Monthly Notices
of the
ROYAL ASTRONOMICAL SOCIETY

MNRAS **435,** 1287–1299 (2013)
Advance Access publication 2013 August 21

doi:10.1093/mnras/stt1372

Variable X-ray reflection from 1H 0419–577

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Accepted 2013 July 22. Received 2013 July 18; in original form 2013 April 20

ABSTRACT

We present detailed broad-band X-ray spectral variability of a Seyfert 1 galaxy 1H 0419–577 based on an archival *Suzaku* observation in 2007 July, a new *Suzaku* observation performed in 2010 January and the two latest *XMM–Newton* observations from 2010 May. All the observations show soft X-ray excess emission below 2 keV and both *Suzaku* observations show a hard X-ray excess emission above 10 keV when compared to a power law. We have tested three physical models – a complex partial covering absorption model, a blurred reflection model and an intrinsic disc Comptonization model. Among these three models, the blurred reflection model provided statistically the best fit to all the four observations. Irrespective of the models used, the soft X-ray excess emission requires contribution from a thermal component similar to that expected from an accretion disc. The partial covering absorption model results in a non-physical high temperature ($kT_{\rm in} \sim 100$ eV) for an accretion disc and is also statistically the worst fit among the three models. 1H 0419–577 showed remarkable X-ray spectral variability. The soft X-ray excess and the power law both became weaker in 2010 January as well as in 2010 May. A moderately broad iron line, detected in 2007 July, is absent in the 2010 January observation. Correlated variability of the soft X-ray excess and the iron Kα line strongly suggest reflection origin for both the components. However, such spectral variability cannot be explained by the light bending model alone and requires changes in the accretion disc/corona geometry possibly arising from changes in the accretion rate.

Key words: galaxies: active – galaxies: individual: 1H 0419–577 – galaxies: nuclei – X-rays: galaxies.

1 INTRODUCTION

Active galactic nuclei (AGNs) exhibit complex X-ray spectra. Seyfert 1 galaxies generally show three primary components – power-law continuum, soft X-ray excess below 2 keV and reflection including an Fe Kα line. The power-law component is thought to arise due to Comptonization of soft photon from an accretion disc in a hot corona, either above or below the accretion disc in a sandwich configuration or around the central supermassive black hole (SMBH; Sunyaev & Titarchuk 1980; Haardt & Maraschi 1991; Reynolds & Nowak 2003). The origin of the soft X-ray excess emission is not clearly understood. It is likely the blurred reflection from a partially ionized accretion disc (Ross & Fabian 1993; Fabian et al. 2002). The soft excess could also arise due to the Comptonization of optical/UV radiation from the accretion disc in a low-temperature, optically thick medium (Magdziarz et al. 1998; Done et al. 2012). The Fe Kα line near 6 keV and the Compton hump in the ∼10–40 keV band are together known as the X-ray reflection. The Fe Kα line arises due to the photoelectric absorption followed by fluorescent line emission. The Compton hump is the result of two competing processes, the photoelectric absorption and the Compton scattering of the illuminating power-law continuum (Guilbert & Rees 1988; Lightman & White 1988). The reflection features arising from the inner disc are strongly modified due to the relativistic effects near the SMBH, thus giving rise to the broad relativistic iron line (see e.g. Fabian et al. 2000; Reynolds & Nowak 2003). In most cases, Seyfert 1 galaxies exhibit the narrow iron Kα line and the Compton hump from distant optically thick matter such as the putative cold torus, and sometimes show a broad line (Reeves et al. 2007; Murphy & Yaqoob 2009).

The primary X-ray emission of Seyfert 1 galaxies may be affected by absorption in the neutral and partially ionized material along the line of sight. Approximately 50 per cent Seyfert galaxies show absorption features e.g. due to O VII and O VIII, in their spectra near 1 keV (e.g. Blustin et al. 2005; Piconcelli et al. 2005). These absorption lines and edges are due to the presence of the warm ionized matter which is named as 'warm or ionized absorber' (Halpern 1984; Turner et al. 1991; Netzer 1993; Kaastra et al. 2000). In some cases, the absorption lines are found in the Fe K band (Pounds et al. 2003; Dadina et al. 2005; Risaliti et al. 2005; Braito et al. 2007; Cappi et al. 2009; Reeves et al. 2009; Tombesi

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