APEX telescope takes part in sharpest observation ever

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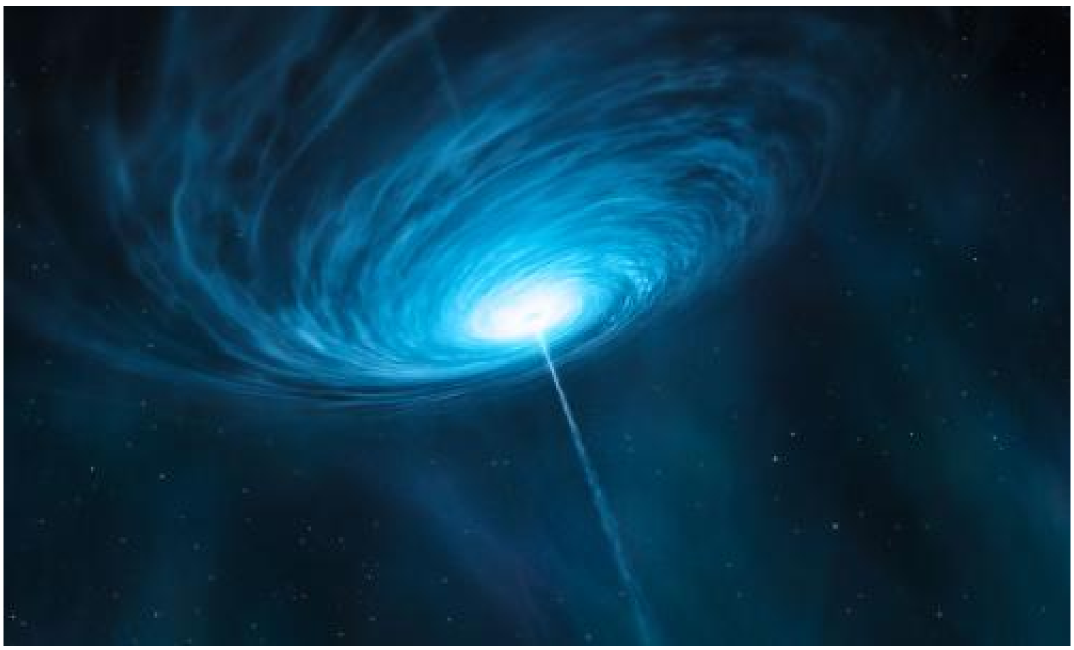


This is an artist's impression of the quasar 3C 279. Astronomers connected the Atacama Pathfinder Experiment (APEX), in Chile, to the Submillimeter Array (SMA) in Hawaii, USA, and the Submillimeter Telescope (SMT) in Arizona, USA, for the first time, to make the sharpest observations ever, of the center of a distant galaxy, the bright quasar 3C 279. Quasars are the very bright centres of distant galaxies that are powered by supermassive black holes. This quasar contains a black hole with a mass about one billion times that of the sun, and is so far from Earth that its light has taken more than 5 billion years to reach us. The team were able to probe scales of less than a light-year across the quasar -- a remarkable achievement for a target that is billions of light-years away. Credit: ESO/M. Kornmesser

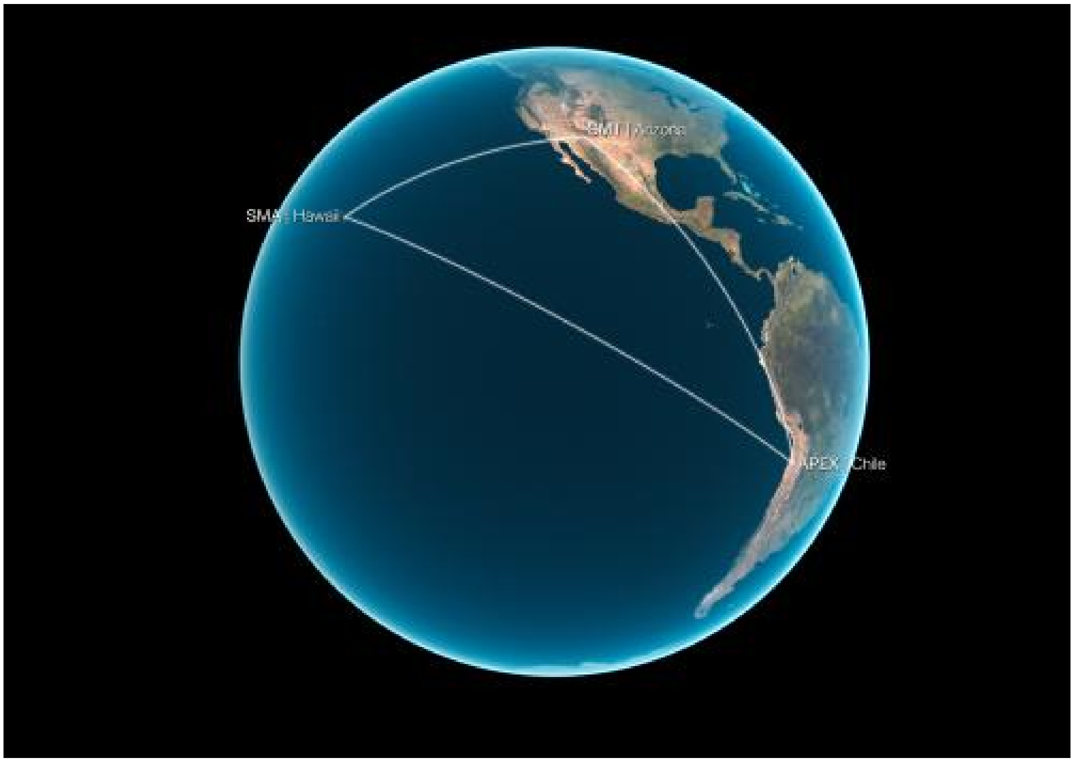
(Phys.org) -- An international team of astronomers has observed the heart of a distant quasar with unprecedented sharpness, two million times finer than human vision. The observations, made by connecting the Atacama Pathfinder Experiment (APEX) telescope to two others on different continents for the first time, is a crucial step towards the dramatic scientific goal of the “Event Horizon Telescope” project: imaging the supermassive black holes at the centre of our own galaxy and others.

