory.



**SZABOLCS MARKA (Associate Professor, Physics)**

Professor Marka received his Diploma from Kossuth Lajos University (Hungary) and his Ph.D. from Vanderbilt University. He has previously worked at Cornell and Caltech. Currently, he is leader of the Columbia Experimental Gravity Group (a member of LIGO) in addition to being a professor at Columbia. He received an NSF CAREER Award and two GRAND Challenges Explorations Award from the Bill and Melinda Gates Foundation.

**AMBER MILLER (Professor, Physics and Dean of Science)**

Professor Miller graduated from U.C. Berkeley in 1995 with a B.A. in Physics and Astronomy and completed her Ph.D. at Princeton University in 2000. Following a Hubble Fellowship at the University of Chicago from 2000 - 2002, she joined the faculty at Columbia University. She received an Alfred P. Sloan Fellowship, an NSF CAREER Award, and the Lenfest Distinguished Faculty Award. She currently serves as Dean of Science in the Faculty of Arts and Sciences.





**LAURA KAY (Ann Whitney Olin Professor and Chair, Barnard)**

Professor Kay received her B.S. in Physics and B.A. in Feminist Studies from Stanford University and her Ph.D. in Astronomy and Astrophysics from the University of California at Santa Cruz. She is lead author of the widely used textbook “21<sup>st</sup> Century Astronomy”. She is currently serving as the chair of the Department of Physics and Astronomy at Barnard College.

**JANNA LEVIN (Associate Professor, Barnard)**

Professor Levin holds a B.A. in Physics and Astronomy from Barnard College and a Ph.D. from MIT in Physics. She has previously worked at the Center for Particle Astrophysics (CfPA) at U.C. Berkeley, and at Cambridge University in the Department of Applied Mathematics and Theoretical Physics. She is the author of several books including *How the Universe Got Its Spots*.



**RESHMI MUKHERJEE (Helen Goodhart Altschul Professor, Barnard)**

Professor Mukherjee received her B.S. from Presidency College, University of Calcutta and her M.A., MPhil, and Ph.D. degrees from Columbia University. In addition to being a professor, she has served as chair of physics and astronomy at Barnard College.

**REBECCA OPPENHEIMER (Adjunct Professor, AMNH)**

Professor Oppenheimer received her B.A. in Physics from Columbia University and her Ph.D. in Astronomy from the California Institute of Technology. She was a Hubble Fellow at the University of California at Berkeley and at AMNH, as well as a Kalbfleisch Research Fellow at the AMNH. She is currently a curator in the Astrophysics Department of AMNH and Chair of the Physical Sciences Division there, as well as an adjunct professor at Columbia.



**MORDECAI-MARK MACLOW (Adjunct Professor, AMNH)**

Professor MacLow received a B.A. in Physics from Princeton University and a PhD. in Physics from the University of Colorado at Boulder. He was a postdoctoral fellow at NASA Ames Research Center at Berkeley and at the University of Chicago, and a staff member at the Max-Planck Institute in Heidelberg, Germany. He is a curator in the Department of Astrophysics at the AMNH, and served as chair of the Museum’s Physical Sciences Division.

**MICHAEL SHARA (Adjunct Professor, AMNH)**

Professor Shara received his Ph.D. from Tel Aviv University. He was a research assistant professor at Arizona State University prior to moving to the Space Telescope Institute where he became a tenured astronomer prior to coming to New York. In addition to being an adjunct professor at Columbia, he is curator in the Physical Sciences division at AMNH.



**CALEB SCHARF (Director, Columbia Astrobiology Center)**

Caleb Scharf received his B.Sc. in Physics from Durham University, and his Ph.D. in Astronomy from the University of Cambridge. Following postdoctoral work at the NASA Goddard Space Flight Center and the Space Telescope Science Institute in Maryland, he is currently Director of the multidisciplinary Columbia Astrobiology Center.

# COLUMBIA ASTRONOMY PUBLIC OUTREACH



## Public Outreach

“No one regards what is before his feet;  
we all gaze at the stars.” – Quintus Ennius

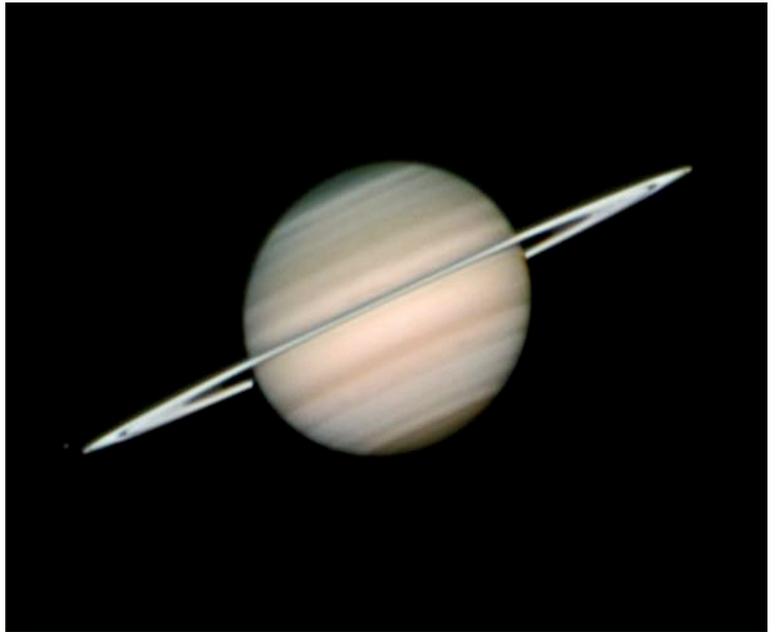
The Columbia Astronomy Department is dedicated to bringing science to the public. In recent years we have reached over 20,000 New Yorkers through the various events of our public outreach program. Our outreach events include:

- Biweekly public lectures given by an astronomer associated with Columbia (often a graduate student) along with an observatory open house where the public can look through small and medium-sized telescopes on our roof.
- Class visits where Columbia astronomers provide tours of our department along with short programs demonstrating astronomical concepts.
- Middle School outreach with presentations by Columbia astronomers and students at local public schools.
- A program called Rooftop Variables that educates NYC teachers and helps them start astronomy clubs at their schools.

