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HIGH-FREQUENCY STELLAR OSCILLATIONS. XII. L19-2, A LOW-AMPLITUDE ZZ CETI VARIABLE WITH PERIODS OF 193 AND 114 SECONDS

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ABSTRACT

L19-2 (EG 110), a DA white dwarf with *UBV* colors in the range where luminosity variability readily manifests itself, is a low-amplitude variable with periods of 192.75 ± 0.1 s and 113.77 ± 0.1 s. It is the closest analog of ZZ Ceti (R548) yet discovered, as well as being the shortest-period white dwarf variable apparently not in a mass transfer binary system.

Subject headings: stars: variables — stars: white dwarfs

I. INTRODUCTION

Only about a dozen apparently single, luminosity-variable white dwarfs, the ZZ Ceti stars, have been discovered. From the small sample, limited progress has been made in understanding their physical nature. The variables are preferentially found in a certain region of the $(U - B, B - V)$-plane (e.g., Lasker and Hesser 1971; Richer and Ulrych 1974; McGraw and Robinson 1975, 1976; Robinson and McGraw 1976*a*, *b*; Hesser, Lasker, and Neupert 1976*a*); and there exist theoretical arguments that the variations may be *g*-mode oscillations (Chanmugam 1972; Brickhill 1975).

The Cerro Tololo program for the discovery of new ZZ Ceti stars has in recent years concentrated on Wegner's (1973, 1975) lists of southern, spectroscopically confirmed white dwarfs. During 1976 August–September we[1] identified two stars from these lists, L19-2 and LFT 1679, as variables (Hesser, Lasker, and Neupert 1976*b*). Our observational data for L19-2 (EG 110, Eggen and Greenstein 1965; $V = 13.75$, $B - V = \pm 0.25$, $U - B = -0.53$, spectral type DA, Wegner 1973), a star that appears to be a particularly simple manifestation of the ZZ Ceti phenomenon, are presented in this *Letter*.

II. OBSERVATIONS

An offset-guided, single-channel, unfiltered FW 130 (S-20), pulse-counting photometry system was used as before (Hesser and Lasker 1971) to take 1.99 s integrations with uniform spacings of 2.0 ± 10^{-8} s. The data, which are summarized in Table 1, were taken in 1976 using the 0.91 m telescope, except for File 2336 which was acquired with the 1.5 m. In the table, N is the number of integrations in a data set; and the A's are amplitudes, in 10^{-4} mag, for the 193 s and the 114 s periods, respectively. Occasional observations of nearby field stars of comparable magnitudes (monitored at the hour-angle extrema used for the program stars) and of quiescent white dwarfs provide assurance that L19-2 is truly variable. The observations often extended to large hour angles; but because of the high declination (−81°) of L19-2, the air mass range was limited to $1.7 \leq \sec z \leq 2.1$.

In Figure 1 the time-series data for L19-2, smoothed to 14.0 s are presented. Rapid, low-amplitude (∼0.015 mag peak-to-peak) variations are apparent. The low-frequency portions of the power spectra for all five data sets are shown in Figure 2 together with a combined power spectrum averaged from the individual ones. The dominant peak lies at 192.75 ± 0.1 s, and typically has 0.004 mag amplitude. A weaker peak at 113.77 ± 0.1 is sometimes also present. There is no evidence for other harmonic activity in the range 0.017 to 900 cycles h^{-1}.

TABLE 1

OBSERVATIONS AND PARAMETERS FOR L19-2

File	Date (1976)	UT Start	Aperture (arc sec)	N	A_{193}	A_{114}
2323.....	20 Aug.	23:35:33	16.7	5362	42	25
2320.....	21 Aug.	23:58:43	16.7	4123	29	≤13
2317.....	22 Aug.	23:25:12	16.7	6790	37	24
2312*.....	23 Aug.	23:34:12	26.7	7581	51	≤19
2336.....	17 Sept.	23:47:41	13.0	3983	46	28

* While File 2312 was acquired on an apparently perfect night, its anomalous low-frequency behavior suggests possible contamination by clouds. This file does not affect our conclusions, and it is listed here for completeness only.

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[1] Discovery observations were made by H. E. N. as part of a *Memoria* to be submitted to the University of Chile in partial fulfillment of the requirements for the degree of *Licenciado en Astronomía*.

