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Frank Eisenhauer

# FRANK EISENHAUER RECEIVES $500,000 GRUBER COSMOLOGY PRIZE

***May 17, 2022, New Haven, CT*** – The 2022 Gruber Cosmology Prize recognizes Frank Eisenhauer of the Max Planck Institute for Extraterrestrial Physics for the revolutionary design of instruments that collected seemingly irrefutable evidence for the existence of a black hole at the center of our galaxy.

Eisenhauer will receive the $500,000 award as well as a gold laureate pin at a ceremony that will take place on August 2 at the XXXIst General Assembly of the International Astronomical Union. The citation honors the "unprecedented and exquisite" precision of his instrumentation.

In 2018, the GRAVITY experiment traced the behavior of various phenomena near Sagittarius A*, or Sgr A*, a supermassive, and therefore gravitationally voracious, invisible object near the center of our galaxy. Thanks to Eisenhauer's technical innovations, the GRAVITY team found that the behavior of stars and gas near the galactic center matches theoretical predictions consistent with the existence of a black hole.

Eisenhauer's mentor and longtime collaborator Reinhard Genzel shared the 2020 Nobel Prize in Physics with Andrea Ghez and Roger Penrose for his contributions to work on Sagittarius A* (Sgr A*).

GRAVITY had its basis in an earlier experiment on which Eisenhauer developed breakthrough technology in imaging spectroscopy—the measurements of how matter affects the absorption and emission of light. In 2003 the instrument, part of the Spectrograph for INtegral Field Observations in the Near Infrared (SINFONI) project at the European Southern Observatory's Very Large Telescope on Mount Paranal in Chile, began observing stars operating under the great gravitational influence of Sgr A* as they execute their exceedingly rapid, highly eccentric orbits.

Two years later Eisenhauer and Genzel began discussing an opportunity to observe an upcoming event involving one of those stars, S2. Having measured a precise orbit of S2 after the first peri-passage in 2002, they could now calculate that in 2018 the star would reach the part of its orbit where it would again pass closest to Sgr A*, a distance of only 17 light-hours. Combining the observing power of all four 8-meter

telescopes at Paranal (through a process called interferometry) meant that the experiment could achieve the necessary thousandfold improvement in sensitivity over earlier interferometers necessary to resolve the resulting relativistic effects.

"This project was seen by some as technically impossible," wrote one nominator for this year's Gruber Cosmology Prize. Advocates for the project, however, argued that even if the experiment didn't reach its goals, any technological advances would have broader benefits. Eisenhauer's designs did indeed wind up revolutionizing several kinds of instrumentation, including imaging detectors, laser metrology, and dual-beam operations.

The GRAVITY collaboration completed the instrument with barely a year to spare, and the initial results, as one nominator wrote, "can only be described as astounding and ground-breaking for many fields of astrophysics."

Those results include:

• Precise measurements of Sgr A*'s general relativistic influence on S2;

• Observations of gas orbiting close to the "last stable orbit"—the point before which it succumbs to the gravitational tug of Sgr A* and disappears from sight forever.

Together this data provides enough evidence to satisfy the astronomical community that Sgr A* is indeed a black hole.

Among GRAVITY's other significant contributions to astronomy are:

• A determination of the distance between the Sun and the galactic center at a level of precision ten times greater than previous measurements (a calibration that other astronomers will use as a reliable first step in tracing the evolution of the universe on the largest scales)

• A test of Einstein's general relativity using supermassive black holes at the highest level of precision to date.

As GRAVITY's advocates hoped, Eisenhauer's innovations in technology—the ones for which he is receiving the 2022 Gruber Prize in Cosmology—have changed astronomy beyond just the study of Sgr A*. Other astrophysicists have already begun using SINFONI and GRAVITY instrumentation to study distant star-forming galaxies, black holes at the centers of nearby galaxies, and planets orbiting stars within our own galaxy.

