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HIGH-FREQUENCY STELLAR OSCILLATIONS. X. THE RAPID BLUE VARIABLE CD −42°14462

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ABSTRACT

The spectrally peculiar degenerate blue variable CD −42°14462 is both a coherent high-frequency variable, with periods of 29.08 and 30.15 s and mean amplitudes 0.00028 mag, and an erratic low-frequency variable. Variable Hα emission and Hβ and Hγ absorption lines are observed; continuum colors place CD −42°14462 near the 12,000° K blackbody line. The observations can be interpreted as *g*-mode oscillations on one member of a white-dwarf binary system.

Subject headings: binaries — pulsation — stars, individual — variable stars — white-dwarf stars

I. PHOTOMETRIC OBSERVATIONS

Following the announcement by Bond and Landolt (1971) that CD −42°14462 has interesting spectroscopic peculiarities, photometric investigations revealed low-frequency flickering (Hesser, Lasker, and Osmer 1972*a*, hereafter referred to as HLO*a*) and periodic high-frequency activity (Warner 1973), while a spectroscopic study (Wegner 1972) showed variations in the hydrogen lines and suggested possible models.

Our time-series monitoring for this object, summarized in table 1 and represented in figure 1, shows complex photometric behavior which is at least superficially reminiscent of BD −7°3007 (Hesser *et al.* 1972*b*, HLO*b*). We have been unable to identify any coherent low-frequency activity, such as an eclipse, in our data. While the low-frequency part of the power spectra may be insignificantly different from an f^{-2} law, more extensive data will be required to make a definitive statement on the 1330- and 1070-s activities suggested earlier (HLO*a*).

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Following Warner's (1973) announcement of a 29.04 s harmonic activity (with amplitude of 0.0033 mag on 1972 April 12/13), a search of the high-frequency part of our power spectra, figure 2, revealed two periods, 30.15 and 29.08 s, with the much lower amplitudes of 0.00028 mag. The reality of the two peaks is supported by their clear presence in each of the three power spectra which were added to construct figure 2; probably the other peaks in the spectrum are dominantly spurious. That the 30-s activity is clearly not present in Warner's data and that the 29-s period is significantly stronger there indicates that the excitation of these oscillations is highly variable, and the presence of two nearly equal periods suggests invoking models involving the splitting of degenerate *l*, *m* modes in the *g* waves of hot white dwarfs (see Chanmugam 1972; Warner and Robinson 1972; Harper and Rose 1970).

Simultaneous monitoring of *B* and *V* on 1972 April 30 indicates that $(B - V) \simeq B$, while on 1972 May 1, $(B - V) \simeq$ constant. On 1973 March 26/27 *B* was monitored continuously with one channel of a dual-channel photometer on the 152-cm telescope, while Strömgren-Crawford *y*, *u*, Hβ-wide, and Hβ-narrow filters were successively sampled in the second channel.

TABLE 1*

SUMMARY OF AVAILABLE TIME-SERIES PHOTOMETRY

Date	Starting UT	τ (s)	N	Q	A_{max} (mag)	$T(A_{max})$ (s)	A_{29}† (s)	A_{30}† (s)	Notes
71 August 7–8.....	$06^h00^m43^s$	2.00	2415	0.0091	0.0018	373	0.0008	0.0007	1
					0.0018	227			
71 August 8–9.....	04 21 04	2.00	3549	0.0049	0.0015	455	0.0003	0.0002	1
72 August 29–30.....	06 08 09	2.00	7497	0.0062	0.0037	1536	0.0002	0.0002	1
72 April 30–May 1.....	06 05 59	4.00	3795	0.0088‡	0.0042	1365	0.0004	0.0004	2
72 May 1–2.....	06 05 46	4.00	3759	0.0066§	0.0026	1365	0.0003	0.0002	2

* See Hesser and Lasker 1971 and Hesser, Ostriker, and Lawrence 1969 for an explanation of the parameters of the table.

† Amplitudes in magnitudes for 29- and 30-s oscillations, respectively.

‡ $Q(V) = 0.0073$. § $Q(V) = 0.0073$.

