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Upper main sequence close binaries with magnetic components

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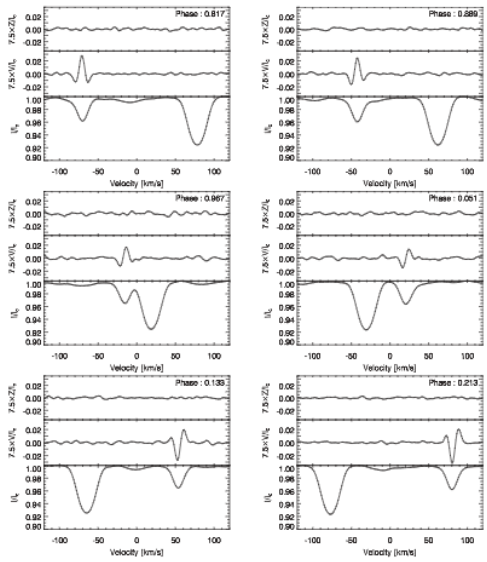
Context

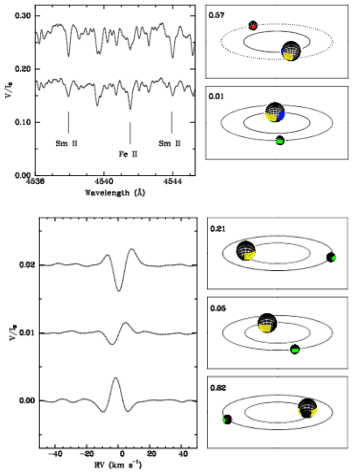
Two scenarios can explain the origin of magnetic fields in upper main sequence stars: binary mergers and fossil relics, i.e. magnetic flux preserved from the stellar formation process, amplified during the early pre-main-sequence evolution. A merger scenario for the magnetic field origin was suggested following the obvious lack of magnetic components in binaries with short orbital periods (Bogomazoc & Tutukov 2009; Ferrario et al. 2009). Only two close binaries with a magnetic Ap component, HD98088 (P_{orb} = 5.9d, Babcock 1958) and HD161701 (P_{orb} = 12.5d, Hubrig et al. 2014), are currently known. The field geometry and the chemical spot distribution on the surface of the magnetic components, as well as the alignment of the magnetic axes with respect to the orbital radius vectors in close binaries can give us important information about the dynamical processes taking place during the star formation and the tidal synchronization.

Do we see interplay between magnetism and binarity?



SVD Stokes I, V, and diagnostic null Z profiles (bottom to top) of HD161701, calculated using Fe I/II lines. Parameters: q = 0.59, T_{eff}(A) = 12,400K, log g(A) = 3.76, T_{eff}(B) = 9750K, log g(B) = 4.15. The orbital inclination is about 72°. HD161701 is the only binary system identified to consist of a HgMn primary and an Ap secondary. No polarization is observed at the position of the average profile of the HgMn primary with a detection limit of 79G in the Stokes V profiles.

Variability of line profiles and Stokes V in the system HD161701



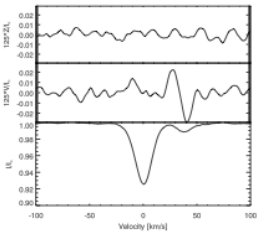
Intensity maxima of rare-earth elements in HD98088 and HD161701 are observed near the phase of conjunction, i.e. at the surface persistently facing the companion. The surfaces facing the companion carry a positive magnetic field. The alignment of the magnetic axes with the orbital radius vector may indicate that the generation of the magnetic field was a dynamic process during tidal synchronization.

Only two late-B type binaries with magnetic components and orbital periods below 20d are known: HD5550 (Alecian et al. 2016) and BD −19 5044 (Landstreet et al. 2017). Only one early-B type short-period magnetic binary, HD136504 (Shultz et al. 2015), is known. Among the O-type stars, only in HD47129 (Plaskett's star, Grunhut et al. 2013) the secondary possesses a magnetic field. Notably, in contrast to the studied close Ap binaries, in all detected B-type binaries the magnetic components are observed close to the rotational pole and at low dipole obliquity, not allowing to study the interplay between magnetism, chemical peculiarities, and binarity. Only three systems with P_{orb} < 10d and only three systems with e~0 are known; in three systems the secondary is magnetic. All these observations contradict the fossil field scenario.

Close binaries among Herbig Ae/Be stars, the potential progenitors of Ap/Bp stars

The majority of Herbig Ae/Be stars (1.5−8$M_{\odot}$) are located at least 300pc from the Sun. Among the Herbig stars, Corporon & Lagrange (1999) found only a binary fraction of 10% with P_{orb} ≤ 100d. Only three Herbig Ae/Be stars have short orbital periods below 10d, with near-circular orbits (Duchene 2015).

HARPSpol observations of the Herbig Ae close binary HD104237, where the longitudinal magnetic field in the secondary was detected by us for the first time.



Summary

Only very few short-period binaries are known among the Herbig Ae/Be and Ap/Bp stars, indicating that the merger scenario can indeed be employed to explain the magnetic field generation in stars with radiative envelopes. Systems born as hierarchical triples may now appear as a wide binary, after the close pair has interacted. The post-interaction products may spin slowly because of magnetic spin-down. It is not yet clear whether close binaries with magnetic components can be considered as failed merger products. In that case, a careful study of the magnetic field topology and the chemical element distribution in binary components is of special interest and may provide us with important clues on the dynamical processes taking place at the early stages of binary evolution.