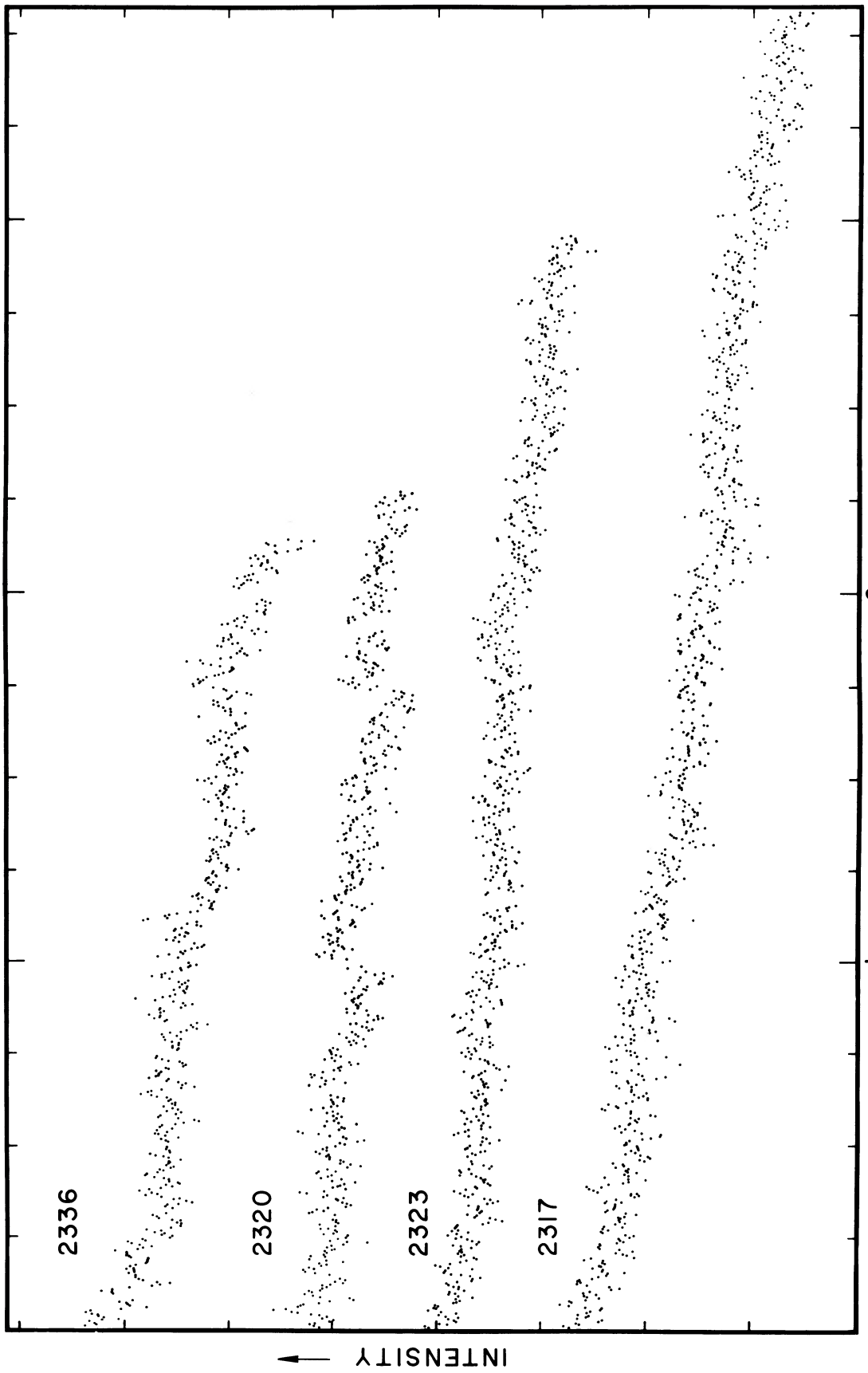

FIG. 1.—Time-domain data for L19-2 (cf. Table 1) smoothed to 14.0 s. The fiducial marks on the intensity scale are separated by 0.050 mag. Gaps are due to sky measurements and centering checks. Typically, the stellar intensity at the 0.9 m telescope was ~3200 counts s^{-1}, and the sky was less than one-tenth of that.

