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# Rapid oscillations of five stars in the spectral range A and F. I*

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The five stars HD 4849, HD 24712, HD 182475, HD 184552 and HD 215874 are a small group of objects enclosed in a larger observational programme for searching of rapid oscillations. They have been observed with the 50 cm ESO-telescope at La Silla (Chile). These objects are characterized as a suspected $\delta$ Scuti-type star, an Ap star, an A9 V star, an A1m star and an A9 III-IV star, respectively. For the first two stars the periods, dedected by other authors, were confirmed. For HD 182475 a period of 112.3 min has been estimated. In the case of HD 184552 an oscillation with a period of 163.3 min has been found. The star HD 215874 shows unambiguously a variation with a period of 97.2 min.

Die fünf Sterne HD 4849, HD 24712, HD 182475, HD 184552 und HD 215874 sind eine kleine Gruppe von Objekten, die in ein größeres Beobachtungsprogramm zur Untersuchung von schnellen Oszillationen eingebunden ist. Sie wurden mit dem 50 cm ESO-Teleskop in La Silla (Chile) beobachtet. Diese Objekte sind ein verdächtigter $\delta$ Scuti-Typ Stern, ein Ap Stern, ein A9 V Stern, ein A1m Stern und ein A9 III-IV Stern. Für die ersten beiden Sterne konnten die von anderen Autoren gefundenen Perioden im wesentlichen bestätigt werden. Bei HD 182475 ergab sich eine Periode von 112,4 min. Für HD 184552 wurde eine Periode von 163.3 min gefunden. Der Stern HD 215874 zeigt eindeutig eine Variation mit einer Periode von 97.2 min.

*Key words:* variable stars — $\delta$-Scuti type stars: HD 4849, HD 24712, HD 182475, HD 184552, HD 215874

*AAA subject classification:* 119

## 1. Introduction

This programme started for searching of rapid oscillations, is a continuation and an extention of an earlier one where only the Ap stars were investigated. Now solar like and late type stars are included. The previously observational results of the latter group of objects will be published in a second paper.
The well investigated Ap star HD 24712 has been used from the author rather than test object for the quality of the 50 cm ESO-telescope and the sky at La Silla.

## 2. Observations and Discussions

The observations of HD 4849, HD 24712, HD 182475, HD 184552 and HD 215874 were obtained during 1991 August 24 to September 1 with the 50 cm ESO-telescope at La Silla (Chile). The standard ESO photometer with an EMI 6256 was used for the observations. Because rapid oscillations were searched, the observations have been made with a time resolution of 2 to 5 sec integrations with nearby no delay time between the integrations. All observations were made only through a Johnson B filter and a diaphragm of 30". Because of both the large time resolution and the very well condition of the seeing nondifferential observations have been carried out.

Table 1 lists the name of objects, the Julian dates, the dates of observations, the duration of the observations ($t$), the number of measurements ($N$), the time resolution ($It$), the estimated periods ($P$) and the amplitudes ($A$) in millimagnitude.

For the frequency analyses of the obtained data the very comfortable computer program of Breger (1990) was used.

*) Based on observations collected at the European Southern Observatory, La Silla, Chile.

Table 1
Journal of observations

| HD-Nr. | JD 2440000+ | Date 1991 | $t$ [hr] | $N$ | $It$ [sec] | $P$ [min] | $A$ [mmag] |
|---|---|---|---|---|---|---|---|
| 4849 | 8493 | Aug.24 | 3.36 | 5350 | 2 | 73.40 | 4.3 |
| 24712 | 8495 | Aug.26 | 1.7 | 2750 | 2 | 6.23 | 0.8 |
| | 8501 | Sep.1 | 1.8 | 2679 | 2 | 6.23 | 4.5 |
| 182475 | 8501 | Sep.1 | 3.34 | 2070 | 5 | 112.4 | 9.5 |
| 184552 | 8494 | Aug.25 | 4.08 | 2410 | 5 | 163.30 | 17.1 |
| 215874 | 8501 | Sep.1 | 4.1 | 2610 | 5 | 97.20 | 8.1 |

### *2.1. HD 4849*

HD 4849 is classified as Fp in the Bright Star Catalogue. Weiss (1978) mentioned that it seems very probable that HD 4849 is not an Fp star but a $\delta$ Scuti-type star. Weiss (1977) found a period of about 80 min with an amplitude of 0.015 mag in V. Kurtz (1982) established a period of 70.9 min with an amplitude of 0.005 mag in B. Kreidl (1985) carried out a differential photometry of this star. He founds that HD 4849 pulsates with a single period of 79.3 min, which agrees very well with that of Weiss (1977).
It is of large interest if this star has a dedectable magnetic field. Therefore, a detailed investigation of high resolution spectra would be very useful. If this star appears as an Ap star then additional photometric observations would be necessary.

Our observations of HD 4849 are nondifferential observations, normalized to zero and shown in Fig. 1. The normalization has been done with a parabel fit in order to obtain extinction corrected data. The seeing during the run was excellent. So that the extinction was assumed as constant. The single points are connected with lines because of a better visualisation of the variability. In Fig. 2 an amplitude spectrum of these normalized data is shown. The frequency of 19.62 days $^{-1}$ is evident. That are 73.4 min with an amplitude of 4.3 mmag in B. This result agrees reasonable well with the values of Weiss, Kurtz and Kreidl between 70.9 min to 80 min. The second peak in the periodogram is nearby the half frequency of the first one. But it is not sure if this frequency is real or not. In the upper part of Fig. 1 the best fit with the frequency of only the largest peak is shown.

