Publ. Astron. Obs. Belgrade No. 86 (2009), 395 *PhD thesis*

GRAVITATIONAL MICROLENSING INFLUENCE ON X-RAY RADIATION FROM ACCRETION DISK OF ACTIVE GALAXIES

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Abstract. The aim of this thesis was to investigate the influence of gravitational microlensing on detected X-ray radiation from accretion disks of active galactic nuclei (AGN). More precisely, the variations of the Fe Kα spectral line and X-ray continuum caused by gravitational microlensing were analyzed, as well as the corresponding time scales and microlensing optical depth (i.e. the probability to observe these effects).

The initial assumption was the existence of a super massive black hole ($10^7 - 10^9\ M_\odot$), surrounded by an accretion disk that radiates in X-rays, in the center of all types of AGN. Accretion disks could have different forms, dimensions and emission, depending on the type of central black hole, being rotating (Kerr metric) or non-rotating (Schwarzschild metric). Except for effects due to disk instability, its emission could also be affected by gravitational microlensing, especially in the case of the gravitationally lensed quasars. The disk emission was analyzed using numerical simulations based on a ray-tracing method in a Kerr metric, taking into account only those photon trajectories which reach the observer's sky plane. The influence of microlensing on a standard accretion disk was studied using three different microlensing models: point-like microlens, straight-fold caustic and quadruple microlens (microlensing pattern).

The main results of the thesis are: a) gravitational microlensing can produce significant variations and amplifications of the line and continuum fluxes, b) even very small mass objects could produce noticeable changes in the Fe Kα line profile due to small dimensions of the X-ray emitting region, c) microlensing hypothesis can satisfactorily explain the excess in the iron line emission observed in some gravitational lensed quasars, d) the Fe Kα line and X-ray continuum amplification due to microlensing can be significantly larger than the corresponding effects on optical and UV emission lines and continua, e) the optical depth for microlensing by compact objects from the bulge/halo of the host galaxy is very small ($\tau \sim 10^{-4}$), while the optical depth for microlensing by cosmologically distributed deflectors could be significant ($\tau \sim 0.01 - 0.1$) and its maximum ($\tau \sim 0.1$) could be expected if dark matter forms cosmologically distributed compact objects, f) although gravitational microlensing is an achromatic effect, it can induce wavelength dependent variations of the X-ray continuum of $\sim 30\%$ due to the radial distribution of temperature in an accretion disk and g) the variations of the X-ray continuum are the fastest ($\sim$ several months) in comparison to the variations of the optical and UV continua, which are weaker and much slower ($\sim$ several years).

The results obtained in this thesis show that gravitational microlensing is a very useful tool for investigating the innermost parts of active galaxies, particularly the relativistic accretion disks around their central supermassive black holes. Therefore, monitoring of gravitational microlenses in the X-ray spectral range may help us to understand the physics and to reveal the structure of the central parts of active galaxies.