Leibniz-Institut für Astrophysik Potsdam

European Southern Observatory

www.eso.org

The evolutionary state of chemically peculiar Ap/Bp stars in NGC 2516 using GAIA data on singles and binaries

S. Hubrig[1], M. Schöller[2], N. V. Kharchenko[3], A. E. Piskunov[4] , S. P. Järvinen[1]

1 Leibniz-Institute for Astrophysics Potsdam (AIP), Germany 2 European Southern Observatory (ESO), Germany 3 Main Astronomical Observatory, Ukraine 4 Institute of Astronomy, Russian Academy of Sciences, Russia

The origin of the magnetism in stars with radiative envelopes and the role the magnetic field plays in their evolution remain unknown. The most popular scenario involves a merging event or a common envelope evolutionary phase. Mass transfer in stellar merging may rejuvenate the mass gaining star, while the induced differential rotation is thought to be a key ingredient to generate a magnetic field. One of the observable manifestations of the presence of coalesced stars or stars experiencing a common envelope evolution is the existence of blue straggler stars. Studies of open clusters and associations have seen great improvement with the advent of Gaia DR3 data, allowing us to determine photometric and kinematic ages, including runaway status of upper-main sequence stars possessing magnetic fields. In this poster we discuss our assessment of the evolutionary state of eleven binary and single chemically peculiar stars, among them stars with strong magnetic fields previously classified as highly probable members of the open cluster NGC 2516.

Knowledge about the evolutionary state of the Ap/Bp stars is essential to understand both the physical processes taking place in these stars and the origin of their magnetic fields. This is illustrated in Fig. 1 adopted from Hubrig et al. (2000, ApJ 539, 352).

However, previous studies of magnetic Ap/Bp stars presumably belonging to open clusters (e.g. Landstreet et al. 2007, A&A 470, 685, and references therein) indicated that these stars are present at essentially all evolutionary stages between ZAMS and TAMS. Of particular interest was the result that the strongly magnetic A0p star HD 66318 belongs to the open cluster NGC 2516 and completed only about 16 ± 5% of its main sequence life. This conclusion contradicted the results by Hubrig et al. (2000) that magnetic fields appear in Ap stars after about 30% of their main sequence lifetime has elapsed.

Recently we used the most accurate and complete Gaia EDR3 data on stellar astrometry and photometry in the area of the nearby rich open cluster NGC 2516 to establish the membership probability of known magnetic peculiar stars and to deduce their evolutionary state. The obtained distribution of stars in this cluster and the observed colour-magnitude diagram are presented in Figs. 2 & 3.

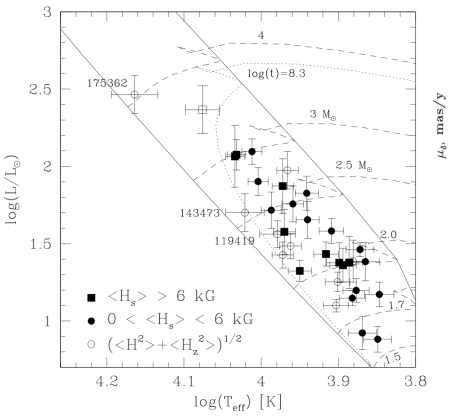

Figure 1: H-R diagram for strongly magnetic Ap stars showing concentration toward the center of the main-sequence band. In particular, it was found that magnetic fields appear only in stars that have already completed at least approximately 30% of their main-sequence lifetime. Adopted from Hubrig et al. (2000, ApJ 539, 352).

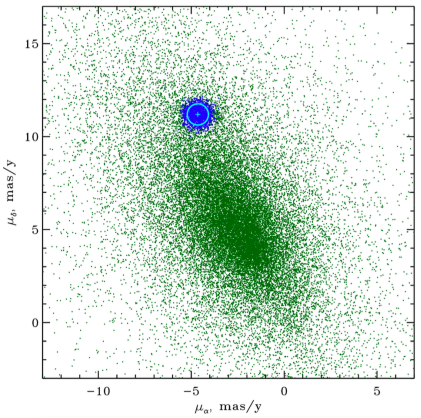

Figure 2: The distribution of stars in the NGC 2516 area in the vector point diagram. Green dots show field stars, blue dots indicate stars used for the calculation of the cluster member distribution parameters, where the cyan plus corresponds to the average proper motion. The large cyan oval (almost a circle) indicates the ellipse of the proper motion standard deviations $\sigma_{\mu\alpha}$ and $\sigma_{\mu\delta}$. Adopted from Kharchenko et al. (2022, MNRAS 515, 3094).

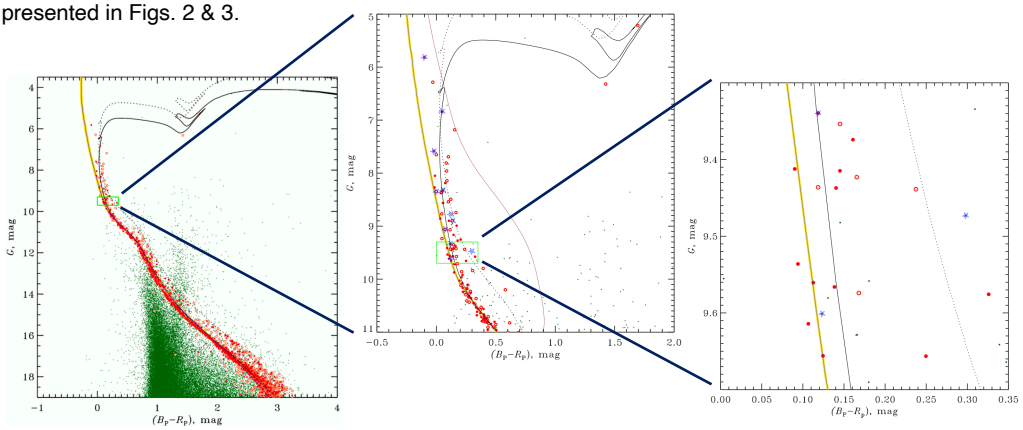

*Figure 3: **Left**: Observed colour-magnitude diagram of NGC 2516 and the Padova isochrone for log t = 8.10 (black line). The black-yellow line indicates the ZAMS, the dotted line is a sequence of equal-mass unresolved binaries. The green dots are field stars, the red dots are cluster 1σ- members, the red open circles mark 2σ-members. **Middle**: Enlarged version of the CMD in the Turn Off-region. The stars of interest are shown with blue five-point star symbols. The thin dark red line shows the TAMS. **Right**: A further enlargement to the region. Adopted from Kharchenko et al. (2022, MNRAS 515, 3094).*

Conclusions:

- The strongly magnetic A0p star HD 66318 does not belong to the cluster at a high level of confidence. Thus, its evolutionary stage is undefined.
- Out of the five bona-fide magnetic chemically peculiar stars, only two stars, HD 65987 and HD 65712, have a high membership probability.
- It is of importance that the apparent younger ages of two Ap stars, HD 66194 and HD 65987, suggest that they are associated with stellar merging, where a merge or mass transfer took place, and can be considered as blue stragglers.