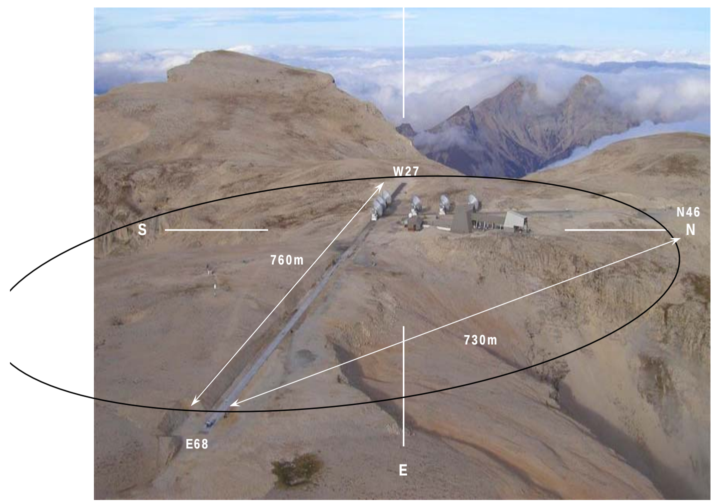
IRAM 0413/06

Seeing the true nature of distant cosmic objects with the extended Plateau de Bure interferometer

The IRAM radio-telescope, located atop a 2500 metre plateau on the French Alps, has entered a new era since the beginning of 2006. The telescope makes use of a technique called interferometry, where a single, parabolic antenna of very large diameter can be substituted by a number of small parabolas within an equivalent area. Six such dishes, 15 metres in diameter form the Plateau de Bure interferometer. The antennas are placed on railway tracks and can be moved nearer or further apart, depending on the desired properties of the synthesized telescope. Moving them closer in a compact array configuration increases the sensitivity to extended astronomical objects in the sky. The real magic comes from the most extended configurations, where the outermost antennas are as far apart as possible. In such a case, the telescope can distinguish between astronomical objects which are very near to each other on the plane of the sky; the more extended the telescope, the closer the pair of objects it can unambiguously resolve.

Up to the end of 2005, the largest separation of antennas at the site was 480 metres. At the wavelength of typical observations of the telescope (1.2 millimetres), this corresponds to a resolving angle of 0.5 seconds of arc, or 0.5/3600 of a degree. This is the equivalent of the size of a 1 euro coin at a distance of 4.7 kilometres.



Aerial view of the Plateau de Bure Observatory at the end of 2005. With the new stations at the far ends of the northern and eastern track extensions, the Plateau de Bure Interferometer spans the surface of a single-dish with a diameter of 760m.

Since the beginning of 2006, the railway tracks have been extended to permit antennas to be positionned at much greater distances than the previous 480 m, thus simulating much larger single-dish telescopes. The optimal new antenna positions were computed by astronomers at the IRAM headquarters in Grenoble, through the development of computer software, which was in the meantime also applied to another radio-telescope array in Hawaii. The largest distance is now 760 meters, 1.6 times the previous size. So now, in the previous example, the telescope could not only see the euro coin at the same distance, it could also distinguish it from two 1-cent coins placed next to each other (the diameter of a 1 euro coin is 2.3 centimeters, whereas a 1 cent coin is only 1.6 centimeters across).

It is, however, in a real astrophysical context that the consequences of the extension will have a large impact. For example, astronomers looking at environments where stars are being born are asking for more information on the size and shape of these clouds of dust and gas to construct accurate physical models. A large molecular cloud seen in another galaxy could in fact be a collection of smaller clouds, shifting astronomers' views on star formation processes. Another example comes from scientists who have been looking at disks of material around young stars, with the ambition to understand the processes that take place during the infancy of stars. Such disks are very small on cosmic scales, and uncovering their secrets requires the ability to look closely at these systems.

Vincent Piétu, a postdoctoral astronomer at IRAM, looked at a couple of such sources very recently, to use the new high resolving power of the telescope to constrain theoretical models on the consistency and structure of the disks, when he stumbled upon a surprising result: "*Instead of seeing a disk with more emission coming from the centre, we observed what is essentially a ring-like shape, with an obvious small hole in the middle. The size of the hole is comparable to our solar-system, so it is tempting to consider the possibility that the central part of the disk has been swept clear by a planet orbiting the young star*". The track extensions and the very high resolving capacity they give the telescope are already, in few months of existence, leading to such spectacular new results!

Either way, the scientific prospects after the extension of the Plateau de Bure interferometer constitute a large step forward in observational radio astronomy at millimeter wavelengths, and consolidate the telescope as one of the world's best millimetric interferometres.