### *2.2. HD 24712*

The rotational period of HD 24712 with 12.4572 days is in coincidence with the magnetic field variations. Beside of the rotation this star is a rapidly oscillating Ap star. The most detailed investigation of this cool Ap star has been carried out by Kurtz et al. (1989). They started a campaign at eight observatories in 1986 October to December. Six principal frequencies of pulsations were found. The pulsation axis is aligned to the magnetic axis. There is a modulation of the amplitudes of pulsations with the rotational period. The largest amplitudes coincide with the maximum of the light curve due to the rotation.

HD 24712 has been used rather than test object for the quality of the telescope and the sky at La Silla. The observations of HD 24712 are shown in Fig. 3 and Fig. 4. In Fig. 5 and Fig. 6 the amplitude spectra of these two runs after the normalization to zero are shown. At both spectra the frequency 231.14 days $^{-1}$ or 2.675 mHz (=6.23 min), respectively, dominates which is close to the frequency of $\nu_3$ of Kurtz et al. The amplitudes of these two runs differ between 0.8 mmag (phase=0.61) and 4.5 mmag (phase=0.10) which is in good agreement to the results of the amplitude modulation.

### *2.3. HD 182475*

HD 182475 is classified as an A9 V star in the Strasbourg Catalogue. Up to now no oscillations of this object are known.

Our observations are shown in Fig. 7. With the frequency analysis a frequence of 12.81 days$^{-1}$ (=112.4 min) and an amplitude of 9.5 mmag was estimated.The amplitude spectrum is shown in Fig. 8.

### *2.4. HD 184552*

This object is classified as an Ap Sr star in the General Catalogue. Contrary to this it is characterized as an A1m star in the Strasbourg Catalogue with a long list of references. From this point of view it was interesting

to investigate this star for short term variations. The observations of HD 184552 are shown in Fig. 9. It is seen that the scattering is large but the variation is visible. The amplitude spectrum of the frequency analysis with the normalized data, Fig. 10, shows a large peak at 8.82 days $^{-1}$ (=163.3 min). For the verification of the variability more observations would be necessary.

### *2.5. HD 215874*

Cowley and Fraquelli (1974) classified this object as an A9 III-IV star. Weiss (1977) published one run and found a period of 125 min with an amplitude in V of 0.025 mag. He characterized this star as $\delta$ Scuti-type variable.

The observations in 1991 September 1 are shown in Fig. 11. With the periodogram, Fig. 12, a frequency of 14.81 days $^{-1}$ (=97.2 min) and an amplitude of 8.5 mmag was estimated. This contradicts with the result of Weiss. The best fit is shown in the upper part of Fig. 11. It is evident that more observations are needed to clarify this open problem.

## 3. Conclusions

The results point out that the method of nondifferential observations is successful for searching of rapid oscillations. But an essential presumtion is an excellent quality of the sky.

Oscillations in the range of minutes and hours are obviously a fairly general phenomenon. It is not only to find in a small group of objects or spectral types. This fact confirm the observations of the late type stars, see paper II. The presented results show that a large number of observations for a reliable interpretation are always needed. Only two or three runs are not enough to solve this complicated task. The oscillations offer one of the possibilities for a view in the inner of the stars. Therefore it is necessary to continue the started observational programmes at different observatories for searching of rapid oscillations.

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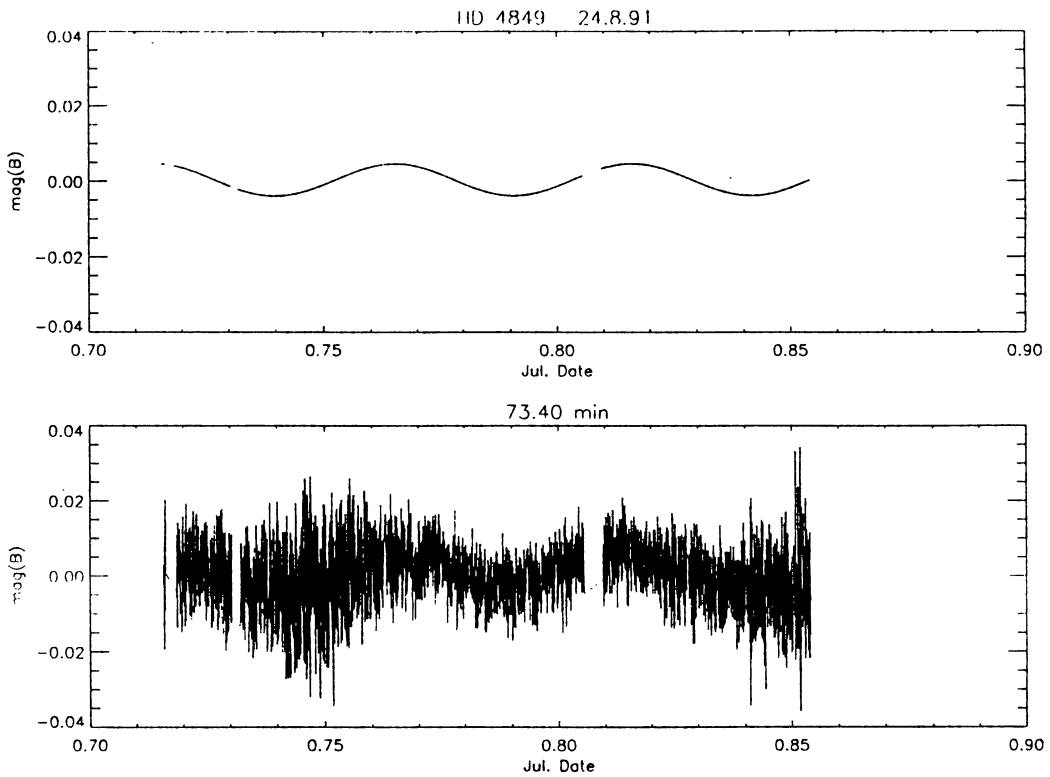