Astronomers connected APEX, in Chile, to the Submillimeter Array (SMA) in Hawaii, USA, and the Submillimeter Telescope (SMT) in Arizona, USA. They were able to make the sharpest direct observation ever, of the centre of a distant galaxy, the bright quasar 3C 279, which contains a supermassive black hole with a mass about one billion times that of the Sun, and is so far from Earth that its light has taken more than 5 billion years to reach us. APEX is a collaboration between the Max Planck Institute for Radio Astronomy (MPIfR), the Onsala Space Observatory (OSO) and ESO. APEX is operated by ESO.

The telescopes were linked using a technique known as Very Long Baseline Interferometry (VLBI). Larger telescopes can make sharper observations, and interferometry allows multiple telescopes to act like a single telescope as large as the separation -- or "baseline" -- between them. Using VLBI, the sharpest observations can be achieved by making the separation between telescopes as large as possible. For their quasar observations, the team used the three telescopes to create an interferometer with transcontinental baseline lengths of 9447 km from Chile to Hawaii, 7174 km from Chile to Arizona and 4627 km from Arizona to Hawaii. Connecting APEX in Chile to the network was crucial, as it contributed the longest baselines.

The observations were made in radio waves with a wavelength of 1.3 millimetres. This is the first time observations at a wavelength as short as this have been made using such long baselines. The observations achieved a sharpness, or angular resolution, of just 28 microarcseconds -- about 8 billionths of a degree. This represents the ability to distinguish details an amazing two million times sharper than human vision. Observations this sharp can probe scales of less than a light-year across the quasar -- a remarkable achievement for a target that is billions of light-years away.

The observations represent a new milestone towards imaging supermassive black holes and the regions around them. In future it is planned to connect even more telescopes in this way to create the so-called Event Horizon Telescope. The Event Horizon Telescope will be able to image the shadow of the supermassive black hole in the centre of our Milky Way galaxy, as well as others in nearby galaxies. The shadow -- a dark region seen against a brighter background -- is caused by the bending of light by the black hole, and would be the first direct observational evidence for the existence of a black hole's event horizon, the boundary from within which not even light can escape.



Astronomers connected the Atacama Pathfinder Experiment (APEX), in Chile, to the Submillimeter Array (SMA) in Hawaii, USA, and the Submillimeter Telescope (SMT) in Arizona, USA for the first time, to make the sharpest observation ever of the centre of a distant galaxy, the bright quasar 3C 279. The telescopes were linked using a technique known as Very Long Baseline Interferometry (VLBI). Larger telescopes can make sharper observations, and interferometry allows multiple telescopes to act like a single telescope as large as the separation — or “baseline” — between them. The baseline length from Chile (APEX) to Hawaii (SMA) is 9447 km, from Chile to Arizona (SMT) 7174 km, and from Arizona to Hawaii 4627 km. Credit: ESO/L. Calçada

The experiment marks the first time that APEX has taken part in VLBI observations, and is the culmination of three years hard work at APEX's high altitude site on the 5000-metre plateau of Chajnantor in the Chilean Andes, where the atmospheric pressure is only about half that at sea level. To make APEX ready for VLBI, scientists from Germany and Sweden installed new digital data acquisition systems, a very precise atomic clock, and pressurised data recorders capable of recording 4 gigabits per second for many hours under challenging environmental conditions. The data -- 4 terabytes from each telescope -- were shipped to Germany on hard drives and processed at the Max Planck Institute for Radio Astronomy in Bonn.

The successful addition of APEX is also important for another reason. It shares its location and many aspects of its technology with the new Atacama Large Millimeter/submillimeter Array (ALMA) telescope. ALMA is currently under construction and will finally consist of 54 dishes with the same 12-metre diameter as APEX, plus 12 smaller dishes with a diameter of 7 metres. The possibility of connecting ALMA to the network is currently being studied. With the vastly increased collecting area of ALMA's dishes, the observations could achieve 10 times better sensitivity than these initial tests. This would put the shadow of the Milky Way's supermassive black hole within reach for future observations.

Provided by ESO

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