ARIEL 5 OBSERVATIONS OF GX 339-4

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ABSTRACT

Observations of GX 339-4 with the Ariel 5 spectrometer are reported. The spectrum of the source is very steep, possibily a low temperature blackbody or Bremsstrahlung distribution. Differences and similarities with the related sources Cyg X-1 and Cir X-1 are discussed.

1. INTRODUCTION

The bright bulge source GX 339-4 (=4U1658-48) was first detected by Markert et al. (1973). They noted the source was highly variable, with high, low and off states. No short term variability was observed by them and also by Forman et al. (1976). Its spectrum is the steepest in the catalog of Jones (1977). A similarity with Cyg X-1 and Cir X-1 is proposed by the latter author. This possibility was enforced by the observation of millisecond variability by Samimi et al. (1979), who proposed on this basis a black hole candidacy.

An optical identification was provided by Doxsey et al. (1979). Grindlay (1979) found the companion to be an X-ray heated main sequence B star. Strong variations in the optical flux have been recently detected (Hutchings et al. 1981, Ilovaisky and Chevalier 1981).

2. OBSERVATIONS AND RESULTS

GX 339-4 was observed by Ariel 5 MSSL experiment C on February 1975 and on April 1977. The source is in a crowded region of the sky, so that the field of view of the instrument contains many strong sources. The different contributions can be separated when the instrument is in quadrant mode (spectral information available, time resolution 100 min), while confusion is unavoidable in multiscaler mode (non spectral information, time resolution 64 sec). We tentatively attribute the 1977 observations to an high state, as defined by Doxsey et al. (1979), while in 1975 the source was intermediate between high and low states (the latter

Space Science Reviews **30 (1981) 447–449. 0038–6308/81/0303–0447 $00.45.**

observations may be affected by confusion with other sources).

Multiscaler data have been tried for periods between 2 and 100 min, but no periods with a significance greater than that of the harmonics of the orbital period of the satellite have been found. We note that the medium term variability of the source is contained within 5 % of the mean value for each orbits. This is consistent with the expectations for the high state.

Spectral information is available for both observations (1975 and 1977). The data have been analyzed with the direct deconvolution method by Blissett and Cruise (1979). Restored spectra are reported in fig. 1.

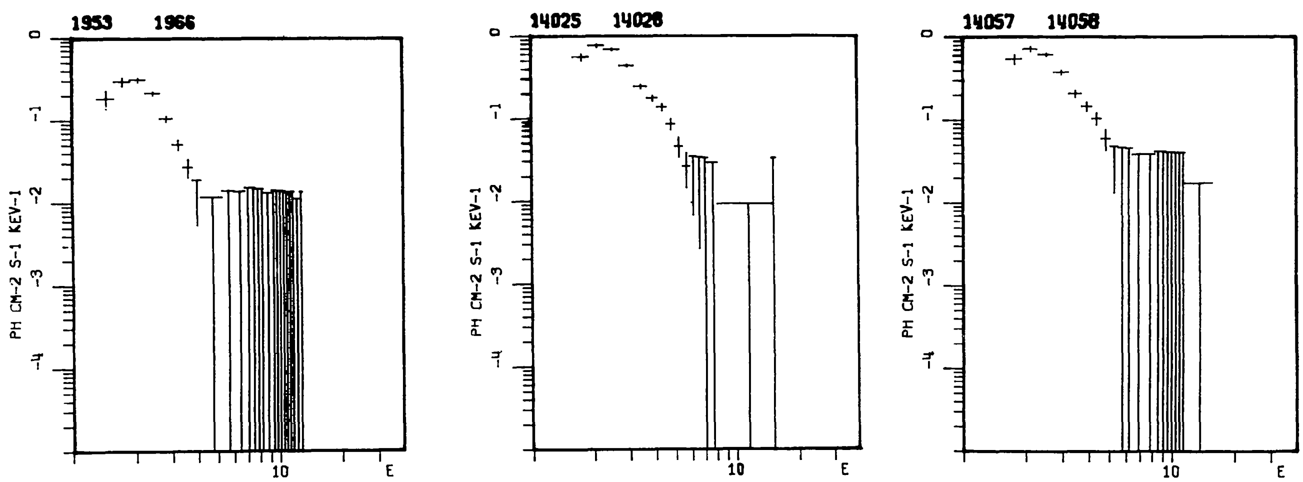

Fig. 1 : Spectra of GX 339-4 taken in 1975 (orbits 1953-1966) and in 1977 (orbits 14025-14058).

The 2-4 keV integral flux obtained with the same method are respectively 9.7 ± 0.6 (orbits 1946-1952), 23.7 ± 0.8 (orbits 1953-1966), 91.7 ± 2.0 (orbits 14025-14028) and 81.3 ± 2.7 (orbits 14057-14058), in units of 0.01 photons/sq cm sec. As it can be seen in the figures, the spectra are very steep, which is a clear signature of GX 339-4. Above 4-6 keV only upper limits are available, which could be due to harder sources in the field of view.

Best fits of the raw spectra obtained with a least square technique give blackbody temperatures of 0.38 keV (orbits 1953-1966), 0.68 keV (orbits 14025-14028) and 0.61 keV (orbits 14057-14058) respectively. Also a thermal distribution fits well the data, with temperatures of 0.77 keV (orbits 1953-1966), 1.39 keV (orbits 14025-14028) and 1.30 keV (orbits 14057-14058) respectively. Since the data under 2 keV are not very reliable, and thus ignored in the fitting procedure, the information on hydrogen column density is very limited.

3. ELEMENTS FOR DISCUSSION

Present observations confirm that GX 339-4 has a very steep spectrum and that the source does not exhibit medium term time scale variations in the high state. The temperature and absorption found for the 1977 observations are comparable with the values found by Markert et al. However a harder spectrum is found by Markert et al. and Doxsey et al. in the low states, while our 1975 observations indicate a lower temperature. The statistics of the latter data is nevertheless worse.

A discussion of the arguments for a common classification of GX 339-4, Cyg X-1 and Cir X-1 is needed. The black hole candidacy rests upon the presence of millisecond variability, which is not a secure black hole signature (a better argument is the mass function, known only for Cyg X-1). GX 339-4 is unusually constant when in the high state. A true bimodal behaviour is present only in Cyg X-1 and GX 339-4, while the long term variability of Cir X-1 is probably accounted for by the orbital motion. Cyg X-1 and Cir X-1 have however been monitored almost continuosly for many years, while only a few observations are known for GX 339-4. The three sources exhibit steep spectra (the steepest being GX 339-4). Spectral variations are possibly correlated with intensity variations. Cir X-1 has a power law spectrum and its slope is similar in high and low states. Cyg X-1 has a two component spectrum with a well known bimodal behaviour. The sof component of Cyg X-1 is similar to the spectrum we observe in GX 339-4. The latter source lacks however the hard tail, usually attributed to Comptonization, present in Cyg X-1. This requires different physical environments for the two sources. Also the optical counterparts of the three sources are probably different (a blue supergiant for Cyg X-1 and possibily for Cir X-1, a main sequence object for GX339-4). We feel in conclusion that the arguments for the belonging of Cir X-1, Cyg X-1 and GX339-4 to a same class are not able to solve the problem.

ACKNOWLEDGEMENT

The author gratefully acknowledges the use of the Ariel 5 MSSL data analysis system and the assistance of the Ariel 5 team at MSSL, where this work began.

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