Fig. 1. The normalized data of HD 4849 and the course of the best fit with $P = 73.4$ min.

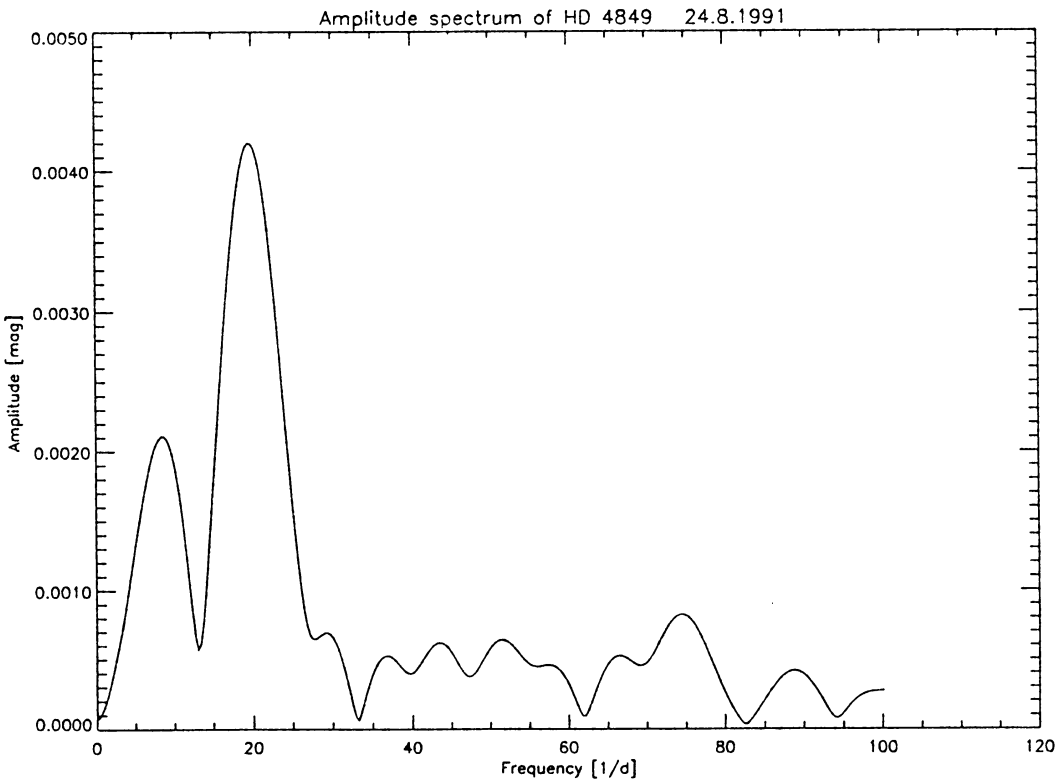


Fig. 2. The amplitude spectrum of HD 4849.