- Harlem Sidewalk Astronomy, where we bring telescopes to 125<sup>th</sup> street in Harlem and attract passersby by offering a beautiful view of the moon, planets, and sometimes even deep sky objects.
- Family Astro Saturdays are also held three times a year. This program engages elementary school students and their families in hands-on astronomy
- Various other public lectures and appearances around the City and beyond.

For more information about the Columbia Public Outreach Program, see our webpage or contact the current director at:

<http://outreach.astro.columbia.edu> or [outreach-admin@astro.columbia.edu](mailto:outreach-admin@astro.columbia.edu)



Credit & Copyright: Jean-Luc Dauvergne, Francois Colas, OMP

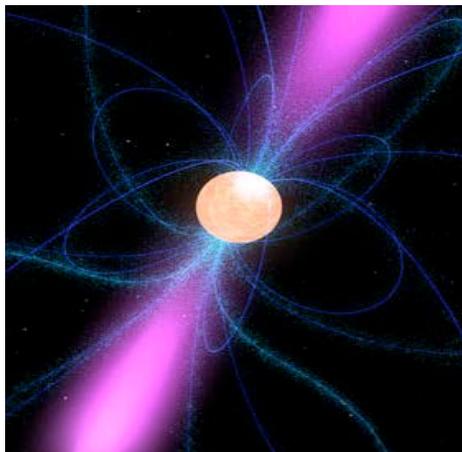
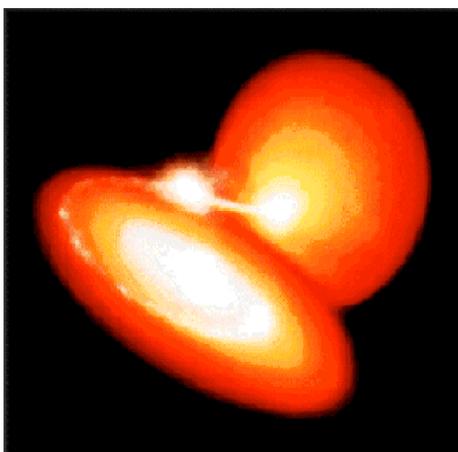


Credit: W. Keel (U. Alabama; January 25, 1997)



# FACULTY RESEARCH

## Formation and Evolution of Stars and Planets



### JOSEPH PATTERSON

Professor Patterson is part of a group that formed the Center for Backyard Astrophysics, a network of primarily amateur astronomers spanning the globe and collaborating on observation of variable stars. This has provided a powerful tool to study periodic processes in cataclysmic variable stars. He has also been working for 20 years to understand the structure of DQ Her stars, often called intermediate polars. One of his major research goals is to understand the structure and evolution of cataclysmic variables, especially the oldest ones (the WZ Sge and AM CVn stars) where both components have evolved to degenerate states. For more on his research, contact him at [jop@astro.columbia.edu](mailto:jop@astro.columbia.edu)

### JAMES APPLGATE

Professor Applegate is a theoretical physicist with broad interests in astrophysics. He has developed a model for the orbital period variations seen in very close binaries, such as the Black Widow Pulsar system PSR B1957+20. He also investigated models of the structure and evolution of tidally powered stars. He has also described the consequences of a first order phase transition in quantum chromodynamics on the early evolution of the universe, and shows how this transition might be detectable through its effect on big bang nucleosynthesis. For more on his research, contact him at [jha@astro.columbia.edu](mailto:jha@astro.columbia.edu)

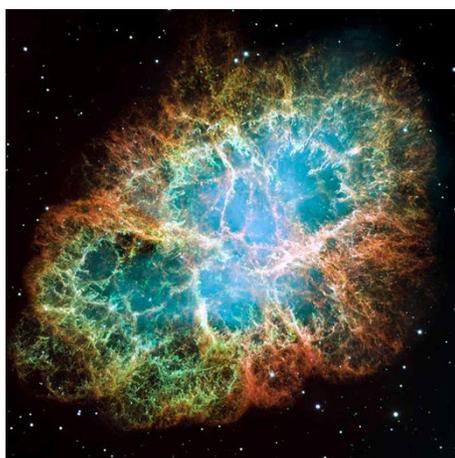
### DAVID HELFAND

Professor Helfand's current research revolves around two large radio sky surveys he has undertaken with colleagues over the past twenty years: the FIRST survey of 10,000 square degrees of the extragalactic sky, and MAGPIS, a survey along the plane of the Milky Way. He also has a long-standing interest in the evolution of neutron stars and supernova remnants. His current projects include the discovery of new supernova remnants and the identification of high energy gamma-ray sources in MAGPIS, computation of the angular-diameter/redshift relation for double radio sources in FIRST, and studies of radio variability in both Galactic and extragalactic objects. For more on his research, contact him at [djh@astro.columbia.edu](mailto:djh@astro.columbia.edu)



