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A LONG PERIOD EARLY F-TYPE VARIABLE: HR 8799

In summer 1987 the early F–type variable star HR 8799 (=HD 218396) was observed on 5 nights with the 0.75 m reflector at Observatorio de Sierra Nevada by means of a Strömgren-Crawford six-channel simultaneous photometer.

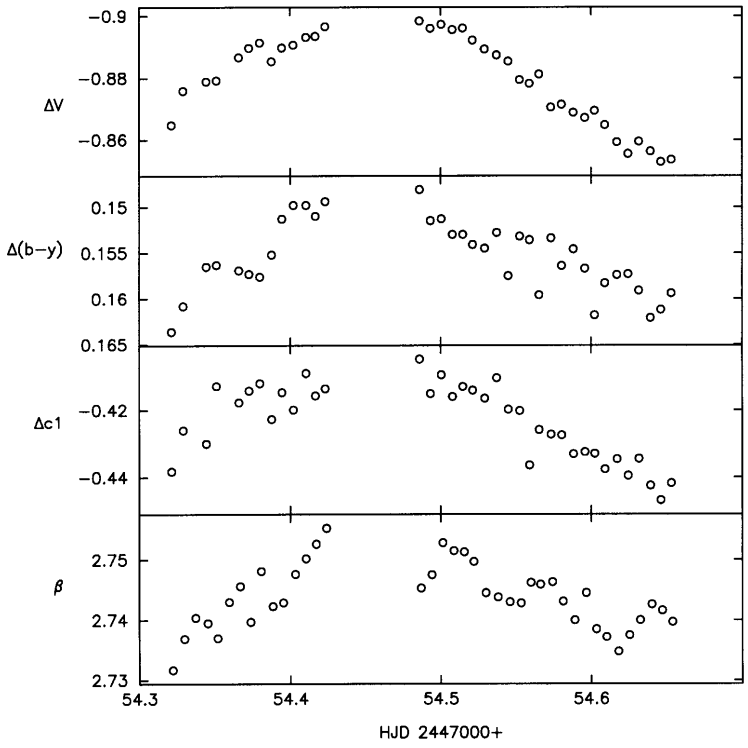
The purpose of the campaign was to investigate its possible SX Phe nature, proposed by Shuster and Nissen (1986) who noticed its slightly low metallicity and a high dispersion in V and c_1 light curves. They proposed a variability on unknown time-scale and amplitude ranging between $0\overset{m}{.}05$ and $0\overset{m}{.}1$ in both colours.

During the 1987 observations, HD 217715, HD 218574 and HD 217510 were used as comparison stars. In this campaign 168 differential measurements were collected with respect to HD 217715 in $uvby-\beta$ colors, unfortunately with large gaps between different observing nights. The differential time-series between HD 217715 and HD 218574 provided evidence of constancy within $0\overset{m}{.}0047$ (u), $0\overset{m}{.}0047$ (v), $0\overset{m}{.}0032$ (b), $0\overset{m}{.}0038$ (V) assumed as mean external errors. Similarly the differential time-series between HD 217715 and the third comparison star HD 217510 provided $0\overset{m}{.}0054$, $0\overset{m}{.}0042$, $0\overset{m}{.}0034$ and $0\overset{m}{.}0036$ in the four colours respectively. A comparison of the above results with the dispersions computed for HR 8799 versus HD 217715, i.e. $0\overset{m}{.}0093$ (u), $0\overset{m}{.}0145$ (v), $0\overset{m}{.}0129$ (b), $0\overset{m}{.}0107$ (V) confirms what reported by Shuster and Nissen.

Furthermore during each night we found variations in the colour indices $b-y$, c_1, and β in the same sense and approximately phased with the V light curve. This can be seen in Figure 1 where the observed light and colour index curves are shown for the night of September 17 as an example. Variations in the m_1 color index can be forecasted but due to its intrinsically low amplitude in the scanty data of this campaign they cannot be revealed.

In spite of the large gaps in the data set spectral analysis, performed on these points by means of Vanicek's (1969) least squares technique, provided evidence of a principal frequency of 1.961 d^{-1} (period $0\overset{d}{.}510$) and the absolute absence of signals in the 5-30 d^{-1} region where δ Sct and SX Phe pulsational frequencies are generally found. However such a periodicity fails to explain the whole signal contained in the time-series: further frequencies must be present even if their determination is beyond the possibility of such a small amount of measurements.