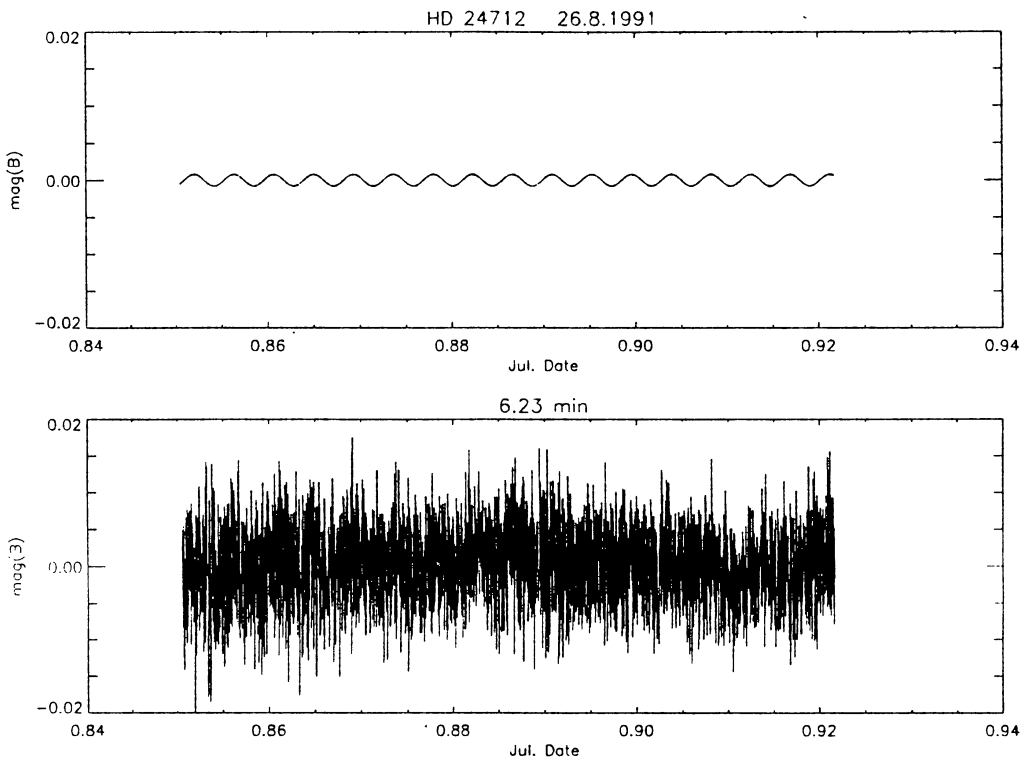


Fig. 3. The normalized data of HD 24712 (26.08.1991) and the course of the best fit with P = 6.23 min.

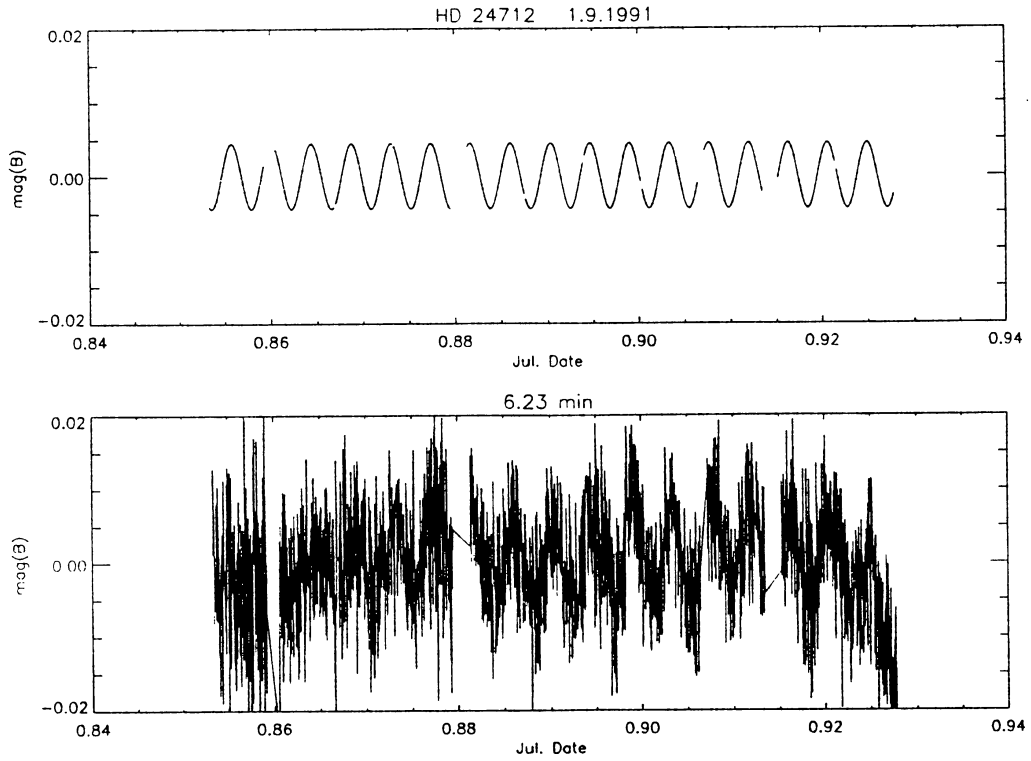


Fig. 4. The normalized data of HD 24712 (01.09.1991) and the course of the best fit with P = 6.23 min.