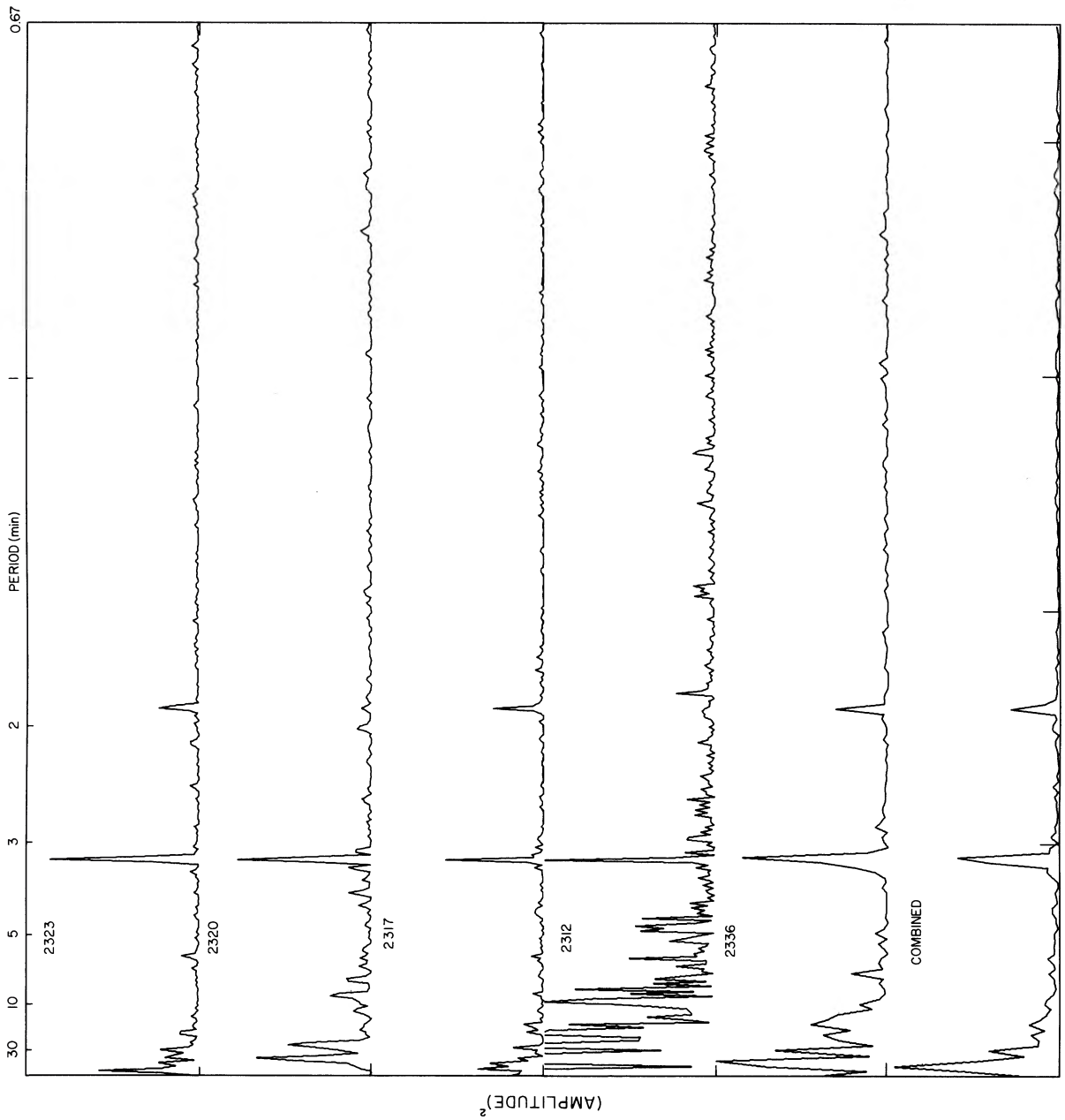

FIG. 2.—Power spectra for the data sets of Fig. 1 and Table 1 calculated after removal of the first three moments from the original data. The maximum amplitude reproduced in each spectrum and represented by the fiducial marks on the ordinate is 0.005 mag.

III. DISCUSSION

Among the ZZ Ceti stars, L19-2 has the shortest period currently known; its relatively low-amplitude light curve is apparently simple (and reminiscent of the bimodal behavior of ZZ Ceti itself [Lasker and Hesser 1971]); and its colors place it in the region of the two-color plane ($U - B \approx -0.55$, $B - V \approx +0.25$) occupied by most of the others.

The 193 and 114 s periods have the ratio, 1.7, that one would expect for degrees, $l = 1$ and 2, of any g-mode oscillations having similar radial eigenfunctions, $P_{kl}/P_{kl'} = \{l'(l' + 1)/[l(l + 1)]\}^{1/2}$ (Brickhill 1975). While it is very satisfying to account for the *ratio* of the periods in this way, the periods themselves are somewhat small to be explained by existing g-mode models (Brickhill 1975, Table 3) at reasonable temperatures. However, the cited formula is rather general, and the hypothesis that the observed periods represent P_{k1} and P_{k2} in some physical picture not very different from that conceived by Brickhill merits further consideration.

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