A SEARCH FOR GRAVITATIONAL LENSING

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Gravitational interactions allow one to investigate the nature of matter in the universe independent of the properties that make it luminous. Much as studies of the dynamics of galaxies and clusters of galaxies have indicated the presence of dark matter, gravitational lensing provides an independent probe of the large scale distribution of dark matter in the universe.

There are six known cases of gravitationally lensed quasars, and they are being discovered at a rate of one per year. As the sample of gravitational lenses grows, we begin to be able to study the properties of these objects as a group. Already the known cases raise some questions:

(1) Why do we observe such large image angular separations?
(2) Why do we always see an even number of images?
(3) Why do we observe brightness ratios so close to unity?
(4) Why do we detect the lens in only three (four?) out of six cases?
(5) Does the correlation between image brightness ratio and lens detection mean anything?

The observed properties could be at least partly due to (poorly-understood) observational selection effects. We wish to study the characteristics of gravitational lenses drawn from a well-defined sample of radio sources.

Our strategy is to (1) observe many (thousands!) of radio sources with the Very Large Array, selecting sources that exhibit multiple point structure; (2) observe the lens candidates optically, selecting sources with radio-optical counterparts; and (3) for these best candidates, carry out optical spectroscopy. Identical spectra will be evidence of gravitational lensing. 3172 radio sources from the MIT-Green Bank 5 GHz survey have been observed with the VLA. To date, 1362 of these sources have been examined for multiple point structure, and 160 appear to be promising gravitational lens candidates. The observations can resolve image angular separations as small as 0".3 and 1".0 in the VLA's A and B arrays, respectively. The range of image brightness ratios detectable is limited by the dynamic range of the maps produced, which in these snapshot observations is, at worst, 17 to 1.

Of the 160 gravitational lens candidates, 80 have been observed optically to approximately 24th magnitude in the R band. Eight sources display radio-optical counterparts. Some of these, of course, will be chance superpositions of radio and optical sources in the sky, but these eight sources are prime candidates for spectroscopic observations. So far, one gravitational lens, MG2016+112, has been found, and another triple radio source shows spectra consistent with the lensing hypothesis.

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