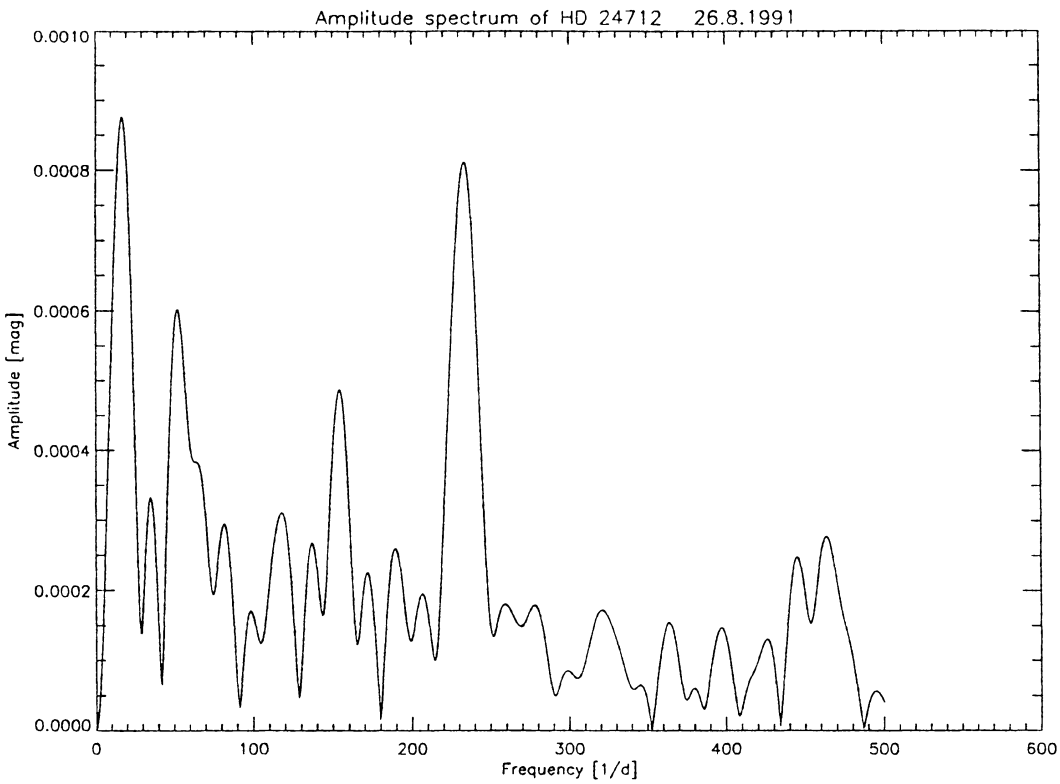


Fig. 5. The amplitude spectrum of HD 24712 (26.08.1991).

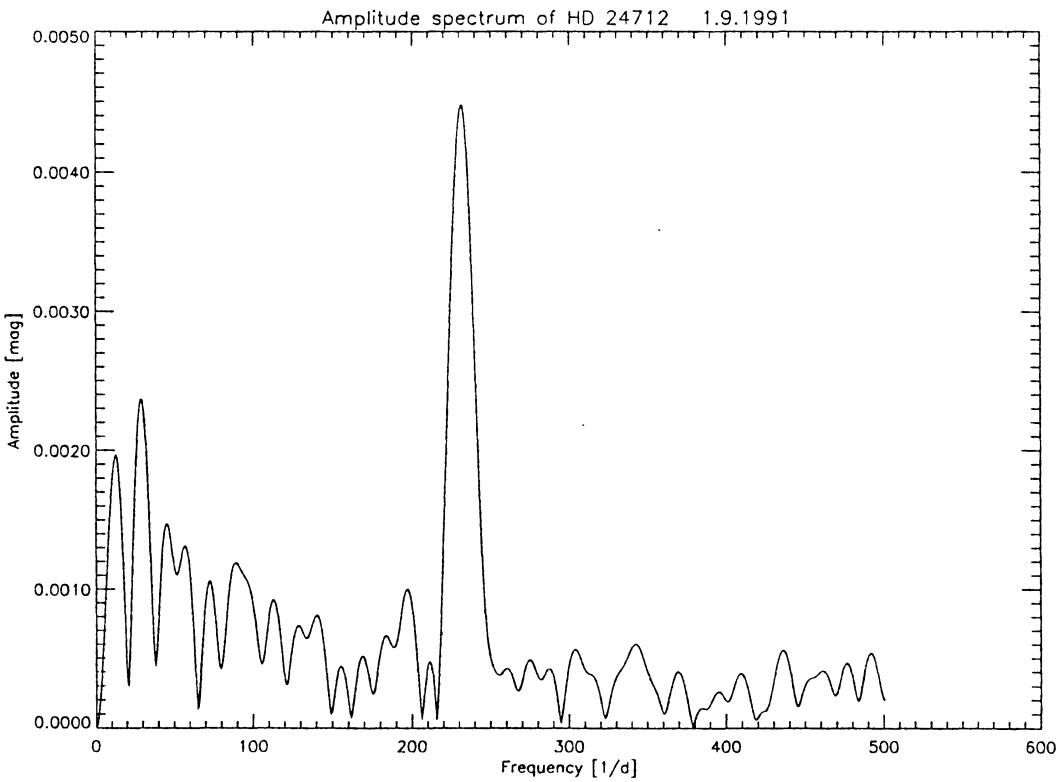


Fig. 6. The amplitude spectrum of HD 24712 (01.09.1991).

