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Rotation and small separations of α Cen A

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Abstract

We observed α Cen A during five nights using HARPS. We identified 34 p modes. We observed multiple frequencies for some value of radial order n and degree ℓ. We analyse the scatter of these frequencies relative to the asymptotic relation and argue that they result from rotational splitting. We derive new values for the small separations taking in account this effect.

Observations

We report here on a five-night run on α Cen A using the high-precision spectrograph HARPS. Our exposure time range typically between 2 s and 10 s. The typical signal-to-noise ratio in the data is in the range $300-450$. In the time series, the dispersion for each individual night is in the range $1.5-3.3$ ms^{-1}. In the amplitude spectrum, we found a 3.7 cms^{-1} mean noise level in the range $4-5.5$ mHz. The estimated photon noise is 0.51 cms^{-1}. The difference is mainly due to guiding noise.

Results

We used both on-sight identification and the CLEAN algorithm to extract frequencies from the power spectrum. We then selected the p modes using the asymptotic relation as a reference. We eventually obtained a set of 34 oscillation frequencies with degrees $\ell = 0, 1, 2, 3$ and radial orders n in the range $16-26$. The amplitudes of the modes range from 13 cms^{-1} to 48 cms^{-1}. In the case of $\ell = 2$ modes, we identified 5 multiplets for radial orders 19 to 23. Assuming that our modes are unresolved, we adopted an uncertainty of 1.3 μHz on our frequencies, which is half the frequency resolution. Our results are in good agreement with the previous runs on α Cen A, the thirteen-night CORALIE campaign (Bouchy & Carrier 2002) and the multi-site campaign using UVES and UCLES (Bedding et al. 2004).

For each degree, the frequencies were fitted using a second-order polynomial. We then computed the scatter around these polynomials. Such a scatter is the consequence of several effects, both observational (S/N, sampling) and stellar (finite mode lifetimes, rotational splitting). The resulting scatters are for HARPS: $\sigma_0 = 0.41$ μHz, $\sigma_1 = 0.57$ μHz, $\sigma_2 = 1.50$ μHz (subscripts indicate the mode degree). For high inclinations of the rotation axis, this effect could be interpreted as a signature of rotational splitting. We note that multiplets were also identified with UVES/UCLES, not with CORALIE.

Considering the effect of rotational splitting, frequencies have to be averaged over the azimuthal order m to compute accurate small spacings, defined by $\delta\nu_{nl} = \nu_{n,l} - \nu_{n-1,l+2}$. These quantities are extremely useful to constrain theoretical models. We display small spacings obtained from each run in Fig. 1.

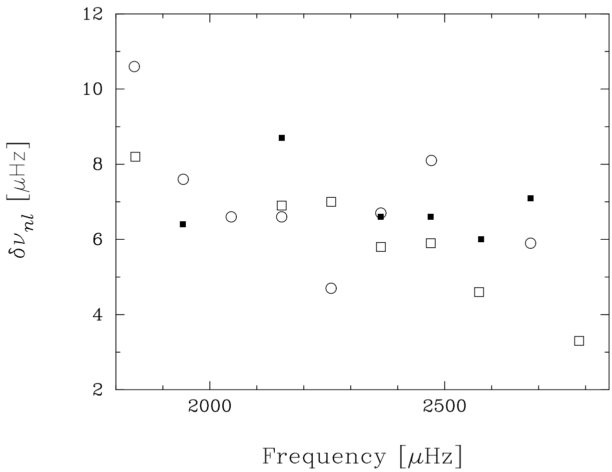

Figure 1: Small spacings of α Cen A from the HARPS (filled squares), CORALIE (open squares) and UVES/UCLES (open circles) runs. The trends in the HARPS and UVES/UCLES spacings are in good agreement.

References

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Bedding T. R., Kjeldsen H., Butler R. P., et al., 2004, ApJ, 614, 380

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