Alpha Centauri B (HD128621) is one of the best targets to search for an habitable Earth-like planet. The brightness of the star (V = 1.3) allowing to reach a very high signal-to-noise ratio, its low activity, its spectral type (K5V) and the proximity of it have made of Alpha Centauri B the holy grail of exoplanet astronomy.

HARP radial velocity (RV) measurements of Alpha Cen B show that the star is not as quiet as expected. Since 4 years, the activity level of the star has raised, increasing strongly the stellar jitter due to the presence of magnetic features on the stellar surface. Due to a high frequency sampling (2 to 3 measurements per night every night) and the very high precision of the HARP spectrograph (~80 c.m.s⁻¹), it is possible to see the magnetic cycle and the day-by-day variation of the rotational activity induced signal. The high quality of these data allows us to correct RVs from these perturbing signals and to detect an Earth-mass planet only 4 light years away.

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1. Contamination from Alpha Centauri A

- Due to the small separation between Alpha Centauri A and B, 7° in 2008, 5° in 2011, Alpha Centauri A will contaminate the spectrum of B when the seeing is poor. We estimate this contamination and remove measurements above a given seeing cutoff.

2. Binary and magnetic cycle

- The effect of the binary and the magnetic cycle can be seen in the RVs of Alpha Centauri B. Once these signals are removed, the rotational period of the star and its harmonics are seen in the periodogram of the residuals, revealing the presence of rotational activity.

3. Rotational activity

- Magnetic features are rotating with the star, therefore they will induce signal at the rotational period of the star and the corresponding harmonics. For season 2009 and 2 for 2010 and 2011.
- For season 2008, no activity signal is observed because the star exhibits a low activity level
- For each year of observation, the peak at 3.236 days conserves the same phase, which is expected for a planetary signal. The periodogram for all seasons is shown in black, the red curve in a shows the variation of the low-frequency part of the activity index scaled to the radial-velocity variation (see Fig. 2). When these low-frequency perturbations are removed, signals induced by rotational activity, pointed out by grey arrows in periodogram d, can be seen at the rotation period of the star and its harmonics.

4. An Earth-mass planet

- After removing the contaminated points, the effects of the binary, the magnetic cycle and the rotational activity, a signal at 3.2 days is revealed with 1 chance over 5000 to be due to noise (FAP = 0.02%). The amplitude of this signal is 51 c.m.s⁻¹.
- For each year of observation, the peak at 3.236 days conserves the same phase, which is expected for a planetary signal. On the contrary, the peak at 2.8 days and its alias at 3.35 days do not keep the same phase and are therefore associated to noise.

5. Skepticism about the planet


6. Conclusion

- Correcting for stellar signal is mandatory to find small amplitude planetary signal with RVs.
- High-frequency sampling is crucial to correct for rotational activity signal.
- We have found an Earth-mass planet orbiting the second closest star.