A Search for Large-Image Separation Gravitational Lenses in the JVAS Radio Survey

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Gravitational lens systems are an important probe of the distribution of matter and geometry of the universe to high redshift. Statistical analyses of lens surveys can place constraints on the cosmological constant λ_0 and the matter density Ω_0 (Turner, Ostriker and Gott 1984; Kochanek 1996).

The JVAS (Jodrell Bank VLA Astrometric Survey) flat-spectrum radio survey is nearing completion (Patnaik et al. 1992) and six arcsecond-scale lenses have been found from ~ 2500 sources (King et al. 1997). JVAS sources were selected by virtue of flat spectral indices ($|\alpha| \leq 0.5$) between 1.4 and 5GHz, and to have $S_{5\mathrm{GHz}} \geq 200$mJy.

In the original JVAS analysis, no attempt was made to look for lenses with separations $> 6''$. Currently, there are no firm examples of radio selected lens systems with image separations $> 7''$. We have reanalysed the original JVAS data to look for candidates with separations $6'' < \Delta\theta < 60''$.

Wambsganss et al. (1995) used numerical simulations to compute the distribution of magnifications for single and multiply imaged point sources as a function of z_s, multiplicity of images, and the distribution of angular splittings for the standard cold dark matter (CDM) scenario. The standard CDM model predicts that $\sim$1 in 1000 JVAS sources will be multiply imaged with angular splittings $\geq$10" and with amplification ratios of less than 4.

The search covered all 2500 fields to look for aditional components up to one arcminute away and above the 6σ level with a flux ratio less than 50:1 of the primary JVAS source flux density. Finally, only those sources with secondary components with an 8.4GHz flux density $\geq$10mJy were considered. Eight candidates satisfying these criteria were found. Two more candidates were discovered with component separations $> 60''$.

All ten candidates were observed with the VLA at 1.5GHz (L-band), 5GHz (C-band), 15GHz(U-band) and 22.5GHz (K-band) in BnC configuration. Radio maps were made at L-band to reveal low surface brightness structure to either confirm or rule out the lensing hypothesis. The observations at C, U and K band were made to build additional spectral information. This spectral information on the source components suggests that the lensing hypothesis in all but three of the candidates is unlikely.

The candidates were also recently observed with MERLIN at 5GHz with 50mas resolution. We have been able to rule out one of the seven unlikely

candidates based on morphological grounds.

For the case of image separations at these scales, time delays in variability of the order of hundereds of years limit our confidence in using component morphologies and spectra to rule out candidates.

Recently, Maoz et al. (1997) searched for wide-separation quasar lensing in the Hubble Space Telescope (HST) snapshot survey which contains 498 quasars. An optical search was made using multicolor photometry and spectroscopy in in the fields of 76 candidates in the $7'' - 50''$ range. None of their candidates are lenses and they confirm our result that large-separation lensing is not common.

The absence of lensed quasars with large-image separations is incompatible with the predictions of standard CDM, assuming the lenses are modelled as singular isothermal spheres. The introduction of a small core radius to the lens model in the numerical simulations would reduce the number of large-separation lenses to levels compatible with observations (Flores and Primack 1996). The large separation quasar lensing test is therefore sensitive to both the cosmological model and to the inner lens structure.

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