SPECTRAL MONITORING OF AGNs:
PRELIMINARY RESULTS FOR Ark 564 AND Arp 102B

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Abstract. We present preliminary results of the long term spectral monitoring of two active galactic nuclei with different broad line shapes: Ark 564 and Arp 102B. Ark 564 is a bright nearby narrow line Syfert 1 (NLS1) galaxy with relatively narrow permitted optical emission lines and a high FeII/ Hβ ratio, while Arp 102B is a nearby broad-line radio galaxy with broad double-peaked Balmer emission lines. The spectra of Ark 564 were observed during 11-year period (1999-2009) and the spectra of Arp 102B in the 12-year period (1998-2009), with SAO 6-m and 1-m telescopes (Russia) and the GHAO 2.1-m telescope (Cananea, Mexico).

Key words: galaxies: active / quasars: individual: Ark 564, Arp 102B / line: profiles

1. INTRODUCTION

Active galactic nuclei (AGN) often exhibit variability in the broad emission lines. In spite of many papers devoted to the physical properties (physics and geometry, see e.g. Sulentic et al. 2000) of the broad line region (BLR) in AGN, the true nature of the BLR is not completely revealed. The broad emission lines (BEL), can give us many information about the BLR geometry and physics. Especially the variability in the BEL profiles and intensities could be used for investigating the BLR nature.

A long-term spectral monitoring of the nucleus of some AGN has revealed a time lag in the response of the broad emission lines relative to flux changes in the continuum (e.g. Wanders and Peterson 1996, Kollatschny and Dietrich 1997). This lag depends on the size, geometry, and physical conditions of the
BLR. Thus, the search for correlations between the nuclear continuum changes and flux variations in the broad emission lines may serve as a tool for mapping the geometrical and dynamical structure of the BLR (see e.g. Peterson 1993, and reference therein). During the past decade, the study of the BLR in some objects has achieved considerable success, mainly because of the increasing number of coordinated multiwavelength monitoring campaigns through the international AGN Watch campaign (see e.g., Peterson 1999). In several papers, we presented results of our long term monitoring of NGC4151, NGC5548, and 3C390.3 (see Table 1). However, in this paper we present the preliminary analysis of the spectral monitoring of Ark 564 and Arp 102B during periods 1999-2009 and 1998-2009, respectively.

| Object name | Period [years] | z | $R_{H\beta}$ [ld] | Spectral characteristics | AGN type | Reference |
|-------------|----------------|---|-----------------|--------------------------|----------|-----------|
| NGC 4151    | 1996-2006      | 0.0033 | 1-50           | CST Sy. 1.5-1.8           | Shapovalova et al. 2008, 2010a |
| NGC 5548    | 1996-2004      | 0.0172 | 6-26           | CST Sy. 1.0-1.8           | Peterson et al. 2002, Shapovalova et al. 2004 |
| 3C 390.3    | 1995-2007      | 0.0561 | 35-100         | DPL RL QSO               | Shapovalova et al. 2010b, Popović et al. 2011 |
| Arp 102B    | 1998-2009      | 0.0242 | DPL RL QSO     | in prep                   | Jovanović et al. 2010 |
| Ark 564     | 1999-2009      | 0.0247 | strong Fe II NLy1 | in prep                   | |

Spectral monitoring was carried out at the 6-m and 1-m telescopes of SAO RAS and at the 2.1-m telescope of INAOE (Cananea, Mexico). Observations were fulfilled with long-slit spectrographs equipped with a CCD. The spectral range was 4000-8000 Å, the resolution 3-15 Å, and the S/N>50 in the continuum near the Hα and Hβ lines. For details on data acquisitions, data reduction and calibration see Shapovalova et al. (2008, 2010b).

2. PRELIMINARY RESULTS FOR Ark 564 and Arp 102B

Ark 564 was the object of one of the most intensive broad-band reverberation mapping programs undertaken to date, which aimed to determine the nature of the relationship between X-ray and UV-optical continuum variations and thus obtain an estimate of the BLR size and virial mass of the central source. Ark 564 was observed by ASCA (Pounds et al. 2001, Edelson et al. 2002), Hubble Space Telescope (Collier et al. 2001, Crenshaw et al. 2002) and from many ground based observatories as part of an International AGN Watch project (1998 Nov to 2001 Jan, Shenmer et al. 2001). Ark 564 has shown a strong associated UV absorber (Cranshaw et al. 1999). There are indications that it also possesses a warm X-ray absorber, as seen by the absorption lines of OVII and OVIII detected in a Chandra spectrum (Matsumoto et al. 2001).

An example of a Ark 564 spectrum obtained from our monitoring of this object is given in Fig. 1. The variability of the flux is clearly seen (Fig 1, left panel). We also fitted one spectrum of Ark 564 using Gaussian components for all lines (see Fig 1, right panel). We fitted the region of Hβ line where we have a strong contribution of Fe II multiplet (for details on fitting procedure see Kovačević et al. 2010). The best-fitting is nicely following the observed spectrum (see the residual
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in Fig 1, right panel), especially the Fe II line group, that have similar widths as the intermediate line component of the Hβ line.

Figure 1: Left panel: Flux variability of Ark 564. Dates are given at top left corner. Right panel: An example of fitted spectrum of Ark 564 using Gaussian components for all lines.

Arp 102B emits double peaked line profiles (see Fig. 2). The simplest possible explanation for this spectral profile identifies an accretion disk as the source of these lines. The AGN also shows strong low ionization lines and very weak/absent high ionization lines (Stauffer et al. 1983; Halpern et al. 1996). The weakness of the high ionization lines and absence of double peaked structure in them supports the accretion disk origin under the assumption that the outer parts of the thin disk are invisible to the photoionizing source. The absence of a strong UV bump, presence of a hard X-ray source and low Eddington luminosity of this object are indicative of an advection dominated flow (Advection Dominated Accretion Flows (ADAF) - Ho et al. 2000).

The profile shape of the broad component of Hα emission line varied strongly (see Fig. 2), but in all cases there is a prominent bump in the blue wing and less prominent one with a flat top in the red wing of the broad Hα component.

Figure 2: Flux variability of Arp 102B. Dates are given at top left corner.

The line profiles in this AGN could be well-fit by the predictions of a model for line emission from a relativistic Keplerian disk (Chen and Halpern 1989). The fit
to Arp102B was quite good but the statistical implications were not. The best disk model fits to lines in Arp102B imply an intermediate viewing angle and that leads to the expectation of many sources with double-peaked emission lines. A search for more double peaked and peculiar profiles among radio-loud AGN revealed only a handful that could be reasonably well fit by disk models (Eracleous and Halpern 1994). AGN with optical line profiles like Arp102B are apparently quite rare. They also appear to be almost uniquely radio-loud sources. Either most radio-loud disk emitters (and all radio-quiet ones) produce emission at larger radii where double peaked lines are not expected or the disk contribution to the broad line emission is small or negligible. This should be investigated. More detailed analysis and discussion about monitoring of these two AGNs will be given elsewhere.

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