The variability and periods in the BL Lac AO 0235+164

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Abstract. Variability is one of the extreme observational properties of BL Lacertae objects. AO 0235+164 is a well studied BL Lac through the whole electro-magnetic wavebands, it is violently variable in the optical bands. In the present work, we show its optical R band photometric observations carried out during the period of Nov. 2006 to Dec. 2012 using the Ap6E CCD camera attached to the primary focus of the 70 cm meniscus telescope at Abastumani Observatory, Georgia. It shows a large variation of $\Delta R = 4.88$ mag (14.20 - 19.08 mag) during our monitoring period. When periodicity analysis methods are adopted to its R observations from our Abastumani monitoring programme and those in the literature, the signs of some periods, $P_1 = 8.26$ yr, $P_2 = 0.55$ yr, $P_3 = 0.85$ yr, $P_4 = 1.99$ yr are found.

Keywords. galaxies: BL Lacertae Objects: individual (AO 0235+164): photometry

1. Introduction

The BL Lac AO 0235+164, located at $z = 0.94$ is a well studied object. It is observed from radio to X-rays bands, and even high energy $\gamma$-ray regimes. It shows variability timescale from a few days to several years (Webb et al. 1998, Romero et al. 2000, Chen & Jiang 2001, Fan et al. 2002, Peng & de Bruyn 2004, Gupta et al. 2008, Rani et al. 2009, and Wang 2014). Raiteri et al. (2001) analyzed about 25 years of observational data in optical and radio bands during the period from 1975 to 2000, and found a quasi-periodicity of the main radio (and optical) outbursts on 5.7 years time scale. Periodicity analysis is also performed to its light curves by us (Fan et al. 2002; Wang 2014). The long-term quasi-period in the light curve perhaps suggests existence of a binary black hole system at its center (Romero et al. 2003; Ostorero, Villata & Raiteri 2004). AO 0235+164 is one of the monitored objects in our monitoring programme at Abastumani Observatory, Georgia (Kurtanidze et al. 2009, Nikolashvili & Kurtanidze 2007 and Fan et al. 2014).

2. Observations and results

Abastumani Observatory is located at the top of Mt. Kanobili in the South-Western part of Georgia. Observations are made using a 70 cm meniscus telescope ($f/3$), to which a Peltier cooled ST-6 CCD imaging camera was attached to the Newtonian focus from March 1997 to Sept 2006. All our observations are made using the filters combined of
glasses. Those filters matched with the standard B, V (Johnson), $R_C$ and $I_C$ (Cousins) passbands.

**Variation:** The magnitude determinations is described in our recent paper (Fan et al. 2014). The photometry results indicate the largest variation of 4.88 mag from $R = 14.20$ to $R = 19.08$ mag.

**Periodicity Analysis:** We performed a Power Spectral Analysis (PSA, or Fourier Analysis, or power-density spectrum analysis) to detect possible harmonic components, and gives some quantitative criterion for the detection of a possible periodic signal as we did in our previous papers (Fan et al. 2006; Fan et al. 2014). Our results show periods: $P_1 = 8.26$ yr, $P_2 = 0.55$ yr, $P_3 = 0.85$ yr, $P_4 = 1.99$ yr; see Fig. 1.

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**References**

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