LISA gravitational-wave mission strongly endorsed by National Research Council

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The National Research Council (NRC) has strongly recommended the Laser Interferometer Space Antenna (LISA) as one of NASA's next two major space missions, to start in 2016 in collaboration with the European Space Agency (ESA). LISA will study the universe in a manner different from any other space observatory, by observing gravitational waves. The recommendation was announced August 13 in a press conference at the Keck Center of the National Academies in Washington, D.C.

In the just-concluded "Astro2010" decadal survey, a panel of experts was convened to look at the coming decade and prioritize all research activities in astronomy and astrophysics, as well as at the interface of these disciplines with physics. The survey recommended LISA highly because of the expectation that observations of gravitational waves in space will answer key scientific questions about the astrophysics of the cosmic dawn and the physics of the universe.

"We are very pleased with the NRC's recognition of LISA's extraordinary research opportunities in astrophysics and fundamental physics," says Tom Prince, professor of physics at the California Institute of Technology (Caltech), senior research scientist at the Jet Propulsion Laboratory (JPL), and the U.S. chair of the LISA International Science Team. Scientists from many European countries participate in LISA either as members of the science team or as members of the LISA International Science Community. "We are looking forward to unveiling a new window on the universe by observing thousands of gravitational wave sources."

"This recommendation and our excellent reputation in the scientific community encourages us a lot. With LISA we will open up an entirely new way of observing the universe, with immense potential to enlarge our understanding of physics and astronomy in unforeseen ways," says Karsten Danzmann, European chair of the LISA International Science Team.

"In the past it has sometimes been difficult to get mainstream astronomers to recognize the importance of gravitational wave astronomy," says Marcia Rieke, a professor of astronomy at the University of Arizona and vice chair for the Astro2010 subcommittee on programs. "The ranking of LISA is an indication that astronomers are recognizing the opportunities that LISA presents for using gravitational waves to study the universe in a new way."

"The science case for LISA has become much richer over the last 10 years. On the experimental side, a similar story could be made that what were once novel measurement concepts are now reliable, proven technologies," says LISA science team member Scott Hughes, associate professor of physics at the Massachusetts Institute of Technology.

"In the 13 years I've been involved with LISA, its technology and science have advanced beyond my wildest first dreams," says Sterl Phinney, professor of theoretical astrophysics at Caltech, current co-chair of the sources and data analysis working group of the LISA science team, and chair of the original LISA Mission Definition Team. "I'm looking forward to its precise measurements telling us if the giant black holes in the centers of galaxies really follow the rules of Einstein's theory of general relativity, and which if any of the ideas about how they get made are correct."

"This strong endorsement by America's leading astronomers makes it official: LISA has the potential to become one of the most important astronomical observatories of our time," says Bernard F. Schutz, director of the Max Planck Institute for Gravitational Physics (Albert Einstein Institute/AEI) in Potsdam, Germany and co-chair of the sources and data analysis working group of the

LISA science team.

"When LISA was adopted by the ESA in 1995, it was because its observations of gravitational waves would provide powerful insight into the fundamentals of gravity, of Einstein's theory and all its predictions," adds Schutz. "In the last 15 years, astronomers also have learned how LISA can open up hidden chapters in the history of the universe, by listening to the waves made by the very first stars, the earliest black holes, and by some of the oldest stars in existence today. By seeing how the waves from early black holes are stretched out as they move toward us through the expanding universe, LISA can even study the mysterious dark energy."

LISA is designed to be complementary to the ground-based observatories (the Laser Interferometer Gravitational-Wave Observatory, or LIGO, in the United States, and Virgo and GEO-600 in Europe) that currently are actively searching for signs of gravitational waves; both search for ripples in the fabric of space and time formed by the most violent events in the universe, such as the coalescence of black holes, that carry with them information about their origins and about the nature of gravity that cannot be obtained using conventional astronomical tools. The existence of the waves was predicted by Albert Einstein in 1916 in his general theory of relativity.

The LISA instrument will consist of three spacecraft in a triangular configuration with 5-million-kilometer arms (12.5 times the distance from the Earth to the moon), moving in an Earth-like orbit around the sun. Gravitational waves from sources throughout the universe will produce slight oscillations in the arm lengths (changes as small as about 10 picometers, or 10 million millionths of a meter, a length smaller than the diameter of the smallest atom). LISA will capture these motions—and thus measure the gravitational waves—using laser links to monitor the displacements of gold-platinum test masses floating inside the spacecraft. It is slated for launch in the early 2020s.

LISA will observe gravitational waves in a lower frequency band (0.1 milliHertz to 1 Hertz) than that detectable by LIGO and other ground-based instruments, which are designed to sense sources at frequencies above 10 Hertz.

Because gravitational waves are moving ripples in the curvature of space, and because LISA will sense ripples coming simultaneously from tens of thousands of sources in every direction, the instrument acts more like a microphone listening to sound than like a telescope or a camera taking a picture. This new kind of observing tells us directly about the motion of invisible masses, complementing traditional astronomical observations of light, which reveal only visible atoms.

In the U.S. the LISA project is managed by the NASA Goddard Space Flight Center and includes significant participation by JPL, which is managed by Caltech for NASA.

LISA's hardware will get its first test in space with the launch of LISA Pathfinder by 2013. This will include a thorough test of a crucial component of LISA's technology: drag-free operation, whereby the spacecraft shield the test masses from external disturbances by precisely monitoring their motions and moving around them to preserve their free fall. LPF recently reached a key phase of development, during which the flight hardware undergoes rigorous pre-flight testing.

Provided by California Institute of Technology