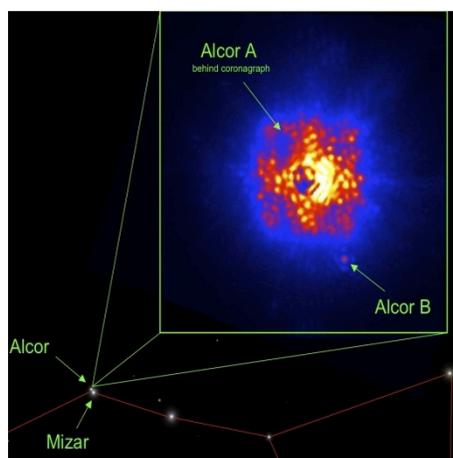
# FACULTY RESEARCH

## Formation and Evolution of Stars and Planets



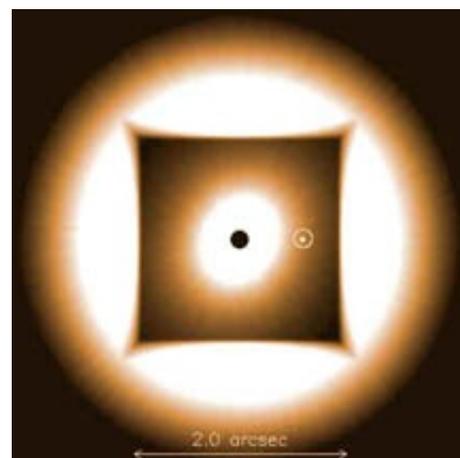
### MARCEL AGÜEROS

From the earliest days of his research career, Professor Agüeros was drawn to multi-wavelength studies of stars and of the by-products of their deaths. His current work ranges from searching for new radio-quiet, X-ray dim isolated neutron stars, uncovering the nature of companions to very low-mass white dwarfs, examining the age/rotation/activity relationship in Galactic open clusters, and studying the properties of nuclear star clusters in nearby galaxies. His research typically involves the use of large-scale catalogs such as the Sloan Digital Sky Survey or ROSAT All-Sky Survey and follow-up observations with ground-based or satellite telescopes. For more information, contact him at [marcel@astro.columbia.edu](mailto:marcel@astro.columbia.edu)



### REBECCA OPPENHEIMER (AMNH)

Professor Oppenheimer is involved in comparative exoplanetary research. Specifically, she focuses on developing advanced optical instruments in order to more accurately measure and analyze the light from planets orbiting stars other than our sun. Her research involves collaboration with scientists from AMNH, Cambridge, Caltech, and NASA/JPL. A large amount of her work takes place at the Rose Center at the American Museum of Natural History (AMNH). Prof. Oppenheimer also works on faint white dwarfs, the remnants of normal stars, and brown dwarfs, star-like objects that are too small to be stars, but too large to be called planets. She is the co-discoverer of the first brown dwarf, called Gliese 229B. For more information about her research, contact her at [bro@amnh.org](mailto:bro@amnh.org)

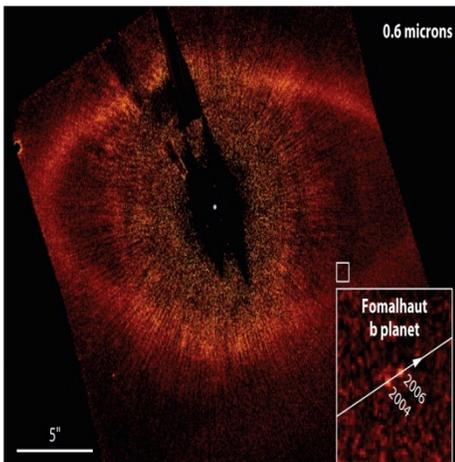


### MICHAEL ALLISON (NASA)

Professor Michael Allison's research focuses on planetary dynamics and spaceflight mission planning. He has worked on several spaceflight projects, including Cassini and the Huygens Doppler Wind Experiment. He is particularly interested in the way the various planetary weather systems were created and maintained. His theoretical research includes studying the "potential vorticity" of weather patterns. For more on his research, contact him at [Michael.D.Allison@nasa.gov](mailto:Michael.D.Allison@nasa.gov)

# + FACULTY RESEARCH

## Formation and Evolution of Stars and Planets



### CALEB SCHARF

Professor Scharf's current areas of research are exoplanetary science and astrobiology. He is particularly interested in studying the dynamical evolution of planetary systems, the effects of close-orbiting giant planets on their parent stars, and the nature of climate and habitability on terrestrial-type worlds. He is also investigating the characteristics of moon systems, the detection of exomoons, and their potential in the search for life. He recently authored the textbook "Extrasolar Planets and Astrobiology," and leads Columbia's Astrobiology Center – a consortium of scientists across many disciplines. For more on his research, contact him at [caleb@astro.columbia.edu](mailto:caleb@astro.columbia.edu)



### MICHAEL SHARA (AMNH)

Professor Shara's research interests focus on novae and supernovae. He leads a group that is conducting an infrared narrowband imaging and spectrographic survey of the Milky Way, trying to locate all 7,000 expected massive star pre-supernovae (Wolf-Rayet stars). The survey has already located the most massive binary star known, and thousands of pre-supernovae candidates are in hand. If even one of them explodes as a supernova, an important confirmation of stellar evolution theory will have been achieved. He also makes use of the Hubble Space Telescope to search for Wolf-Rayet stars in nearby galaxies. In addition, he is surveying dwarf novae to demonstrate that some have classical nova shells, establishing that there is a metamorphosis between these classes of objects. For more on his research, contact him at [mshara@amnh.org](mailto:mshara@amnh.org)



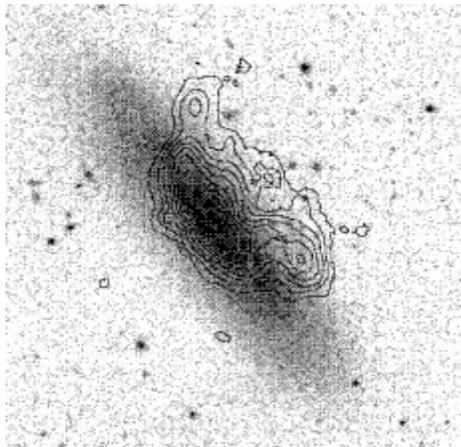
### DAVID KIPPING

Professor Kipping leads the "Cool Worlds" group, which pursues a variety of science relating to extrasolar planets. From detection to characterization, the group uses astrostatistics and data science methods to understand both unique objects and ensemble populations of alien worlds, particularly thermally cool objects lying near or beyond the habitable-zone. The group is well-known for its expertise with exomoons in particular, leading the Hunt for Exomoons with Kepler project. The Cool Worlds group also researches novel methods to characterize planet hosting stars through a variety of methods such as flicker, stellar anchors, asteroid density profiling, and star spot analysis. For more on his research, contact him at [dkipping@astro.columbia.edu](mailto:dkipping@astro.columbia.edu)



