Astronomers simulate real-time telescope as big as the world to study peculiar active galaxy

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Using a perfectly orchestrated world-wide network of radio telescopes, astronomers have produced a high-resolution map of an Active Galactic Nucleus (AGN) belonging to an unknown class of gamma-ray sources. The unusual source and the groundbreaking technique used to produce the image are detailed in a letter published today in *Astronomy & Astrophysics*.

The paper, "Global e-VLBI observations of the gamma-ray narrow line Seyfert 1 PMN J0948+0022", presents very high resolution radio observations of the active nucleus of a peculiar Seyfert galaxy. In 2009, observations made with the Fermi satellite of PMN J0948+0022 revealed the emission of high energy gamma rays, presumably from the active nucleus of this galaxy. No other galaxy of this kind had ever been revealed at such high energy, and it could be the first member of a new class of gamma-ray extragalactic sources. Gamma-ray emission is typically associated with relativistic jets of plasma that also emit radio waves. Therefore, the best way to image such structure is in the radio spectrum using VLBI, Very Long Baseline Interferometry. "We immediately realized this was an extremely interesting object, so we decided to look at it using the best resolution we could attain. And we knew it was important to do it as soon as possible, since this was a variable source," says Marcello Giroletti, astronomer at INAF-IRA in Bologna, Italy, who led the observations.

VLBI observations are performed by simultaneously pointing at a source with telescopes distributed across several countries, and the more distant their locations, the better the achieved angular resolution. With traditional VLBI, each station records data on hard disks which are shipped to a central supercomputer called a correlator, which processes the data. Recently, it has become possible to directly connect the telescopes to the correlator using optical fibres and to process the data in real-time, in the so-called electronic VLBI (e-VLBI) technique, providing astronomers with data in a matter of hours rather than weeks. Although e-VLBI is done routinely at the European scale, it had only been done at a global scale for testing and demonstration purposes. Scientific observations using a world-scale, real-time connected array had never been done before.

Giroletti and his team conducted observations in three sessions from May to July 2009 using radio telescopes in Europe, East Asia, and Australia, connecting observatories as far apart as 12,458 km. With such a long baseline, the central region of the galaxy was mapped at an astonishing resolution of a few tens of microarcseconds - about the same as identifying a football on the moon!

All aspects of the technical experiment were successful, with each telescope streaming its data to the correlator at the Joint Institute for VLBI in Europe (JIVE) in the Netherlands. This type of observation is testing new frontiers, since it permits real-time network performance monitoring and the possibility of delivering prompt results, which is essential for coordination with other observatories at other wavelengths. Several of them, including space satellites Fermi and Swift, joined the same observing campaign. More radio telescopes are expected to become connected through real-time high-speed networks, such as the upcoming 64m INAF Sardinia Radio Telescope, and technology developments are being made through the NEXPReS project to remove the distinction between traditional VLBI and e-VLBI techniques.

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