Black Holes from Stars to Galaxies – Across the Range of Masses
Proceedings IAU Symposium No. 238, 2006
V. Karas & G. Matt, eds.

doi:10.1017/S1743921307005959

The X-ray–radio association in RATAN and RXTE monitoring of microquasar GRS 1915+105

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Abstract. In the daily RATAN-600 monitoring of the radio variability of the microquasar GRS1915+105 we detected a clear correlation of the flaring radio emission and X-rays "spikes" at 2–12 keV emission (1–2 Crab) detected with RXTE (ASM data) during nine bright (200–600 mJy) radio flares in October 2005. The spectra of these flares in maximum were optically thick at ν <2.3 GHz and optically thin at $\nu \geqslant$2.3 GHz. During radio flares the spectra of the X-ray spikes became definitely softer than those of a quiescent radio state. Thus these data indicated transitions from very high/hard states to high/soft ones during which massive ejections are probably happened, and the ejections are detected as the radio flares.

Keywords. X-rays: binaries – radio continuum: stars – radiation mechanisms: nonthermal

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The X-ray transient source GRS 1910+105 was discovered by Castro-Tirado *et al.* (1992) with WATCH instrument on board GRANAT. In 1994, a superluminal motion of the radio jets had been detected from GRS 1915+105 (Mirabel F. & Rodriguez 1994). Since then a new class of astrophysical objects 'microquasars' was established. Nearly 20 microquasars were distinguished from near 300 Galactic X-ray binaries. We are far form the full understanding the jet phenomena in microquasars, however, from radio monitoring data a jet activity and state of the source can be diagnosed and even predicted.

We have carried out the 250-day almost daily monitoring observations of the microquasar GRS 1915+105 with RATAN-600 radio telescope at 1–22 GHz from September 2005 to May 2006. We have used a standard continuum radiometer complex of cryoreceivers at 4.8, 7.7, 11.2, and 21.7 GHz and the low-noise HEMT-based radiometers at 1 and 2.3 GHz. Observations were carried out using the 'Northern sector' antenna of the RATAN-600 radio telescope at the upper culmination of the sources. The measured multi-frequency light curves were directly compared with series from the X-ray observatory RXTE (ASM, Levine *et al.* 1996).

During the total set we have detected nine radio flares from 200 to 600 mJy, and all of them had counterparts in the soft X-rays emission (ASM RXTE). In Fig. 1 the radio and X-ray light curves in October 2005 with the first five flares are showed. The X-ray emission was defined as high (1–2.5 crabs) and hard (HR2 = 1–1.5). Radio spectra were optically thin in the first two flares, and optically thick in third one or were so-called "gigahertz-peaked" spectra, often measured from AGNs.

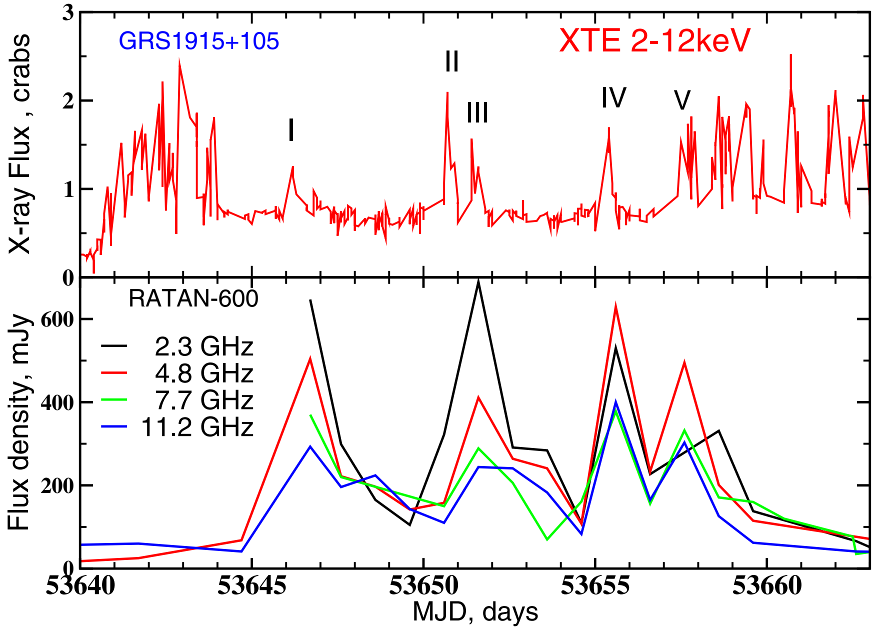

Figure 1. The radio and X-ray light curves of GRS1915+105 in October 2005.

The profiles of the X-ray spikes during the radio flares are clearly distinguishable from other spikes because of its shape, it shows the fast rise and the exponential decay. The other X-ray spikes, which reflect the activity of an accretion disk, exhibit an irregular pattern. During the radio flare, the spectra of the X-ray spikes become softer than those of the quiescent phase by a fraction of ∼30% in the hardness ratio (1.3–5 keV/5–12 keV). Thus a X-ray spike associated with a radio flare has a specified characteristics, and probably only such ones could produce the massive ejections (Namiki *et al.* 2007).

Miller-Jones *et al.* (2006) have detected a large-scale radio jet with VLBA mapping during the ninth radio outburst on 23 February 2006 (MJD53789.258), associated with a X-ray spike. Then the optically thin flare with fluxes 340, 340, 342, 285, 206, and 153 mJy was detected at frequencies 1, 2.3, 4.8, 7.7, 11,2 and 21.7 GHz.

Acknowledgments

These studies were supported by Russian Foundation Base Research (RFBR) grant N 05-02-17556 and mutual RFBR and Japan Society for the Promotion of Science (JSPS) grant N 05-02-19710.

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https://doi.org/10.1017/S1743921307005959 Published online by Cambridge University Press