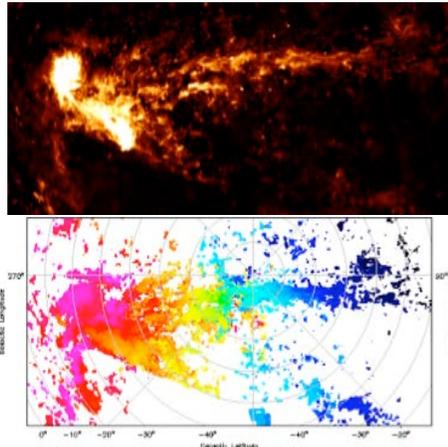
# FACULTY RESEARCH

## Structure and Evolution of Galaxies



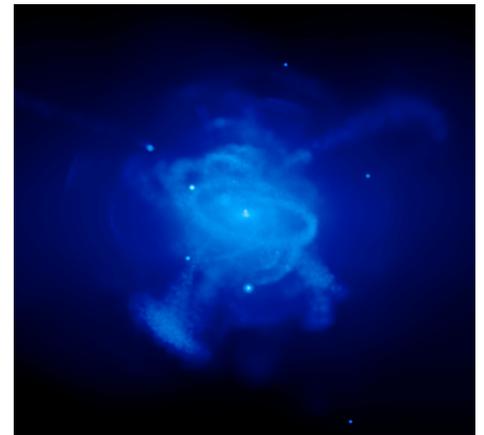
### JACQUELINE VAN GORKOM

Professor Van Gorkom's main research interest is the structure and evolution of galaxies and, more specifically, the role of gas in galaxy evolution. She studies the interplay between galaxies and their environments, leading to such questions as: What are the residual signatures of the formation process around galaxies? Do galaxies evolve along the Hubble sequence? If so, how, and in what direction? Do mergers really convert spirals to ellipticals? How does the environment affect the evolution of galaxies? Where and how are SO's made, in clusters or in groups? For more on her research, contact her at [jvangork@astro.columbia.edu](mailto:jvangork@astro.columbia.edu)



### MARY PUTMAN

Much remains unknown today about how galaxies evolve from a pocket of dark matter to a structured galaxy full of gas and stars. Professor Putman is currently researching gas flows into galaxies using multi-wavelength observations combined with the results of high-resolution simulations. She explores galaxy evolution by examining the gaseous halos of the Milky Way and other spiral galaxies, dwarf galaxies in the Local Group, star formation in the local universe, and the properties of the intergalactic medium. For more information on Professor Putman's research, e-mail her at [mputman@astro.columbia.edu](mailto:mputman@astro.columbia.edu)



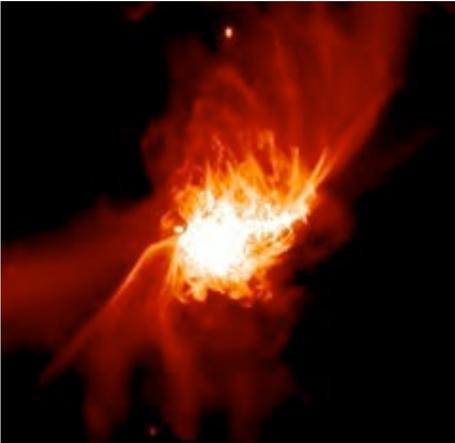
### KATHRYN JOHNSTON

Professor Johnston is interested in the structure and dynamics of galaxies. Her research focuses in particular on what we can learn about these topics from our own Milky Way Galaxy and its nearest neighbors. She uses models – from simple analytic pictures to full N-body simulations – to explore the different mechanisms that are thought to structure galaxies. She then examines her models in order to understand what signatures these mechanisms might leave in the dynamics and chemistry of stars within galaxies. For more on her research, contact her at [kvj@astro.columbia.edu](mailto:kvj@astro.columbia.edu)



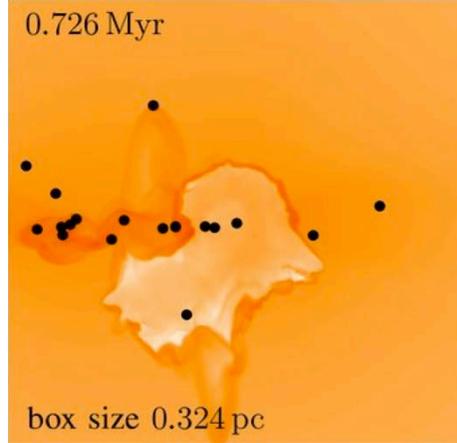
# FACULTY RESEARCH

## Structure and Evolution of Galaxies



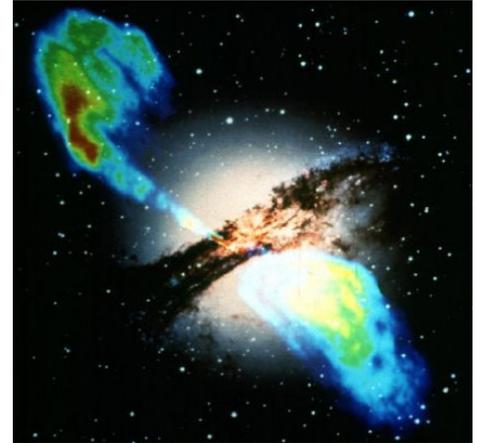
### GREG BRYAN

Professor Bryan's research has tackled a broad range of problems in cosmology. He has pioneered the use of adaptive, three-dimensional numerical simulations, and is the principal author of the widely used and publicly available simulation code Enzo. He has worked on understanding the formation of the first stars in the universe, as well as the large-scale cosmic structures that form later, such as galaxies, clusters of galaxies, and the intergalactic medium that fills space between these objects. He is also interested in developing visualization methods for three-dimensional simulations, and his work has been featured in exhibits at the American Museum of Natural History, and in the Oscar-nominated IMAX film "Cosmic Voyage". For more on his research, contact him at [gbryan@astro.columbia.edu](mailto:gbryan@astro.columbia.edu)



### MORDECAI-MARK MAC LOW (AMNH)

Professor Mac Low studies the formation and evolution of planets, stars and galaxies, and the structure of the interstellar medium. He has placed a particular emphasis on understanding the role of turbulence and magnetic fields in these processes. Much of his work uses supercomputers to perform numerical gas dynamics and magnetohydrodynamic (MHD) simulations. He has also been lead curator on the Hayden Planetarium Space Show "Journey to the Stars," and had his simulations included in two others. For more information about his research, contact him at [mordecai@amnh.org](mailto:mordecai@amnh.org)



