X-ray & Observational Astronomy

XMM-Newton observations of 3C 273

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Nine XMM-Newton observations of the radio-loud quasar 3C 273 (z = 0.158) are investigated. The broad-band X-ray spectra can be fitted with a power-law and multiple blackbody components, or with a double Comptonisation model; both the power-law and soft excess components are found to vary over time, with the soft excess being hotter when brighter. Co-adding all nine spectra reveals a weak, broad iron line.

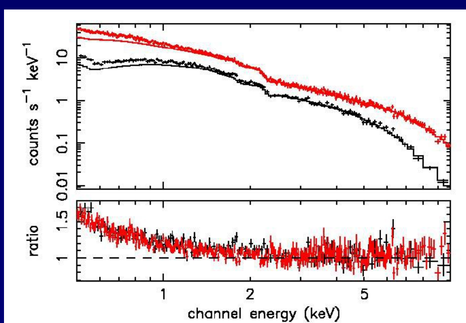

FIG. 1. Fitting a power-law over 3-10 keV (rest frame) and extrapolating down to 0.5 keV clearly shows the soft excess of 3C 273.

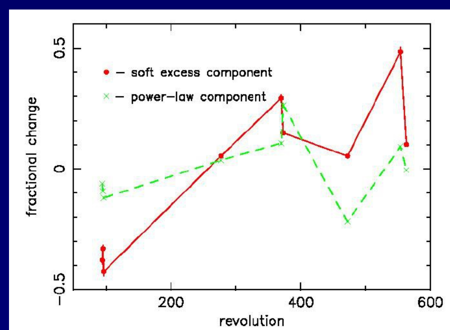

FIG. 2. Variation in strength of the soft excess and power-law components, determined from the double Comptonisation model.

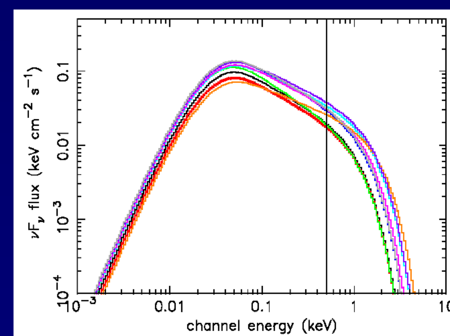

FIG. 3. Comptonised soft excess components for all nine observations, extrapolated down to low energies.

MOS 2 and PN spectra were jointly modelled to analyse the soft excess of 3C 273 (Fig. 1). Over 0.5-10 keV, the spectra were well represented by either a power-law (Γ~1.6-1.8) and 2 or 3 blackbodies (kT~40-330 eV) or a double Comptonisation model (kT~300-400 eV). The strength of the soft excess varies more strongly over time than that of the power-law (Fig. 2).

Because the input photons to the Comptonisation model are thought to come from the accretion disc directly, they are much cooler than the energetic electrons. Thus, the whole model extends well below the XMM-Newton energy band of ~0.5-10 keV. Figure 3 plots an over-lay of the soft excess components from each revolution extrapolated to ~1 eV. The vertical line shows the point above which the model was fitted.

The hotter soft excess components are found to be brighter (Fig. 4); this is inconsistent with Compton cooling, since that theory implies an increase of input photons should *cool* the Comptonising corona.

The 3-10 keV power-law slope varies between Γ~1.6-1.8, but does not appear to be correlated with luminosity (Fig. 5). There is a suggestion that 3C 273 exists in 2 different 'hardness states', with the photon index clustering around either $\Gamma \sim 1.66$ or ~ 1.77.

Figure 6 demonstrates that there is evidence for a (weak) broad iron emission line, if all the observations of 3C 273 are added together.

The observations cover a 0.5-10 keV luminosity range of 1-2 x 10^{46} erg s^{-1}.

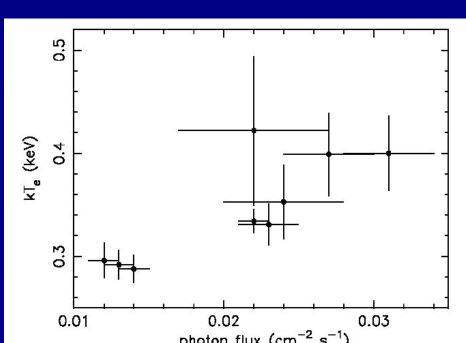

FIG. 4. The Comptonised soft excess component is hotter when brighter.

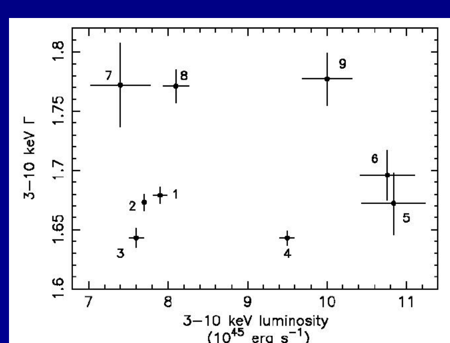

FIG. 5. The power-law slope changes over time. The numbers in this plot show the order in which the observations were made.

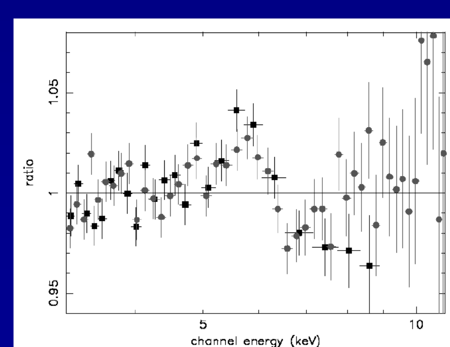

FIG. 6. Co-adding all 9 observations reveals an emission feature in the 3-10 keV residuals. This is well fitted with a broad line of $E_{line} \sim 6.4$ keV, $\sigma \sim 0.6$ keV and equivalent width ~56 eV.

Full details of the work can be found in Page et al. (2004, MNRAS, 349, 57).