AMERICAN MUSEUM OF NATURAL HISTORY

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# ROSE CENTER TO GO TO SPACE

## COMPONENT CRAFTED AT AMERICAN MUSEUM OF NATURAL HISTORY WILL LAUNCH WITH THE JAMES WEBB SPACE TELESCOPE

A wafer-thin titanium disk, nearly two inches in diameter and punctured with seven perfect holes, will launch into space with the James Webb Space Telescope in 2014. Called a non-redundant mask, this tool filters light coming from very bright objects like stars to dramatically improve a telescope's resolution for fainter objects. Conceived of on the sixth floor of the Rose Center for Earth and Space at the American Museum of Natural History, this non-redundant mask was described in a white paper submitted to the National Academy of Sciences' Astronomy & Astrophysics Decadal Survey and will launch in the Canadian Space Agency's Fine Guidance Sensor Tunable Filter Imager on board the James Webb Space Telescope.

"We designed a non-redundant mask for the space telescope late in the Webb project, but it was accepted because it improved resolution by more than a factor of two and is so easy to implement," says Anand Sivaramakrishnan, chief instrumentation scientist in the Museum's Department of Astrophysics. "This is not a new technique—it was invented for radio astronomy in the late 1950s and revised for ground-based astronomy in the late 1990s. But this is the first time it will be used in space."

Sivaramakrishnan and his team designed non-redundant masks for ground-based telescopes like Palomar and Gemini; one such mask is currently assisting the Museum's Project 1640 to image extrasolar planets on the 200-inch telescope at Palomar.

The new mask for the space telescope was designed using a simple concept. By punching holes in a metal plate, much of the light from a telescope's primary mirror is obscured. The beams selected by the mask come through to the image, turning an imaging telescope into an interferometer, an instrument that spreads light into a complex fringe pattern that reveals the presence of close faint structure around a bright object.

Non-redundant masks improve a conventional telescope's resolution by a factor of 2.44 so that objects very close to each other can be resolved in an image. On the ground, the mask enables objects about 100 times fainter than a bright star to be imaged. But in space, a non-redundant mask that is part of an exceptionally stable space telescope should be able to detect objects 10,000 times fainter than the nearby bright object or star. Extrasolar planets can be directly imaged by the James Webb Space Telescope, a large infrared telescope with a 6.5 meter primary mirror, the successor to the Hubble Space Telescope.

The mask conceived of at the Museum for the James Webb Space Telescope is 50mm in diameter. Its seven holes are hexagonal in shape to maximize the amount of light passing through, but they are also smaller than their corresponding mirror segments in order to correct for a potential misalignment of the telescope's mirror and the mask. Finally, the mask was designed so that none of the telescope's supporting struts arch across holes.

"Our initial observational targets will be proto-planets and Jupiter-like planets in the constellation Taurus and other nearly stellar nurseries," says Sivaramakrishnan. "But in addition to planets and faint companions, images obtained with the mask can also reveal regions around supermassive black holes in the centers of galaxies as well as the host galaxies around quasars to see how these incredibly powerful sources affect their environments."

The "JAM Team," or the James Webb Space Telescope Aperture Masking group led by Sivaramakrishnan, includes Peter Tuthill and Michael Ireland of the University of Sydney and James Lloyd of Cornell University.  The team also counts David Lafrenière of the University of Montreal, Frantz Martinache of the Subaru Telescope, and Rémi Soummer of the Space Telescope Science Institute as members. Barry McKernan and Saavik Ford, both affiliated with the Museum and at the City University of New York, broaden the scientific goals of this masking project to include black holes and quasars. Sivaramakrishnan's non-redundant masking study is funded by the National Science Foundation and NASA.

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