Media Contact:
A. Sarah Hreha
+1 (203) 432-6231
info@gruber.yale.edu
Online Newsroom: www.gruber.yale.edu/news-media

Sandra Faber

SANDRA FABER RECEIVES $500,000 GRUBER COSMOLOGY PRIZE FOR CAREER ACHIEVEMENTS

May 17, 2017, New Haven, CT – The 2017 Gruber Foundation Cosmology Prize recognizes Sandra M. Faber for a body of work that has helped establish many of the foundational principles underlying the modern understanding of the universe on the largest scales.

The citation praises Faber for "her groundbreaking studies of the structure, dynamics, and evolution of galaxies." That work has led to the widespread acceptance of the need to study dark matter, to an appreciation of the inextricable relationship between the presence of dark matter and the formation of galaxies, and to the recognition that black holes reside at the heart of most large galaxies. She has also made significant contributions to the innovations in telescope technology that have revolutionized modern astronomy. Through these myriad achievements, the Gruber citation adds, Faber has "aided and inspired the work of astronomers and cosmologists worldwide."

Faber will receive the $500,000 award as well as a gold medal at a ceremony this fall.

Less than a hundred years ago, astronomers were still debating whether our Milky Way Galaxy was the entirety of the universe or if other galaxies existed beyond our own. Today astronomers estimate the number of galaxies within the visible universe at somewhere between 200 billion and 2 trillion. For more than four decades Faber—now Professor Emerita at the University of California, Santa Cruz, and Astronomer Emerita of the University of California Observatories—has served as a pivotal figure in leading and guiding the exploration of this unimaginably vast virgin scientific territory.

A partial summary of her achievements includes:

• In 1976 Faber and Robert Earl Jackson discovered a relation between the orbital speeds of stars in elliptical galaxies and the galaxy's mass. Other such laws have emerged since then, but the Faber-Jackson relation was the first.

• In 1979 Faber and John S. Gallagher published a paper that provided a comprehensive review of the evidence for the existence of dark matter. Among astronomers this paper is regarded as the turning point in the debate about whether 80 percent of the mass in the universe is "missing"—mysterious, invisible, and impervious to direct detection.

• Faber's discovery of large amounts of dark matter (using indirect methods of detection) in a certain exotic species of galaxy led her to conclude, in a 1983 paper with Douglas Lin, that dark matter could not be neutrinos, a subatomic particle that travels close to the speed of light ("hot," in cosmological parlance), but might be another species of subatomic particle, not yet known, that travels at a much slower rate ("cold").

• The following year Faber was part of a four-member collaboration that presented a comprehensive theory of how cold dark matter could explain the structure and behavior of galaxies and superclusters of galaxies that we actually observe in the universe. This theory remains the paradigm underpinning all modern models of galaxy formation.

• In 1985 Faber emerged as the leading science advocate for the construction of the 10-meter Keck telescope in Hawaii (the most powerful on the planet when it went online in 1993) and, with Harland Epps, developed the optical design. She later served as the co-chair of the Keck Science Steering Committee and went on to lead construction of the DEIMOS spectrograph on Keck, one of the largest and most innovative astronomical instruments in the world.

• During that same period Faber was a member of the collaboration developing the Wide-Field Camera for the Hubble Space Telescope. (She may have been the only astronomer to play a major role on both Keck and Hubble.) After the launch of the telescope a few years later, she and postdoc Jon Holtzman diagnosed the spherical aberration that was compromising the telescope's image quality. Faber then led the replanning of the entire suite of early observations.

• In 1988 Faber was the Principal Investigator among the so-called Seven Samurai, a collaboration that discovered irregularities in the rate of the universe's expansion that apparently depend on the distribution of matter, and therefore the distribution of gravitational effects, on the largest scales.

• From 1985 to 2002 Faber served as the Principal Investigator for a collaboration that came to call themselves the "Nukers"—because they were studying the nuclei of galaxies. Among the discoveries that the Nuker collaboration made under Faber's leadership were that the center of every large galaxy harbors a massive black hole and that the mass of that central black hole closely correlates to the orbital speed of stars within the galaxy as a whole.

• Since 2010 Faber has served as co-Principal Investigator, with Henry Ferguson, on the CANDELS (Cosmic Assembly Near-infrared Deep Extragalactic Survey) collaboration, the largest project in the history of the Hubble Space Telescope. Over the course of more than 900 Earth orbits, the team collected data on the most distant, and therefore (because the light from the galaxies takes billions of years to reach us) among the youngest, galaxies. By comparing those data with the already existing voluminous data about galaxies near to us, astronomers can trace the evolution of galaxies throughout cosmic time.

As a body of work, these advances and discoveries, both observational and technological, have helped define how scientists think about and investigate galaxies and superclusters of galaxies, the largest structures in the universe.

For Faber, though, they have also helped define how civilization can conceive of its place in the cosmos. In recent years she has become a prolific public speaker, delivering her lecture "Cosmic Knowledge and the Future of the Human Race" around the world. That title speaks volumes about her own philosophy.

