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Asymptotic giant branch stars in the eROSITA-DE eRASS1 catalog

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ABSTRACT

Context. Asymptotic giant branch (AGB) stars are not expected to be X-ray-emitters, yet a small fraction of them, the so-called X-AGBs, show X-ray emission that can be attributed to coronal activity of a companion or accretion onto one.

Aims. By searching the recently released SRG eROSITA-DE eRASS1 source catalog, we aim to increase the sample of known X-AGBs and investigate their X-ray and far-UV properties. So far, 36 X-AGBs have been reported, which includes 21 previous detections from ROSAT RASS, Chandra, and XMM-Newton and 15 recent detections from eROSITA eRASS1.

Methods. We cross-correlated the position of sources in the eROSITA-DE eRASS1 catalog with the largest available samples of AGB stars in order to find possible X-ray counterparts. We carefully checked the possible counterparts by comparing X-ray and near-IR *K* images, disregarding those affected by optical loading, those found to be diffuse sources, or those simply considered unreliable positional associations.

Results. We have found seven high-confidence X-AGBs and another seven possible ones. Accounting for previous X-ray detections, the sample of X-AGBs is increased by 11 new sources, increasing the sample of X-AGBs from 36 up to 47. Adding these sources to previous eROSITA-DE eRASS1 X-AGB detections, eROSITA has so far discovered 26 new X-AGBs, more than doubling the number of known X-AGBs. This demonstrates eROSITA's capability to detect X-AGBs despite the challenge posed by the optical loading caused by their near-IR brightness, which makes the X-ray detection untrustworthy in a number of cases.

Conclusions. The eRASS1 X-AGBs tend to have a higher X-ray luminosity than that of previously detected X-AGBs, suggesting a bias toward brighter sources that is very likely due to the short exposure time of eRASS1 sources. A comparison of the X-ray and far-UV luminosity of X-AGBs with those of X-ray-emitter symbiotic stars (X-SySts) revealed an overlap in the X-ray luminosity range $10^{29.5} < L_X$ (erg s^{-1}) $<10^{33.0}$. The average higher X-ray luminosity of X-SySts AGBs ($\approx 10^{32}$ erg s^{-1}) can be interpreted as X-ray emission arising from a boundary layer between an accretion disk and a white dwarf, whereas the average lower X-ray luminosity ($\approx 5 \times 10^{30}$ erg s^{-1}) of X-AGBs would arise from an accretion disk around main-sequence or subgiant F-K companion stars.

Key words. accretion, accretion disks – stars: AGB and post-AGB – binaries: general – X-rays: binaries

1. Introduction

Asymptotic giant branch (AGB) stars are bright cool giant stars with an inert core of carbon and oxygen, an inner shell where helium is burned into carbon, an outer shell where hydrogen is burned into helium, and an extended hydrogen-rich envelope. AGB stars are the immediate progenitors of planetary nebulae (PNe), and as such, they hold the keys to understanding their formation. Most PNe are believed to be shaped by binary interactions (De Marco 2009), and thus AGB stars have become a target for companion searches.

The discovery of a companion to an AGB star, however, is only straightforward when it is a member of a symbiotic star (SySt), a close binary system composed by a red giant and a white dwarf (WD). In these systems the components are so close to each other that mass transfer takes place from the giant primary to the secondary WD, very likely through an accretion disk around the latter (Merc et al. 2024). Thus, although the secondary cannot generally be visually detected, the spectrum of a SySt usually contains (in addition to absorption lines produced at the atmosphere of the cooler red giant; e.g., Schmidt et al. 2006) emission lines formed in the accretion disk that unveils the presence of the companion. On the other hand, if a binary system consists of an AGB star and a low- or intermediate-mass main-sequence or subgiant companion, the detection of the secondary is cumbersome because (1) the high luminosity of the AGB star overshines its companion, (2) no emission lines from an accretion disk are detected, and (3) the radial pulsations of the AGB star hamper the detection of the radial velocity variations caused by the mutual orbital motion.

Alternatively, the binarity of an AGB star can be revealed at high energies, particularly in X-rays. Single AGB stars are expected to be X-ray quiet because they are slow rotators and thus unlikely to have strong surface magnetic fields to support a corona (Ayres et al. 1981; Linsky & Haisch 1979). Therefore, AGB stars with X-ray counterparts (hereafter X-AGBs) are believed to be members of binary systems, particularly those with X-ray luminosity in excess of a few times 10^{29} erg s^{-1}