J. Astrophys. Astr. (2011) **32,** 277–280

Identification of MgII Absorption Line Systems from SDSS Quasar Catalogue

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1. Motivation

The quasar absorption lines are crucial to our understanding of the Universe since the absorption lines provide a wealth of information on the gaseous Universe from high redshift to present day. The absorption lines can also allow us to probe the metallicity and ionization state of the gas (Wild *et al.* 2008). Owing to the advent of large spectroscopic surveys such as the Sloan Digital Sky Survey (SDSS; York *et al.* 2000), tens of thousands of quasar absorption lines can be identified. However, it is very difficult to identify absorption line systems, especially for the weak absorption line system and the spectrum of low signal-to-noise ratio. In the most previous works, the identification of absorption line systems were mainly completed by two steps: estimating the continuum using the principal component analysis (PCA) and auto-identifying the absorption line systems by computer programs (see, e.g., Lundgren *et al.* 2009). In this work, we provide our method for identifying the MgII absorption line systems.

2. Spectral analysis

In the first step, the SDSS spectra are corrected for the Galactic extinction using the reddening map of Schlegel *et al.* (1998) and then shifted to its rest wavelength. In order to measure line parameters reliably, we choose those wavelength ranges as pseudo-continua, which are not affected by prominent emission lines and broad absorption lines, and then decompose the spectra into the following two components.

2.1 *A power-law continuum to describe the emission from the active nucleus*

The 11 line-free spectral regions are firstly selected from SDSS spectra covering 1140 Å to 4230 Å, namely, 1140 –1150 Å, 1275 –1280 Å, 1320 –C1330 Å, 1455 – 1470 Å, 1690 –1700 Å, 2160 –2180 Å, 2225 –2250 Å, 3010 –3040 Å, 3240 –3270 Å, 3790 –C3810 Å, 4210 –C4230 Å (Forster *et al.* 2001; Vanden Berk *et al.* 2001). From these spectral regions, the initial power-law are obtained for each source.

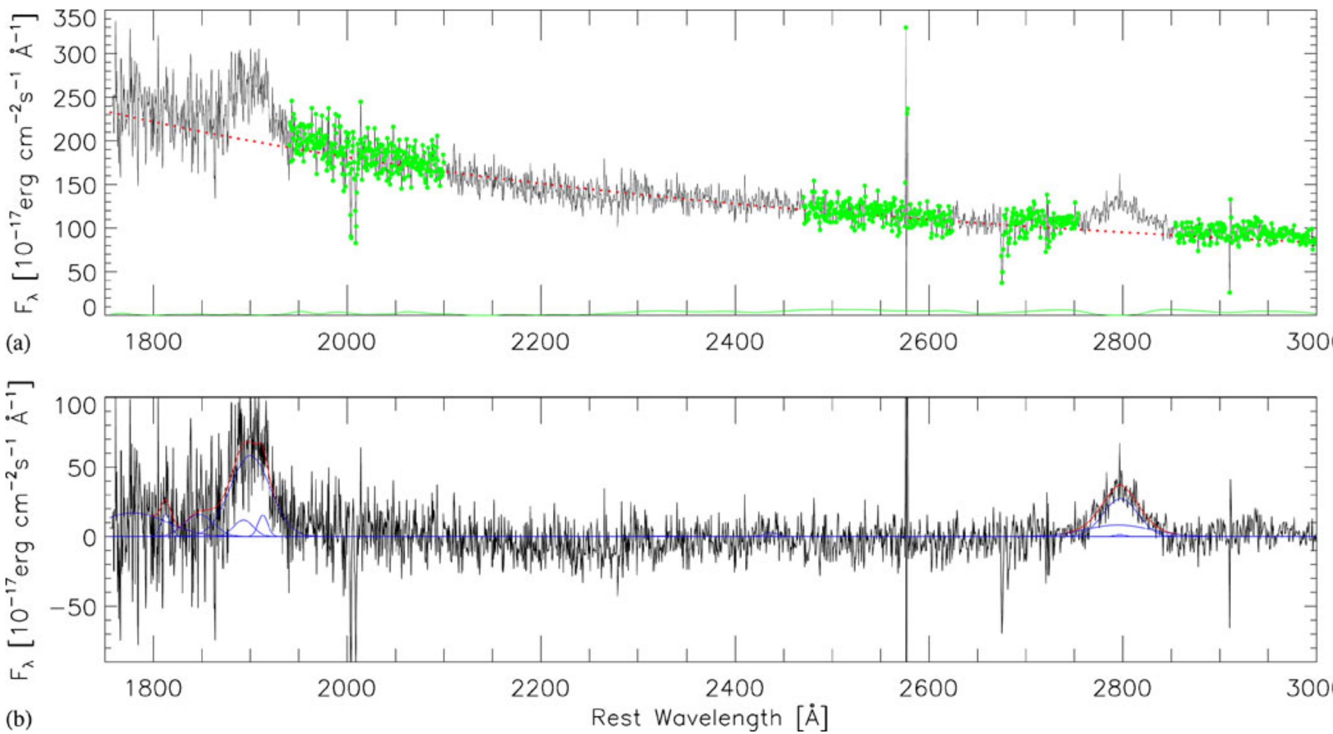

Figure 1. spSpec-52375-0620-226: (**a**) Black line is the original spectrum, the dotted line represents the power-law continuum, and the green spectral region in the spectrum is used to fit Fe II emission, and the bottom green line is Fe II emission (which is insignificant in this plot). (**b**) The black line is the continuum-subtracted and Fe II-subtracted spectrum, the blue lines are the individual emission line components in multi-line spectral fitting, and the red line is the integrated emission lines fitting.

