Search for the best solar twin in the Geneva Copenhagen Survey

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Until today no object was found on which the astronomical community could agree on being the best solar twin. Mostly photometric and spectroscopic candidates do not match, as can be seen in figure (1), where our photometric selection varies from Soubirand & Triauds spectroscopic selection. One needs to combine both techniques to find the best solar twin. In our work we used Sun-like stars from the Geneva Copenhagen Survey, constraining absolute magnitude, b-y and the metallicity to values as close as possible to the solar values. Our aim is to find in this sample of 71 stars the object which is spectroscopically closest to the Sun. For this we have obtained FEROS spectra for all of them, which we are now in the process of analysing.

Choice of targets:

The targets were chosen from the Geneva Copenhagen Survey (Nordstrom et al., 2004). The choice was windowed around the Sun in the centre, with the Sun's colours being determined by Holmberg et al. (2006) and taking colour 0.371 < b-y < 0.435, absolute magnitude 4.63 < M_V < 5.03 and metallicity -0.15 < [Fe/H] < 0.15.
As can be seen in figure (1), the Sun (in the circle) is nicely centred in our sample (dotted box).
Of the resulting 80 targets, 71 spectra were taken with the FEROS spectrograph on the 2.2m telescope at La Silla, Chile. Thus providing a look for a solar twin in the southern hemisphere. The FEROS spectrograph provides a spectral coverage from 3500 to 9200 Angstrom with a resolution of 48000.
It needs to be mentioned that looking for solar twins with solar elemental abundances now seems to be a difficult choice, as Melendez et al. (2009) showed that the Sun's abundances may be special due to its planets.

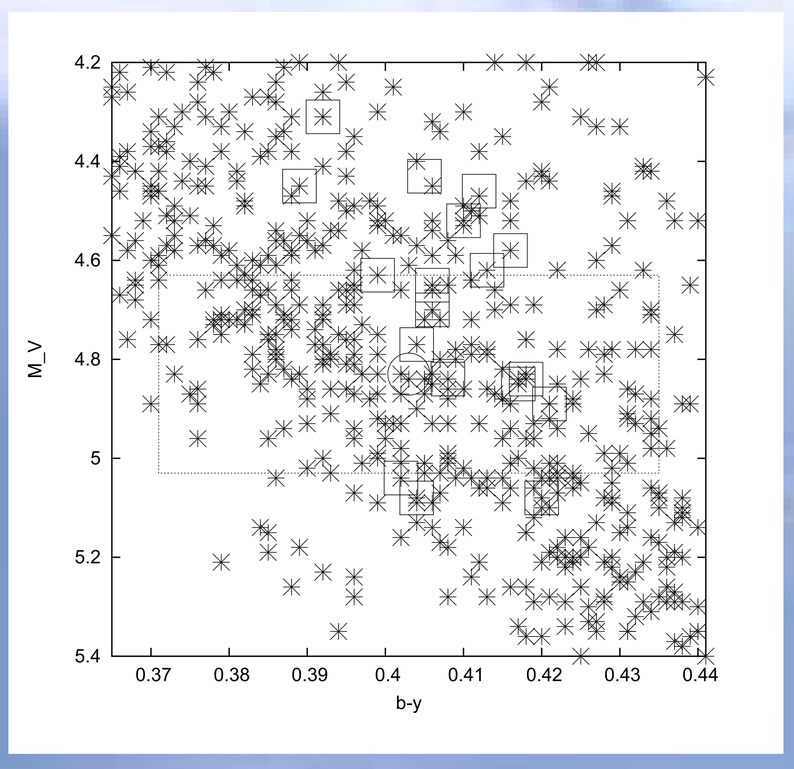

Figure 1: A volume sample of stars from the Nordström et al. catalogue (stars), together with the solar analogue candidates from Soubiran and Triaud (2004) (boxes) and the Sun (circle). The solar analogues in the Soubiran & Triaud sample, being based on a pure spectroscopic match, appear to be redder and more luminous than the Sun. Our chosen sample of solar analogues is drawn from stars with near solar abundance inside the small box around the Sun.
(From the original ESO proposal by Johan Holmberg et al.)

After the new release of the GCS catalogue, we then found that part of our sample had moved out of the original box and new targets had moved inside. After going through the FEROS archive, we found spectra for some of the new targets, which we then included into our analysis. The sample grew to 97 stars. We also included stars from other papers for comparison. The total size is now 144 stars.

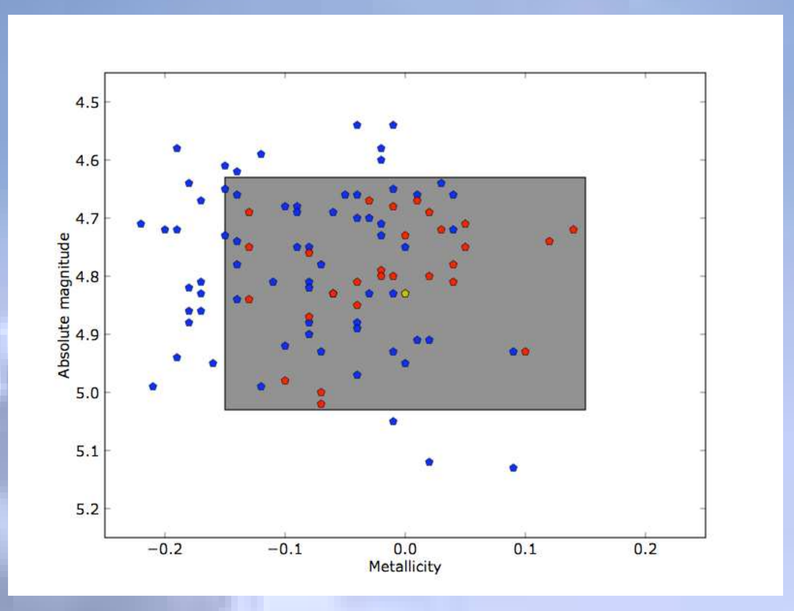

Figure 2: The blue stars represent the old sample, the red ones are stars included from the newest GCS release. The yellow star is the sun.

