A VIRTUAL TELESCOPE 100000 KM ACROSS

Astronomers using an orbiting radio telescope in conjunction with four ground-based radio telescopes have achieved the highest resolution, or ability to discern fine detail, of any astronomical observation ever made. Their achievement produced a pair of scientific surprises that promise to advance the understanding of quasars, supermassive black holes at the cores of galaxies.

The scientists combined the Russian RadioAstron satellite with the ground-based telescopes to produce a virtual radio telescope more than 100,000 miles across. They pointed this system at a quasar called 3C 273, more than 2 billion light-years from Earth. Quasars like 3C 273 propel huge jets of material outward at speeds nearly that of light. These powerful jets emit radio waves.

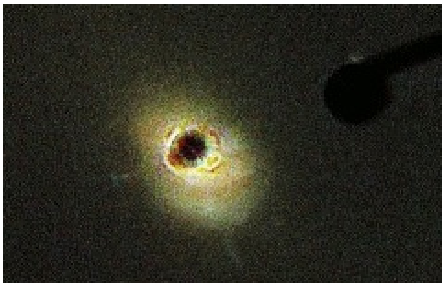
Just how bright such emission could be, however, was thought to be limited by physical processes. That limit, scientists thought, was about 100 billion degrees. The researchers were surprised when their Earth-space system revealed a temperature hotter then 10 trillion degrees. Now they have to figure out how that environment can reach such temperatures, a significant challenge to our current understanding of quasar jets.

The observations also showed, for the first time, substructure caused by scattering of the radio waves by the tenuous interstellar material in our own Milky Way Galaxy. Such distortion of an extragalactic object has never been seen before. It is like looking through the hot, turbulent air above a candle flame. The amazing resolution achieved with this set-up gives us a powerful new tool to explore not only the extreme physics near the distant supermassive black holes, but also the diffuse material in our home Galaxy.

The RadioAstron satellite was combined with the Green Bank Telescope in West Virginia, The Very Large Array in New Mexico, the Effelsberg Telescope in Germany, and the Arecibo Observatory in Puerto Rico. Signals received by the orbiting radio telescope were transmitted to an antenna in Green Bank where they were recorded and then sent over the internet to Russia where they were combined with the data received by the ground-based radio telescopes to form the high resolution image of 3C 273.

In 1963, astronomer Maarten Schmidt of Caltech recognized that a visible-light spectrum of 3C 273 indicated its great distance, resolving what had been a mystery about quasars. His discovery showed that the objects are emitting tremendous amounts of energy and led to the current model of powerful emission driven by the tremendous gravitational energy of a supermassive black hole.

Researchers in Germany and Russia have obtained the first detection of interferometric signals between the Effelsberg 100-m telescope and the space-bound radio telescope satellite Spektr-R. The distance between the two radio telescopes is up to 350,000 kilometres -- which corresponds to a virtual telescope of this aperture and an angular resolution of about 40 micro arc seconds. Both telescopes were targeted at BL Lacertae, an Active Galactic Nucleus at a distance of approximately 900 million light years.



Close-up of active galactic nucleus: First interferometric signals between Earth telescopes and orbital radio telescope

RadioAstron is an international project for VLBI (Very Long Baseline Interferometry) observations in space, led by the Astro Space Center (ASC) in Moscow and employing a 10-meter radio antenna on board of the Russian Spektr-R satellite. Launched in July 2011, the Spektr-R is a spacecraft orbiting the Earth on an elliptical orbit reaching out to 350 000 km from Earth. Combining the space borne antenna together with other radio telescopes on Earth, the RadioAstron project uses interferometric measurements to achieve extremely high angular resolutions -- **equivalent to the resolution that would be achieved by a single telescope the size of the distance from the Earth to the Moon**! The RadioAstron mission will enable astronomers to study exciting scientific topics including particle acceleration near supermassive black holes in active galactic nuclei, neutron stars and pulsars, to dark matter and dark energy. The radio interferometry technique utilized by the RadioAstron mission relies on having pairs of telescopes that record the incoming radio wave signals, which are then electronically compared in a process called correlation. This processes, directly comparable to the optical "double-slit experiment" encountered in elementary optics classes by physics students, results in a series of sinusoidal intensity fluctuations as a function of the direction on the sky. Such sinusoidal variations are called "fringes" in radio astronomy, and the greater the distance between the two telescopes, the more precisely astronomers can measure the direction on the sky where a radio source is located.   AK with ScienceDaily Notes