Single lined spectroscopic binary stars in the RAVE survey

D. Birko, T. Zwitter

E-mail: danijela.birko@gmail.com

Faculty of Mathematics and Physics, University of Ljubljana

RAVE – the Radial Velocity Experiment

- 10 years of observations (2003. - 2013.)
- 1.2 UK Schmidt Telescope of the Australian Astronomical Observatory
- 574.630 spectra; 483.330 stars
- up to ~3 kpc from the Sun
- magnitude range: 8 < I < 12 mag
- spectral region: 8410 – 8794 Å
- resolution: R ~ 7000
- accuracy of velocity determination: ~ 1.5 km/s

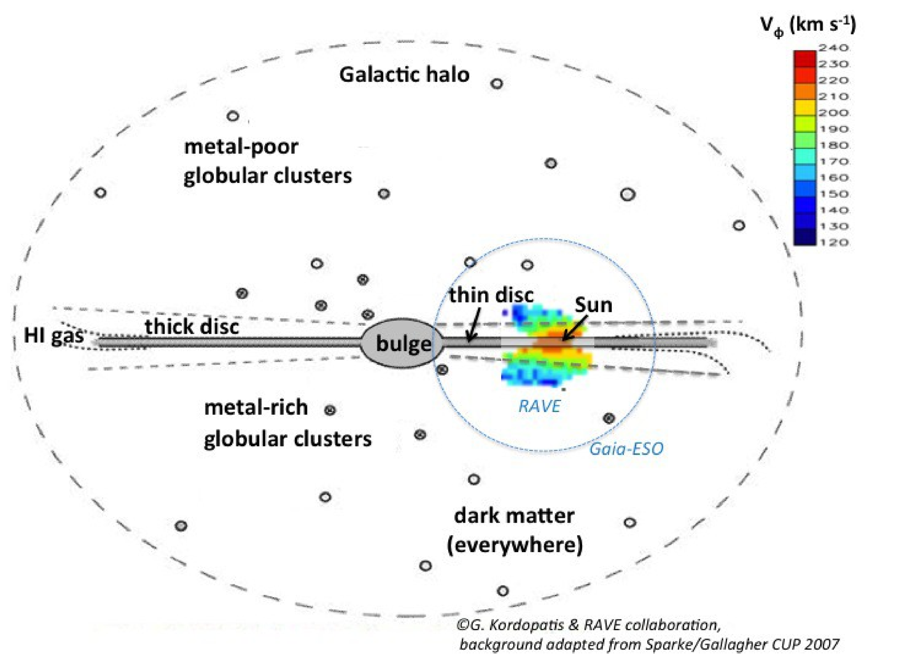

Figure 1

Radial velocities

- quantitative criterion for RV variability

$$p_{\log} = -\log_{10}(1 - \mathrm{P})$$

where P is probability

$$\mathrm{P}(2{>}1) = \frac{1}{2}[1 + \mathrm{erf}(\frac{\mathrm{RV}_2 - \mathrm{RV}_1}{\sqrt{2(\sigma_1^2 + \sigma_2^2)}})]$$

Table 1

Nobs	N	plog > 2.87		plog > 4		plog > 6	
		N	%	N	%	N	%
2	32569	1056	3.2	747	2.3	533	1.6
3	2983	125	4.1	77	2.6	51	1.7
4	1149	99	8.6	66	5.7	43	3.7
5	1395	250	17.9	159	11.4	108	7.8
6	1120	269	24.0	171	15.3	106	9.5
7	166	46	27.7	30	18.1	18	10.8
8	141	34	24.1	21	14.9	15	10.6
9	100	36	36.0	27	27.0	16	16.0
10	55	29	52.7	24	43.6	10	18.2
11	26	11	42.3	7	26.9	3	11.5
12	6	4	66.7	3	50.0	1	16.7
13	5	5	100.0	5	100.0	2	40.0

- the adopted lower limit indicating real variability (Pourbaix et. al, 2005) is $p_{\log}$ = 2.87
- Figure 3: distribution of maximum radial velocity changes between two measurements of the same star

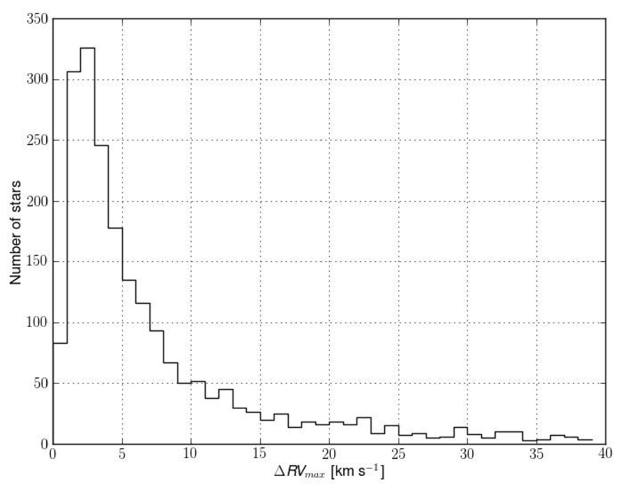

Figure 3

Repeated observations

- randomly selected stars
- more than one observation of the same star is needed to identify variable radial velocities and single lined binary stars
- Figure 2: distribution of the time span between the consecutive observations of the same object
- most of the repeats were observed in the following few days
- maximal time span between two observations is ~3000 days
- 39715 stars (< 10%) observed more than once
- morphological classification (Matijevič et. al, 2012): excluded double lined binary stars, chromospherically active stars and other peculiar stars (5 – 10%)
- 1965 normal stars which are high probability SB1 candidates ($p_{\log}$ > 2.87)
- ~5 % of all stars with repeated observations

