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Astro Space Center
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First space-VLBI polarization images with RadioAstron

The RadioAstron Key Science Program on polarization has succeeded in producing the first space-VLBI polarization images from observations of the high-redshift quasar 0642+449 and BL Lacertae.

The RadioAstron observation of 0642+449 was made on March 9-10, 2013 at a wavelength $\lambda = 18\,\mathrm{cm}$, with participation of the European VLBI Network (EVN) including the Russian Quasar network and the telescopes in Evpatoria and Green Bank (GBT). The correlated signal between the ground telescopes and the 10-m space radio telescope (SRT) of RadioAstron has been detected on projected baselines of up to 5.9 Earth diameters in length, achieving a resolution of 0.8 mas at the respective fringe-spacing of $420\,\mathrm{M}\lambda$. A hybrid image of 0642+449 made from the RadioAstron data is shown in Figure 1.

Observations of BL Lac with RadioAstron were performed on November 11, 2013 at 1.3 cm, with an array of ground antennas that includes the European VLBI Network and NRAO's VLBA, adding for a total of 16 antennas. Correlated visibilities between the ground and space antenna have been found up to a projected baseline distance of 6 Earth diameters, yielding a maximum angular resolution of 33 μas, the highest achieved to date. Images of BL Lac with RadioAstron are shown in Figure 2, revealing a twisted structure within the innermost 0.2 mas (0.25 parsec) consisting of two components with orthogonal linear polarization.

Both experiments were correlated by the DiFX correlator in Max Planck Institute for Radio Astronomy in Bonn. The estimated instrumental polarization (D-terms) of the space antenna are found to be within 10% at both observed wavelengths of 18 and 1.3 cm, which confirms excellent polarization performance of the SRT. Results from these experiments will be used for further development of RadioAstron polarization imaging.

These observations, recently reported at the COSPAR-2014 assembly in Moscow, represent a milestone in polarimetric space-VLBI observations. They demonstrate the unprecedented polarization and high angular resolution capabilities of the RadioAstron mission. These and continued observations as part of the RadioAstron Polarization Key Science Program are aimed to obtain a better understanding of the innermost regions of AGN jets and their magnetic field structure.

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The RadioAstron project is led by the Astro Space Center of the Lebedev Physical Institute of the Russian Academy of Sciences and the Lavochkin Scientific and Production Association under a contract with the Russian Federal Space Agency, in collaboration with partner organizations in Russia and other countries.

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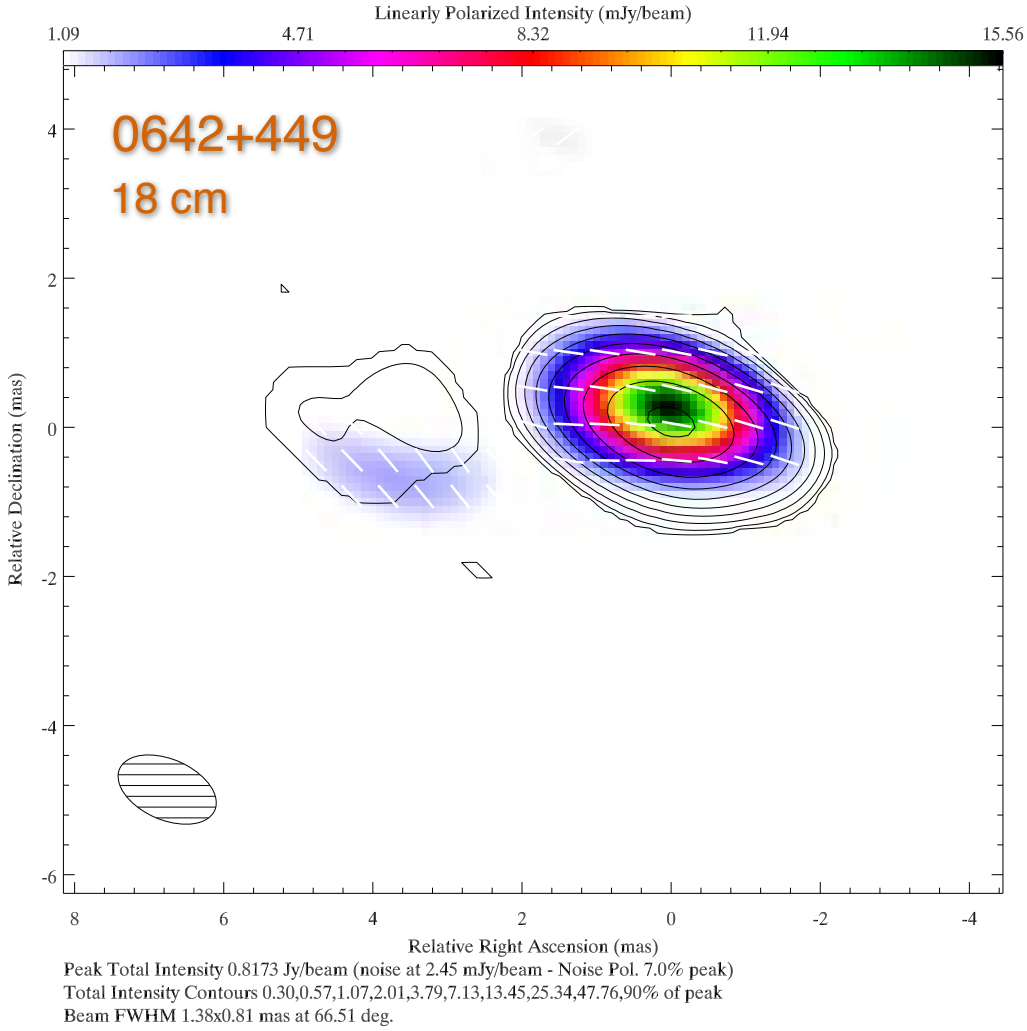