NOTES.—1. 91-cm telescope, FW 130 photomultiplier, no filter.
2. 91-cm telescope, 2-channel photometer with FW 130 for *V* and RCA 4156 for *B*. Parameters in table are for *B* except as noted.

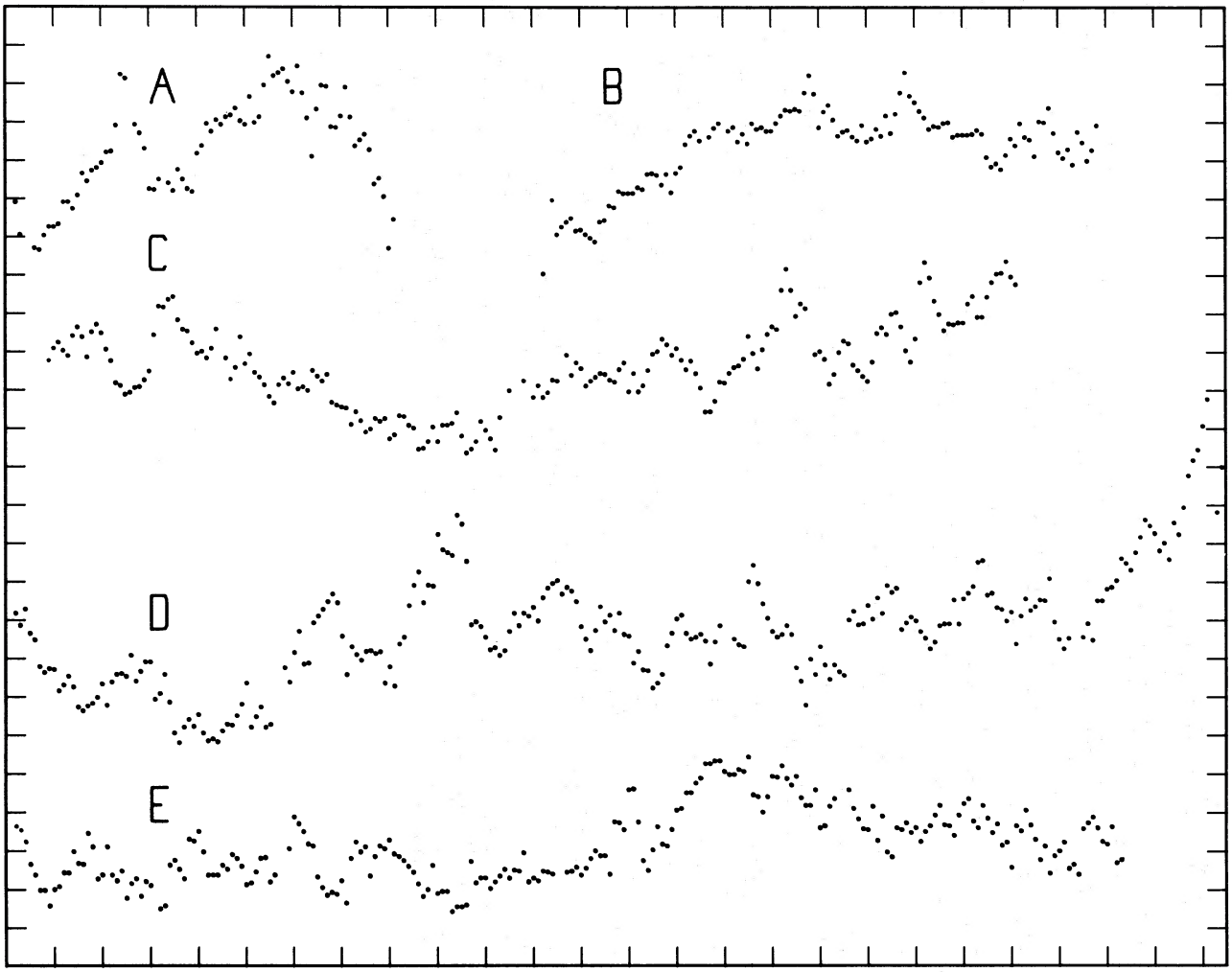

FIG. 1.—Light curves for the data given in table 1 are plotted in (A)–(E), respectively, in the same order as in table 1. Each point is a 1-min integration, and the time scale is 10 min per horizontal division. The vertical scale is 0.025 mag per division. Both zero points for each data set are arbitrary. The light curves have been approximately corrected for extinction.

