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Accretion disk parameters estimations in the Einstein Cross system Using chromatic microlensing from X-Shooter spectra and multi-Epoch photometry

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We present the estimation of the accretion disk temperature profile and size (p and r_s) for the QSO2237+0305 gravitational lens system. These estimates are done by measuring the magnitude differences produced by chromatic microlensing at different wavelengths and by assuming a thin accretion disk model (Shakura & Sunyaev, 1973).

At present, there are nearly 220 gravitational lens systems discovered and confirmed with different techniques. However, only in a fraction of them have chromatic microlensing and, thus, are suitable to estimate their internal structure with this technique.

QSO2237+0305 (the "Einstein Cross" gravitational lens system, Huchra et al. (1985)) has four quasar images that form in the bulge of a spiral galaxy ($z_s = 1.695$, $z_l = 0.039$). These images are susceptible of microlensing by stars. We analyzed spectra from VLT/X-Shooter and compared photometric data from CASTLES[1] database Falco et al. (1999) and Mosquera et al. (2009). The spectra of each quasar image show several prominent emission lines (Ly-α, CIV, CIII], MgII, Hβ and Hα) and continuum emission from the accretion disk. As the narrow line region (NLR) is larger than the accretion disk, is not affected by microlensing (contrary to the continuum). Thus, we used the flux integrated in the narrow emission lines (NELs) as a baseline of no microlensing. We measured the magnitudes difference (MD) as $m_A - m_B = -2.5 \times Log(F_A/F_B)$ between the flux in the NELs (and continuum) for each pair of images. We observed chromatic when continuum MD in the bluest part of the spectra is larger than in the reddest part respect to the NELs MD (Motta et al., 2017). We selected three representative wavelength of the spectra (in λ327 nm; λ516 nm; λ754 nm) to measure the slope of the chromatic microlensing.

[1]CfA-Arizona Space Telescope Lens Survey.

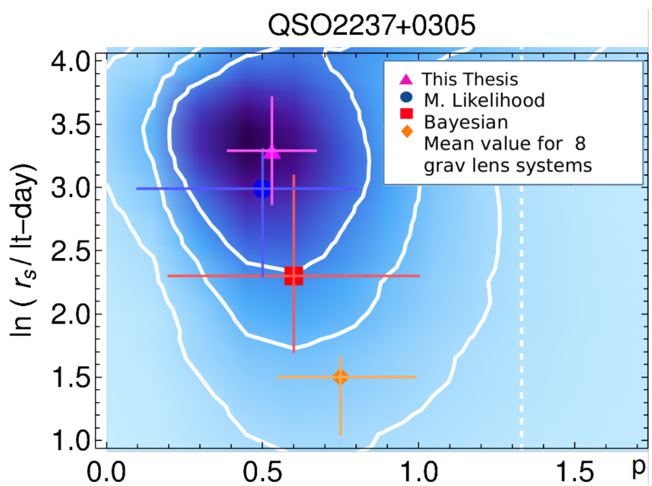

Figure 1. PDFs of the p and r_s parameters. White contours are the confidence level at 0.5σ, 1σ, 1.5σ y 2σ, respectively. White dashed line is the Shakura & Sunyaev disk model, with $p = 4/3$.

We use the inverse polygon mapping method (Mediavilla et al., 2006) to simulate the microlensing magnification using the properties of the matter distribution of the lens galaxy (obtained from the lens model). By convolving our disk model at three different rest-frame wavelength (with λ reference 1026 Å) and varying the accretion disk parameters (p and r_s, with $r_s \propto \lambda^p$) we have estimated the likelihood of reproducing the observed MD. The probability density functions of the accretion disk parameters at 1σ shows a maximum when $r_s = 26.8^{+14.1}_{-9.2}\sqrt{0.3M/M_\odot}$ ld-day and $p = 0.53 \pm 0.14$. Our results are in good agreement with previous research (Jiménez-Vicente et al., 2014).

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