"Astronomical knowledge," she says, "is probably the most important single discipline that you need to know in order to be an informed citizen of earth." The reason, she says, is that developments in astronomy over the past few decades have shown us that we have been given "the precious gift of cosmic time"—the concept that the universe exists on a scale of billions of years and that planet Earth will be a safe haven for us for hundreds of millions of years into the future. "Astronomical knowledge tells us how we got here and furthermore, having understood that, we can extrapolate more confidently for the future."

Few if any astronomers have done more to make that understanding possible than Sandra Faber.

Additional Information

In addition to the cash award, the recipient will receive a gold laureate pin and a citation that reads:

The Gruber Foundation proudly presents the 2017 Cosmology Prize to Sandra Faber for her groundbreaking studies of the structure, dynamics, and evolution of galaxies. Her research ranges from detailed studies of the stellar populations, masses, dark matter content, and supermassive black holes in nearby galaxies, to surveys of distant galaxies over cosmic time. The results of these investigations have aided and inspired the work of astronomers and cosmologists worldwide.

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Laureates of the Gruber Cosmology Prize:

- **2016: Rainer Weiss, Kip Thorne, Ronald Drever,** and the **LIGO team** for a vision to observe the universe in gravitational waves, leading to a first detection from the collision of black holes
- **2015: John Carlstrom, Jeremiah Ostriker, and Lyman Page**, for individual and collective contributions to the study of the universe on the largest scales
- **2014: Jaan Einasto, Kenneth Freeman, Brent Tully and Sidney van den Bergh** for pioneering contributions to the understanding of the structure and composition of the nearby Universe
- **2013: Viatcheslav Mukhanov** and **Alexei Starobinsky** for their profound contribution to inflationary cosmology and the theory of inflationary perturbations of the metric
- **2012: Charles Bennett and the WMAP Team** for exquisite measurements of anisotropies in the relic radiation from the Big Bang---the Cosmic Microwave Background
- **2011: Marc Davis, George Efstathiou, Carlos Frenk** and **Simon White** for the use of numerical simulations to model and interpret large-scale distribution of matter in the Universe
- **2010: Charles Steidel** for his groundbreaking studies of the distant Universe
- **2009: Wendy Freedman, Robert Kennicutt** and **Jeremy Mould** for the definitive measurement of the rate of expansion of the universe, Hubble's Constant
- **2008: J. Richard Bond** for furthering understanding of development of structures in the universe
- **2007: Saul Perlmutter** and **Brian Schmidt** and their teams: **Supernova Cosmology Project** and **High-z Supernova Search Team,** for discovering the expansion of the universe is accelerating
- **2006: John Mather** and **Cosmic Background Explorer (COBE) Team** for studies confirming that our universe was born in a hot Big Bang

- **2005: James E. Gunn** for leading design of a silicon-based camera for the Hubble Space Telescope and developing the original concept for the Sloan Digital Sky Survey
- **2004: Alan Guth** and **Andrei Linde** for developing and refining the theory of cosmic inflation
- **2003: Rashid Alievich Sunyaev** for pioneering work on the nature of the cosmic microwave background and its interaction with intervening matter
- **2002: Vera Rubin** for discovering that much of the universe is unseen black matter, through studies of the rotation of spiral galaxies
- **2001: Martin Rees** for extraordinary intuition in unraveling the complexities of the universe
- **2000: Allan R. Sandage** and **Phillip J. E. (Jim) Peebles**: Sandage for pursuing true values of the Hubble constant, the deceleration parameter, and age of the universe; Peebles for advancing understanding of how energy and matter formed the patterns of galaxies observed today

The Prize recipients are chosen by the Cosmology Selection Advisory Board. Its members are:

James Evans, University of Puget Sound, **Andrew Fabian,** University of Cambridge; **Robert Kennicutt,** University of Cambridge (Chair); **Sadanori Okamura,** Hosei University; **Frans Pretorius,** Princeton University; **Subir Sarkar**, University of Oxford; and **Rashid Sunyaev**, Max Planck Institute for Astrophysics. **Owen Gingerich** of the Harvard-Smithsonian Center for Astrophysics and **Martin Rees** of the University of Cambridge also serve as special Cosmology advisors to the Foundation.

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By agreement made in the spring of 2011 The Gruber Foundation has now been established at Yale University.

The Gruber International Prize Program honors individuals in the fields of Cosmology, Genetics and Neuroscience, whose groundbreaking work provides new models that inspire and enable fundamental shifts in knowledge and culture. The Selection Advisory Boards choose individuals whose contributions in their respective fields advance our knowledge and potentially have a profound impact on our lives.

The Cosmology Prize honors a leading cosmologist, astronomer, astrophysicist or scientific philosopher for theoretical, analytical, conceptual or observational discoveries leading to fundamental advances in our understanding of the universe.

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For more information on the Gruber Prizes, visit www.gruber.yale.edu, e-mail info@gruber.yale.edu or contact A. Sarah Hreha at +1 (203) 432-6231. By mail: The Gruber Foundation, Yale University, Office of Development, PO Box 2038, New Haven, CT 06521.

Media materials and additional background information on the Gruber Prizes can be found at our online newsroom: www.gruber.yale.edu/news-media

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