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Confirmation of Solar-Like Oscillations in η Bootis

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1. Excess power in η Bootis

Kjeldsen et al. (1995) detected excess power in the G0 subgiant η Boo from measurements of Balmer-line equivalent widths. The excess was at the expected level, and these authors were able to extract frequency separations and individual frequencies which agreed well with theoretical models (Christensen-Dalsgaard et al., 1995; Guenther & Demarque, 1996). A more detailed discussion of theoretical models for η Bootis was given by Di Mauro & Christensen-Dalsgaard (2001).

Kjeldsen et al. (1995) estimated the average amplitude of the strongest modes to be 7 times solar, corresponding to 1.6 m/s in velocity. 13 individual oscillation modes were identified consistent with a large frequency separation of 40.3 μHz. We note, however, that a search for velocity oscillations in this star by Brown et al. (1997) failed to detect a signal, setting limits at a level below that expected on the basis of the Kjeldsen et al. result.

In this paper we report further observations made in 1998. We observed this star in Balmer-line equivalent width with the 2.5-m Nordic Optical Telescope and in velocity with the 24-inch Lick CAT.

Equivalent-width observations We observed η Boo over six nights during May 1998 using ALFOSC (Andalucia Faint Object Spectrograph and Camera) on the 2.5 m Nordic Optical Telescope on La Palma. This is the same telescope used by Kjeldsen et al. (1995) but with a different spectrograph. We used seven echelle orders covering the range 420–680 nm with a spectral resolution of 1700. We obtained a total of 1843 spectra (sampling period 84 s) in 44.2 hours over six consecutive nights (1998 May 1–6).

Velocity observations We used the Hamilton Echelle Spectrometer and the 0.6-m Coudé Auxiliary Telescope (CAT) at Lick Observatory. To produce high-precision velocity measurements, the star was observed through an iodine absorption cell mounted directly in the telescope beam. We were allocated 56 nights in 1998 April and May, but the weather was unseasonably poor, permitting observations on only 26 nights (and many of these were partly lost). On the 11 best nights we obtained 95–120 spectra per night (sampling period 245 s), and the total number of spectra obtained was 1989 (about one third of the number possible with no weather losses).

In both sets of data we see an excess in the power spectrum, with oscillation frequencies that confirm the earlier observations by Kjeldsen et al. (1995).

2. Conclusion

- Observations in 1998 in a search for solar-like oscillations in η Bootis confirm the earlier observations by Kjeldsen et al. (1995).
- The large and small separations for η Bootis measured to be $(40.06 \pm 0.02)\,\mu$Hz and $(3.85 \pm 0.28)\,\mu$Hz, in excellent agreement with theory (Di Mauro & Christensen-Dalsgaard, 2001).
- The amplitudes of p-modes are in good agreement with those predicted by Kjeldsen & Bedding (2001) using a $1/g$ scaling relation, g being the surface gravity. The measured amplitudes are between 3 and 7 times solar (predicted value is 4.6 times solar). The higher amplitudes observed by Kjeldsen et al. (1995) could have been unusually high, reflecting the stochastic nature of the excitation. This may also explain why Brown et al. (1997) failed to detect any signal.

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