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MULTIPERIODIC PHOTOMETRIC VARIATIONS OF HD 210111 AND SUSPECTED VARIABILITY OF HD 210049

We present time series of our observations of a new variable λ Boo star, HD 210111 (m_V = 6.4), which is classified as kA2hA7mA2V λ Boo by Gray and Corbally (1993). λ Bootis stars are a group of metal poor Population I stars (Weiss et al. 1994) with broad and often shallow hydrogen lines, which are probably caused by a gas shell. There are indications for such a gas shell also for HD 210111 (Stürenburg 1993). An abundance analysis for that star (Stürenburg 1993) gave a metal deficiency of about a factor of 10 compared to the Sun.

Our observations were part of a survey for pulsation among λ Boo stars (Paunzen, Weiss and North 1994, Kuschnig, Paunzen and Weiss 1994a,b), using the 70 cm Swiss-telescope at ESO, La Silla with the Geneva photometer. When variability of HD 210111 became evident in the raw data, it was decided to observe this λ Boo type star as frequently as possible. PN and EP used HD 210049 ($m_V = 4.5$, A1 IVnn) as first comparison star during 8 nights distributed over 2 weeks, and in addition in one of these nights HD 210302 (m_V = 4.9, F6 V) as a second comparison.

HD 210111: A quick look at the extinction corrected differential instrumental magnitudes (Fig. 1) indicates already multiperiodic variations for this star. An amplitude spectrum computed with a single-frequency Fourier technique for unequally spaced data (program PERIOD, Breger 1990) indicates the presence of at least 2 pulsation frequencies (Fig. 2, second panel). The frequencies with the largest amplitudes are $f_1 = 27.99$ c/d and $f_2 = 17.01$ c/d, which could be influenced by a 1 c/d aliasing. In any case, this solution is rather formal and serves only as a guideline for the relevant frequency range.

A simultaneous 4-frequency fit to the observations of HD 210111, based on the lowest residuals after a step-by-step prewhitening, results in a scatter of 4.0 mmag, which is almost twice the value for the extinction corrected observations of the comparison star HD 210049. We thus conclude that probably several modes may be excited in HD 210111. A problem for the frequency analysis is the poor duty cycle of only 7% of our single-site data. However, it is quite obvious that HD 210111 is a promising candidate for an international photometric observing campaign.

The calibration (Crawford 1979, Philip & Relyea 1979, for [Fe/H] = -1) of $uvby\beta$ photometry applied to the indices listed by Hauck & Mermilliod (1990) for HD 210111 results in $M_v = 1.65$, $T_{eff} = 7900$ K, and $\log g = 3.95$. These parameters give Q-values ranging from 0.014 to 0.022 d, based on

$$\log Q = -6.456 + \log T_{eff} + 0.5 \log g + 0.1 M_{bol} + \log P$$

According to pulsation models (Fitch 1981), such Q-values indicate pulsation in the second to fifth overtone.

HD 210049: Our present analysis depends on the constancy of the primary comparison, HD 210049, except for one night, where a second comparison star has been observed.

