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Broad-band spectra of Cygnus X-1 and correlations between spectral characteristics

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Abstract

We present the results of the spectral analysis of 42 simultaneous broad-band Ginga-OSSE and RXTE-OSSE observations of Cygnus X-1 carried out in 1991 and 1996-1999. The broad-band spectra from 3 to ~1000 keV can be well described by the thermal Comptonization model with reflection from the cold disc, with an additional soft component visible below 10 keV. The relative contribution of this component to the total energy flux appears to be higher in the spectra with larger reflection amplitude and steeper photon index of the thermal Comptonized component. We consider a number of physically realistic models to describe the shape of the E ≲ 10 keV excess. The additional soft component can result from thermal Comptonization by electrons with a low Compton parameter, or can be a part of a non-thermal, power-law-like emission extending above 1 MeV. We study correlations between parameters obtained from the spectral fits with different models. We confirm a general correlation between the photon index γ and the amplitude of reflection R. We find that simple phenomenological models (such as power law plus Compton reflection) applied to the narrow band (3-20 keV) data overestimated the values of R and γ, although the simple models did rank correctly the spectra according to R and γ, as demonstrated in the original publications on this subject. The dynamic corona model provides a satisfactory description of the observed correlation, while the hot inner disc models have problems in reproducing it quantitatively. On the other hand, in the context of the dynamic corona model it is difficult to understand correlations with the timing characteristics, which seems natural in the hot disc scenario. We do not find significant correlation between the electron temperature and other spectral parameters, while the optical depth of the hot medium seems to decrease when the spectrum becomes softer. It is also shown that spectral parameters are well correlated with the timing characteristics of the source. © 2005 RAS.

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Keywords

Accretion, accretion discs, Black hole physics, Gamma-rays: observations, Stars: individual: Cygnus X-1, X-rays: binaries