MILLER INSTITUTE NEWSLETTER

Winter 2005

Miller Fellow Focus: Saurabh Jha

Third-year Miller Fellow Saurabh Jha is primarily an observational cosmologist, working in the Department of Astronomy with Prof. Alex Filippenko (a former Miller Fellow and currently a Miller Professor). He uses telescopes large and small, on the ground and in space, to study a particular kind of exploding star known as a Type Ia supernova (SN Ia, for short) that turns out to be an incredibly useful tool to survey the Universe. Recent studies of SN Ia have galvanized a revolution in our cosmological understanding: the expansion rate of the Universe is accelerating.

In 1929, Edwin Hubble discovered that the Universe is expanding. Galaxies are receding from us, and galaxies twice as far away from us are moving away twice as fast, and the same holds true for any observer in any galaxy. This linear relation between recession velocity and current distance is known as Hubble's law, and the constant of proportionality is Hubble's constant. For the past seven decades, extending measurements of Hubble's law to progressively more distant galaxies has been a major quest in astronomy. Because of the finite speed of light, the farther away a galaxy is, the farther back in time we see it. Measuring the distance to a faraway galaxy reveals how long ago we are observing it, and measuring its velocity (or to be more precise, its redshift) tells us the factor by which the Universe has expanded over that time. Combining these two gives us the expansion history of the Universe, if we measure a large number of galaxies at different distances.

While the measurements are simple in principle, they are not so easy in practice. The redshift is by far the easier of the two quantities to measure for a distant galaxy; nevertheless, it takes a large telescope (like the Keck 10-m telescopes on Mauna Kea volcano on the Big Island of Hawaii) and sensitive instruments to take a spectrum of the faint galaxy and determine the wavelength shift of spectral lines as the galaxy light gets stretched by the expansion of the Universe during its long journey to the telescope.

Measuring the distance to other galaxies is much harder. Galaxies come in all shapes, sizes, and luminosities; it is hard to know whether you are looking at a big, bright galaxy that happens to be far away, or a small, faint galaxy nearby. This is where the supernovae come in; SN Ia are believed to be thermonuclear explosions of "white-dwarf" stars as they accrete material and approach a fundamental limit to their mass (known as the Chandrasekhar limit, about 1.4 times the mass of the Sun). Because they occur under similar conditions throughout the Universe, they are expected to be very homogeneous in their energy output, and indeed, observationally we can see that is the case.

Miller Fellow Saurabh Jha

Saurabh uses SN Ia as "standard candles," measuring their distances by how bright they appear. Supernovae are difficult to observe; they are rare, unpredictable, and fleeting. SN Ia occur on average once every few hundred years in galaxies like our Milky Way (the last Galactic SN Ia was observed by Tycho in 1572), so thousands of galaxies must be monitored to catch one of these explosions. Here at Berkeley,

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Announcements:

The Miller Institute will be celebrating **50 years** in December 2005!

Remember: Visiting Miller Professor nominations due by ***Wednesday, February 9***.

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the Filippenko group operates the world's most successful nearby supernova search, using a small robotic telescope called KAIT (the Katzman Automatic Imaging Telescope), located at nearby Lick Observatory on Mt. Hamilton. Beyond simply finding them, SN Ia >must be carefully followed-up with brightness measurements. At their maximum output, SN Ia are ten billion times more powerful than stars like the Sun, but this doesn't last long. SN Ia rise and fall over a period of only a few weeks when they must be observed to be useful distance indicators.

While the unpredictability and time-critical nature of supernova observations are a challenge, they are also part of the excitement that drew Saurabh to this field as a graduate student, working with Prof. Robert Kirshner (a former Visiting Miller Professor) at Harvard University. In 1998, Saurabh was a member of one of two teams (both with strong ties to Berkeley) to conclude that observations of distant SN Ia billions of light-years away showed that, contrary to expectations, the expansion of the Universe is currently speeding up, implying the existence of a previously unknown and dominant constituent of the Universe. The discovery of "dark energy" driving the acceleration of the Universe was called the top "Breakthrough of the Year" (1998) by Science magazine.

Understanding the nature of this dark energy is at the frontier of current research, and theoretical possibilities abound, such as Einstein's "cosmological constant" which is associated with the energy of "empty" space (breathing new life into what he perhaps apocryphally called his "greatest blunder"), or something even more exotic, intimately connected with fundamental physics. Does nothing really weigh something? (Are there lucrative opportunities here for applications to the diet industry?) Current and

Dr. Jha on the summit of Mauna Kea in Hawaii

The spiral galaxy Messier 96, before and after the appearance of the Type Ia Supernova 1998bu.

future large surveys of SN Ia will lead the way in unraveling this mystery.

