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DETERMINATION OF RADIAL VELOCITY VARIATIONS IN THE Ap STAR HR1217

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ABSTRACT. Radial velocity variations measurements of the oscillating Ap star HR1217 (HD24712) were obtained by coude spectroscopy.

RESUMEN. Por medio de espectroscopia coude se obtuvieron mediciones de variaciones de la velocidad radial de la estrella Ap oscilante HR1217 (HD24712).

Key words: STARS-OSCILLATING — STARS-PECULIAR A

1. INTRODUCTION

The rapidly oscillating Ap (roAp) stars are the A or F stars which vary in broad-band light curves with periods from 4 to 20 min and typical amplitudes of a few milimagnitudes. The photometric oscillations have been attributed to p-modes nonradial pulsations with low degree ($l<4$) and high radial order ($n>15$) (Kurtz 1982). The roAp class includes 12 variables.

HR1217 is one of the coolest of the SrCrEu Ap star with an effective temperature equivalent to a normal spectral type of about F0. It presents low-amplitude light variations and oscillates in at least six pulsations modes simultaneously (Kurtz and Seeman 1983). The pulsation with largest amplitude has a period of 6.126 min. Kurtz (1982) also found that the pulsation amplitude is modulated with the rotation period.

We have started a program to measure radial velocity (RV) variations using a coude spectrograph. The observation and reduction will be described briefly in section 2. In section 3, we will show the methods used and the results obtained. Section 4 is a discussion.

2. OBSERVATIONS AND REDUCTION

Spectroscopic observations were carried out with the coude spectrograph on the 1.6-m telescope of the Laboratorio Nacional de Astrofisica (LNA), Brasil, and a GEC CCD detector with 600 pixels on the dispersion direction, during 1988 October, obtaining 60 spectra. The grating, blazed at 6563 A, gives a dispersion in the first order of 18 A/mm. The spectral coverage is about 220 A between 6450-6670 A, centerd on Halpha.

The integration time was 60s plus 17s for the read out procedure. We also obtained flat field exposures and comparison spectra of Th-Ne during the observations.

For reductions we used the Image Reduction and Analysis Facilty (IRAF) system of NOAO. All flat field exposures were combined into a single image to increase the signal to noise ratio (S/N). The relative pixel response in the spectra of the star and calibration arcs were corrected by dividing by this flat field. After, wavelenght calibrations were executed using the Th-Ne comparison spectra.

3. ANALYSIS AND RESULTS

There are difficulties associated with measuring RV variations due to the low amplitude of the oscillations and the short oscillation periods. Therefore we expected RV amplitudes no larger than a few hundred m/s but we could only obtain small S/N ratio for individual exposures. The determination of RV variation is also affected by instrumental precision, but the spectral resolution of 1A can be improved with a larger number of spectra. During the observation, the star was at its maximum photometric amplitude.

We determined the RV variations by auto-correlation and gaussian fits reduction methods. We describe each method in the following subsections.

3.1. Auto-correlation:

We separated the data in the 5 phase bin, and all spectra at the same oscillation phase were added, resulting in 5 binned spectra, plus a grand total mean spectrum. We then subtracted each binned spectra from the mean and added up the differences. The mean spectra, fig. 1, was shifted for different initial values of lambda and the residuals relative to each phase were calculated. Fig. 2 presents the residuals for phases 1 and 5. The minimum values for the differences gave us the best value of lambda for that phase (fig. 3). For phase 1, the best value for delta lambda is -0.01 A, and 0.01, -0.01, 0.01 and -0.01 for the following phases.

3.2. Gaussian fit:

a. For each binned spectra we fitted a gaussian and the residuals from the averaged central wavelength were calculated (fig. 3).

b. We also obtained a power spectra of a time series of lambda calculated by fitting a gaussian to each single spectrum (fig. 4).

The RV variations obtained are:

method	delta lambda	RV variation (m/s)
3.1	.020	910
3.2.a	.017	770
3.2.b	.025	1140

4. CONCLUSIONS

A direct analysis of the results show us that the errors are apreciable. Excluding the method 3.2.b because the power spectrum did not show the existence of any significant variations above 3 sigma-level from the noise, and assuming the measured values are real, the mean RV variation is 840 m/s with a standard deviation of 100 m/s, for a hydrogen line. These results should be compared with thoses obtained by Matthews et al. (1988) for metallic lines, and with the RV variations measurements obtained by Belmonte et al. (1989) and Ando et al. (1988) using a Fabry-Perot interferometer. All claimed to have measured RV variations in this star with an amplitude of a few hundred meters per second.

The suggestion to explain the different results would be that the lines originate at different atmospheric depths. To confirm our purpose, further RV observations with higher dispersion of HR1217 will have to be made before obtaining a final answer.

