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STSM title: GMVA Polarization observations of Blazars
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Scientific Report

The STSM has been extremely succesful. During the Scientific Mission, I have analyzed the observations of the quasars 4C39.25 and 1055+018 with the Global Millimeter VLBI Array (GMVA) at a wavelength of 3mm in polarimetric mode in close cooperation with Dr. Eduardo Ros and Dr. Thomas Krichbaum. Those sources were selected according to the following criteria: i) the sources have averaged fluxes at 86 GHz > 3 Jy; ii) the average degree of polarization at 86 GHz is > 4%, indicating that they are strongly polarized; iii) they show a core-jet structure, as observed with cm-VLBI and 7mm-VLBI; iii) the spectral index is flat; iv) the sources show strong variability, and they are "flaring" at 1mm. They are, therefore, excellent candidates to be detected and imaged with the GMVA. These observations are tracing the polarized fine structure of the nuclear regions of these AGNs close (< 0.4 pc) to the SMBH. For a typical black hole mass of 10^9 M_{sun}, 1 pc corresponds to 10280 Schwarzschild Radii (Rsch); thus, for the GMVA interferometric beam of 50 µas –which at z = 1 corresponds to 0.4 pc–, we get a linear resolution of 4000 Rsch.

During the scientific visit, we have performed the "Fringe Fitting" of the data. Once the data have been correlated, they need to be aligned in time and frequency in order to obtain the interferometric observables. The recent GMVA observations are using the new Digital Broadband Converters (DBBCs) in the VLBI receivers. Therefore, there shouldn't be phase-jumps between the different sub-bands. However, some residual phase slopes are still present in some of the telescopes (e.g. some of the VLBA dishes and the Plateau de Bure interferometer, where the old equipment has still not been renewed). A very careful analysis was required to identify these phase jumps and correct them. Once the phases were aligned along the whole bandwidth, the fringe-fitting was performed, looking for the values of the phase delay and fringe rate that maximize the correlation function. The data required also a careful determination of the tropospheric contribution to the interferometric phase. In order to do it, the opacity and the receiver temperatures for each of the telescopes (in both LCP and RCP polarizations) should be determined interactively. The final product are the interferometric visibilities that have shown a good quality both at 7mm and 3mm. We have already imaged the sources at 7mm (see Figure 1). We are now in the process of obtaining the images at 3mm.

Once the sources have been imaged in total intensity, it is possible to calibrate the cross-hand visibilities to obtain the polarized flux density images. In order to do it, it is necessary to determine the instrumental polarization (the leakage terms between the LCP and RCP polarizations) and the absolute orientation of the B-field. This is not trivial at these high frequencies and with these large bandwidths. It is not clear whether these leakage terms could be considered constant across the bandwidth or they vary with frequency. This is something we will have to determine with a careful analysis of the experiments. This work is still in progress.

The 86 GHz polarimetric images will reveal the relativistic jet magnetic field properties (across and along the jet) and their structural changes in the neighbourhodd of the SMBH, in those regions where the jets are supposed to be launched and collimated. Our observations will permit to test the different magneto-hydrodinamic (MHD) jet formation models on scales of a few thousands of Schwarzschild Radii: Blandford-Payne type models, where the jet is anchored to magnetized rotating disks and helical fiels are generated in a natural way, should result in an edge-brightened polarisation up to the base of the jet with a high degree of polarization; on the other hand, Blandfod-Znajek models, where the jet is driven by the Black Hole spin, result in a more compact footprint of the jet, which implies a higher opacity and a smaller polarisation degree.

