Establishing the nature of three BeXRBs through infrared spectroscopy

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Abstract

European Space Agency's *INTEGRAL* satellite have discovered **new X-ray sources** due to its sensitivity above 20 keV. Most of these sources suffer from **high absorption** and the classical **blue band** spectral classification region is normally **not accessible**. This can be overcome, however, through infrared spectroscopy. The characterisation of these systems can influence the population synthesis models currently in use. We obtained *H* and *K* band spectra of selected counterparts to these X-ray sources using the *NICS* instrument mounted on the **Telescopio Nazionale Galileo** (*TNG*) 3.5-m telescope. We complement the spectral analysis with **infrared photometry** from *UKIDSS*, *2MASS*, *WISE* and *NEOWISE* databases. We refine the **distances** to the sources using suitable calibrations that **take into account the contamination by the circumstellar disk**. We present the **first infrared spectroscopy** for three INTEGRAL sources. Our spectra show all the significant features in emission and are, thus, consistent with a Be nature of the companions. Owing to their X-ray characteristics, we classify them as **Be X-ray binaries**.

Introduction

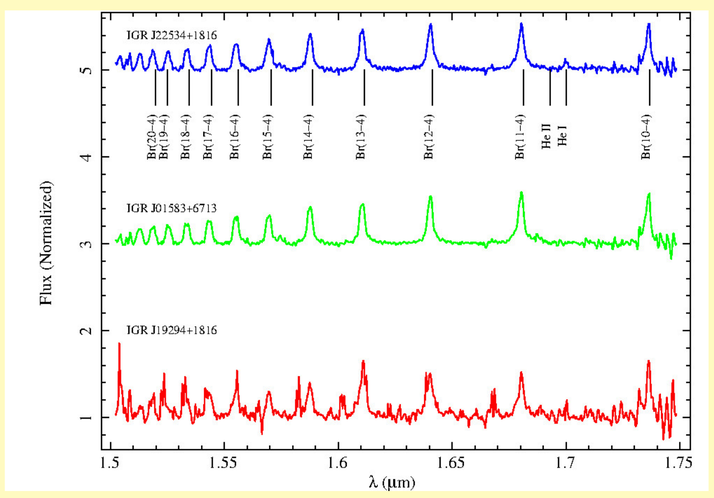
High-mass X-ray binaries (HMXBs) are X-ray systems fed by accretion of material from a donor OB star onto a compact object (a black hole or a neutron star). The largest group of the known sources are **Be/X-ray binaries** (BeXBs) consisting of a Be star donor which harbours a circumstellar equatorial disc and a neutron star. Most of them are **X-ray transients** showing short and bright outbursts (see [6] for a review). The fourth *IBIS/ISGRI* soft γ-ray catalogue [2] contains **more than 700 high-energy sources of which 331 are new sources**, including a substantially increased coverage of extragalactic fields, when compared to the third catalogue. Of these, around **29% of the catalogued sources remains unidentified and/or unclassified**, a little under a third is dominated by Active Galactic Nuclei, 13% HMXBs, 13% low-mass X-ray binaries (LMXBs) and 5% Cataclysmic Variables.

Amongst the HMXBs, *INTEGRAL* discovered a large fraction of systems **displaying higher column densities** than would be expected along the line of sight [5]. Furthermore, the **distances** to the vast majority of **these objects are beyond the ESA's *Gaia* sensitivity**. Its **distances** (hence its **X-ray luminosities and the accretion physics**) must be calculated using the **traditional methods**.

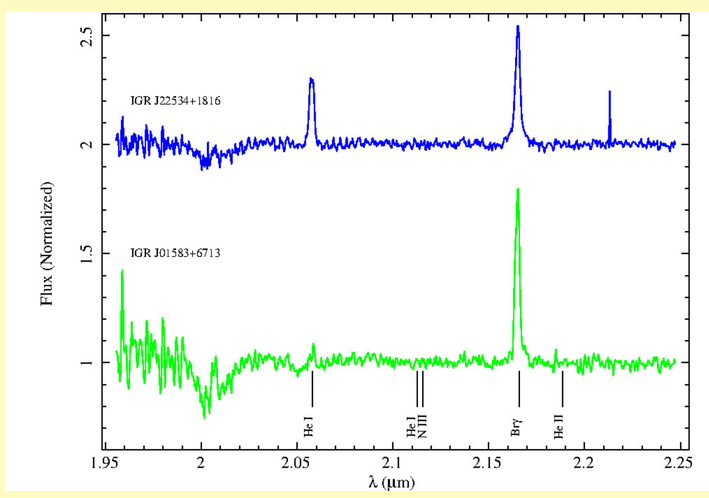
In the case of Be stars, this is further complicated by the contamination of the circumstellar envelope whose contribution must be properly taken into account. In this work, we focus on the near-IR spectral and photometric properties of the *INTEGRAL* counterparts and together with the X-ray characteristics we confirm that all of the IR candidates are Be stars [8].

Results

In this section we present both our **near infrared spectra (NIR)** and the **available photometric data of the counterparts**. Our NIR spectra show all the **significant lines in emission consistent with a Be star nature of the donors** [3], [9].

