SPECTRAL EVOLUTION OF THE THERMAL COMPONENT IN CYGNUS X-1 DURING INTENSITY VARIATIONS IN THE SOFT STATE

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1. Introduction

Cygnus X-1 was in the Soft State between May and September 1996 for the first time in more than 20 years creating an opportunity to study the thermal component, its spectral evolution, time variability and its relation to the hard component during intensity variations. We will show how the luminosity of the thermal component changes in relation to its temperature and attempt to determine whether the emitting area varied during the variations.

2. Results and Conclusions

Cygnus X-1 was observed with *ASCA* during the Soft State on May 30th, 1996. We present results for spectral analysis of *ASCA* GIS data from this observation lasting $\sim$ 60,000 s. The light curve showed that the intensity increased steadily by 30% during the observation. Spectral analysis revealed that the increase was primarily due to brightening of the dominant thermal component. We have selected spectra from 5 parts of the observation where the intensity below 5 keV was stable, i.e without fast changes. Spectral fitting of these with a simple blackbody to model the disc emission plus a power law for the hard component was used to determine the disc luminosity and the colour temperature. Results constrain the relationship $L \propto T_{col}^{\beta}$ to a range for β of 2.3 to 4.8 with 90% confidence. The Figure shows the variation of L with temperature in the Soft State. We have also tested

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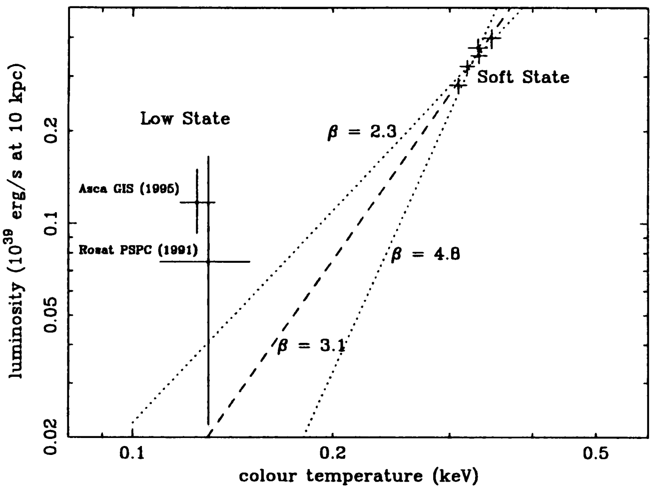

whether the disc inner radius varies with intensity. The actual inner radius R_{in} of the disc is proportional to $f^2 R_*$, where R_* is the apparent inner radius determined by fitting a multi-colour disc, and f is the ratio of T_{col} to effective temperature, determined by fitting the relativistic disc model. Thus we can obtain R_{in}. The data are consistent with a constant R_{in} in the Soft State, although the quality of the data does not allow us to say absolutely that R_{in} does not vary with luminosity. We can also test *whether* R_{in} *varies between the Low State and the Soft State.* In the Soft State, spectral fitting gives $f \simeq 1.7$. The Low State *ROSAT* and *ASCA* values of disc luminosity (Balucinska-Church et al. 1995, 1997) imply an increase in R_* by ~ 2.5 and 4.0 times respectively compared with the Soft State. The results are consistent with *two explanations.* Firstly, if R_{in} does not change, to explain the change in R_*, f would have to be ~ 1 in the Low State giving a factor of $(1.7)^2 = 2.9$ in R_*. In this case the disc emission in the Low State would have to be simple blackbody at every radius. Alternatively, if $f \simeq 1.7$ in both states, the inner radius decreases by 2.5 - 4.0 times from the Low State to the Soft State in general agreement with the advective disc model (Narayan 1997).

References

Bałucińska-Church M., Belloni T., Church M. J. and Hasinger G., 1995, A&A **302**, L5.

Bałucińska-Church M., Takahashi T., Ueda Y., Church M. J., Dotani T., Mitsuda K., and Inoue H., 1997, ApJ, **480**, L115.

Narayan R., 1997, in: "Accretion Phenomena and Related Outflows", IAU Colloqium no. 163,eds.: D. T. Wickramasinghe, L. Ferrario and G. V. Bicknell.