GRAVITATIONAL LENSING IN THE CLUMPY UNIVERSE

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Most of methods to determine the cosmological parameters by using the gravitational lensing are based on the following three typical observations; (1) the image separation, (2) the lensing statistics and (3) the time delay. For the accurate estimation of the cosmological parameter, it is of great importance to clarify the relation between the observation in the realistic universe and the determination of the cosmological parameters. In particular, it has been discussed by many authors that inhomogeneities of the universe may affect the cosmological tests.

Here, Dyer-Roeder (DR) angular diameter distance (Dyer and Roeder, 1972,1974) has been used in order to take account of the inhomogeneities. Besides the three parameters (the Hubble constant H_0, the density parameter Ω and the cosmological constant λ), the DR distance includes another parameter which represents the clumpiness of the matter along the line of sight. It is shown analytically (Asada, 1997a,1997b) that all three combinations of distances appearing in the above observations (1)-(3) are monotonic with respect to the clumpiness, for any given set of Ω, λ and redshifts of the lens and source. Some implications for the observation are also presented (Asada, 1997a,1997b); the clumpiness decreases both the image separation and the lensing event rate, while it increases the time delay. The latter means that the use of the DR distance never decreases the estimated H_0.

References

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