EXOSAT OBSERVATIONS OF FLUX AND SPECTRAL VARIABILITY IN THE SEYFERT GALAXY NGC5548

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The Seyfert galaxy NGC5548 was observed with *EXOSAT* 12 times between February 1984 and March 1986. The bottom panel of Fig. 1 shows the lightcurves obtained with the Low Energy telescope and CMA detector and the Medium Energy proportional counters. The CMA flux doubled in a month at the beginning of the *EXOSAT* coverage, and was down by more than an order of magnitude 15 months later; the source was again in a high state in January and March 1986. The ME lightcurve mirrors that of the CMA, with $L_{2-6\ keV}$ varying between 1 and 5 x 10^{43} erg s^{-1}.

Optical and IUE observations of NGC5548 with a coverage very similar to that obtained with *EXOSAT* have been presented by Reichert and Peterson (1988, and private communication). Their continuum fluxes at 5500 and 1775 Å are displayed in the middle panel of Fig. 1 and the HeIIλ4686 fluxes in the top panel. The X-ray flare in 1984 is clearly associated with brightening of the optical and UV continuum and of the HeII line flux, but the temporal characteristics of the lightcurves are different in the three cases. The UV and HeII fluxes show initially a slower rise to peak than the X-ray flux, with evidence for a time lag of at most 3 months at the top of the flare (but note the broken coverage available). The optical continuum rises very fast initially and the overall lightcurve is very smooth.

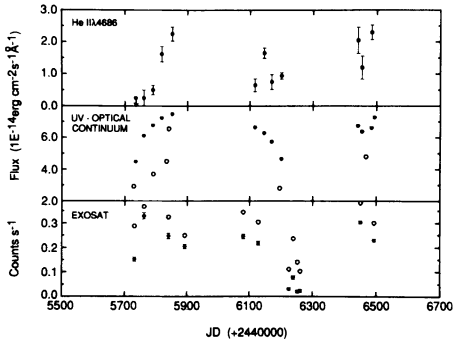

Figure 1. *Bottom panel* – *EXOSAT* lightcurves of NGC5548: LE CMA with 3000 Å Lexan filter, 0.02 – 2.5 keV (filled dots); ME, 2 – 6 keV (open dots; the data have been multiplied by a factor of 0.1 to ease comparison with the LE data). *Middle panel* – Continuum fluxes at 5500 Å (filled dots) and 1775 Å (open dots). *Top panel* – HeIIλ4686 fluxes.

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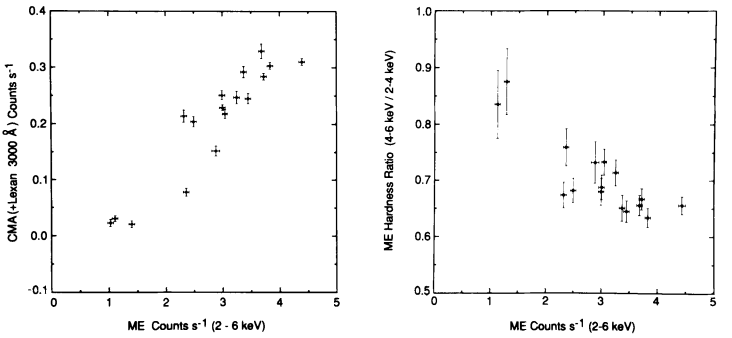

Figure 2. *Left* – The LE CMA countrate of NGC5548 plotted against the ME countrate: a clear correlation is visible. *Right* – The ME hardness ratio plotted against the ME countrate: the spectrum is softer when the source is brighter.

X-ray spectral variability is associated with the large changes in flux observed in NGC5548. The LE CMA and ME countrates are clearly correlated (Fig. 2, left). Moreover, the hardness ratio of the ME spectrum (the ratio of the counts in the 4 – 6 keV and 2 – 4 keV bands) correlates with the source brightness, so that the spectrum is softer when the source is brighter (Fig. 2, right). This behaviour has been observed in a number of Seyfert galaxies, but never with such a large set of data for a given source and with such consistency. Spectral fitting of the combined LE and ME data of NGC5548 shows that the best fit ME power-law is consistent with the data below 1 keV only when the source is weakest. For the rest of the time a soft X-ray excess is unequivocally present in the source spectrum.

The X-ray data presented here and the correlated optical and UV observations offer a unique opportunity to investigate the details of the emission processes in NGC5548, in particular the interaction of the ionizing flux from the nucleus with the gas clouds surrounding it, which is represented by the dramatic increase of the HeIIλ4686 line flux. With regard to the X-ray properties of NGC5548, while the soft X-ray excess could be the signature of an accretion disk surrounding a massive nuclear black hole, its temperature is too low to cause the correlated changes in spectral slope of the medium energy emission. However, these can be qualitatively reproduced as the effects of variability of the energy input in an $e^+ - e^-$ pair plasma at the nucleus (Fabian *et al.* 1986). A possible alternative is offered by Kazanas (1986): the pair plasma would manifest itself directly with a quasi-thermal EUV 'bump' as the source luminosity increases. A soft X-ray excess is observed in NGC5548 when $L_{2-6\ keV} > 2 \times 10^{43}$ erg s^{-1}. Applying a bolometric correction of 10 and taking the result to be 1 percent of the Eddington luminosity (the condition for pair production to be important) implies a black hole mass of $\sim 10^8\ M_\odot$.

References

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