Long-term spectral changes in GX 1+4

P. Kretschmar (1); A. González Galán (2); E. Kuulkers (1); Konstantin Postnov (3), Mark Finger (4), Stefan Larsson (5)
(1) ESA/ESAC, Madrid, Spain; (2) DFSTIS, Universitat d’Alacant, Spain; (3) Sternberg Astronomical Institute, Moscow, Russia
(4) National Space Science and Technology Center, Huntsville, AL, USA (5) Department of Astronomy, Stockholm University, Sweden

Abstract

GX 1+4 is the best known member of the small class of symbiotic accreting X-ray pulsars. It shows strong, irregular luminosity variations typical for this source class. Long-term monitoring indicates significant spectral changes on the orbital timescale in recent years and in the behaviour around periastron passages.

GX 1+4

GX 1+4 is an accreting X-ray pulsar discovered in 1970 by a balloon observation at energies above 15 keV [1]. At the time it was one of the brightest X-ray sources in the Galactic centre region. The optical companion was confirmed to be the M giant V2116 Oph in 1997 [2]. With an orbital period of 1616 days with unknown inclination, the masses of the binary partners have been estimated as \(-1.35\ M_\odot\) for the neutron star and \(-1.2\ M_\odot\) for the M giant. This means that the M giant does not fill its Roche lobe and the neutron star is capturing the slow stellar wind of its companion [3].

The X-ray flux is very variable on all timescales, from minutes to decades. In the years after its detection the source remained bright and spun up strongly. During an extended low state in the 1980s the previously strong luminosity variations typical for this source class. Long-term monitoring indicates significant dependence of the spectral shape on intensity, but during a low flux interval in 1996, significant spectral variations in the 2-60 keV band were observed [7].

In contrast to the stable spin-down, we find no firm pattern in the flux and spectral variations.

In the late 1990s the spectral hardnes remained rather constant, regardless of the luminosity variations, except for brief intervals of ‘soft flares’ (see Fig. 2). More recently, from 2006 to end 2007 the spectral hardnes increased steadily, dropping abruptly during a perigee passage period, due to a drop in hard flux. Other variations seem to happen on timescales of several months.

Conclusions

From the quasi-spherical accretion model, which has been invoked to explain the long-term pulse period evolution of GX 1+4 [5,11], we would actually expect a correlation between flux and hardnes, because increased Compton cooling leads to higher accretion rates. But as the historical data shows, the source behaviour is more complex. There are intriguing indications for accretion state changes triggered at periastron passages, but with contrasting results for different passages.

These results emphasize the necessity of long-term consistent monitoring in order to truly understand accreting X-ray sources.

References


Keywords: X-ray pulsar, accretion, long-term monitoring, spectral variations.