THE X-RAY SOURCE 1RXS J180431.1-273932: THE IMPORTANCE OF BEING PINPOINTED

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1. Introduction

Recently, Ref. (2) has proposed that several faint X-ray sources (with typical luminosities in the range 10^{32}-10^{34} erg s^{-1}) in the Galaxy are wide-orbit LMXBs composed of a compact object, most likely a neutron star (NS), accreting from the wind of an M-type giant. This new kind of system is known as a *symbiotic* X-ray binary system, by analogy with symbiotic stars in which a white dwarf accretes from the wind of an M-type giant companion. Currently there are only 7 confirmed objects of this type known in the Galaxy: 6 cases listed in (2) (but see also Ref. (7)) to which a newly-identified one, XTE J1743−363, has recently been added (10). With the aim of confirming (or disproving) the nature of yet another SyXB candidate, we performed an optical imaging and spectroscopic campaign on two possible counterparts of the X–ray source 1RXS J180431.1−273932(8). The X-ray object 1RXS J180431.1−273932, first detected in the *ROSAT* bright source survey, was subsequently observed on October 2005 with XMM-Newton. The main results of this observation, reported by Ref. (8), are: (i) the detection of an X–ray period of 494 s, most likely due to the spin of the compact accretor; (ii) the description of its X–ray spectrum in the 0.2-7 keV range in the form of a power law with index $\Gamma \sim 1$ plus a Gaussian emission at ∼6.6 keV; and (iii) the detection, with the Optical Monitor (OM) onboard *XMM-Newton*, of an object with magnitude $v \sim 17.2$ at a position consistent with the ∼2″-radius (1σ, corresponding to 3.3″ at the 90% confidence level) X–ray error circle of the source. Concerning the last point, Ref. (8) found that the OGLE catalogue (11) reports a red optical object at ∼5″ from the X–ray position of the source and having a periodicity of about 20.5 days in its I-band light curve. On the basis of the optical and near-infrared magnitudes of this object (assuming that the OM and OGLE sources are one and the same), Ref. (8) concluded that its colors are compatible with those of a red giant star of type M6 III, thus making 1RXS J180431.1−273932 a viable SyXB candidate. We started an optical imaging and spectroscopic campaign to clarify the nature of 1RXS J180431.1−273932 using the Italian Telescopio Nazionale Galileo. We also decided to reanalyze here the *XMM-Newton* data first reported in Ref. (8) using updated software and response matrices and a more physical model to describe the X–ray spectrum. We address the reader to the Ref. (5) for more details on the analysis we conducted. For the sake of clarity, we remind that the optical image, acquired at TNG on 8 September 2010, was processed to obtain an astrometric solution based on 30 USNO-A2.0 reference stars in the field of 1RXS J180431.1−273932. The conservative error on the optical position is 0.252″, which was added in quadrature to the systematic error of the USNO catalogue (≃0.25″). The final 1σ uncertainty on the astrometric solution of the image is thus 0.35″. The result of this analysis is that a relatively bright object is well within the XMM-Newton error circle of 1RXS J180431.1−273932; a brighter source is also present just outside the *XMM-Newton* error circle, west of it. Optical spectroscopic data of the two brightest optical sources mentioned above were acquired on 21 August 2011 using the LR-B grism and a 1.5″ slit: this setup provided a dispersion of 2.7 Å/pixel and a nominal wavelength coverage between 3700 and 8100 Å. The total exposure time was 3×20 min centered at 21:24 UT. The spectrograph slit was suitably oriented in order to acquire the spectra of both objects simultaneously. The source inside the X–ray error circle shows a number of emission lines (see (5)), among which we identify the Balmer ones (up to at least H_ζ), He I, He II and the Bowen blend around 4640 Å; These spectral characteristics are typical of CVs of dwarf nova type (2); moreover, the Balmer decrement clearly appears negative, the HeIIλ4686/Hβ EW ratio is larger than 0.5 and the EWs of He II and Hβ are around 10 Å; all this indicates that this source is quite possibly a magnetic CV belonging to the Intermediate Polar (IP) subclass not strongly affected by interstellar reddening; in addition, all features are at $z = 0$, confirming that this is a Galactic object. 1RXS J180431.1-273932 was also observed by the XMM-Newton satellite on October 2005 (Observation ID 30597) with both the EPIC MOS and pn cameras operating with a thin filter mode. The epic observation data files (ODFs) were processed using the *XMM*-Science Analysis System (SAS version 12.0.0) and standard procedures resulted in source coordinates in full agreement with Ref. (8). Thus, we considered a more physical model built on the basic picture for the accretion onto a magnetized CV, i.e. absorbed bremsstrahlung and black-body components with a Gaussian line accounting for the emission feature observed at ≃6.6 keV (see the discussion in Ref. (5)). A neutral absorber partially covering the source was also used to describe the intrinsic absorption, as sometimes seen in the spectra of similar objects (9). To conclude, we can use some of the results from the physical description of the X–ray spectrum to infer parameters relative to the X–ray emitter. It is found that the X-ray spectrum of the source can be modeled by a bremsstrahlung plus black-body components with temperatures of $kT_{br} \simeq 40$ keV and $kT_{bb} \simeq 0.1keV$, respectively. We also confirm an X-ray periodicity of 494 s from this source which we interpret as the spin period of the WD. With the results of the joint X-ray and optical data analysis, 1RXS J180431.1-273932 is identified as a magnetic CV (possibly a polar) containing an accreting white dwarf and its SyXB nature is excluded. A wd mass of $M_{\rm WD} = 0.8^{+0.4}_{-0.3}\ M_{\odot}$ is inferred. The observed the X–ray luminosity implies implies an average mass accretion rate $\dot{m} \sim 1.6{\times}10^{-11}\ M_{\odot}\ {\rm yr}^{-1}$. Note that the best-fit value of the black-body normalization of $r_{\rm bb} \sim 1$ km is quite modest when compared with the size of the WD surface but it is not uncommon in magnetic CVs (1).

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