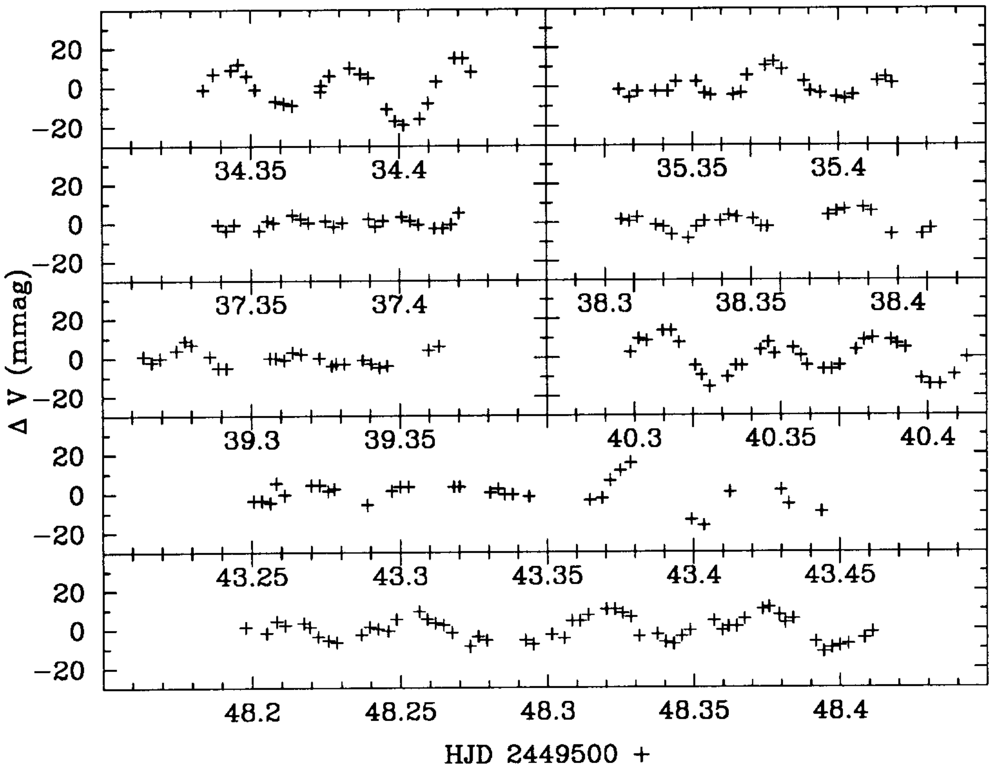

Figure 1. HD 210111–HD 210049 in Geneva-V, residuals to night-mean

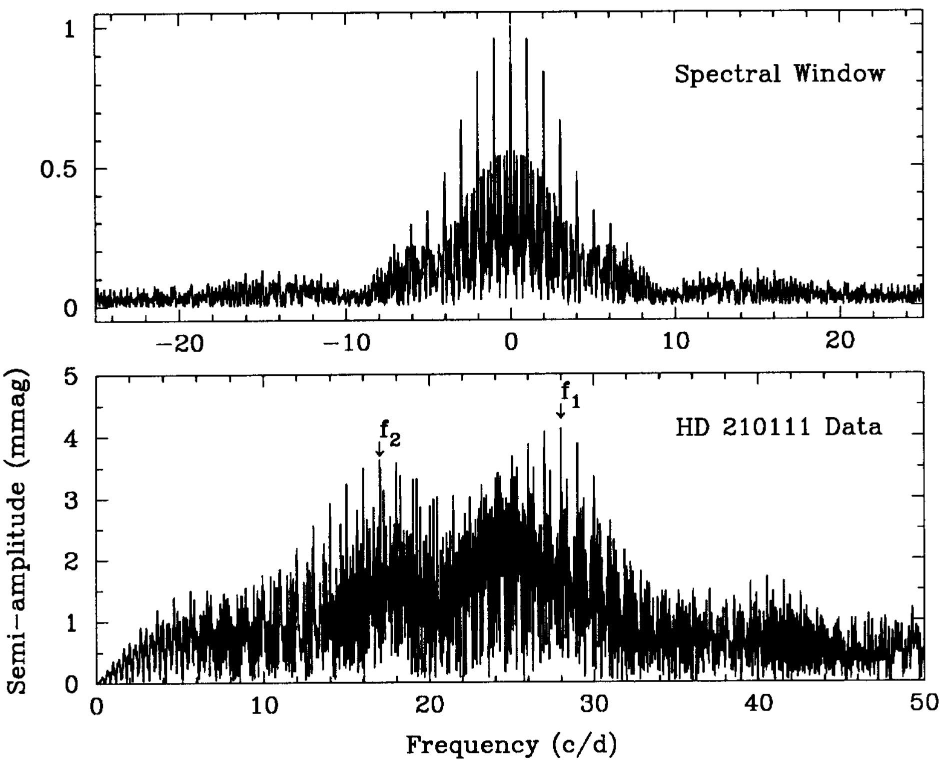

Figure 2. Amplitude spectrum (bottom panel) and spectral window of the data of Fig. 1