In addition to working on some of these surveys, Saurabh's research aims to make SN Ia better distance indicators. Though similar, SN Ia are not all identical, but careful observations can provide other clues to help "read the label" on these cosmic light-bulbs and learn their intrinsic luminosity. Saurabh's dissertation work on the ultraviolet properties of SN Ia was a key to observing the farthest-known supernovae, whose ultraviolet light is redshifted to wavelengths that can be sensitively observed with the Hubble Space Telescope. These observations, led by former Miller Fellow Adam Riess, confirmed that the Universe was decelerating before its current accelerated expansion, as predicted by dark-energy models. Other tests of this new standard model of cosmology using SN Ia are underway.

Saurabh's love of the changing sky has also led him to other fields in observational astronomy. Recently, he has been involved on a project to find "transiting" planets around other stars: planets which periodically block a small fraction of their host star's light as seen from Earth. Saurabh helped discover the first planet found by its transit, around the star ingloriously named OGLE-TR-56, located a few thousand light-years toward the center of the Milky Way. Because of the special geometry, precise measurements of the velocity modulation and transit light curve of the host star yield both the mass and radius of the planet, providing key constraints on the theory of planet formation and evolution.

In his copious spare time, Saurabh is a die-hard (now die-happy) fan of the Boston Red Sox, and relishes a good game of Texas Hold'em, though he tries to take it easy on the poor grad students at poker night.

Visiting Miller Professorship Awards

The Miller Institute is pleased to announce the Visiting Miller Professorships granted during the Fall competition cycle. The purpose of the Visiting Professorship program is to bring promising or eminent scientists to the Berkeley campus for collaborative research interactions. The recipients will be on campus for terms during academic year 2005-06.

August Evrard University of Michigan	*Physics*
Herbert Koch Universitat Dortmund, Germany	*Mathematics*
Richard Losick Harvard University	*Molecular & Cell Biology* *Public Health*
Peter Molnar University of Colorado at Boulder	*Earth & Planetary Science* *Geography*
Kathryn Miller Washington University	*Plant & Microbial Biology*
Martin Quack Eidgenössische Technische Hochschule Zürich, Switzerland	*Chemistry*

Miller Professorship Awards

The Miller Institute is happy to announce the awards for Miller Research Professorship terms in Academic Year 2005-2006. Recipients are released from teaching and administrative duties, allowing them to pursue their research, following promising leads as they develop.

John Harte - *Environmental Science, Policy, & Management*

Sydney Kustu - *Plant & Microbial Biology*

Philip Marcus - *Mechanical Engineering*

Hitoshi Murayama - *Physics*

Christos Papadimitriou - *Computer Science*

Bjorn Poonen - *Mathematics*

John Rice - *Statistics*

Michael Turelli - *Integrative Biology*

Awards & Honors

Paul Alivisatos (Miller Professor 2001-02) was presented with the American Chemical Society award in Colloid and Surface Chemistry.

Manuel Cardona (Visiting Miller Professor Fall 1987, Spring 2000) has been awarded the Blaise Pascal Medal by the European Academy of Sciences and the Matteucci Medal by the Italian National Academy of Sciences.

David Chandler (Executive Committee Member and Miller Professor Fall 1991, 1999-2000) was awarded the 2005 Langmuir Award by the American Physical Society.

Yi Cui (Miller Fellow 2003-06) was named as one of the Top Young Innovators by Technology Review.

Matthew Francis (Miller Fellow 1999-2001) received Hellman Family Faculty Fund award for Chemistry.

Alex Filippenko (Miller Fellow 1984-86, Miller Professor Spring 1996, Spring 2005) was awarded the 2004 Carl Sagan Prize for Science Popularization by the Trustees of Wonderfest, the Bay Area Festival of Science.

Eugene E. Haller (Miller Professor Fall 1990, Fall 2001) was named a fellow of the American Association for Advancement of Science.

Stephen Leone (Visiting Miller Professor Fall 1990) was awarded the Peter Debye Award in Physical Chemistry by the American Chemical Society.

Erin O'Shea (Miller Fellow 1992-93) was recently elected to the National Academy of Sciences.

Sheila Patek (Miller Fellow 2001-04) was named one of the "Brilliant 10" upcoming scientists by Popular Science magazine.

Richard Saykally (Miller Professor 1985-86, 1997-98) was one of seven winners of the 2004 E.O. Lawrence Award announced by Secretary of Energy Spencer Abraham.