Based on observation at the 2.2m telescope at La Silla, Chile. Data was taken by Johan Holmberg, Turorla Observatory (at the time)

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and in collaboration with Johan Holmberg.

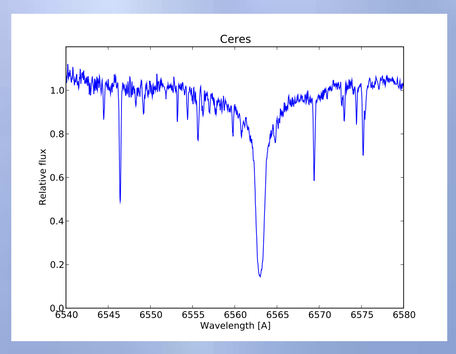
A first glance at the data:

The first step was to extract and reduce the data, which was done with the FEROS pipeline. Then as a first criterion when comparing the the spectra, we chose to look at the Halpha lines of the objects as it is a prominent feature and a good indicator for the effective Temperature of the star. Here it is shown a solar Halpha line, taken from an asteroid spectrum (Ceres), then four spectra which seem quite similar and finally one Halpha line, were the surroundings are quite different.
Just by looking at these plots, the Halpha region of the spectrum suggests HD12264 as a possible candidate for a solar twin.

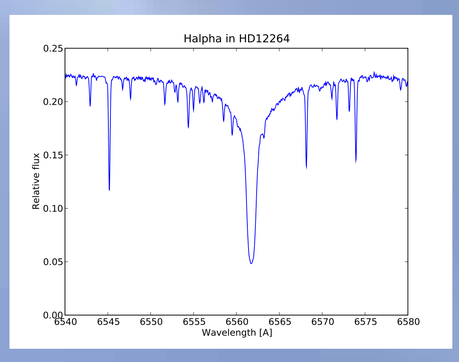
See here listed the values for metallicitiy, effective temperature and M_V of the above-mentioned stars:

Table 1: Parameters of the above-shown targets

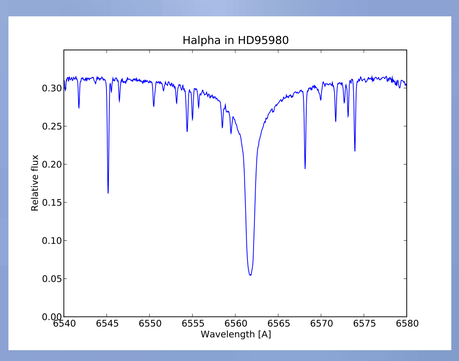
Object	Metallicity in [Fe/H]	Effective temperature	M_V
Sun	0.00	5778	4.83
HD12264	-0.14	5728	4.84
HD95980	-0.12	5754	4.59
HD117860	-0.08	5821	4.75
HD225299	0.00	5598	4.95
HD110668	-0.02	5702	4.58



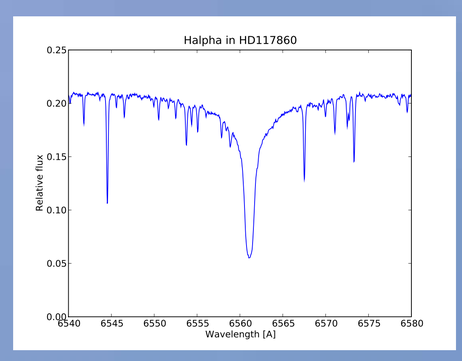
(a) H alpha in the Sun



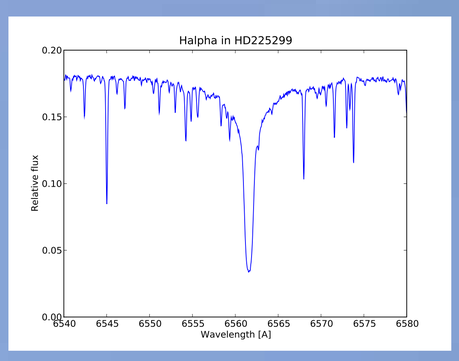
(b) H alpha line in HD12264



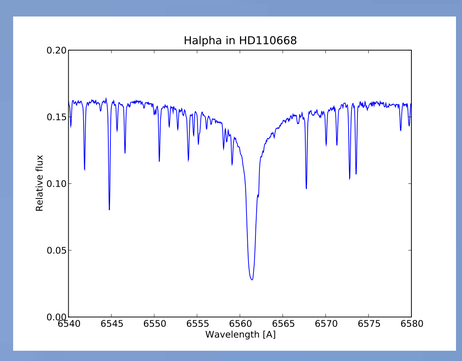
(c) H alpha in HD95980



(d) H alpha line in HD117860



(e) H alpha in HD225299



(f) H alpha line in HD110668

Work in progress:

This first look at our sample of possible solar twins merely shows that the spectra seem comparable in a single line, but the full available spectral range should be considered. Many other criteria have been adopted in the past literature to select solar analogues, and we plan to critically compare them.
We shall analyse iron lines and various other metal lines as indicators of both metallicity and temperature.
Taking advantage of the wide wavelength coverage of FEROS, we shall also consider the overall shape of the spectrum, by means of chi^2 match to the solar spectrum.

References

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