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Spectral Variability of Quasar SDSS J030639.57 + 000343.1

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Abstract. In a sample of 60 quasars selected from the Sloan Digital Sky Survey (SDSS) with at least six-epoch spectroscopy, we investigated the variability of emission lines and continuum luminosity. In this paper, we present the results of SDSS J030639.57 + 000343.1. We found a strong anticorrelation between the continuum luminosity at 5100 Å and the spectral index, implying a bluer-when-brighter trend. The luminosity of the broad H_α line is in proportion to the continuum luminosity at 5100 Å. Correspondingly, we did not find a strong correlation between the equivalent width of broad H_α and the continuum luminosity, i.e. no Baldwin effect of broad H_α in this source.

Key words. Galaxies: active—galaxies: individual: SDSS J030639.57 + 000343.1—techniques: spectroscopic.

1. Introduction

Quasars are one kind of powerful active galactic nuclei (AGNs), characterized by strong and rapid variability (Schmidt 1969). There are extensive investigations on the continuum variability, especially in radio-loud AGNs (e.g., Fan *et al*. 1998; Ghosh *et al*. 2000; Gu & Ai 2011a, b). Two trends of colour variation have been found. The bluer-when-brighter trend (BWB) was commonly found in blazars as well as in radio quiet AGNs (e.g., Wu *et al*. 2005; Gu & Ai 2011a, b). However, the redder-when-brighter trend (RWB) has also been found (e.g., Gu *et al*. 2006; Bian *et al*. 2012).

From the multi-epoch spectra, the variabilities of the broad emission lines luminosity and spectral shape can be explored. However, only few works have been done on optical variabilities using multi-epoch spectroscopy. The variability of C IV lines has been studied for a sample of 105 quasars at two epochs (Wilhite *et al*. 2006). Recently, the spectral variability of FIRST bright quasars was investigated using SDSS spectra (Bian *et al*. 2012). We have compiled a large sample from SDSS with multi-epoch spectroscopy. As a first step, the spectral variability was explored for a sample with ≥6 epochs spectroscopy. In this paper, we present the results of SDSS J030639.57 + 000343.1.

2. Sample

We selected 7,063 quasars having spectra on at least two epochs from 105,783 SDSS DR7 quasars in Shen *et al.* (2011). As the first of series papers, we present in this work the results of 60 quasars with at least six-epoch spectroscopic observations. The redshift covers from 0.08 to 3.78 for these 60 objects. Following Chen *et al.* (2009), the spectra was first corrected for the galactic extinction, and then transferred to the rest frame. The continuum was fitted with a power law, and the optical and UV Fe II features and the Balmer continuum were considered.

SDSS J030639.57 + 000343.1 ($z = 0.107$) has been observed spectroscopically nine times in SDSS. The spectra is shown in Fig. 1. We fitted two bright emission lines (H_α, H_β) each with two gaussians, one for the broad component and the other for the narrow component. Shen *et al.* (2011) estimated the black hole mass $M_{\rm bh} = 10^{7.51\pm0.13} M_\odot$, and the Eddington ratio $L_{\rm bol}/L_{\rm Edd} = 0.24$. The radio loudness $R = f_{6\,\rm cm}/f_{2500\,\text{Å}}$ is given as 5.32, where $f_{6\,\rm cm}$ and $f_{2500\,\text{Å}}$ are the flux density at 6 cm and 2500 Å at the rest frame, respectively. Therefore, the source is likely to be a radio intermediate quasar, and the jet emission may not severely contaminate the optical continuum emission.

3. Results

We found a strong anti-correlation between the continuum luminosity at 5100 Å and spectral index α_λ ($f_\lambda \propto \lambda^{\alpha_\lambda}$) with the Spearman rank correlation ($r = -0.85$ at 99.7% confidence level) (Fig. 2a). This implies that the source relates to a bluer-when-brighter trend, which is commonly found in our sample. A significant correlation was also found between the continuum luminosity at 5100 Å and broad H_α luminosity with $r = 0.867$ at confidence level of 99.7% (Fig. 2b). A linear fit shows $\log L_{\rm H\alpha} = (1.03 \pm 0.13) \log(\lambda L_{\lambda,5100\,\text{Å}}) - (2.83 \pm 5.81)$. Consistent with this linear relation, we did not find any significant correlation between the equivalent width of the broad H_α and 5100 Å continuum luminosity, i.e. no Baldwin effect of broad H_α in this source

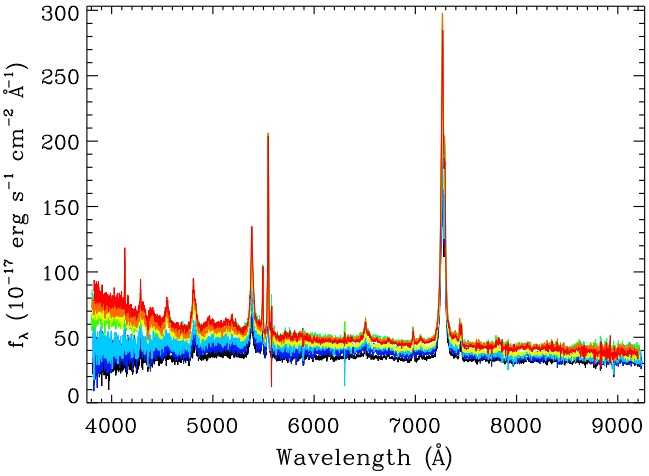

Figure 1. The spectra of SDSS J030639.57 + 000343.1 ($z = 0.107$) at nine epochs in the observed frame after extinction correction.

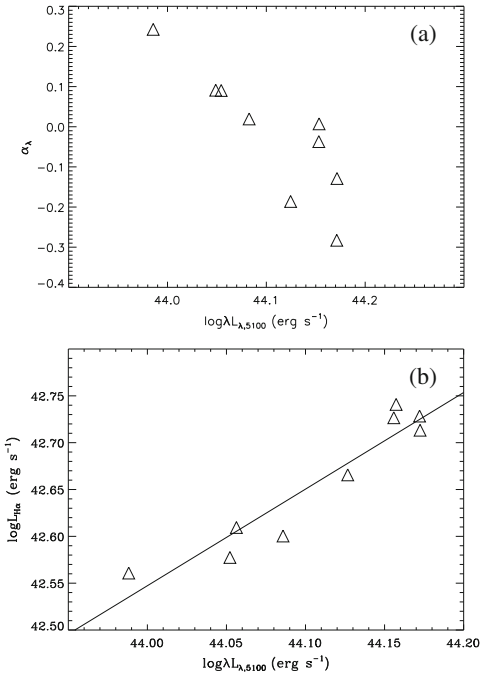

Figure 2. (**a**) The spectral index vs. the continuum luminosity at 5100 Å at nine epochs. (**b**) The continuum luminosity at 5100 Å vs. broad H_α luminosity at nine epochs. The solid line is the linear fit.

was found. We found similar results for broad H_β. The comprehensive investigations on our whole sample will be presented in a forthcoming paper (Guo & Gu 2014).

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