Intra-night optical monitoring of a sample of broad absorption line quasars: first results

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Abstract. We present preliminary results from the intra-night optical monitoring of a sample of broad absorption line quasars. We discuss the results for PG 1552+085. It didn't show intra-night optical variability during our monitoring.
Key words: quasars: individual (PG 1552+085) – techniques: photometric

Introduction

Variability has proven to be an effective diagnostic tool for the physical processes responsible for the activity in galactic nuclei. Quasars – the most luminous active galactic nuclei – have been recognized as optically variable since their discovery, varying on time scales from hours to years. The intra-night optical variability (INOV), intrinsic to radio-loud quasars, is rare in the radio-quiet ones.

For about 15 % of the quasars very broad absorption lines are found at redshifts slightly below the corresponding emission lines. The absorption lines are believed to originate from outflowing material in the quasar. The bulk of these broad absorption line quasars (BALQs) are radio-quiet (Schneider 2006). There has been a lack of systematic intra-night optical monitoring of BALQs till very recently (see Joshi et al. 2011). Carini et al. (2007) pointed out the higher percentage of INOV detections in BALQs than in the other radio-quiet AGNs in their sample (see also Anupama & Chokshi 1998).

To obtain the INOV characteristics of BALQs, and, in particular, the incidence of variability detections relative to the other radio-quiet AGNs, as well as their duty cycle[1], we undertook an intra-night optical monitoring programme of a sample of BALQs. Here we present first results for PG 1552+085.

1 PG 1552+085 ($z = 0.118874$, $r_{\rm SDSS} = 15\overset{\rm m}{.}78$)

The intra-night optical monitoring of this radio-quiet (Kellermann et al. 1994) BALQ (Turnshek et al. 1997) was performed on April 24$^{\rm th}$, 2009, with the 1340×1300 Princeton Instruments VersArray:1300B CCD camera attached to the 2-m telescope (with a scale of $0\overset{''}{.}258$/px) of the Rozhen National Astronomical Observatory (NAO), Bulgaria. The duration of the monitoring was 2.47 hours through Cousins R filter; we collected a total of 46 data points with typical exposure times 150 – 200 s. The median $FWHM$ is $1\overset{''}{.}16$ (with a standard deviation about the median of $0\overset{''}{.}13$). The target was observed at

[1] Duty cycle is the fraction of time when an object displays intra-night variability (Romero et al. 1999).