### LAURA KAY

Professor Kay's research focuses primarily on the study of active galactic nuclei using a cutting edge technique called spectropolarimetry. This is a process that allows the observer to obtain information about spectroscopy and polarization of the target simultaneously. She also recently co-authored a textbook called *21<sup>st</sup> Century Astronomy*. For more on her research, contact her at [lkay@barnard.edu](mailto:lkay@barnard.edu)



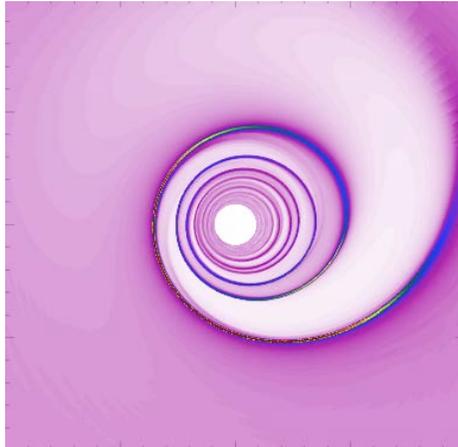
# FACULTY RESEARCH

## Large Scale Structure and Cosmology



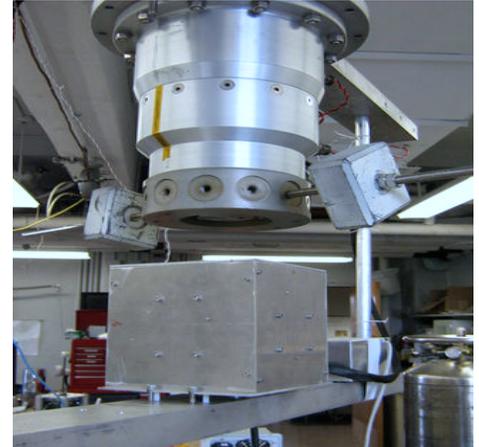
**DAVID SCHIMINOVICH**

Professor Schiminovich is currently studying galaxy formation and the intergalactic medium in order to understand the processes that trigger and quench star formation over cosmic time. He has developed ultraviolet instrumentation to study faint signatures from gas and stars around galaxies. He is currently working on data from the Galaxy Evolution Explorer (GALEX), a UV satellite, as well as the FIREBall experiment, a balloon-borne UV spectrograph designed to produce maps of the cosmic web, the 3D structure of the gaseous universe. In doing so, he is looking for signatures of gas that is primarily involved in star formation. He is continuing to develop novel instrumentation and is planning several future space experiments and satellite missions. For more on his research, contact him at [ds@astro.columbia.edu](mailto:ds@astro.columbia.edu) or visit his website: [sgl.astro.columbia.edu](http://sgl.astro.columbia.edu)



**ZOLTAN HAIMAN**

Professor Haiman is a theoretical astrophysicist and cosmologist. He is currently involved in three areas of research. He studies the expected properties of the first generation of stars and black holes in order to gain insight into the earliest stages of cosmic structure formation of the early universe. He has worked on possible ways to understand the nature of dark energy and dark matter, especially with techniques looking for tell-tale signatures in large-scale cosmic structures. Finally, he has been interested in the emerging field of gravitational wave astronomy, in particular in the gravitational waves from the collisions of supermassive black holes at the centers of galaxies and the corresponding electromagnetic signatures of such events. For more information about his research, e-mail him at [zoltan@astro.columbia.edu](mailto:zoltan@astro.columbia.edu)



**AMBER MILLER**

Professor Miller is currently studying remnants of the Big Bang in order to gain a clearer picture of the evolution of the universe. She and the Columbia University Experimental Cosmology group use cm and mm-wave instruments to study the Cosmic Microwave Background and the Sunyaev-Zel'dovich Effect. The team is responsible for the construction, deployment, and data analysis of several telescopes. She and her group are responsible for the QUIET camera (still in use in Chile) and the EBEX experiment which had its first high-altitude balloon flight in spring of 2009. For more on her research, contact her at [amber@phys.columbia.edu](mailto:amber@phys.columbia.edu)

# + FACULTY RESEARCH

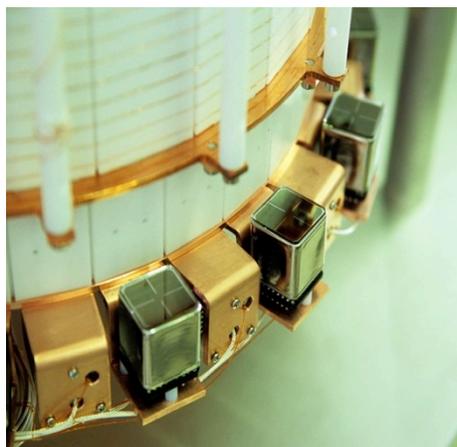
## Large Scale Structure and Cosmology

W.N. Colley (Princeton University), E. Turner (Princeton University), J.A. Tyson (AT&T Bell Labs) and NASA



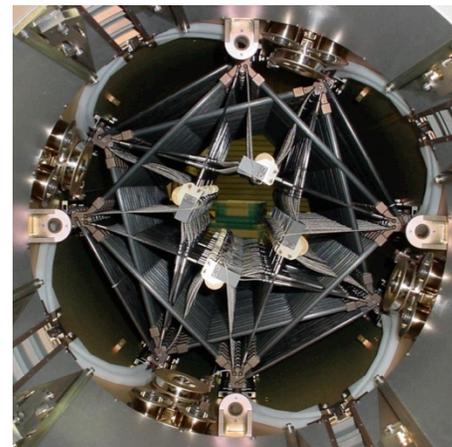
### LAM HUI

Professor Hui has broad research interests in theoretical astrophysics and cosmology. He has worked on large-scale structure, the intergalactic medium, gravitational lensing, early universe physics, particle astrophysics and extrasolar planets. His current research focuses on modifications to general relativity on cosmological scales, pre-inflationary perturbations from bubble collisions, and magnetospheres of neutron stars and black holes. For more on his research, contact him at [lh399@columbia.edu](mailto:lh399@columbia.edu)