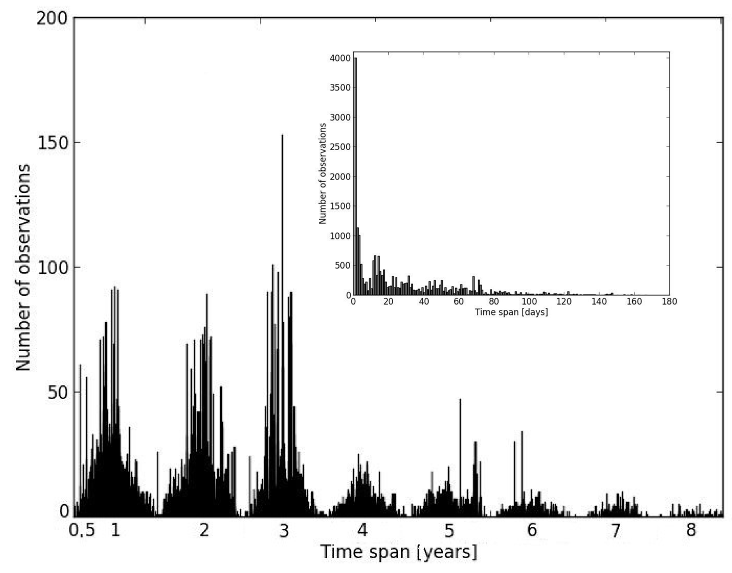

Figure 2

Single lined binary stars (SB1) candidates

- most SB1 candidates are short period systems
- Figure 4: vertically rescaled distributions of the effective temperature, metallicity, magnitude and S/N
  - two peaks at 4500 K (red clump and giant stars with masses larger than 1.2 M_{sun}) and at 6000 K (mostly main sequence dwarfs with masses ~1-1.2 M_{sun})
  - SB1 candidates have slightly lower metallicity than general population (may be due to contribution from a secondary star spectrum)
  - apparent J (2MASS) Magnitude
  - S/N of re-observed stars and SB1 is higher than in general population
  - brighter stars are observed more frequently than the faint ones
- Figure 5: HR diagram of SB1 candidates
  - isochrones for [M/H]= -0.3 and [M/H]= -0.7 for stars with log ages between 9 and 10 and a step of 0.2. (Marigo et. al, 2008)
  - dashed line divides giants and red clump stars from the main sequence dwarf stars

