H0557-385: a Seyfert in quietude and reflection

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The nearby Seyfert galaxy H0557-385 is both highly luminous and has a high-column warm absorber, making it a possible low-redshift analogue to Broad Absorption Line Quasars. During a 140 ks XMM-Newton observation designed for spectroscopy of the warm absorber, the source was found to be in a very low state. The usual power-law continuum was absent, revealing normally-obscured continuum features in the EPIC spectra. In this poster we present these spectra, and discuss the interpretation of the continuum shape in terms of absorption and reflection models.

Introduction

The Seyfert galaxy H0557-385 (z=0.034; Fairall et al. 1982) appeared in the Piccinotti sample (Piccinotti et al. 1982) as one of the brightest AGN in the sky, but despite this has been little studied. The results of a 20 ks observation performed with XMM-Newton in 2002 confirmed that this AGN has a high-column warm absorber in the soft X-rays (Ashton et al 2006; see also Turner, Netzer & George 1996 (ASCA) and Quadrelli et al. 2003 (BeppoSAX)); the depth of the absorber, plus the high X-ray luminosity, raises the possibility that H0557-385 has some similarities with the higher redshift – and perhaps cosmologically interesting – Broad Absorption Line Quasars.

For the purpose of obtaining high resolution spectroscopy of the ionised absorber, a total of 140 ks of data were obtained with XMM-Newton during two observations in 2006. This poster presents data from both the 2002 and 2006 epochs, processed in the same way using SAS V7.1. The RGS and EPIC spectra for each epoch were respectively combined using the method of Page et al (2003). The Optical Monitor fluxes were averaged for each epoch.

Broad-band spectral energy distributions

During the long observations in 2006, H0557-385 appeared to have gone into a low state: figure 1 shows the rest-frame spectral energy distribution (SED) of the source in 2002 (black) and 2006 (red). The optical/UV points are from the XMM-Newton Optical Monitor, obtained simultanously with the EPIC-pn X-ray spectra. The optical/UV and X-ray fluxes have been corrected for, respectively, Galactic extinction and absorption.

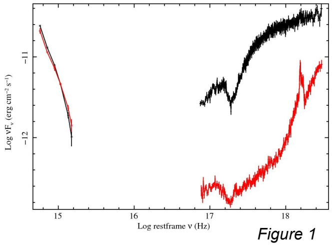

Figure 1

As well as demonstrating the depth of the absorption – it has never been possible to perform UV spectroscopy on this source due to its UV faintness – it is clear that the X-ray flux has decreased by a factor of ~10 between the two epochs, and that what appear to be reflection features have become visible in the 2006 observation.

EPIC-pn spectra

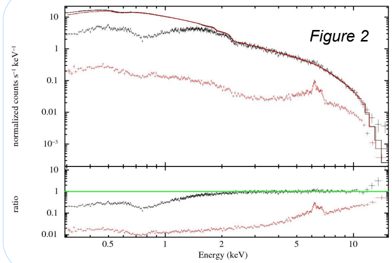

Figure 2

Figure 2 shows the combined EPIC-pn spectra for each epoch, showing a Galactic-absorbed power-law fit to the 4-6 keV range of the 2002 high-state observation superimposed on the spectra from 2002 (black) and 2006 (red), and the ratio of this fit to the spectra.

RGS spectra

Figure 3 shows the combined RGS spectra for each epoch (2002 (black) and 2006 (red)); the RGS spectrum from the recent long observation is evidently unsuitable for absorber spectroscopy, with the only significant spectral feature being the O VII forbidden line at 22.1 Å, possibly originating in low-density plasma in the X-ray Narrow Line Region (see e.g. Kinkhabwala et al. 2002).

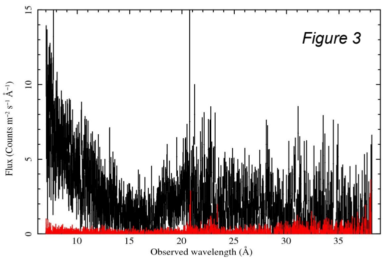

Figure 3

The role of reflection and absorption in shaping the EPIC spectral continuum

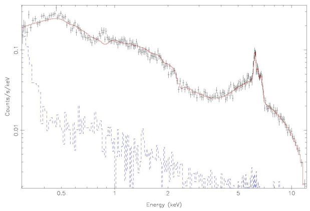

Figure 4a

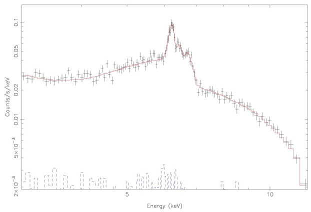

Figure 4b

Figures 4a and b show the current status of the fitting of the low-state (2006) X-ray spectrum; this present best fit model, generated in SPEX 2.00.11, consists of a power-law of Γ=1.9 which is 94% covered by an almost neutral (log ξ=-4) absorber with log N_H=23.9; there is also a non-covered reflection component from lowly-ionised log ξ~-2.5 gas (with its power-law illumination constrained to have the same spectral index as the fitted power-law), and two emission lines from highly ionised iron at 6.67 and 6.93 keV respectively, which are behind the cold covering component. Finally, the whole system is seen through two warm absorber phases, with [log N_H, log ξ] equalling [22.3, 2.3] and [21.4, 0.3] respectively, at an assumed turbulent velocity of 100 km s^{-1}.

The physical scenario implied by this model involves a high-column cold cloud having moved into our line of sight to the ionising source, with the distant reflection being on a sufficiently large spatial scale to be unaffected by this. The narrow iron Kα line is part of the reflection component, whilst the highly ionised iron lines would seem more likely to originate close to the central engine. The warm absorber, as in nearby Seyferts, is envisaged as being distant (~parsec) from the nucleus.

Future work

The principal weakness of the fit presented here is the treatment of the warm absorber; it is difficult to derive a reliable representation of these from low-resolution EPIC data. The XSTAR-based ionised absorber model used here does not use the latest ionisation balance calculations for the M-shell iron UTA, which is expected to be a major continuum absorption feature at the ionisation level of the second warm absorber component. This will be corrected in future work.

Also, the reflection model *refl* in SPEX, which generates the Fe Kα line and reflected continuum (based on Magdziarz & Zdziarski 1995, Zycki & Czerny 1994, and Zycki, Done & Smith 1999, with the option of relativistic broadening) may have been superseded by more recent self-consistent realisations (c.f. Ross & Fabian 2005). Future fitting will incorporate improved reflection models, improved absorber models, and will also investigate disc-line interpretations of the spectrum.

References

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