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Dark-Matter in Galaxies from Gravitational Lensing and Stellar Dynamics Studies

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Abstract. Strong gravitational lensing and stellar dynamics provide two complementary methods in the study of the mass distribution of dark matter in galaxies out to redshift of unity. They are particularly powerful in the determination of the total mass and the density profile of mass early-type galaxies on kpc to tens of kpc scales, and also reveal the presence of mass-substructure on sub-kpc scale. I will shortly discuss these topics in this review.

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In recent years, the combined study of early-type galaxies using stellar dynamics and gravitational lensing has born exiting and unique results on the density profile of early type galaxies to redshift of unity, showing that massive early-type galaxies are close to homologous, have total density profile close to isothermal and do not appreciably evolve in their ensemble properties (for example Treu & Koopmans (2004), Koopmans *et al.* (2009)). Neither through lensing alone, nor through dynamics would these results have been possible to obtain. This has become even more exciting in recent years through the discovery of nearly 100 new strong galaxy-scale lens systems in the SLACS survey, for example Bolton *et al.* (2008) and development of powerful modeling techniques that self-consistently combine these two methods, using HST imaging and IFU/Longslit spectroscopic data Barnabè & Koopmans (2007), Czoske *et al.* (2008), Barnabè *et al.* (2009).

A second exiting new development is the *imaging* of mass-substructure on sub-kpc scales in these galaxies using extended arcs and Einstein rings Vegetti & Koopmans (2009). Also this is now possible thanks to the typical extended and highly-magnified nature of the lensed images in SLACS systems. Because multiple images allow one to separate the source structure from the lens-potential structure, this provides a unique method to probe unseen structure in lenses from dwarf satellites to general deviations from simple symmetries. Recently, the first detection of a high M/L-ratio dwarf satellite was reported using this method. Detection (even non-detections) promise to be a unique avanue to study the low-mass end of the dwarf-satellite mass function and possibly even probe the nature of dark matter – Vegetti & Koopmans (2009).

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