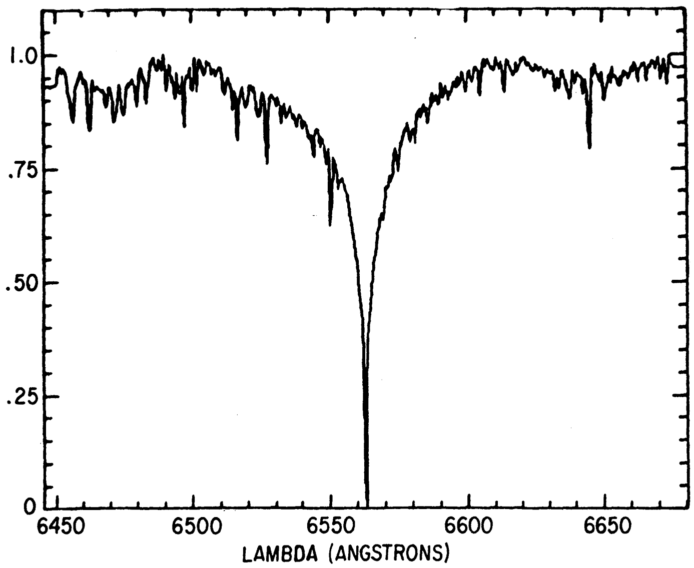

Fig. 1.- Mean spectrum obtained with the coude spectrograph. The continuum is normalized to unity. The star was at maximum photometric amplitude.

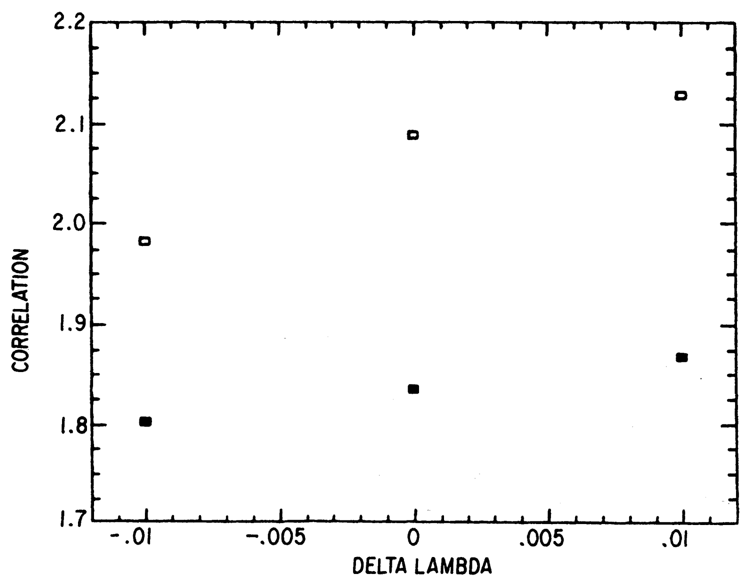

Fig. 2.-Residuals for phases 1(■) and 5.

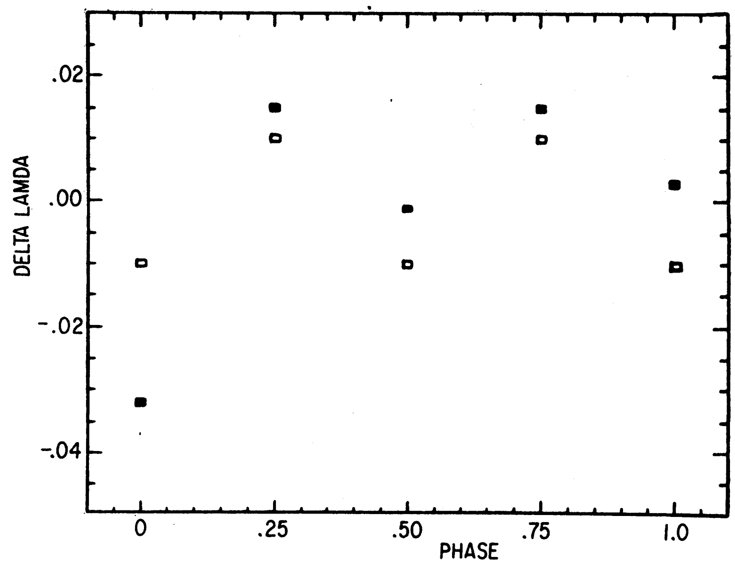

Fig. 3.- Delta lambda shift obtained from auto-correlation and gaussian fit (■) methods for 5 separated phases.

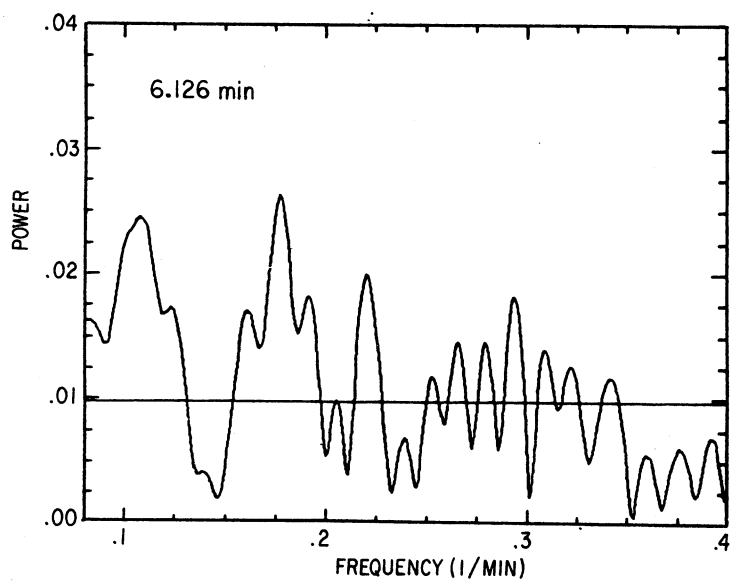

Fig. 4.- Power spectrum of a time series of lambda. The straight line correspond to mean noise.

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