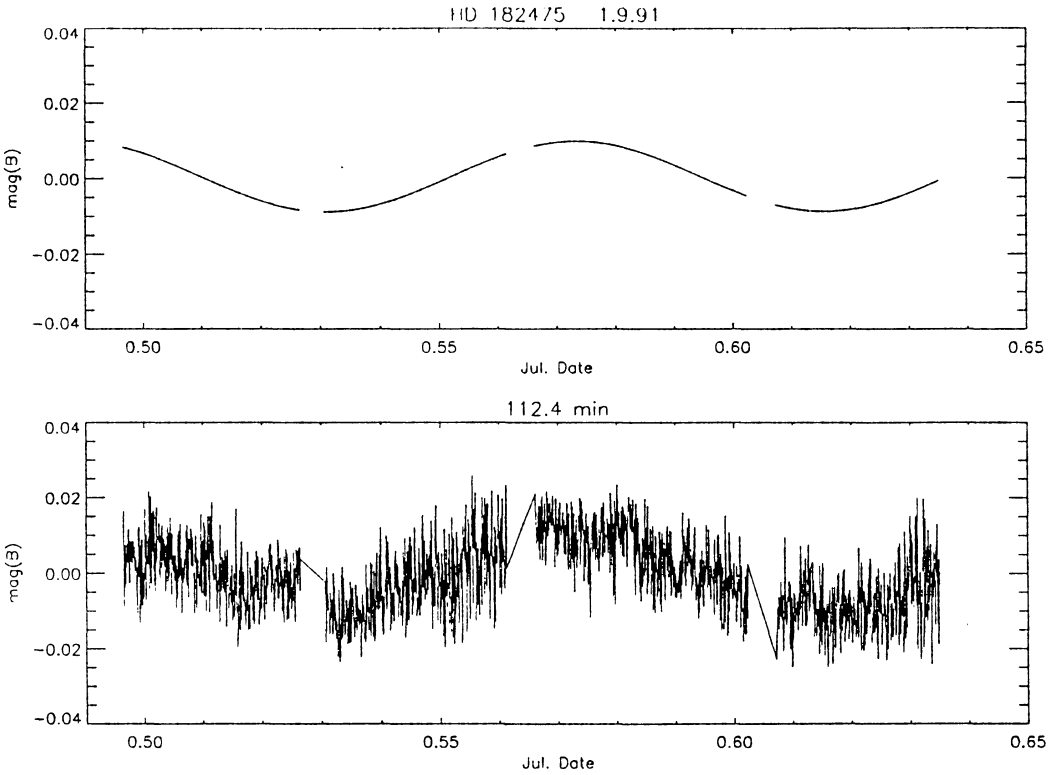


Fig. 7. The normalized data of HD 182475 and the course of the best fit with P = 112.4 min.

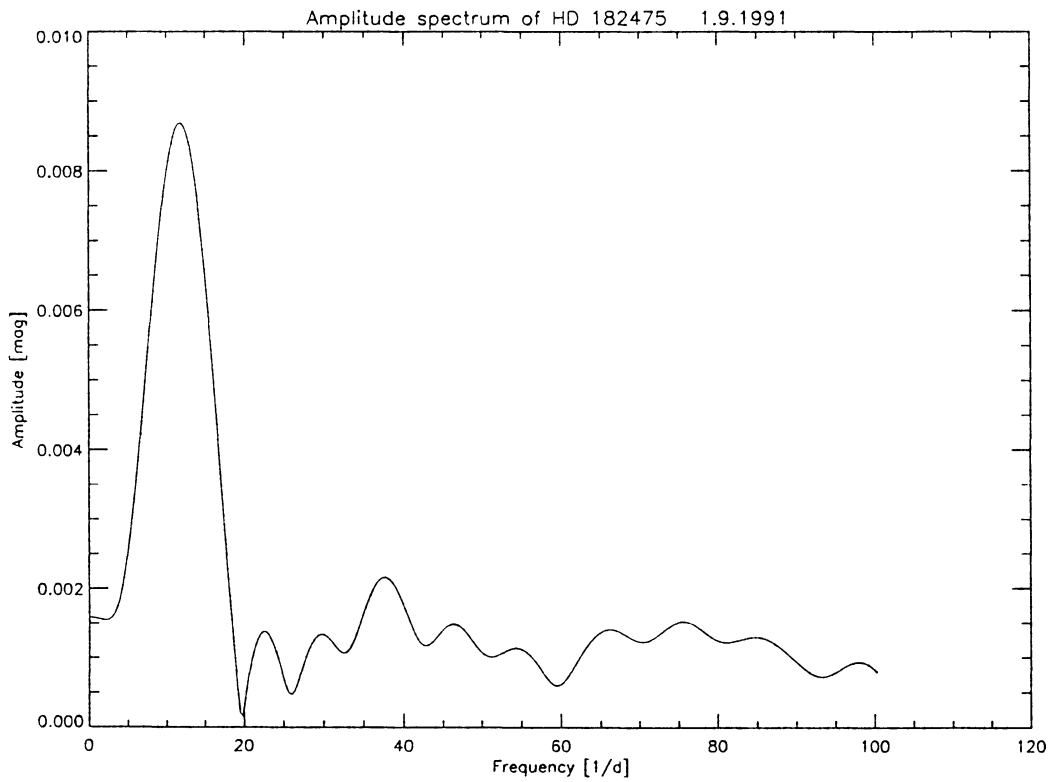


Fig. 8. The amplitude spectrum of HD 182475.