## Additional Information

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

*The Gruber Foundation is pleased to present the 2022 Cosmology Prize to Frank Eisenhauer for his innovative design and construction of the GRAVITY instrument, a near-infrared interferometric beam combiner for the ESO Very Large Telescope Interferometer in Chile.*

*GRAVITY has opened up near-infrared interferometry to help us understand a wide range of astrophysical and cosmologically important phenomena, including black holes, and exoplanets.*

*Eisenhauer also led the construction of the SPIFFI/SINFONI, the first adaptive optics integral field spectrometer on an 8m class optical telescope. These instruments enabled the detection of general relativity effects close to a black hole by defining the orbit of the star S2 around the Galactic Center Massive Black Hole SgrA* with unprecedented and exquisite angular resolution.*

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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.

Laureates of the Gruber Cosmology Prize:

- **2021 Marc Kamionkowski, Uroš Seljak, and Matias Zaldarriaga,** for contributions to methods essential for studying the early universe
- **2020**: **Lars Hernquist** and **Volker Springel,** for computer simulations that revolutionized the study of processes behind the structure of the cosmos
- **2019: Nicholas Kaiser** and **Joseph Silk,** revolutionized cosmology with contributions to two of its vital components: dark matter and relic radiation from the Big Bang
- **2018: The Planck Team, Jean-Loup Puget** and **Nazzareno Mandolesi,** for measuring the universe's contents and the geometry and test inflation with unparalleled precision
- **2017: 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
- **2016: Rainer Weiss, Kip Thorne, Ronald Drever,** and the entire **LIGO team,** for a first detection of gravitational waves that emanated from the collision of two black holes
- **2015: John Carlstrom, Jeremiah Ostriker,** and **Lyman Page**, for their 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 contributions to inflationary cosmology and the theory of inflationary perturbations of the metric, which changed our views on the origin of our universe and on the mechanism of formation of its structure
- **2012: Charles Bennett** and the **WMAP Team,** for their exquisite measurements of anisotropies in the relic radiation from the Big Bang---the Cosmic Microwave Background
- **2011: Marc Davis, George Efstathiou, Carlos Frenk**, **Simon White,** pioneering use of numerical simulations to model and interpret the 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 his pioneering contributions to our understanding of the development of structures in the universe
- **2007: Saul Perlmutter** and **Brian Schmidt** and their teams: the **Supernova Cosmology Project** and the **High-z Supernova Search Team,** for independently discovering that the expansion of the universe is accelerating

- **2006: John Mather** and the **Cosmic Background Explorer (COBE) Team,** for studies confirming that our universe was born in a hot Big Bang
- **2005: James E. Gunn,** for leading the 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 their roles in developing and refining the theory of cosmic inflation
- **2003: Rashid Alievich Sunyaev,** for his 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 her studies of the rotation of spiral galaxies
- **2001: Martin Rees,** for his extraordinary intuition in unraveling the complexities of the universe
- **2000: Allan R. Sandage** and **Phillip J. E. (Jim) Peebles**, Sandage for pursuing the true values of the Hubble constant, the deceleration parameter and the age of the universe; Peebles for advancing our understanding of how energy and matter formed the rich patterns of galaxies observed today

The International Astronomical Union partners with the Foundation on the Prize and nominates the members of the Selection Advisory Board that chooses the Prize recipients. Its members are:

**James Evans,** University of Puget Sound; **Paul Ho,** Institute of Astronomy and Astrophysics, Academia Sinica; **Angela Olinto** (Chair), The University of Chicago; **Jean-Loup Puget,** The National Centre for Scientific Research (CNRS); **Hans Ringström**, KTH Royal Institute of Technology; **Linda Tacconi,** Max Planck Institute for Extraterrestrial Physics; Licia Verde, Universitat de Barcelona**. Wendy Freedman** of The University of Chicago and **Martin Rees** of The University of Cambridge also serve as special Cosmology advisors to the Foundation.

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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 Gruber Foundation was established in 1993 by the late Peter Gruber and his wife Patricia Gruber. The Foundation began its International Prize Program in 2000, with the inaugural Cosmology Prize.

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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 are in our online newsroom: https://gruber.yale.edu/news-media