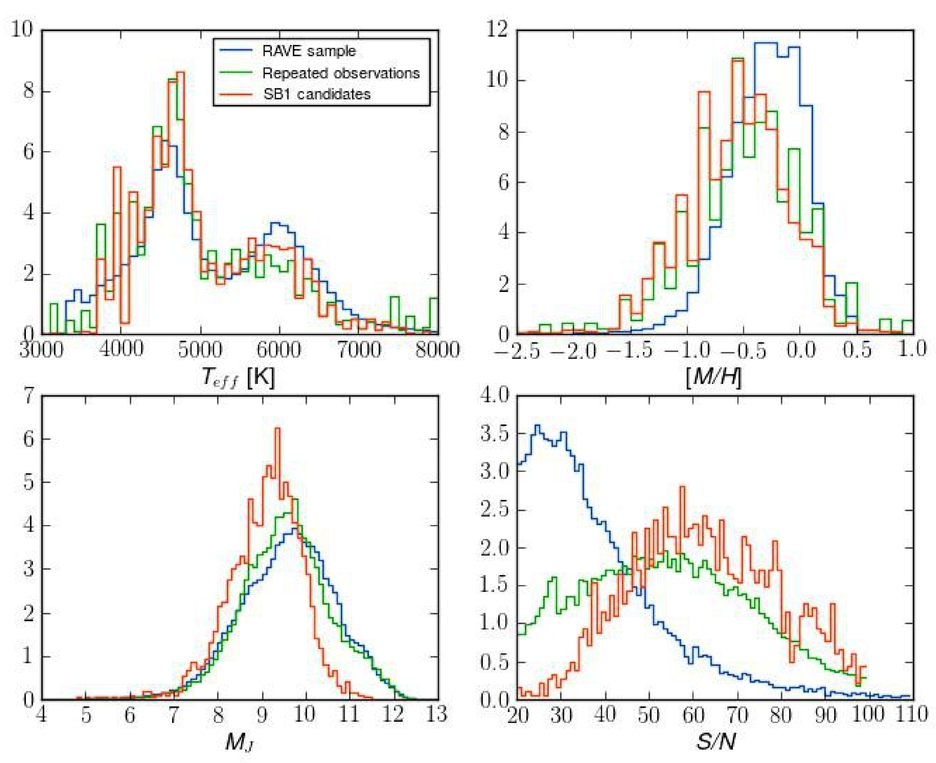

Figure 4

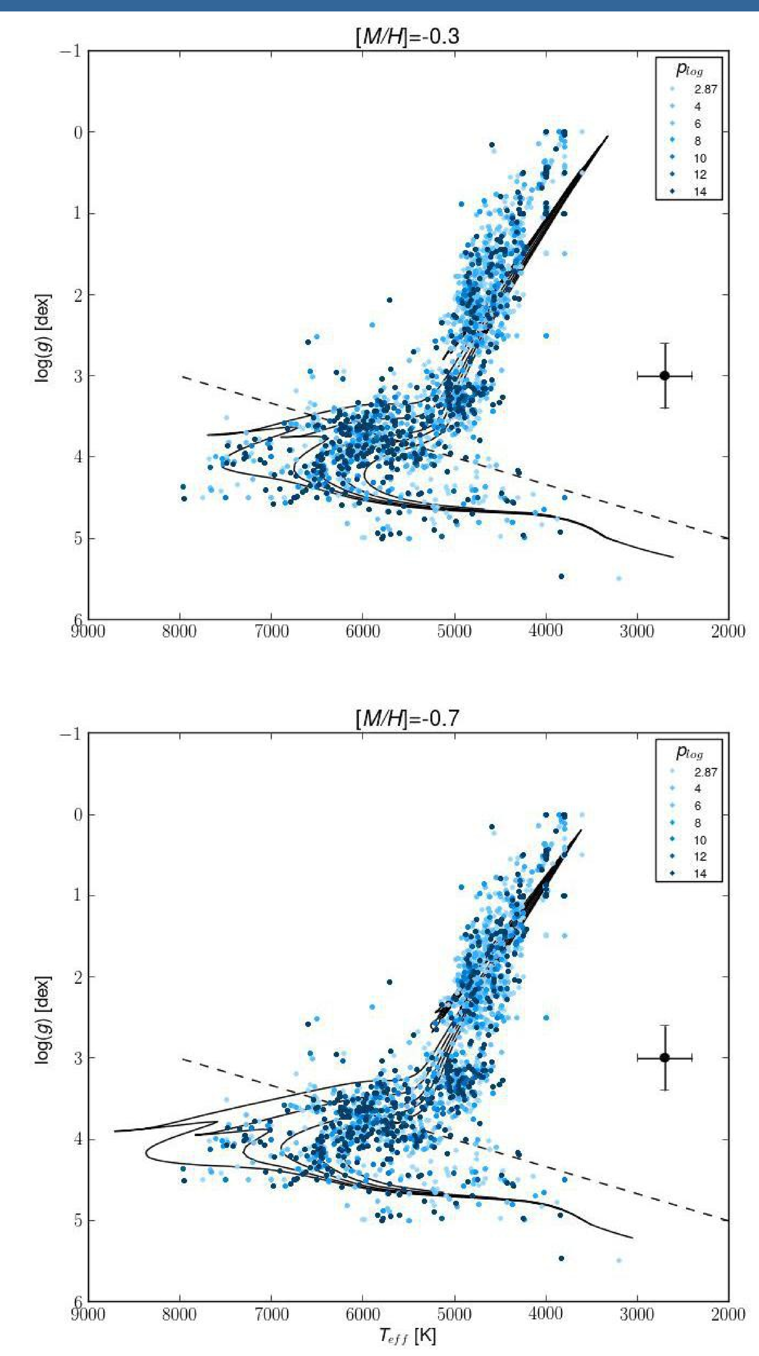

Figure 5

Conclusions

- fraction of observed SB1 candidates is a function of the number of observations
- systems with larger RV amplitudes probably have shorter periods
- reanalysis of spectra may identify contribution from a secondary component
- this possibility is mostly limited to main sequence pairs with similar masses

References

[1] Kordopatis, G., Zwitter, T., et al., AJ, 146, 134 (2013)
[2] Marigo, P., Girardi, L., et al., A&A, 482, 883 (2008)
[3] Matijevič, G., Zwitter, T., Bienayme, O., et al., AJ, 141, 200 (2011)
[4] Matijevič, G., Zwitter, T., Bienayme, O., et al. ApJS, 200, 14 (2012)
[5] Pourbaix, D., et al., A&A, 444, 643 (2005)
[6] Siebert, A., Williams, M. E. K., Siviero, A., et al., AJ, 141, 187 (2011)
[7] Steinmetz, M., Zwitter, T., Siebert, A., et al., AJ, 132, 1647 (2006)
[8] Zwitter, T., Siebert, A., Munari, U., et al., AJ, 136, 421 (2008)