Garrison Sposito (Miller Professor Spring 1995) was selected to receive the Horton Medal from the American Geophysical Union.

Jeremy Thorner (Miller Professor 1999-2000) has been awarded the 2004 Award for Distinguished Research Mentoring of Undergraduates in the Biological Sciences by the College of Letters and Science. He was also named as a recipient of a 2004 award from the Faculty Research Fund for the Biological Sciences.

Miller Institute @ 50

The Miller Institute for Basic Research in Science invites you to celebrate 50 years of science

December 9-10, 2005
Location: Berkeley Campus

You are invited to join the Miller Institute in celebration of its 50th Birthday, to be held on December 9-10, 2005. This will be a time of looking both backward through the history of our Institute, and forward to the next 50 years.

Friday evening will begin with an informal gathering of alumni, providing all a chance to renew old acquaintances, reminisce, and to share common career and personal experiences.

Saturday will feature an interdisciplinary symposium with presentations on, and discussions of, nano-science, biology in the 21st century, and cosmology and its connection to fundamental physics. See the list of alumni speakers in the sidebar.

Saturday evening we will host a festive dinner and party, with minimal after dinner speaking.

We will be creating a web-registration site soon where you can let us know your interest in attending, choose a hotel, and pay the $125 registration fee.

I look forward to this festive occasion and do hope you can join us.

Executive Director

Featured Speakers:

New Science at the Scale of Nanometers:

- Paul Alivisatos (UCB, Miller Professor - 2001-02)
- Matthew Francis (UCB, Miller Fellow - 1999-2001)
- Hong Kun Park (Harvard, Visiting Miller Professor - Fall 2003)

The Cosmology Fundamental Physics Connection:

- John Barrow (Cambridge, Miller Fellow - 1980-81)
- Hitoshi Murayama (UCB, Miller Professor - Fall 2005)

Voices in Biology:

- John Hulsenbeck (UC San Diego, Miller Fellow - 1995-97)
- David Jablonski (University of Chicago - Miller Fellow - 1980-82)
- Erin O'Shea (Harvard, Miller Fellow - 1992-93)

HOLD THE DATE!

REGISTRATION INFORMATION TO BE COMING SOON ON OUR WEBSITE

Registration will include:

• Friday, December 9	Alumni Gathering
• Saturday, December 10	Lunch
• Saturday, December 10	Dinner

Miller Institute for Basic Research in Science

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Publications

The following Miller Institute members have recently published works resulting from research during their Miller Institute terms. For more information about these publications, please visit the Miller Institute's website at: http://millerinstitute.berkeley.edu/news/publications.htm

Connie Chang-Hasnain
Miller Professor, 2003-04

Irit Dinur
Miller Fellow, 2003-04

Alison Galvani
Miller Fellow, 2002-04

Mark Hauber
Miller Fellow, 2002-05

Jon Magne Leinaas
Visiting Miller Professor, Fall 2002

Arunava Majumdar
Miller Professor, 2003-04

Jerry Mitrovica
Visiting Miller Professor, Spring 2004

George Oster
Miller Professor, 2003-04

Rhaguveer Parthasarathy
Miller Fellow, 2002-05

Alex Thompson
Miller Fellow, 2003-06

Jeffrey Townsend
Miller Fellow, 2002-04

Bin Yu
Miller Professor, Spring 2004

COMING SOON...

A new look for the Miller Institute's website!

Obituaries

Shiing-Shen Chern, Miller Professor 1963-64, 1969-70, Emeritus Professor of Mathematics, and world-renowned mathematician, passed away on December 3, 2004. He was 93.

Gerard Debreu, Miller Professor 1973-74, Emeritus Professor of Economics and Mathematics, and Nobel Prize winner, passed away on December 31, 2004. He was 83.

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Next Steps

The Miller Institute congratulates the following Miller Fellows on their next endeavors.

Irit Dinur
Assistant Professor, Deptartment of Computer Science
Hebrew University of Jerusalem, Isreal

Mark Hauber
Lecturer in Animal Behaviour - Ecology, Evolution, and Behaviour Research Group
University of Auckland, New Zealand

Olafur Magnusson
Research Scientist
deCODE Genetics/Drug Discovery, Reykjavik, Iceland

The Miller Institute is "dedicated to the encouragement of creative thought and the conduct of research and investigation in the field of pure science and investigation in the field of applied science in so far as such research and investigation are deemed by the Advisory Board to offer a promising approach to fundamental problems."