HgMn stars as apparent X-ray emitters

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Abstract. In the ROSAT all-sky survey 11 HgMn stars were detected as soft X-ray emitters (Berghöfer, Schmitt & Cassinelli 1996). Prior to ROSAT, X-ray observations with the *Einstein Observatory* had suggested that stars in the spectral range B5–A7 are devoid of X-ray emission. Since there is no X-ray emitting mechanism available for these stars (also not for HgMn stars), the usual argument in the case of an X-ray detected star of this spectral type is the existence of an unseen low-mass companion which is responsible for the X-ray emission. The purpose of the present work is to use all available data for our sample of X-ray detected HgMn stars and conclude on the nature of possible companions.

Key words: X-ray sources – HgMn stars

1. Introduction

In the ROSAT all-sky survey X-ray emission was detected in 11 HgMn stars (5 spectroscopic binaries, 4 double-lined spectroscopic binaries, and 2 HgMn stars without available radial velocity data). For 2 of 3 spectroscopic binaries (SB) additional observations obtained with the ROSAT High-Resolution Imager (spatial resolution of ≈ 5 arcsec) confirmed X-ray sources at the position of two systems (Berghöfer & Schmitt 1994). Known visual companions could be discarded as most likely X-ray emitters. Previous X-ray observations (by the *Einstein Observatory*) had suggested that stars in the spectral range B5–A7 are devoid of X-ray emission. Since there is no X-ray emitting mechanism available for these stars, the usual argument in the case of an X-ray detection is the existence of an unseen low-mass companion which is responsible for the X-ray emission. However, this hypothesis is not easily testable.

For our sample of X-ray detected HgMn stars we used all available data to conclude on the nature of the companion. We emphasize that some of our sample stars consist of two nearly equal B stars. The observed X-ray emission in these systems is also inconsistent with the secondary star and, thus, a third component must exist to explain the X-ray emission by a low-mass companion. Some of our sample stars show X-ray luminosities that exceed the X-ray output

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of normal late-type stars and, therefore, an active pre-main sequence companion (PMS) is required. This hypothesis is supported by the fact that a significant fraction of the HgMn stars found in the ROSAT survey belong to rather young stellar groups like the Pleiades supercluster or the Sco-Cen association. Recently, it has been shown that there is a population of pre-main sequence stars in the Pleiades supercluster, and that both cluster and non-cluster members range in age from about $2.6 \cdot 10^6$ to 10^8 yrs (Eggen 1995; Oppenheimer et al. 1997). Many of these stars exhibit high levels of stellar activity and strong lithium lines. If there is ongoing star formation in these regions, the phenomenon demands further study and the possibility of protostars in multiple star systems has wide-ranging implications.

2. Results and conclusions

Here we describe our method to conclude on the nature of possible low-mass companions. In a first step stellar masses and ages were derived for our sample of HgMn stars. For this we used the stellar model grids provided by Schaller et al. (1992); the stellar distances were taken from the recently released Hipparcos catalog and the effective temperatures were compiled from the literature. We then assumed that the absence of a secondary in the optical spectrum implies a mass ration of $M_1/M_2 \geq 1.5$ for the two binary components and all systems are formed coeval. A further criterion was the saturation limit of $\log(L_x/L_{Bol}) \approx -3$ known for late-type star X-ray emission (cf. Schmitt 1997); for the observed X-ray luminosities this relation provides upper limits for the bolometric luminosities of the possible secondaries. Together with these limits for the companions masses, luminosities, and ages, we used the pre-main-sequence evolutionary tracks provided by D'Antona and Mazzitelli (1994) to limit the range of possible companions of the 11 HgMn stars.

For all of our sample HgMn stars detected in the ROSAT all-sky survey we find that a companion of lower mass can provide a natural explanation for the observed X-ray emission. In 7 cases (HD 32964, HD 33904, HD 35497, HD 75333, HD 110073, HD 141556, and HD 173524) the detected X-ray emission can be explained by a main-sequence late-type star, whereas for the stars HD 27295, HD 27376, HD 29589, and HD 221507 a PMS star is required. Further investigations by means of radial velocity studies and high-resolution imaging (e.g., in the near IR) are needed to detect the predicted companions. According to the lower mass limits derived for possible companions in our sample of HgMn stars, spectral types are in the range late K-M4.

It is remarkable that in many cases when a spectroscopic binary with a late-B primary has a third, distant companion, the SB primary is a HgMn star (e.g., Hubrig & Mathys 1995).

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