Radial and Nonradial Pulsations as Probes of Stellar Physics
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Results of Spectrograph EMILIE with the AAA System on Solar-Like Oscillations

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1. Radial velocity measurement with the AAA system

The spectrograph EMILIE (Bouchy et al., 1999; Bouchy, 1999; Bouchy et al., 2000) coupled to the Absolute Astronomical Accelerometer (AAA, Connes, 1985; Schmitt, 1997) and implemented at the 152-cm Coudé telescope of the Observatoire de Haute Provence is dedicated to high-precision Doppler measurements. The AAA method uses a sliding reference spectrum constrained to track the stellar lines and to use the spectrograph as a null-checking device. The goal of AAA is to eliminate the calibration of the spectrograph as well as the displacement of the spectra across the CCD pixels due to the earth motion (and suspected to introduce a systematic error in the RV measurement). Here we report seismological results obtained with AAA on the Sun and the bright stars Procyon and ζ Her A that are expected to present solar-like oscillations.

2. Observation of the full-integrated solar disk

A sequence of RV measurements was realized on the full-integrated solar disk in order to avoid any possible guiding errors. The power spectrum shown in Fig. 1 exhibits a series of peaks between 2 and 4 mHz which correspond to identified low-degree p-modes. The mean white noise level computed above 5 mHz reaches 6.2×10^{-3} $\mathrm{m^2\,s^{-2}}$. Considering the 485 measurements, the velocity accuracy corresponds thus to 0.87 $\mathrm{m\,s^{-1}}$.

3. Results obtained on Procyon and ζ Her A

Procyon (HR2943 - F5IV-V - $m_V = 0.34$) was observed over 10 partial nights. The dispersion of the 602 RV measurements reaches 5.5 $\mathrm{m\,s^{-1}}$. The power spectrum shown in Fig. 1 presents an excess power between 0.4 and 1.5 mHz and confirms the previous detection of solar-like oscillations (Martic et al., 1999). ζ Her A (HR6212 - G0IV - $m_V = 2.81$) was observed 4 partial nights not contiguously. The dispersion of the 293 RV measurements reaches 4.6 $\mathrm{m\,s^{-1}}$

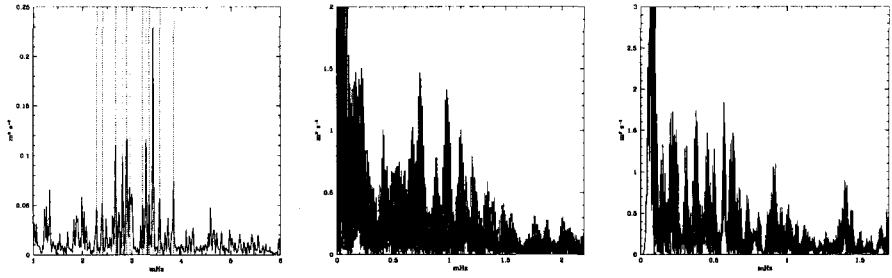

Figure 1. Power spectrum of the radial velocity measurements obtained on the Sun (left), on Procyon (center), and on ζ Her A (right).

after a fit polynomial subtraction to eliminate the spectral effect of binarity of this star. The power spectrum shown on Fig. 1 seems to present an excess power between 0.2 and 1.0 mHz and tends to confirm the suggested detection of solar-like oscillations by Martic et al. (2001).

4. Discussion

It is difficult at this stage to estimate the gain of accuracy of the AAA compared to other RV techniques. EMILIE is at present strongly limited by the photon noise (global efficiency = 0.4%) and the detector noise (Peltier cooled CCD). Moreover we suspect to be limited by the "guiding noise" or geometrical fluctuations of the stellar beam not completely eliminated by the optical fiber (no double fiber scrambler used). However, EMILIE with the AAA can reach the level of precision needed to detect seismic signals of bright solar-like stars, even without an intensive dedicated campaign.

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