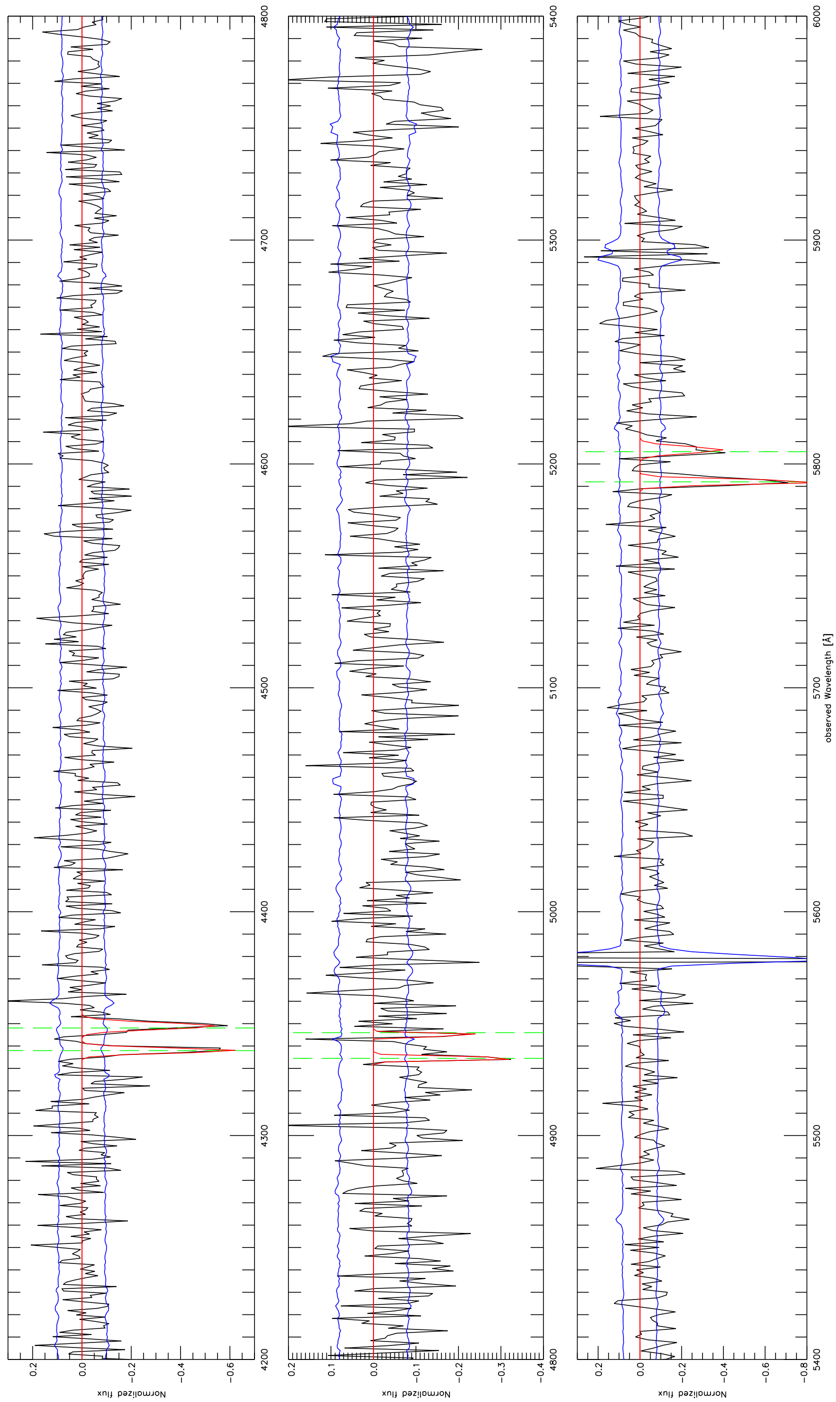

Figure 2. spSpec-52375-0620-226: In each panel, the black line and blue line are the normalized residual spectra and error, respectively, and the red Gaussian fitting lines are the identified MgII absorption line systems with absorption line redshift 0.5515, 0.7648 and 1.0715 from the top to the bottom, respectively.

2.2 *An Fe II template*

The SDSS spectra covers UV and optical regions, therefore, we adopt the UV Fe II template from Vestergaard & Wilkes (2001), and the optical one from Véron-Cetty *et al.* (2004). And then we connect the UV and optical templates into one template covering the whole spectra (see Hu *et al.* 2008; Chen *et al.* 2009). In the fitting process, we assume that Fe II has similar profile as the broad emission lines.

The fitting of these two components is performed with the least-square method. The final multicomponent fitting curve is then subtracted from the observed spectrum. As an example, the fitted power-law, Fe II lines, and the residual spectra are illustrated in Fig. 1. According to Vestergaard & Wilkes (2001), Kim *et al.* (2006) and Chen *et al.* (2009), the Fe II fitting windows are selected as the regions with prominent Fe II line emission and with no other strong emission lines.

The emission lines are measured from the continuum and Fe II subtracted spectra and fitted with one or more Gaussians using the least-square method. And then the emission lines are subtracted from the residual spectra. The example of the fitting of the emission lines is shown in Fig. 1 as well.

In the next step, the residual spectra and error in flux are normalized by the fitted continuum, and the normalized spectra are used to identify the MgII absorption line systems. An example of normalized spectra and error in flux is shown in Fig. 2. The identification of MgII absorption line systems requires the detection of the $\lambda 2796$ line and at least one additional line, the most convenient line being the $\lambda 2803$. We fit the doublet with two Gaussian. The MgII absorber candidates are found by eyes. When the detective level of absorber is smaller than 5-sigma, it is considered as false candidate and is removed. The example of the fitting is shown in Fig. 2 as well.

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