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The enigmatic highly peculiar binary system HD 66051

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Abstract. HD 66051 (V414 Pup) is an eclipsing and spectroscopic double-lined binary, hosting two chemically peculiar stars: a highly peculiar B star as primary and an Am star as secondary. It also shows out-of-eclipse variability that is due to chemical spots. Using a set of high-resolution spectropolarimetric observations, a weak magnetic field on the primary was found. The investigation of the new high-resolution UVES spectrum of HD 66051 allowed us to decide on the chemical peculiarity type of both components with more reliability.

Key words: binaries: eclipsing – Stars: chemically peculiar

1. Introduction

Chemically peculiar (CP) stars comprise about 10% of upper main-sequence stars (spectral types early B to early F). They are characterized by peculiar atmospheric abundances which deviate significantly from the solar composition. Two groups of CP stars are relevant to this investigation. The Bp/Ap stars are set apart by the presence of stable, globally-organized magnetic fields with strengths from about 300 G to several tens of kG. The origin of the observed magnetic fields is still a matter of some controversy, the main competing theories being the dynamo theory (field generated by dynamo action in the convective core) and the fossil field theory (field is a relic of the frozen-in interstellar magnetic field). Another important group is made up of the so-called Mercury-Manganese (HgMn) stars. As their name implies, these stars are characterized by their unusually strong lines of Hg and Mn. These stars do not show strong, organized magnetic fields, the presence of weak fields has been claimed but remains controversial.

2. Prior analysis of HD 66051

Niemczura et al. (2017) and Paunzen et al. (2018) analyzed high-resolution spectra and photometric time series allowing them to determine the atmospheric parameters, the preliminary chemical composition of both stars, and orbital parameters ($P = 4.749218$ d) of the system. The primary component was found to be a slowly rotating late B-type star with a highly peculiar composition reminiscent of the primary in the SB1 system HD 65949, which seems to be its closest analogue. Some light elements such as He, C, Mg and Al are depleted, while Si and P are enhanced. For atomic numbers $Z > 20$ all elements are overabundant with the single exception of Ni, which has generally been found deficient in HgMn stars. The secondary component was estimated to be a slowly rotating A-type star. Later on Kochukhov et al. (2018) challenged this first analysis on the basis of high-resolution spectropolarimetric observations. This situation motivated us to perform a new analysis of this system using all already published photometric as well as spectroscopic data. In addition, new photometric data from the *TESS* satellite and a high-resolution, high signal-to-noise UVES spectrum obtained in the framework of the ESO DDT program 2102.D-5017(A) were used.

3. Results

As already known, the primary star is a highly peculiar object. In the spectrum of this star we found some light elements (He, Mg, Al) underabundant and all analyzed iron-peak elements except Ni enhanced. Similarly, heavy and rare-earth elements are overabundant in its spectrum. An overabundance of these elements indicates that the primary is a Bp star. On the other hand, we identified lines of Mn, Xe, Pt, and Pb in its spectrum. Abundances of these elements are enhanced, suggesting an HgMn type. Most importantly, up to the present, Xe and heavy element overabundances were observed exclusively in HgMn stars, but never in Bp star atmospheres. The lines that we could identify with the secondary star indicate an abundance pattern with overabundant iron-peak, heavy, and rare-earth elements and depleted Sc, which agrees very well with the definition of Am-type objects.

References

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