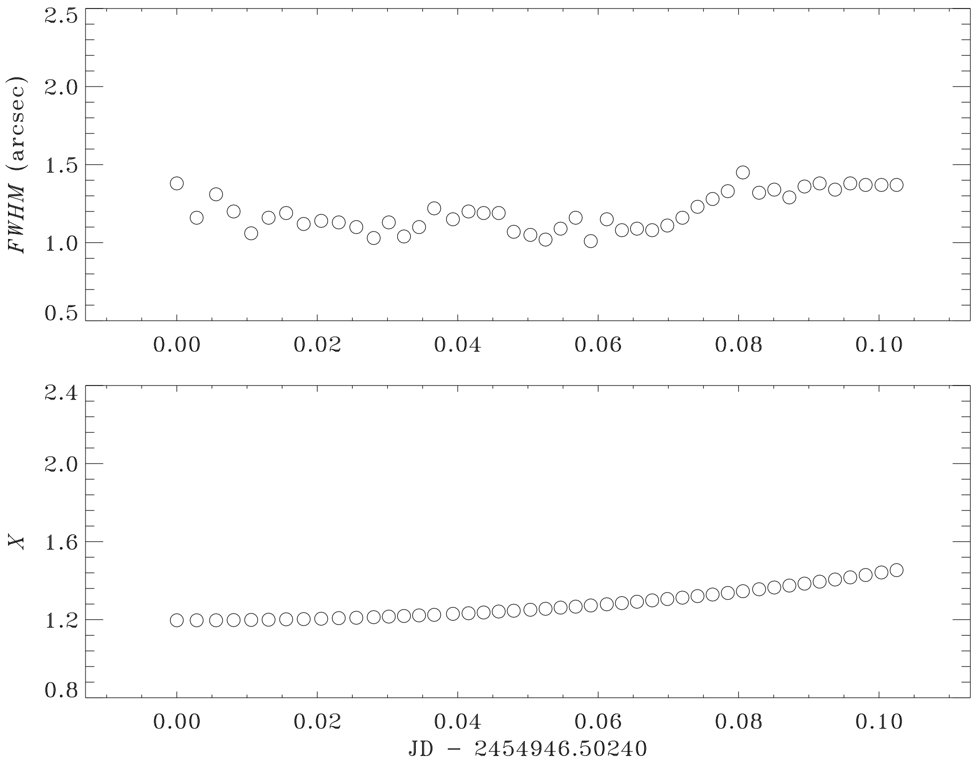

Fig. 1. Seeing and airmass distribution during the intra-night monitoring.

airmass ranging from 1.197 to 1.454. The $FWHM$ and airmass distribution is shown in Fig. 1.

We selected 5 reference stars (denoted as R1 – R5 in Fig. 2) and a control one (marked as C) in the field of PG 1552+085 (marked as T). The reference stars were chosen to be bright, while the control star – with brightness close to that of the target. Neither the reference stars, nor the control one coincide with known variable stars according to SIMBAD. Flux measurements were performed using DAOPHOT package (Stetson 1987) run under IDL 7. The aperture radius was picked up as $2 \times FWHM$ for each frame.

We estimated the ensemble magnitude, $m_{\rm ens}$, of the reference stars adding up the individual stellar fluxes. The differential light curves (DLCs) of the target, $m_{\rm T} - m_{\rm ens}$, and control star, $m_{\rm C} - m_{\rm ens}$, with respect to the ensemble magnitude are shown in Fig. 3. Both DLCs were found to correlate neither with the seeing, nor with the airmass variations. The weighted standard deviation about the weighted mean is $0\overset{\rm m}{.}005$ for the target DLC and $0\overset{\rm m}{.}006$ for the control star DLC. We performed F-test to search for INOV of the target

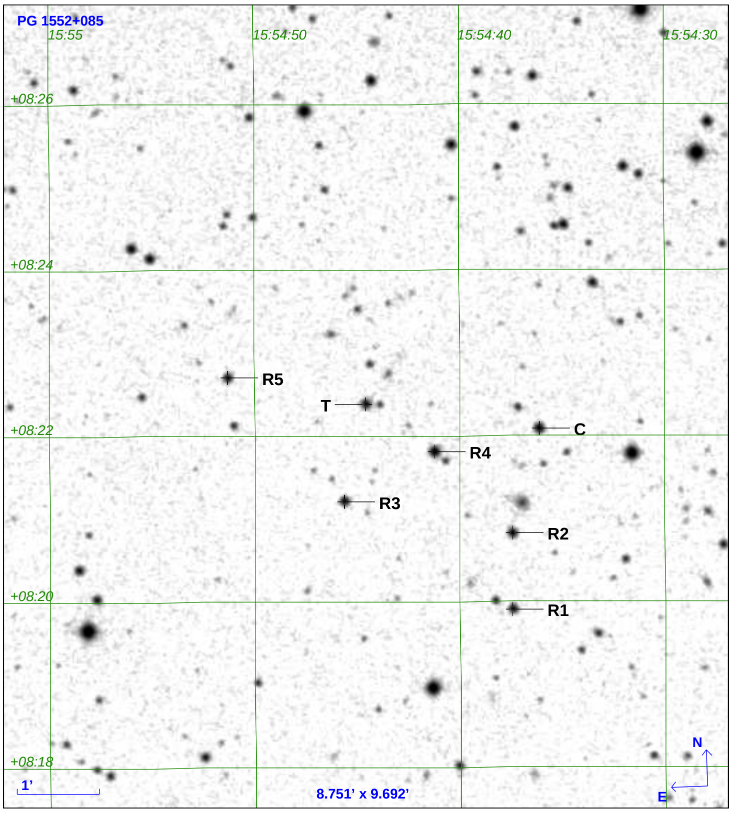

Fig. 2. Finding chart for PG 1552+085 (T), control star (C), and reference stars (R1–R5), numbered in order of increasing declination.

