STRONG AND WEAK GRAVITATIONAL LENSING AND ITS ASTROPHYSICAL AND COSMOLOGICAL APPLICATIONS

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Gravitational lensing is a powerful tool for studying astrophysical and cosmological properties of the Universe. In this dissertation a few applications of strong and weak gravitational lensing are presented.

Based on publicly available results from N-body Millennium Simulation the light propagation in the inhomogeneous cosmological model was simulated and shear maps at several redshifts were obtained. Using the Born approximation, the influence of haloes and background mass density on the tangential shear component was analysed. It was shown that the presence of a weak signal at large separations is caused by the large scale structure in matter distribution. The investigation of the relation between the shear peaks and the distribution of halo masses in their foregrounds showed the dependence of mass spectra on the shear value.

Millennium Simulation was used to create mock samples of lensed supernovae type Ia and core-collapse. Through the galaxy-galaxy lensing simulation rates of lensed supernovae were derived and the conclusion was reached that at redshifts higher that 0.5 about 0.06 per cent of supernovae will be lensed by a factor two or more. Future wide field surveys like Gaia or LSST should be able to detect lensed supernovae in their unbiased sky monitoring. Gaia (from 2013) should detect at least 2 cases whereas LSST (from 2018) will see more than 500 a year. The strong galaxy-galaxy lensing gives an opportunity to reach high-redshift supernovae type Ia and extend the Hubble diagram sample. However, these measurements cannot be expected to easily distinguish between different SFH functions.

Gravitational lensing is another method of extending surveys to potentially smaller and fainter galaxies and does not rely on extremely deep imaging. In strong lensing, a massive foreground galaxy deflects the light from a background object, resulting in multiple and magnified images. Here, the sample of gravitationally lensed galaxies, selected from the CASSOWARY catalogue, was studied. The multi-filter modelling was performed, which allowed to reconstruct the lens and source properties. The lensing potential was approximated with a singular isothermal ellipsoid with external shear. The Sérsic profile was used to describe lens and source light profile. The comparison between ellipticity of the stellar component to that of the mass model showed more scatter than in previous studies, likely caused by substructures. Moreover, there were shown other correlations between profiles' parameters. More extended study is necessary.