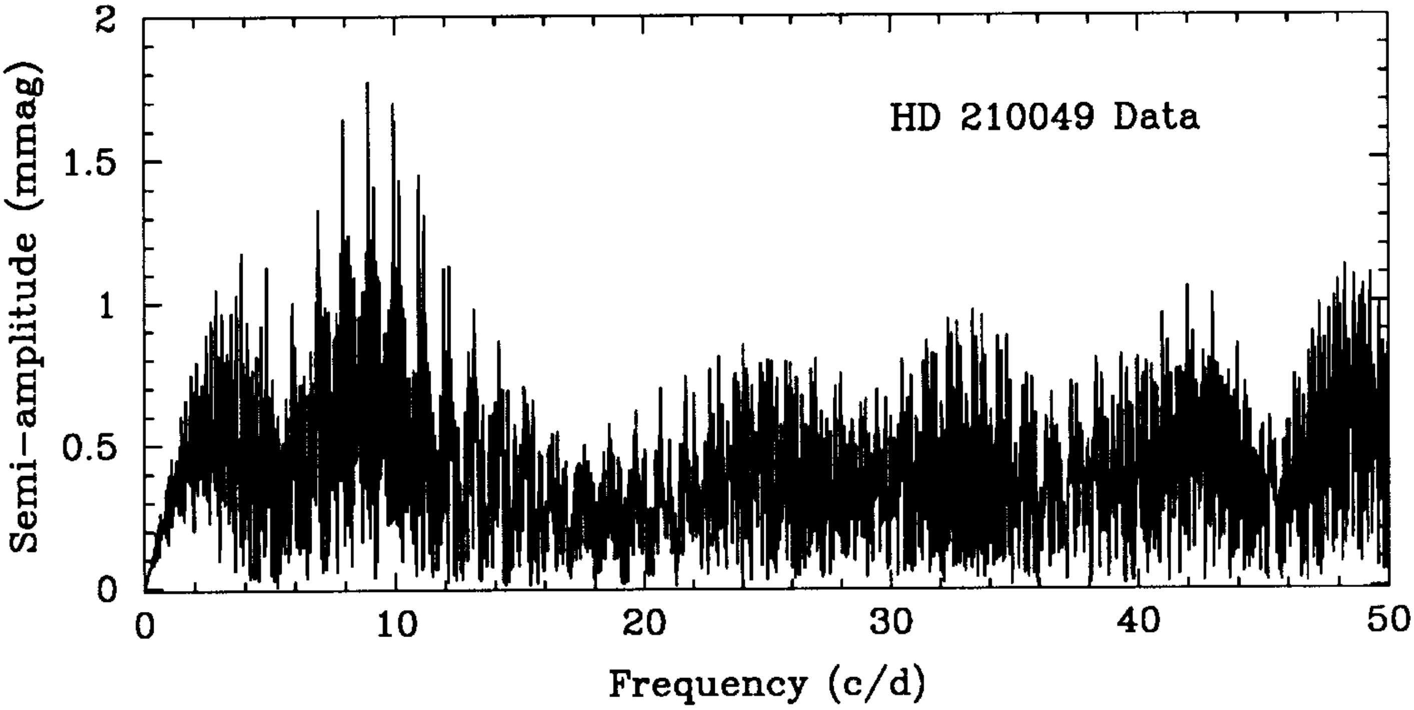

Figure 3. Amplitude spectrum of the extinction corrected Geneva-V photometry of HD 210049

In order to demonstrate the validity of this assumption we show the amplitude spectrum of our extinction corrected instrumental data of HD 210049 in Fig. 3. The highest noise peaks for frequencies larger than 15 c/d show amplitudes of 0.7 mmag. However, a peak at 8.9 c/d with an amplitude of 1.7 mmag clearly exceeds the noise level. This peak also appears in the amplitude spectrum of the *differential* HD 210111 − HD 210049 data, but *not* in the HD 210111 data alone. The differential magnitudes of the two comparison stars HD 210049 − HD 210302 have σ=2.0 mmag.

We therefore cannot exclude variability of our primary comparison star, HD 210049, with a period of about 2.7 hours, but cannot proof this claim with the second comparison star. However, it is quite safe to attribute the variability in the differential photometry of our λ Boo star in the 15 to 30 c/d frequency domain (Figs. 1 and 2) to HD 210111, and *not* to the comparison star.

Pulsation of HD 210049 would be remarkable, because effective temperature and absolute magnitude ($T_{eff} = 9000\,\mathrm{K}$, $M_v = 0.9$), based on Strömgren photometry, locate this star outside the δ Scuti instability strip. On the other hand, the hot border of this instability strip is not very well defined and a shift towards hotter temperatures was recently proposed by Rodriguez et al. (1994).

Conclusions: We discovered multi-periodic variability in the λ Boo star HD 210111 and cannot rule out variability of HD 210049. The frequency spectrum of HD 210111 is complicated and only a sufficiently long multi-site campaign (3 weeks or more) will allow a successful resolution. HD 210111 is a promising candidate for applying asteroseismic techniques and thus to investigate the problem of the origin of λ Bootis stars. Another interesting case is HD 111786 (Kuschnig et al. 1994a). We also encourage further observations of HD 210049.

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