Figure 1: Map of total (contours) and linearly polarized (color scale) flux density of radio emission from the quasar 0642+449 at a wavelength of 18 cm. White bars denote the positional angle of electric vectors of polarized emission.

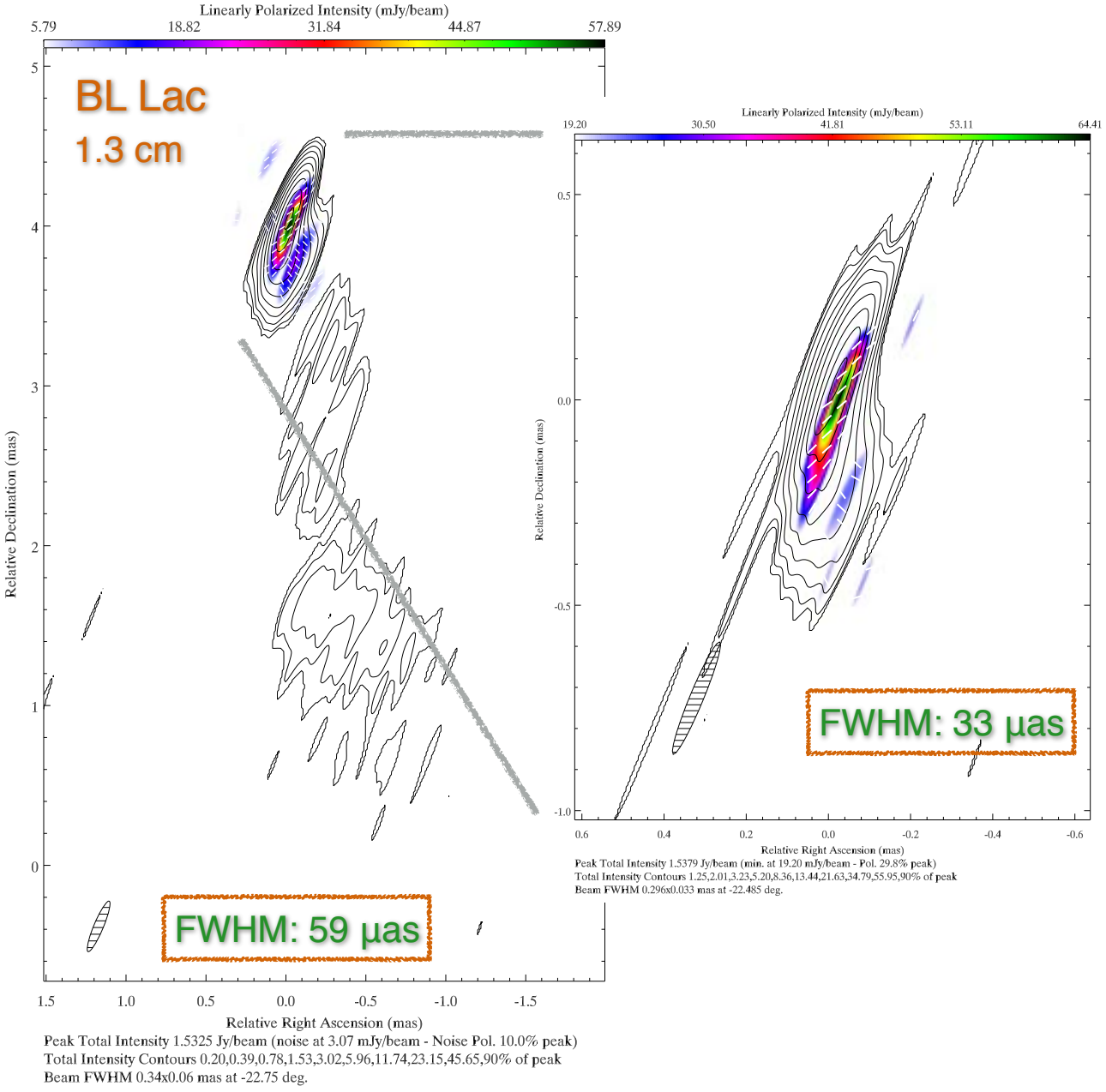

Figure 2: RadioAstron images of BL Lac at 1.3 cm obtained in November 11, 2013. Total intensity is shown in contours, linearly polarized intensity in color scale, and white bars indicate the electric vector position angle. Inset panel shows the highest angular resolution image, with FWHM of 33 μas or 1.6 light months, obtained using a "super" uniform weighting for the correlated visibilities.