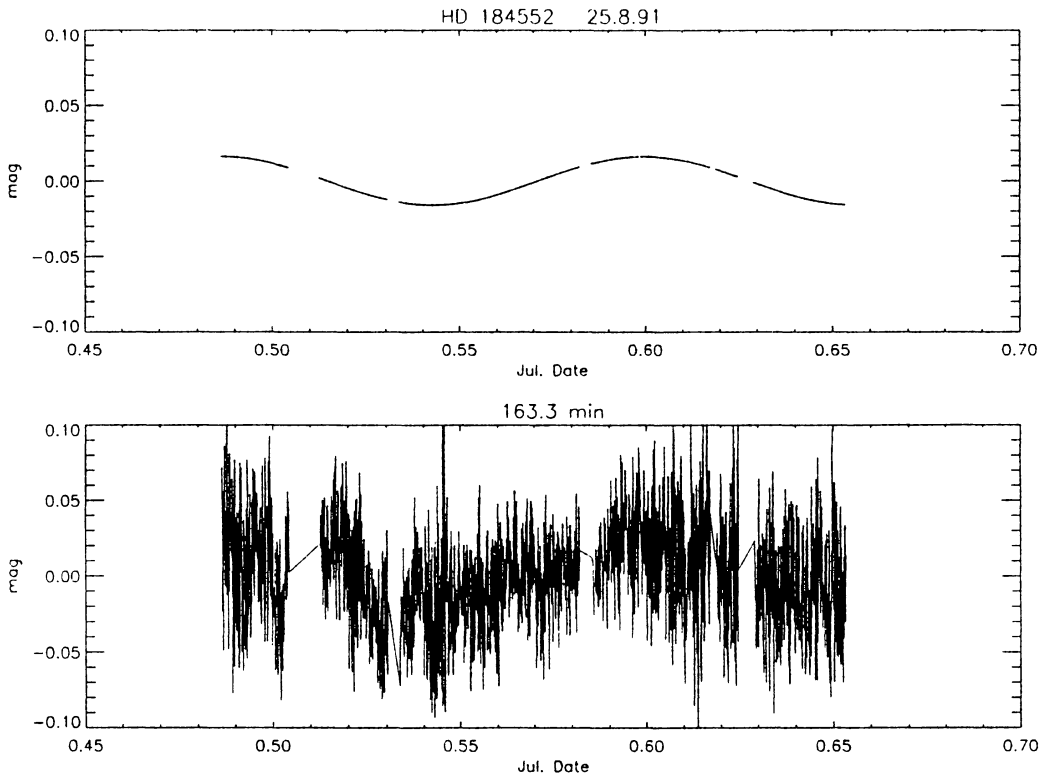


Fig. 9. The normalized data of HD 184552 and the course of the best fit with P = 163.3 min.

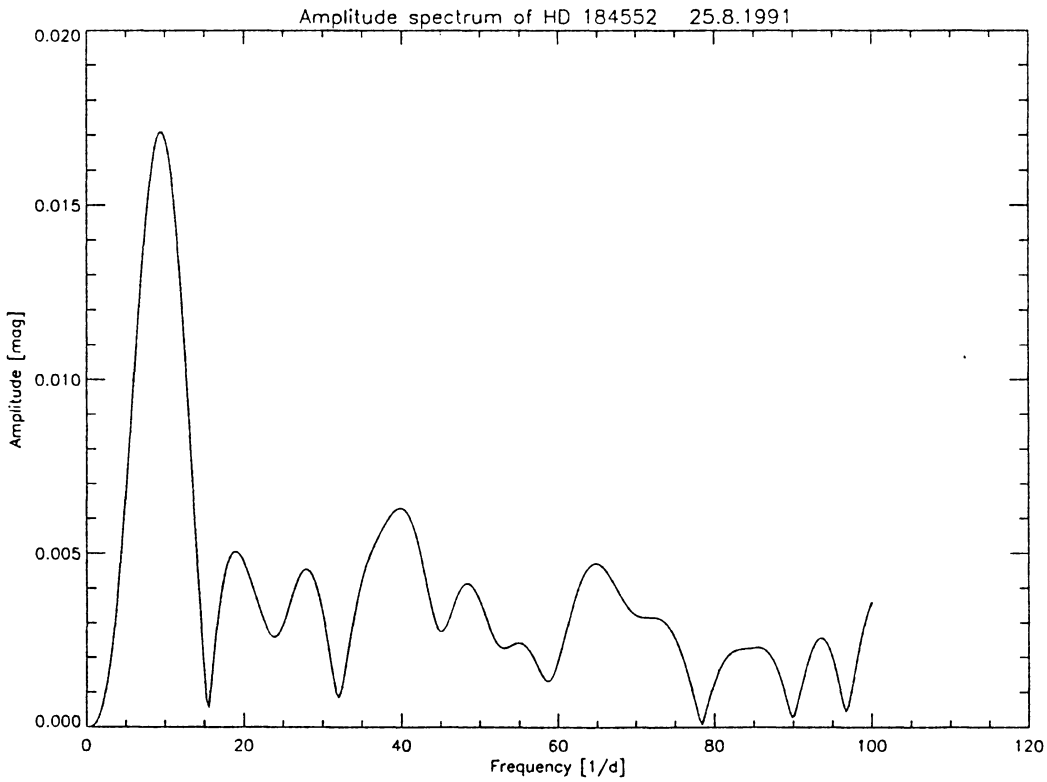


Fig. 10. The amplitude spectrum of HD 184552.