Fluctuations of 3–10 times those expected from photon statistics were observed on time scales of $\lesssim 15$ min in both the continuum and line measures, and B was occasionally seen to change by 0.02 mag in < 1 min. Additionally, observations made through the Hβ-wide filter appeared to dominate the variations in the Hβ ratio, but all variations in this ratio were less than 0.010 mag during the 1.5 h of observation.

II. SPECTROPHOTOMETRIC OBSERVATIONS

Observations (fig. 3) from the dual-channel scanner on the 152-cm telescope show weak, variable Hα emission and Hβ and Hγ absorption features. The nature of the variation in the lines is complex. The apparent line doubling observed by Bond and Landolt (1971) and Wegner (1972) may be due to filling in by central emission. Nonetheless our observations on June 18/19 and July 3/4 of Hβ and Hγ show that the equivalent widths can change by a factor of 1.5 while the central depth of the line remains constant. The Hβ filter observations suggest a similar effect on April 30. In any case the full width at half-maximum of Hγ is ~ 60 Å, typical of degenerate objects (Eggen and Greenstein 1965).

In the two-color plane of HLOb, CD $-42°14462$ has a Balmer jump parameter, $\log F_\nu(3571\text{ Å})/F_\nu(4255\text{ Å})$, of -0.05 and a continuum parameter, $\log F_\nu(4255\text{ Å})/F_\nu(7100\text{ Å})$, of $+0.11$; and thus, like BD $-7°3007$, lies near the region of a 12,000° K blackbody. Out to 7100 Å no infrared excess appears in our data.

III. DISCUSSION

If CD $-42°14462$ is a rotating object and the nearly equal periodicities are due to splitting of degenerate l, m modes in g waves, equation (3) of Warner and Robinson (1972) gives a rotation period

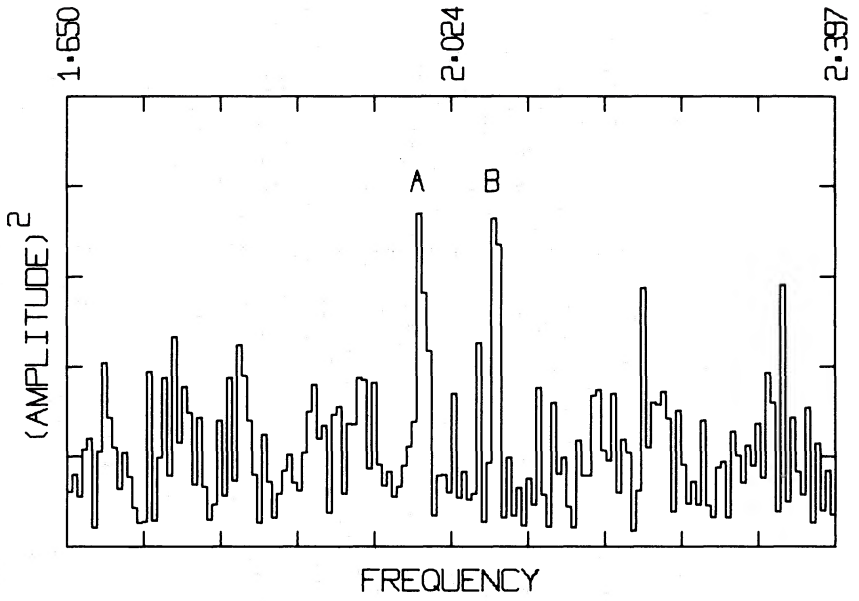

FIG. 2.—The combined high-frequency power spectrum for the 1972 data. Peaks A and B correspond to the 30- and 29-s periodicities, respectively; both have amplitudes of about 0.00028 mag. The amplitude scale originates at zero, and frequency is given in units of cycles per min.

