Chandra localization of KS 1731–260

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Abstract

We present the analysis of the Chandra image of KS 1731–260. The improvement of the source localization (down to ~0.6") allowed us to rule out 12 of 13 infrared companion candidates proposed by Barret et al. (1998). The remaining possible infrared counterpart of KS 1731–260 (angular distance between sources ~ 1.45", or ~ 2σ) has the brightness m_J ~16 in the J band. If this star is really the counterpart of KS 1731–260, the lower limit on its luminosity is L_{tot} > L_{J,H} ~ 10L_⊙. The strong drop of the X-ray flux from the source allow us to propose the additional check of whether the described star is the real counterpart of KS 1731–260. If the optical and infrared brightness of the binary system is partially caused by the reprocessing of X-rays, as it is usual for the low mass binary systems, the infrared brightness of real counterpart should strongly reduce in 2001, when the X-ray flux from KS 1731–260 turned off (Wijnands et al. 2001).

Keywords: “MIR-KVANT”, neutron stars, X-ray sources, KS1731-260.

The X-ray source KS 1731–260 was discovered by TTM telescope aboard MIR-KVANT observatory in 1988 (Sunyaev 1989, Sunyaev et al. 1990).
Since then the source was under special attention of the MIR-KVANT-TTM group. During more than 10 years the source demonstrated moderate X-ray activity at the level of 100-200 mCrab. KS 1731–260 was observed many times by GINGA, GRANAT, ROSAT, ASCA, RXTE observatories (e.g. Barret et al. 1998, 2000, Narita 2001). The type I X-ray bursts were observed from the source, which indicates that the compact object in the binary system is a neutron star. The average luminosity of the system during its active state in 1989-2000 is of the order of $5 \times 10^{37}$ ergs/s (assuming source distance 7–8 kpc, see Smith et al 1997). At the beginning of 2001 the source flux dropped below the level of approximately 10 mCrab and it became undetectable by the RXTE/ASM monitor (Wijnands et al 2001). The subsequent observation of Chandra observatory revealed a weak X-ray source with the position consistent with KS1731–260 (Wijnands et al. 2001). The source luminosity at that time could be estimated to be $L_x \sim 2 \times 10^{33}$ erg/s (Wijnands et al. 2001). The long time history of the source according to the MIR-KVANT-TTM and RXTE/ASM data could be found in Aleksandrovich et al. (2001).

KS 1731–260 is located within the Galactic plane, which makes its optical observations very difficult. The estimation of the photoabsorption from the X-ray measurements give $N_H L \sim 1.2 \times 10^{22}$ cm$^{-2}$, that corresponds to the optical extinction $A_V \sim 7.2$ (see e.g. Barret et al. 1998). Using the TTM error box Cherepashchuk et al. (1994) proposed two possible optical counterparts of KS 1731–260. However, more precise localization of the source with ROSAT/HRI (~10" error circle) ruled out these candidates (Barret et al. 1998). Barret et al. instead proposed 13 other candidates for infrared counterparts of KS 1731–260.

In this Letter we present the localization of KS 1731-260 using a Chandra observation. Also we discuss the possible source counterpart.

**DATA ANALYSIS AND RESULTS**

In our Letter we used data of Chandra observation of KS 1731–260, performed in Mar. 27, 2001 (the total exposure ~20 ksec). The data analysis was done with the help of standard tasks from CIAO 2.1.2. package. The spectral analysis of this observation and the discussion of obtained spectral results can be found in Wijnands et al. 2001, Wijnands 2001.

The Chandra mission requirements on the accuracy of the celestial posi-
tions of X-ray sources was 1". However, the cross-analysis of positions for known optical and infrared sources with the Chandra positions shows that 0.6 arcsec could be taken as $\text{rms}$ deviation of Chandra’s values from more accurate optical localizations (see \url{http://asc.harvard.edu/mta/ASPECT/cel_loc/} and \url{http://asc.harvard.edu/mta/ASPECT/celmon/}). Therefore we quote uncertainties of our localizations as 0.6".

The Chandra image gives the source at the position that is consistent with the previous ROSAT/HRI error circle and improve it. The source has the coordinates: $\text{RA}=17^h34^m13^s.45$, $\text{Dec}=-26^\circ05'18''.7$ (equinox 2000). This improvement of the source position allows us to choose between the 13 possible infrared counterparts proposed in Barret et al. (1998). In the Fig.1 we present the Chandra image of KS 1731–260 with the circles, representing the positions of possible infrared counterparts. The letters denotes the counterparts, as they were mentioned in Barret et al. 1998. It is clearly seen that 12 of 13 possible counterparts now can be ruled out. The only candidate, whose position at $\sim 2\sigma$ level is compatible with the position of KS 1731–260 is the star H. (its coordinates from Barret et al. 1998: $\text{RA}=17^h34^m13^s.35$, $\text{Dec}=-26^\circ05'18''.0$, equinox 2000). However, we should note that there is still some ($\sim 1.46''$) offset of the candidate counterpart from KS 1731–260. The additional infrared observation of this region of the sky in needed to confirm the connection of KS 1731–260 with the star H. If the star H is indeed the counterpart of KS 1731–260 and its optical and infrared brightness is partly caused by the reprocessing of the X-rays, emitted by the neutron star, as it is the case for most of low mass binary systems, we can anticipate that the infrared brightness of the star companion should significantly reduce in 2001, when the X-ray source tuned off. If the companion in the system is not massive, the change in the optical and infrared brightness should be large, however, if the companion is massive the change of the brightness can be small.

If the star H is indeed the infrared counterpart of KS 1731–260, we can estimate its luminosity, or, more precisely, a lower limit on it. The paper of Barret et al. (1998) give us the brightness of star H: $m_J \sim 16$ and $m_H \sim 15$. For a source distance of 7–8 kpc these magnitudes translate into the infrared luminosity of the counterpart of $4–5\times10^{33}$ ergs/s. However, we should take into account the optical extinction. The estimates of the source optical extinction from the X-ray measurement give us $A_J \sim 2.0$ $A_H \sim 1.25$ (see e.g. Barret et al. 1998). If we take into account these values, the infrared luminosity of the star could be estimated to be $L_{J,H} \sim 0.4–1\times10^{35}$ ergs/s. It
means that the total bolometric star luminosity should be \( L > 10L_\odot \).

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Figure 1: The *Chandra* image of the sky region around KS 1731–260. Circles with letters denotes the positions of the possible infrared counterparts reported in Barret et al. 1998