ASTRONOMY FROM WIDE-FIELD IMAGING

Part Fifteen:

PROPERTIES AND CLUSTERING OF OBJECTS AT LARGE REDSHIFTS

QUASAR VARIABILITY FROM MICROLENSING

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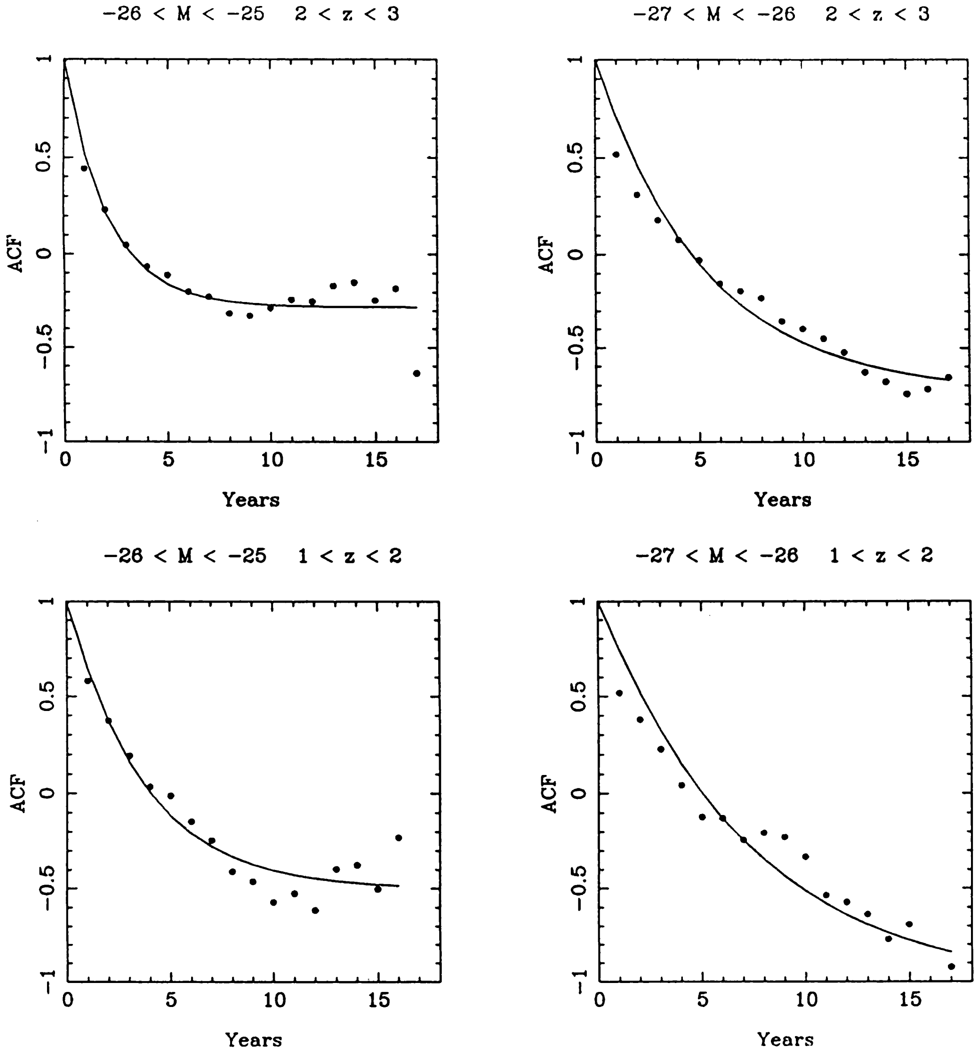
Over the past 17 years a large scale quasar monitoring programme has been underway at the Royal Observatory, Edinburgh, using COSMOS measures of a long sequence of plates from the UK 1.2 m Schmidt telescope in Australia. 3 or 4 plates were taken each year, and quasar candidates were selected solely on the basis of variability, with a minimum amplitude of 0.35 mag. over the 17 years of the survey. Of the 1000 or so quasars detected in this way, redshifts were available for about 300, which formed the sample to be investigated. Inspection of the light curves suggested a typical timescale of variation of around 5 to 10 years. To investigate the cause of variability, the timescales of subsamples were measured using the timevarying autocorrelation function (ACF).

Figure 1 shows data from the sample of quasars, binned in redshift and luminosity. Each ACF is fitted with an exponential function, shown as a solid line, enabling the timescale to be measured. This shows that for an increase in luminosity the timescale increases in both redshift bins, whereas for an increase in redshift the timescale actually decreases slightly. This is a remarkable result, as for any intrinsic variation in the quasar light time dilation should increase the observed timescale as redshift increases. It implies that the variation cannot be intrinsic to the quasars.

The idea that quasars may vary due to gravitational microlensing has been discussed for some time. Numerical simulations of microlensing by distribution of compact bodies produce light curves very similar to those observed in the quasar survey. This is not the case for most postulated mechanisms for intrinsic variation. An important aspect of variability from microlensing is that any time dilation effect would be at the redshift of the lensing object which would typically be quite small, and only indirectly connected with the redshift of the quasar itself. The increase in timescale with luminosity would come from the additional time a lensing object would take to cross the larger disk of a more luminous quasar.

If microlensing is the cause of variability, then from the timescale it is possible to deduce the typical mass of the microlensing objects. In the simplest case this is obtained by assuming a typical transverse velocity and using the timescale to estimate the extent of the gravitational lensing effect or Einstein radius, which is directly related to the mass. In the present instance the typical mass is around 0.001 solar masses. It is also possible to deduce the mass density needed to produce the microlensing effect. In this case, the fact that essentially every line of sight is microlensed implies a cosmological density of around unity in lensing objects.

H. T. MacGillivray et al. (eds.), Astronomy from Wide-Field Imaging, 721–722.



−26 < M < −25 2 < z < 3

−27 < M < −26 2 < z < 3

−26 < M < −25 1 < z < 2

−27 < M < −26 1 < z < 2

Figure 1.

The results of the survey thus imply that there is a population of compact Jupiter mass objects sufficient in numbers to make up the dark matter content of the Universe.