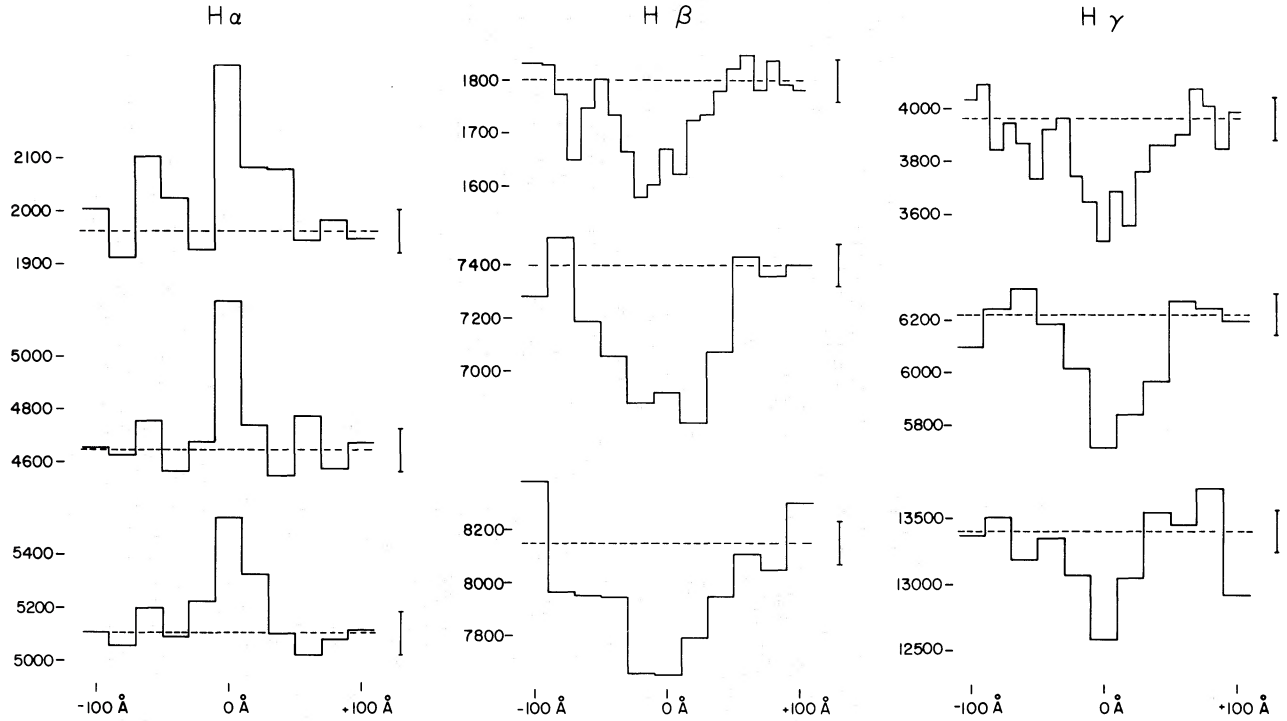

FIG. 3.—Hydrogen-line profiles measured with the scanner using a 10 or a 20 Å exit slot. For each spectral line data from 1972 May 2/3, June 18/19, and July 3/4, from top to bottom respectively, are given. The ordinates are counts per channel, and the vertical scale for each profile gives the $\pm 1\ \sigma$ limits of the photon statistics.

of ~610 s. The corresponding equatorial velocities would be much too low to substantiate Wegner's (1972) suggestion that the observation can be explained by a single, rapidly rotating object. Thus, to account for both the hydrogen and helium lines observed in this star but not in any classical single white dwarf, the hypothesis of a pair of degenerate objects, or of a pair consisting of a cool white dwarf and a hot subdwarf, perhaps with mass exchange exciting the oscillations, remains attractive.

We suggest that constructing models of hot, rotating white dwarfs, perhaps with binary perturbations, might be rewarding at this time; that efforts to estimate the distance of CD −42°14462 are very important; and that further time-series monitoring of line and continuum features is quite justified. We are presently engaged in further exploration of the analogies between this star and BD −7°3007 (HLO*b*).

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