MICROLENSING OF POLARIZED LIGHT OF THE GRAVITATIONAL LENS J1004+4112

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MOTIVATION

Here we present new spectroscopic and polarimetric observations of the lensed quasar SDSS J1004+4112, a four image system with source redshift zs=1.734 and lens redshift zl=0.58. This system exhibits an unusually large separation between images of even 15". SDSS J1004+4112 is also interesting because of the variability of the broad emission lines in component A. The variability is observed in the blue wing of CIV and is not observed in the continuum or in the low-ionization lines (for more details, see Popović et al. 2020). Spectra of the four images were taken in 2007, 2008, and 2018 (see Fig. 1), and the polarization parameters were obtained in the period 2014-2017 (see Fig. 2).

METHODS

We carried out spectropolarimetric observations with 6m telescope of SAO RAS (Speceial astrophysical observatory of the Russian Academy of sciences) using modified version of the SCORPIO spectrograph (Afanasiev & Moiseev 2005, 2011). Data reduction, correction for the interstellar polarization and the polarization parameters was done in the same way as described by Afanasiev & Amirkhanyan (2012). Magnification map (Fig. 3) was calculated using the Inverse Polygon Mapping method (Mediavilla et al. 2006, 2011) To simulate equatorial scattering in the inner part of the torus, we apply the 3D Monte Carlo radiative code STOKES (Goosmann & Gaskell 2007).

RESULTS

We find that a blue enhancement in the CIV line wings affects component A in all three epochs. We also find that the UV continuum of component D was amplified in the period 2007-2008, and that the red wings of CIII] and CIV appear brighter in D than in the other three components. We report significant changes in the polarization parameters of image D, which can be explained by microlensing. Our simulations of equatorial scattering region in the dusty torus can qualitatively explain the observed changes in the polarization degree and angle of image D. We do not detect significant variability in the polarization parameters of the other images (A, B and C), although the averaged values of the polarization degree and angle are different for the different images (see Fig. 2). Microlensing of a broad line region model including a compact outflowing component can qualitatively explain the CIV blue wing enhancement (and variation) in component A (see Fig. 4). However, to confirm this hypothesis, we need additional spectroscopic observations in the future. More detailed results and discussion is given in Popović et al. 2020, 634, A27, pp.16)

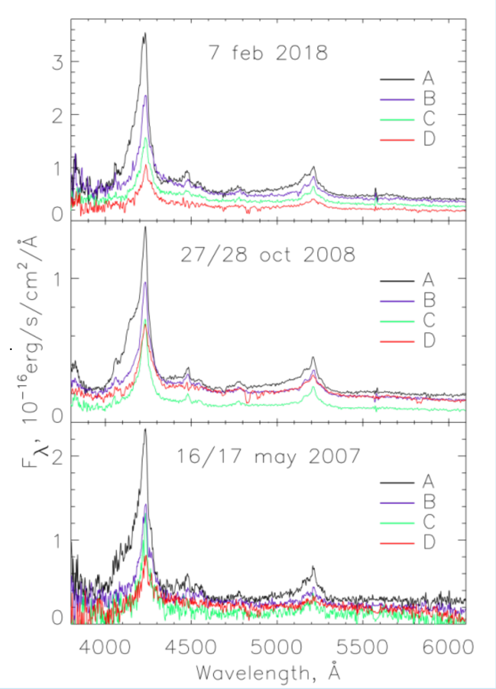

Figure 1. Spectra of the four components corresponding to three epochs: 2007. (bottom), 2008. (middle) and 2018. (up).

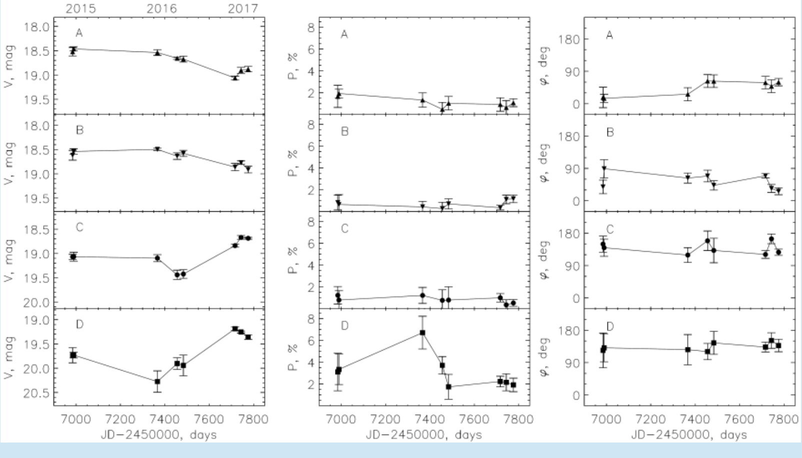

Figure 2. Spectra of the four components corresponding to three epochs: 2007. (bottom), 2008. (middle) and 2018. (up).

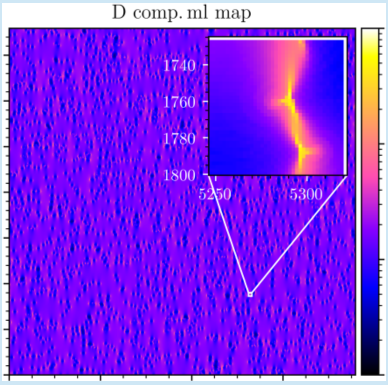

Figure 3. Microlensing magnification map of image D of the gravitational lens system SDSS J1004+4112

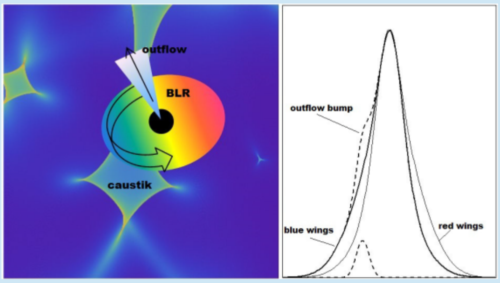

Figure 4. Scheme of caustic crossing of the compact jet-like region (left) which emits a small contribution to the blue wing of the CIV line (right).