### ELENA APRILE

Professor Aprile's current research includes the experimental study of dark matter. She specifically works to develop dark matter detectors using cryogenic noble liquids such as Xenon and Argon. She is the P.I. for the Xenon Experiment, which is designed to detect the likely components of dark matter – weakly interacting massive particles (WIMPs). For more on her research, contact her at [age@astro.columbia.edu](mailto:age@astro.columbia.edu)



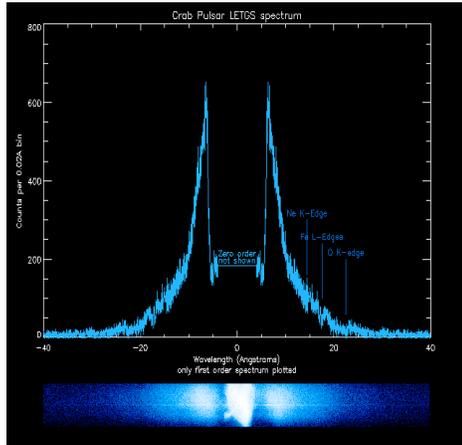
### CHUCK HAILEY

Professor Hailey studies the development of new balloon borne and satellite borne instrumentation and experiments in order to solve astrophysical problems. He is currently working on the NuSTAR project, which is the first high energy astrophysics mission to use hard X-ray optics focused in the 10-70 keV band to conduct a census of black holes in the universe. This instrument provides approximately 300 times the sensitivity of previous missions. The optics for NuSTAR was built and calibrated at Columbia University. Professor Hailey is also involved in the General Anti-Particle Spectrometer experiment (GAPS). This mission will search for cosmic anti-deuterons that are a byproduct of dark matter interactions with the galactic halo. For more on his research, contact him at [chuckh@astro.columbia.edu](mailto:chuckh@astro.columbia.edu)



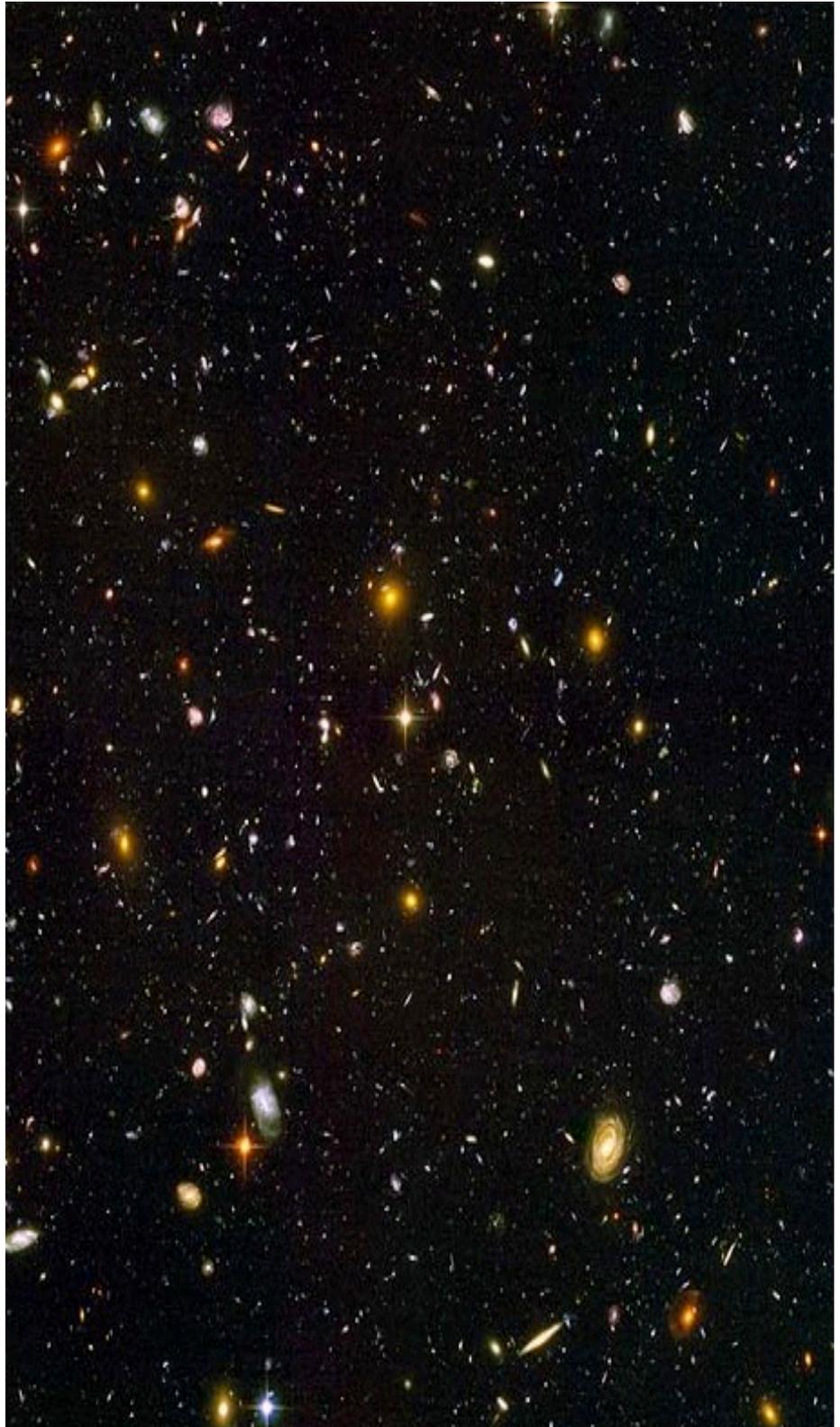
# FACULTY RESEARCH

## Large Scale Structure and Cosmology



### FRITS PAERELS

Professor Paerels' main research topics include X-ray astronomy and spectroscopy, the intergalactic medium, and properties of neutron stars. He is involved in the analysis of data coming from the XMM-Newton X-ray observatory. He has also done analysis on data from the Chandra X-ray telescope. In addition, he plans to use X-ray data to map high-red-shift dust in the intergalactic medium. Finally, he plans to look at the X-ray emission from the local IGM. For more on his research, contact him at [frits@astro.columbia.edu](mailto:frits@astro.columbia.edu)