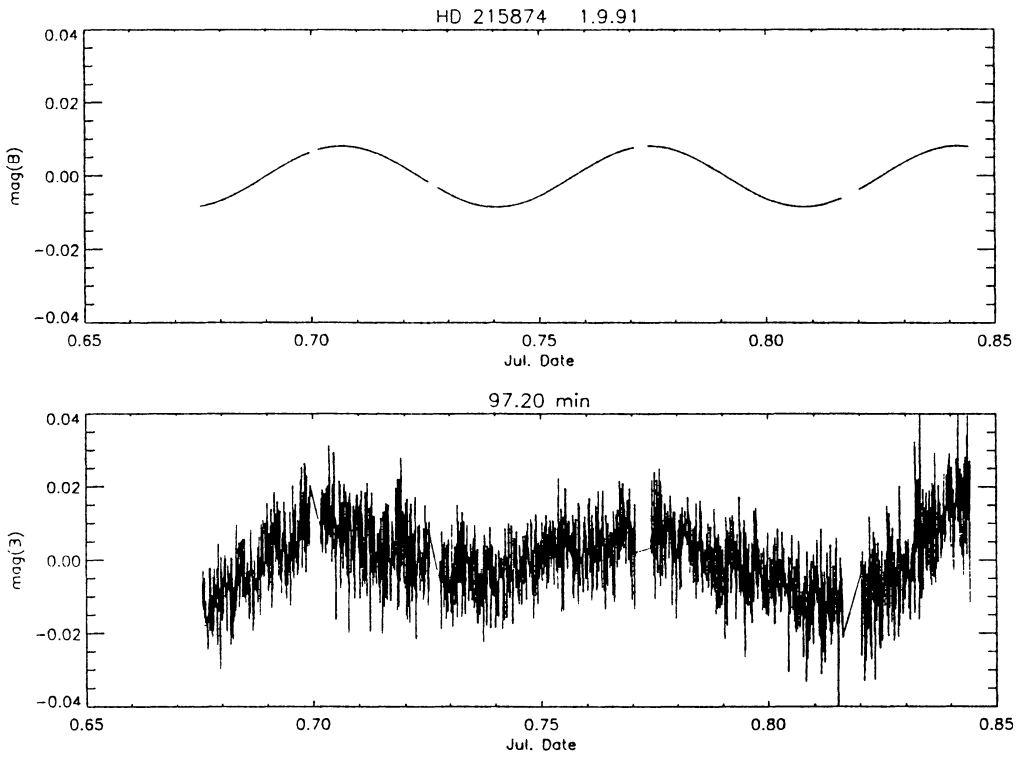


Fig. 11. The normalized data of HD 215874 and the course of the best fit with P = 97.2 min.

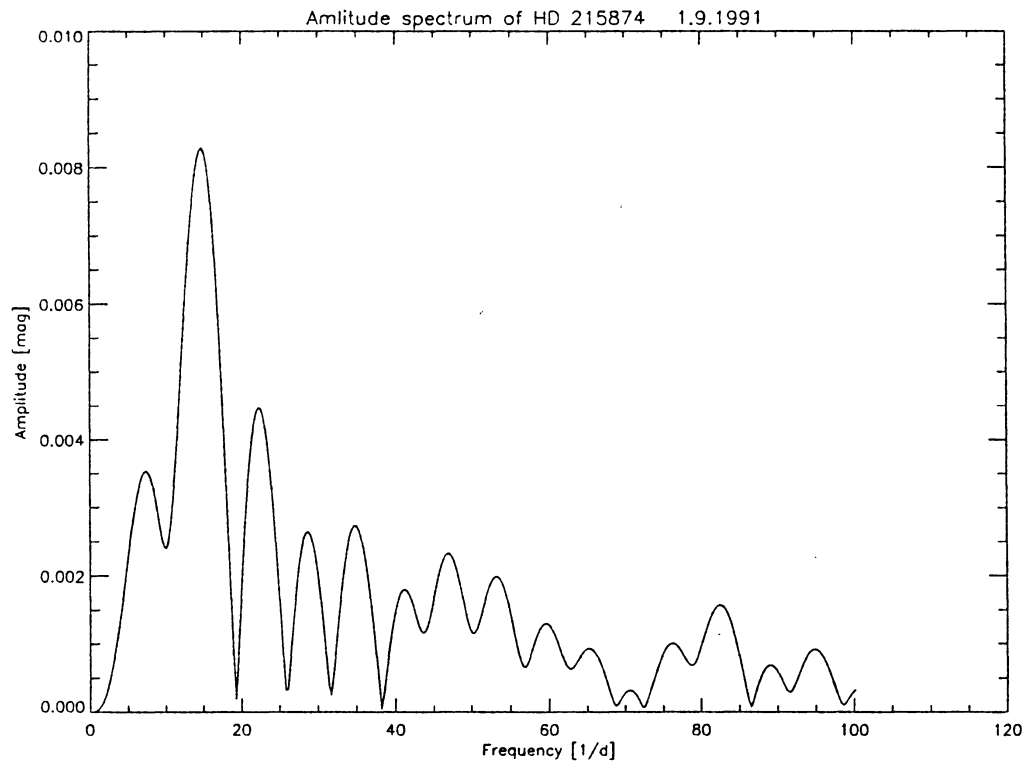


Fig. 12. The amplitude spectrum of HD 215874.