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X-ray/UV variability and the origin of soft X-ray excess emission from II Zw 177

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ABSTRACT

We study X-ray and UV emission from the narrow-line Seyfert 1 galaxy II Zw 177 using a 137 ks long and another 13 ks short *XMM–Newton* observation performed in 2012 and 2001, respectively. Both observations show soft X-ray excess emission contributing 76.9 ± 4.9 per cent in 2012 and 58.8 ± 10.2 per cent in 2001 in the 0.3–2 keV band. We find that both blurred reflection from an ionized disc and Comptonized disc emission describe the observed soft excess well. Time-resolved spectroscopy on scales of ∼20 ks reveals strong correlation between the soft excess and the power-law components. The fractional variability amplitude $F_{\rm var}$ derived from EPIC-pn light curves at different energy bands is nearly constant ($F_{\rm var}$ ∼ 20 per cent). This is in contrast to other active galactic nuclei where the lack of short term variation in soft X-ray excess emission has been attributed to intense light bending in the framework of the 'lamppost' model. Thus, the variations in power-law emission are most likely intrinsic to corona rather than just due to the changes of height of compact corona. The variable UV emission ($F_{\rm var}$ ∼ 1 per cent) is uncorrelated to any of the X-ray components on short time-scales suggesting that the UV emission is not dominated by the reprocessed emission. The gradual observed decline in the UV emission in 2012 may be related to the secular decline due to the changes in the accretion rate. In this case, the short term X-ray variability is not due to the changes in the seed photons but intrinsic to the hot corona.

Key words: accretion, accretion discs – radiation mechanisms: general – galaxies: active – galaxies: individual: II Zw 177 – galaxies: nuclei – X-rays: galaxies.

1 INTRODUCTION

Most active galactic nuclei (AGN) show complex broad-band spectra. The optical/UV to X-ray spectrum consist of primarily four components – the big blue bump (BBB), the X-ray power-law emission in the ∼0.1–100 keV band, Fe–K line near 6 keV with reflection hump at higher energies and the soft X-ray excess emission below 2 keV. The BBB is likely the thermal emission from a standard accretion disc (Shakura & Sunyaev 1973; Shields 1978). According to this model, the outer accretion disc with low temperature emits within the optical band and the inner disc with the highest temperature emits in the extreme UV. In rare cases of low-mass AGN with high accretion rates, the disc can emit in the soft X-ray band (e.g. Done et al. 2013; Chiang et al. 2015). The power-law continuum emission is believed to originate through the Compton upscattering of the soft photons from the accretion disc in the hot electron plasma (Sunyaev & Titarchuk 1980; Haardt & Maraschi 1991; Reynolds & Nowak 2003). The Fe–K α line near 6 keV and the reflection hump in the 20–40 keV band are considered together as the X-ray reflection. The Fe–K α line and the reflection hump are caused by the photoelectric absorption, followed by fluorescence, and the Compton scattering of the coronal emission in an optically thick medium, such as accretion discs (Guilbert & Rees 1988; Lightman & White 1988; George & Fabian 1991; Tanaka et al. 1995). Since the discovery of the soft X-ray excess emission (Arnaud et al. 1985; Singh, Garmire & Nousek 1985), the origin of this component has been widely debated with high-energy tail of thermal emission from the accretion disc discussed as an early possibility (Arnaud et al. 1985; Magdziarz et al. 1998; Leighly 1999). However, the expected thermal emission from accretion disc of AGN is too cool to contribute significantly in the soft X-ray band, except for a sub-class of AGN known as narrow-line Seyfert galaxies (NLS1s) which have low black hole mass and high accretion rate (e.g. Boller, Brandt & Fink 1996).

Nonetheless, in NLS1, the predicted shape of Wein tail of inner disc should drop faster than the observed shape of soft excess with energy (Bechtold et al. 1987; Laor et al. 1997). The extent

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