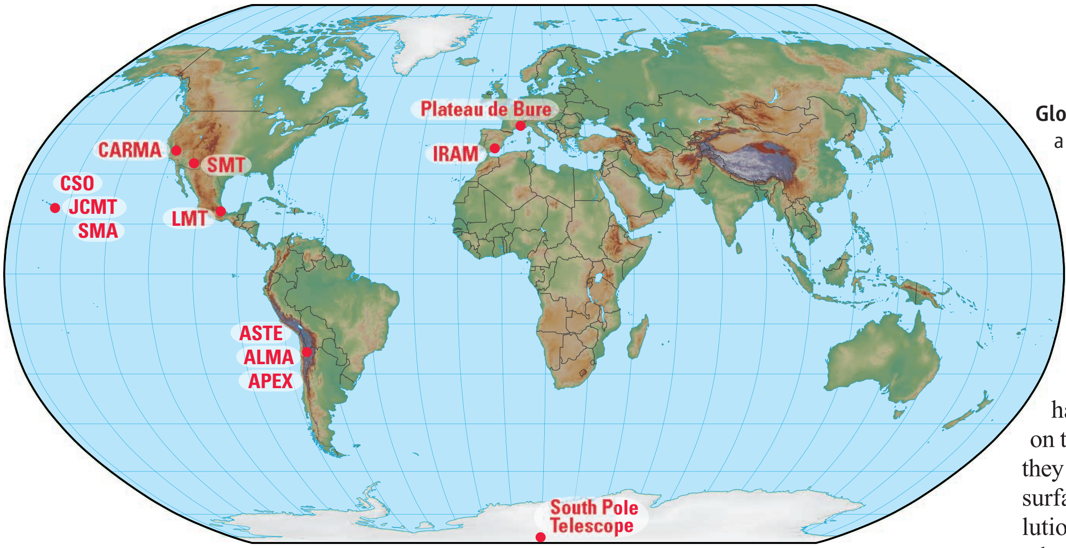


Global coverage. Radio telescopes that could play a role in the Event Horizon Telescope.

ASTRONOMY

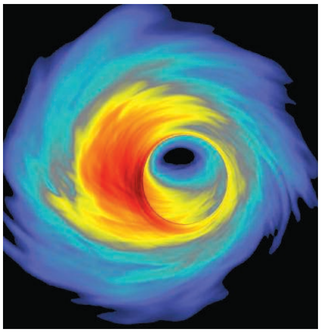
Worldwide Telescope Aims to Look Into Milky Way Galaxy's Black Heart

The center of our galaxy—surrounded by a maelstrom of stars, gas, and dust, and separated from us by 26,000 light-years of space filled with all the detritus of the galactic plane—is one of the most challenging things for astronomers to observe. Last week, astronomers gathered in Tucson, Arizona, to work out a plan to combine data from radio telescopes worldwide and create, in effect, a dish the size of Earth. With such a virtual instrument, they say, they'll be able to peer into our galaxy's heart and see the supermassive black hole that resides there.

"It would be an amazing thing. It's never been done before, getting an image of a black hole," says one of the project's organizers, astronomer Daniel Marrone of the University of Arizona's Steward Observatory. Heino Falcke of Radboud University in Nijmegen, the Netherlands, agrees. "This is a very, very important thing to do," he says. Despite such enthusiasm, however, it's not yet clear how a worldwide collaboration would be organized or funded. "Most of the relevant telescopes had someone present [in Tucson], and all wanted to make it work. But there was no real consensus on how to do it," says Falcke, who, along with two colleagues, first suggested in 2000 that such observations might be possible (*Science*, 7 January 2000, p. 65).

The organizational details are "still in flux," says Shep Doeleman, an astronomer at the Massachusetts Institute of Technology's Haystack Observatory in Westford and principal investigator of the project, known as the Event Horizon Telescope (EHT). But with such a tantalizing scientific goal and an estimated cost of a few million dollars to upgrade instruments at some telescopes, "I don't see problems getting the resources," Doeleman says.

Black holes are extremely difficult to see directly because they emit no light, except possibly the proposed very faint Hawking radiation. Astronomers have inferred the presence of black holes by observing nearby gas or orbiting stars. Being able to observe one directly would be a huge advance for astrophysicists. "Black holes may be part of our everyday lives, but they haven't been proven. No one has seen an event horizon," Falcke says. As well as obtaining proof, direct observation would allow astronomers to study how black holes swallow up nearby material, a process known as accretion, and how the jets of material often seen coming out of them form. They could also conduct precise tests of general relativity, something never done in such a strong gravitational field.



Eye of the storm. Simulation of hot gas around a black hole.

Our galaxy's central black hole, known as Sagittarius A* (Sgr A*), is thought to be 4 million times as massive as the sun but only 30 times as wide, smaller than Mercury's orbit. Proponents of EHT believe they can image it—or rather, see its "shadow" against a bright background of hot gas—using a technique known as very long baseline interferometry (VLBI). It takes data from widely spaced dishes and combines them as if they were two small patches of a large dish. A VLBI array lacks the light-collecting power of a full dish its size, but with enough small patches it can build up a high-resolution image of distant objects.

In a sense, EHT has begun observing already. For several years, Doeleman, Marrone, and colleagues have been observing Sgr A* using dishes in Hawaii, Arizona, and California. They have seen features of the galactic center on the same scale as the black hole, although they don't yet have the resolution to image its surface, the event horizon. To improve resolution they need to use shorter wavelengths, a longer baseline, or both. The shorter wavelengths are on the way: The team hopes soon to switch its observations from light with a wavelength of 1.3 millimeters to 0.83 millimeters—fortuitously, a wavelength in which the material of the galactic plane is relatively transparent. But they are "pushing up to near the limit of the radio window in the atmosphere," Marrone says.

To extend the baseline will require more telescopes. About a dozen around the world either are equipped to work at such short wavelengths or can be adapted relatively cheaply. In addition, EHT needs to incorporate the Atacama Large Millimeter/Submillimeter Array (ALMA) in Chile (*Science*, 30 September 2011, p. 1820). ALMA's 66 dishes high in the Andes will match the collecting power of a 90-meter-wide dish. "ALMA is key because of its enormous collecting power and sensitivity," says theorist Dimitrios Psaltis of the Steward Observatory. It is also far from other observatories, creating a long baseline.

EHT researchers at Haystack have won $4 million from the U.S. National Science Foundation to equip ALMA for VLBI. ALMA, which is not yet complete, should be ready to play a part in EHT by 2015. To get an even longer baseline, the project would also like to enlist the South Pole Telescope (*Science*, 16 March 2007, p. 1523), but it will require upgrading to make it suitable.

EHT's enthusiastic reception at Tucson has set the ball rolling, and researchers have set up a committee to work out the details of an international collaboration. "We're aiming for an MOU [memorandum of understanding] this summer, though tests and work will go on under the current, less formal, arrangements," Marrone says.

–DANIEL CLERY

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