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Double, triple and quadruple-line spectroscopic binary candidates within the Gaia-ESO Survey

Thibault Merle[1], Sophie Van Eck[1], Alain Jorissen[1] Mathieu Van der Swaelmen[1], Gregor Traven[2] and Tomaz Zwitter[2]

[1]Institut d'Astronomie et d'Astrophysique, Université Libre de Bruxelles CP 226, boulevard du Triomphe, B-1050 Brussels, Belgium
email: thibault.merle@ulb.ac.be

[2]Faculty of Mathematics and Physics, University of Ljubljana, Jadranska 19, 1000, Ljubljana, Slovenia

Abstract. The Gaia-ESO Survey (GES, Gilmore *et al.* 2012) provides a unique opportunity to detect spectroscopically multiplicity among different populations of the Galaxy using the cross-correlation functions (CCFs). We present here the GES internal Data Release 4 (iDR4) results of the detection of double, triple and quadruple-line spectroscopic binary candidates (SBs) and discuss some peculiar systems.

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We developed a method based on the computation of the CCF successive derivatives to detect multiple peaks and determine their radial velocities, even when the peaks are strongly blended. The Detection Of Extrema (DOE) code therefore allows to automatically detect multiple line spectroscopic binaries (SBn, $n \geqslant 2$). We reveal about 354 SBn candidates in iDR4 (342 SB2, 11 SB3 and even one SB4), including only nine SBn already known in the literature. About 98% of these SBn candidates are new because of their faint visual magnitude ($V < 19$), as clearly illustrated by the comparison with the Geneva-Copenhagen Survey (GCS, Holmberg *et al.* 2009; see left panel of Fig. 1). In particular:

• An orbital solution could be computed for two new SB2: 06404608+0949173 in NGC 2264 (known as V642 Mon) and 19013257-0027338 in Berkeley 81.

• Three giant SB2 candidates (right panel of Fig. 1) are surprising, since they should have a mass ratio very close to 1. Interestingly, the one with the lowest gravity (a CoRoT target) shows a very short estimated period of about 7.5 d compared to minimum periods of 25 d (resp. 200 d) for samples of K (resp. M) giants (Mermilliod *et al.* 2007, Jorissen *et al.* 2009). This system will provide important insight into the evolution of close binaries composed of stars with similar (low) masses.

• Eleven SB3 have been discovered (left and middle panels of Fig. 2) and given the stability issues raised by the dynamics of such systems, it is important to increase the statistics of their detection and to constrain the hierarchy of their orbits. A monitoring of the most probable SB3 candidates have been proposed with UVES/VLT.

• HD 74438 (A2V, $V = 7.5$) is a candidate quadruple system (SB4, right panel of Fig. 2), member of the very young open cluster IC 2391 (50 Myr). Indeed, the velocities of the A and B components (corresponding to the highest CCF peaks on the top right panel of Fig. 2) vary slowly and oppositely to each other, with similar variation amplitudes

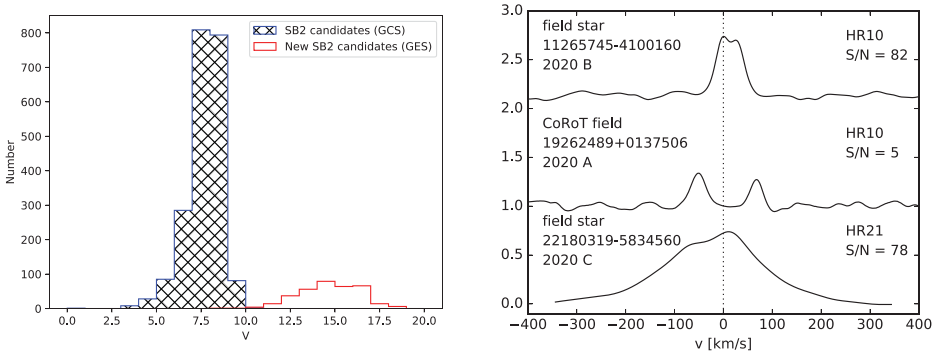

Figure 1. Left: Histogram of the SB2 candidates within the GCS and within the GES. Right: The CCFs of the three SB2 giant candidates.

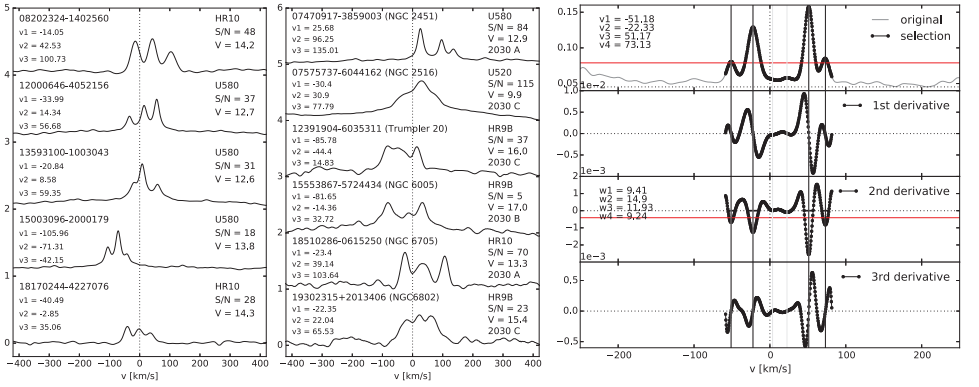

Figure 2. Left: five SB3 candidates in the field. Middle: six SB3 candidates in clusters of various ages. Right: CCF and the three successive derivatives of the SB4 candidate.

with respect to the cluster velocity (14.8 ± 1 km s^{-1}), as expected in a binary system ($\Delta v_r(B)/\Delta v_r(A) = M_A/M_B$). The same prevails for the CD pair. From a preliminary analysis, we found an upper limit on the period of each pair: $P_{AB} < 155$ d and $P_{CD} < 1.2$ d. Such an SB4 candidate would clearly deserve a follow-up.

The frequency of SBn ($n \geqslant 2$) found in the GES iDR4 sample is 0.7%, comparable to the RAVE detection rate (Matijevič *et al.* 2010). Our automated method has allowed an efficient discovery of many new multiple systems (Merle *et al.*, submitted). New CCFs calculated with adapted masks are under investigation to increase the rate detection (see M. Van der Swaelmen's contribution, this issue). We warn against the use of atmospheric parameters for these system components not derived by SB-specific pipelines. Our method can easily be applied to other spectroscopic surveys like the ESA Gaia mission.

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