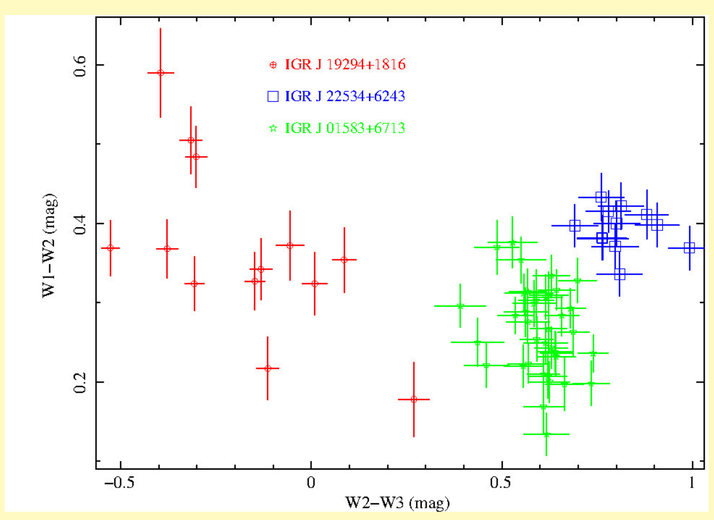


a) *H*-band spectra

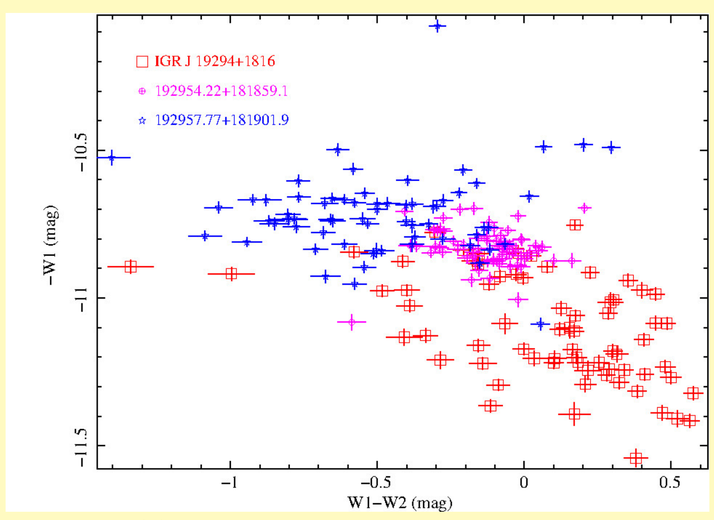


b) *K*-band spectra

Classical Be stars tend to occupy a reduced region in **colour-colour diagram (CC)** [W1−W2] versus [W2−W3] [4]. Although IGR J19294+1816 seems to be quite variable, two nearby sources also showed the same behaviour in the **colour-magnitude diagram (CM)**. In summary, **counterparts** are also consistent with a **classical Be star**.



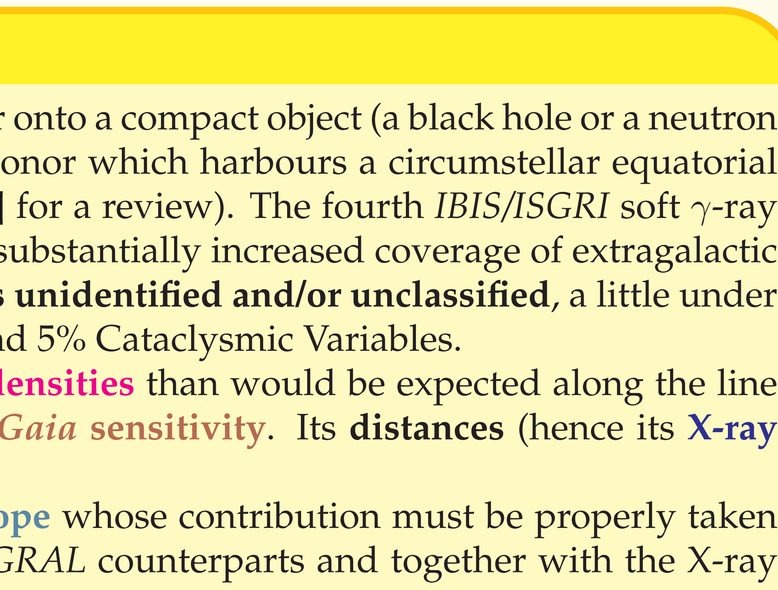
a) *WISE* CC diagram



b) *NEOWISE* CM diagram

As the **circumstellar envelope emission contaminates the underlying photospheric spectrum of the Be star** with respect to B stars of the same spectral type and luminosity class, we will use the recipes given in [7] to **correct the effects of systematic underestimation of the distance** and, hence, the X-ray luminosity. According to this correction, we derived a **distance** of $d = 11 \pm 1$ kpc locating **IGR J19294+1816** at the **far edge of the Perseus arm**. We also estimated a lower limit for the **visual magnitude** of $V \sim 23.4$ mag, which is **corroborated by the spectral energy distribution analysis (SED) [1]**.

Spectral energy distribution



Conclusions

Our **analysis** of **new NIR spectroscopy** as well as the **WISE photometry**, **combined with the properties of the X-ray data, firmly classify all the systems as new Be X-ray binaries**. **Conventional methods to estimate distances** will **remain important** because these kind of systems have **great uncertainties even in the *Gaia* era**.

References

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