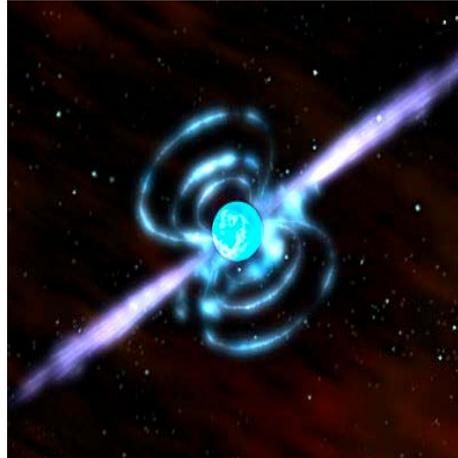
# FACULTY RESEARCH

## High Energy and Theoretical Astrophysics



### SZABOLCS MARKA

Professor Marka is an experimental physicist. His research is focused on the effort to directly detect gravitational waves of cosmic origin, which will allow for the study of cosmic processes and objects unreachable through conventional methods based on electromagnetic observations. His current major interest is astrophysical trigger-based data analysis and essential development/diagnostic projects aimed towards enhancing the astrophysical reach and reliability of the Laser Interferometer Gravitational-wave Observatory (LIGO). He also heads up the Columbia Experimental Gravity Group (GECG). For more information on GECG, please visit [geco.phys.columbia.edu](http://geco.phys.columbia.edu). For more on Professor Marka's research, contact him at [smarka@phys.columbia.edu](mailto:smarka@phys.columbia.edu)



### JULES HALPERN

Professor Halpern is investigating the extreme physical properties of neutron stars through timing and spectroscopy at X-ray and radio wavelengths. This reveals their strongest magnetic fields, found in Anomalous X-ray Pulsars (AXPs), as well as their weakest, found in Central Compact Objects (CCOs). Monitoring the transient outbursts of AXPs is leading to an understanding of how their enormous magnetic field energy is converted to X-ray luminosity. In contrast, the relatively inconspicuous CCOs seem to have been born with very weak magnetic fields, and not much rotational energy either. This work makes use of the X-ray observatories Chandra, XMM-Newton, and Swift. For more on his research, contact him at [jules@astro.columbia.edu](mailto:jules@astro.columbia.edu)



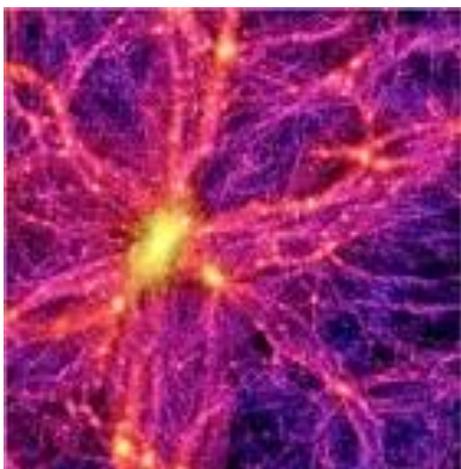
### EDWARD A. SPIEGEL

Professor Spiegel's research focuses primarily on the dynamics of fluids and plasmas with emphasis on the influence of radiative forces as they occur in hot stars, disks, and in the early universe. For more on his research, contact him at [eas@astro.columbia.edu](mailto:eas@astro.columbia.edu)



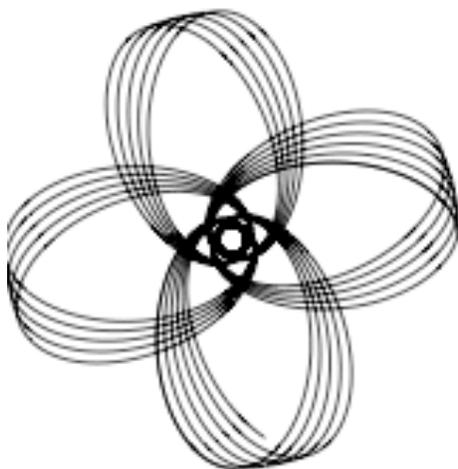
# FACULTY RESEARCH

## High Energy and Theoretical Astrophysics



**JERRY OSTRIKER**

Professor Ostriker's research has ranged over most field of modern astrophysics. His most recent papers cover such topics as hyper-Eddington accretion flows onto massive black holes, the effects of both AGN and supernova feedback on star formation in galaxies, galaxy mergers, the evolution of globular clusters and galactic nuclei, interstellar grain physics and the infrared emission from dust in AGN and speculations on the nature of the dark matter. To hear more about these and other topics, contact him at [jpo@astro.columbia.edu](mailto:jpo@astro.columbia.edu)



**JANNA LEVIN**

Professor Levin's astrophysical research focuses on black hole pairs. In an extreme binary system, a small black hole orbits a super-massive black hole millions of times the mass of the sun. As they orbit, the pair bangs on the drum of spacetime itself thereby emitting a black hole song in the form of gravitational waves. Over time, the orbit decays until the pair merges. Professor Levin also studies the effect of black hole scattering on gravitational waves. In this case, two comparably sized black holes scatter off each other, become gravitationally bound, and emit a gravitational wave with each pass. She also researches various multi-dimensional theories of string cosmology. To find out more about her research, contact her at [www.jannalevin.com](http://www.jannalevin.com)



