GALAXY MASS DISTRIBUTION FROM GALAXY-GALAXY GRAVITATIONAL LENSING

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The average gravitational lens distortion of background galaxy images by foreground galaxies is an independent, non-kinematical measurement of galaxy mass distribution M(r)/r (Tyson, et al. 1984). The upper limit we obtained for the equivalent circular velocity, while small compared with some heavy halo models, is consistent with dynamical estimates for samples of galaxies of all types (e.g. Turner's binary data and the Rubin, et al. rotation curves). For example, for a mean cutoff radius of 65 kpc/h, our 3σ upper limit for the equivalent circular velocity $(GM/r)^{\frac{1}{2}}$ = 190 km/sec. For a mass cutoff at 190 kpc/h our 2σ upper limit is 175 km/sec. If I weight a sample of asymptotical rotation curve velocities by recent field luminosity functions, I get mean circular velocities less than 170 km/sec.

Is it possible to improve on the accuracy of this coherent lens distortion technique? Statistical gravitational lens image distortion of background galaxy images about the positions of foreground galaxies is complicated by several low-level systematics. Limits to many systematics were found by substituting either random positions or stars for the "foreground" or "background" galaxies. I have re-examined 46,954 images of galaxies which are behind and within 30 arcsec of 11,789 foreground galaxies, using new techniques for correcting some small systematics. The two largest offenders are: (1) contamination of the background galaxy sample by foreground dwarf galaxies, and (2) light contamination from the foreground galaxy.

(1) The average magnitude of galaxies in our foreground sample is 20.75 J mag, and the background sample is 23.06 J mag. Thus, any physical companions of foreground galaxies, masquerading as background galaxies, have absolute magnitudes about 2 mag fainter than the average foreground galaxy in our sample. The cross-correlation $w_x(\theta)$ between these samples clearly reveals clustering of foreground dwarf galaxies, with an amplitude slightly less than we found in our original simulation. Thus, this effect does not change our conclusions regarding the average galaxy M(r).

(2) Fatal systematic errors occur when working within 4 arcsec of the foreground galaxy, due to its light. Up to now, we have avoided this region. I now have a program which fits the foreground galaxy's 2-d light profile, and subtracts it. This permits automated detection, moments and photometry of faint galaxies closer to the center of the foreground galaxy. Pending confirmation from simulated data, this may offer a much improved mass determination.

The limits for the mass distribution of an average field galaxy are consistent with our previous results, but are not consistent with the hypothesis that all galaxies have heavy halos corresponding to circular velocities over 180 km/sec extending beyond 80 kpc/h.

Tyson, A., Valdes, F., Jarvis, J., Mills, A., 1984, Ap.J. 281, L59

J. Kormendy and G. R. Knapp (eds.), Dark Matter in the Universe, 241.