Gravitational lensing at milliarcsecond resolution with global VLBI observations

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Gravitational lensing is a powerful tool for quantifying the mass content and distribution in distant galaxies. By using milliarcsecond angular resolution observations of radio-loud gravitationally lensed sources it is also possible to detect and quantify small deviations from a smooth mass density distribution. With this aim, we use 1.65 GHz global VLBI observations of the gravitationally lensed radio source MG J0751+2716 (at z = 3.2). The background radio source is highly resolved in the tangential and radial directions, showing evidence of both compact and extended structure (core-jet morphology) across several gravitational arcs that are 200 to 600 mas in size. By identifying compact sub-components in the multiple images, we constrain the mass distribution of the foreground z = 0.35 gravitational lens using analytic models for the main deflector and for the members of the galaxy group. The mass models with and without the group find an inner mass-density slope steeper than isothermal for the main lensing galaxy, which is consistent with the two-phase galaxy formation scenario. Moreover, we find randomly distributed image position residuals of about 3 mas. These residuals are much larger that the intrinsic astrometric uncertainties (40 μas on average), suggesting that at the mas level, the assumption of a smooth mass distribution fails, requiring additional structure in the model.