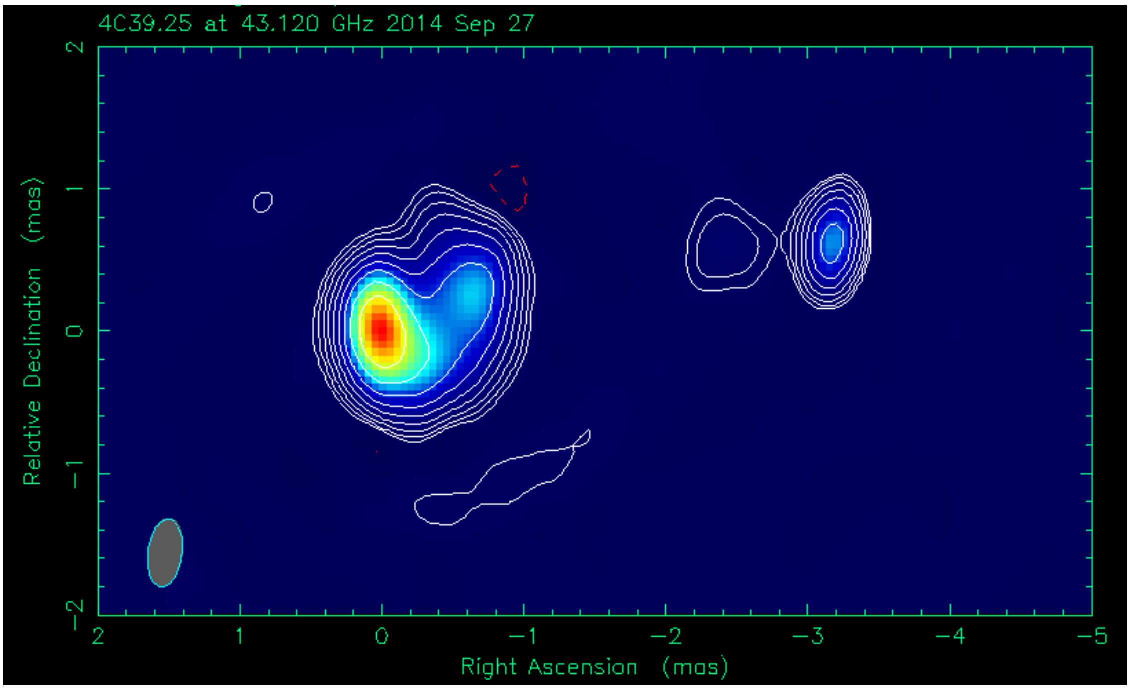

Figure 1: Image of 4C39.25 at 7mm; Beam: 0.48 mas x 0.24 mas @ PA -7 deg

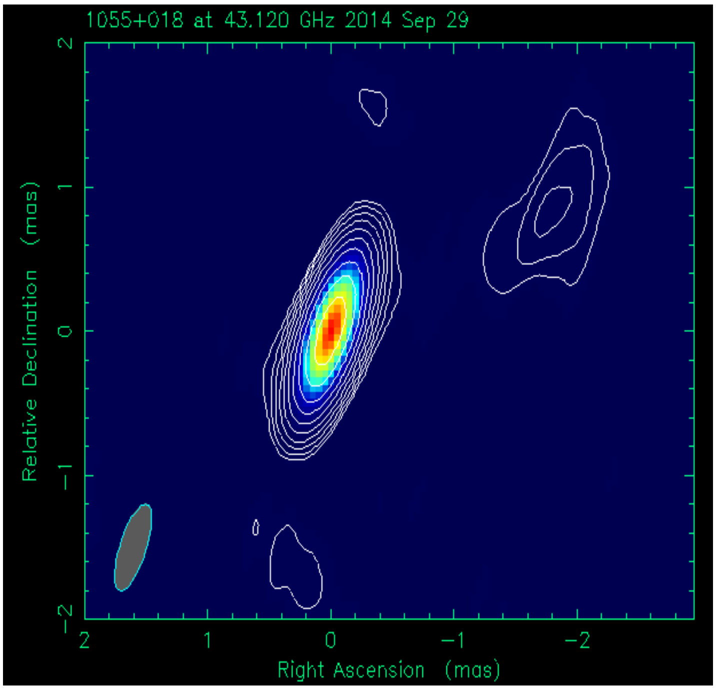

Figure 2: Image of 1055+018 at 7mm; Beam: 0.64 mas x 0.21 mas @ PA -21 deg