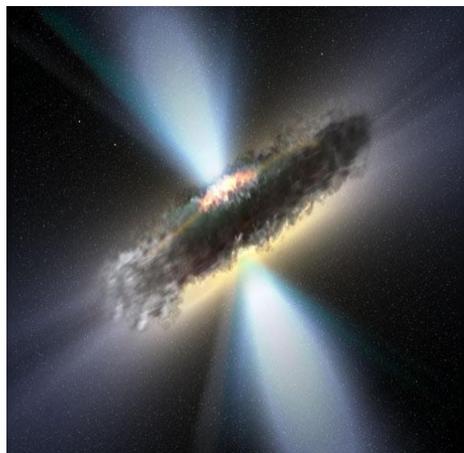
**RESHMI MUKHERJEE**

Professor Mukherjee is currently involved in several projects. She studies GeV/TeV gamma rays from astrophysical sources using VERITAS (Very Energetic Radiation Imaging Telescope Array System). VERITAS is an air Cherenkov telescope located in southern Arizona: it detects Cherenkov radiation from energetic particles produced by the interaction of a gamma-ray primary in the atmosphere using four 12-m optical reflectors on the ground. She is also involved in the Cherenkov Telescope Array (CTA), which is an advanced facility for ground-based gamma-ray astronomy being planned for the future. Her general research topics include experimental astrophysics, gamma ray sources, active galactic nuclei, and the study of high energy sources using the Fermi Gamma-Ray Space Telescope. For more on her research, contact her at [muk@astro.columbia.edu](mailto:muk@astro.columbia.edu)



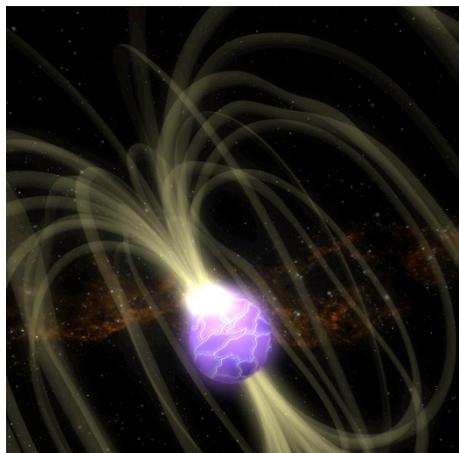
# FACULTY RESEARCH

## High Energy and Theoretical Astrophysics



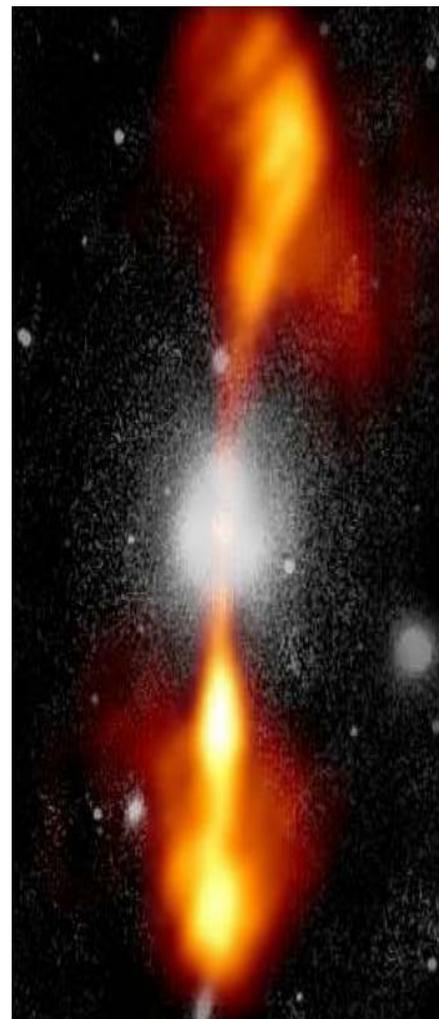
**ANDREI BELOBORODOV**

Professor Beloborodov is a theoretical astrophysicist interested in relativistic astrophysics. His work focuses on compact objects such as black holes and neutron stars. His research topics include X-ray binaries, pulsars, active galactic nuclei, and cosmological gamma-ray bursts. These are all cosmological high-energy sources. He is currently developing a new method of gravity estimation called “orbital roulette.” This method could be used in the future to estimate the mass of dark matter in our Galaxy, stellar clusters, and clusters of galaxies. For more on his research, contact him at [amb@phys.columbia.edu](mailto:amb@phys.columbia.edu)



**MALVIN RUDERMAN**

Professor Ruderman works mainly on problems associated with collapsed objects in astrophysics, especially neutron stars. This has been particularly exciting as new unexpected phenomena involving these stars continue to be discovered. Some neutron stars are extraordinarily efficient as accelerators for extremely relativistic particles and their gamma-ray emission. Others have sudden jumps (“glitches”) in their spin rates. Magnetic fields on neutron star surfaces are observed to range from less than a billion Gauss to more than a million times larger. Within our galaxy, there are young strongly magnetized neutron stars which support repeated explosions. Distant ones near the edge of the observable universe may be the source of extraordinary explosions in which perhaps a tenth of their rest mass energy is converted to bursts of gamma-rays. Observations are far ahead of theories and much remains to be understood. For more on Professor Ruderman’s research, contact him at [mar@astro.columbia.edu](mailto:mar@astro.columbia.edu)



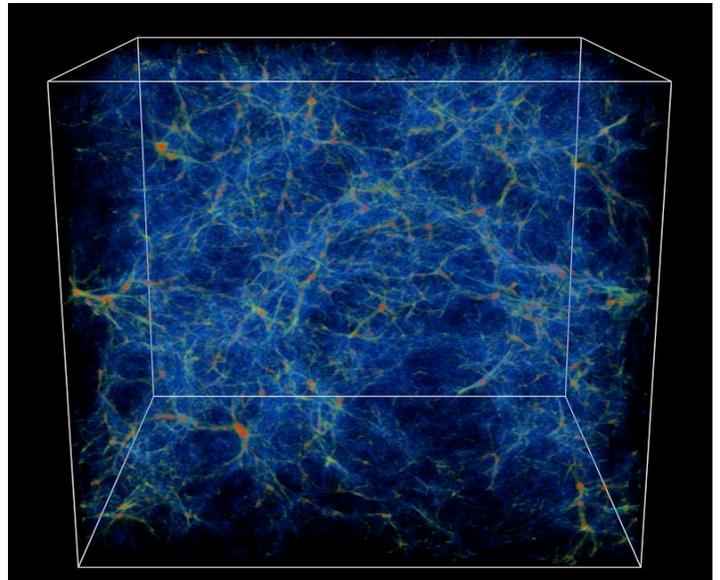
Active galactic nucleus of NGC 4261. Credit: HST/NASA/ESA.



# + Columbia Astronomy



Credit: pinksplash.com



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