following Howell et al. (1988):

$$F_{\rm test} = \frac{\sigma^2_{\rm T-ens}}{\Gamma^2 \sigma^2_{\rm C-ens}},$$

where $\sigma^2_{\rm T-ens}/\sigma^2_{\rm C-ens}$ is the variance of the target/control star DLC and the Γ^2 factor accounts for the different brightness of the target and control star (see Howell et al. 1988). To reject the null hypothesis (stating that the target is not variable) at the confidence level $\alpha = 0.05$, we must have $F_{\rm test} > F_{\rm crit}(1-\alpha; n_{\rm T}-1; n_{\rm C}-1)$, where $n_{\rm T}$ and $n_{\rm C}$ are the number of data points of the target and control star DLCs, respectively. We got $F_{\rm test} = 0.884$, which is less than the corresponding critical value, $F_{\rm crit}(0.95; 45; 45) = 1.642$. Therefore, PG 1552+085 does not show INOV. We found no intra-night optical monitoring data for it in the literature. Therefore, to estimate a reliable duty cycle of this BALQ, more observations are needed.

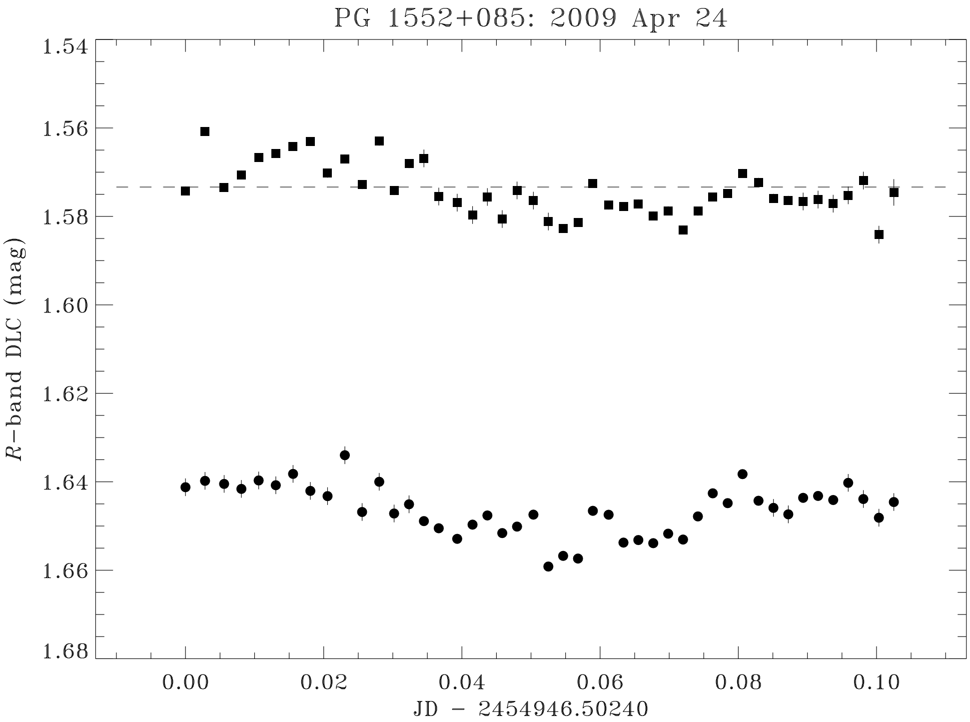

Fig. 3. DLCs of the target (filled circles) and control star (filled squares). The dashed line marks the weighted mean value of the control star DLC.

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