In a pulsational scenario the period found should be related to a non-radial g-mode pulsation never reported in the lower part of the instability strip at the time when the observations were collected. Nevertheless in the last decade a number of objects in this region of the HR-diagram showing variability on longer time-scales with respect to typical δ Sct or SX Phe pulsations and with amplitudes below $0\overset{m}{.}1$, were reported by various authors and gathered into a group of about ten objects believed to undergo the same phenomenon (Mantegazza et al., 1993). The physical nature of their behaviour its still



Differential light and colour index curves of HR 8799 with respect to HD 217715 versus Heliocentric Julian Day in the night September 17, 1987.

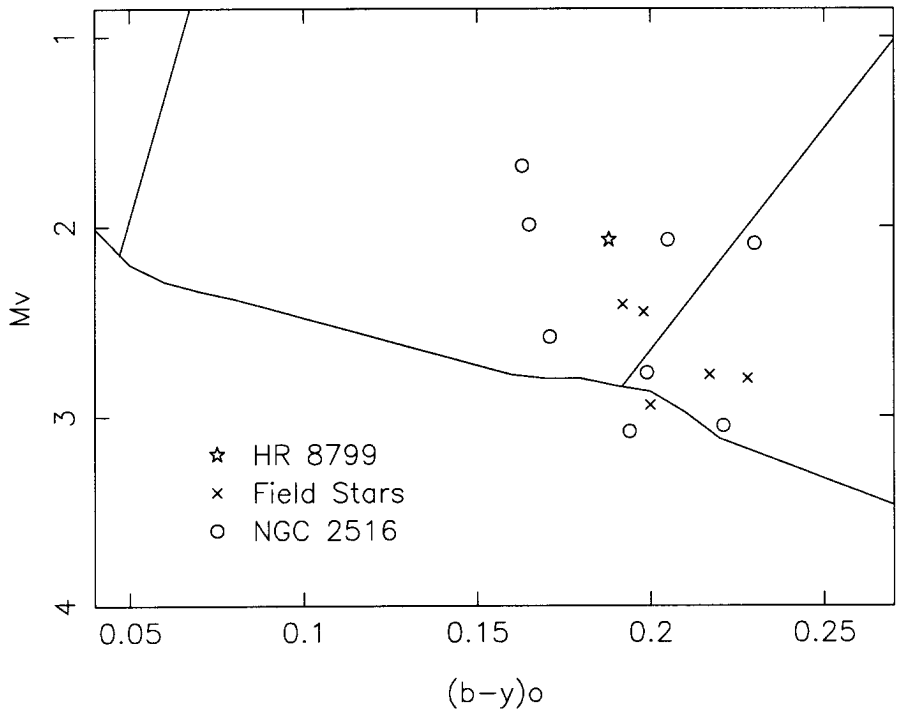


Figure 2. Position of the new variables in HR diagram. Main Sequence track is taken from Philip and Egret (1980) while hot and cool border of the instability strip from Rodríguez et al. (1994).

Table 1. Comparison between HR 8799 and other stars in the group of new early F-type variables. Data are taken from the corresponding references quoted in the text. HR 8799 Strömgren's colours are taken from Shuster and Nissen (1986) while its radial velocity from Uesugi and Fukuda (1982). ν_{ph} means photometric frequency.

Name	$(b\text{-}y)$	m_1	c_1	β	$v \sin i$	ν_{ph}
HD 224638	0.192	0.147	0.719	2.743	24	0.68, 0.81
HD 224945	0.198	0.154	0.690	2.726	60	0.70, 0.93
HD 164615	0.228	0.179	0.624	2.716	60	1.23
γ Dor	0.200	0.175	0.660	2.739	50	1.34
9 Aur	0.217	0.152	0.642	2.723	14	0.80, 0.32
HR 8799	0.188	0.137	0.689	2.742	45	1.95

a matter of discussion and beside non-radial g-mode pulsation also models taking into account spots and binarity have been proposed and developed. Some of the stars in the sample have been studied more thoroughly: HD 164615 (Abt et al., 1983), HD 224638 and HD 224945 (Mantegazza et al., 1994), 9 Aur (Krisciunas et al., 1993), γ Dor (Balona et al., 1994). The principal characteristics of these stars, to be compared with HR 8799 results, are briefly summarized in Table 1.

In order to locate HR 8799 in the Hertzsprung–Russell diagram we computed its absolute visual magnitude by means of Philip and Egret (1980) calibrations obtaining a value $M_V = 2.7$. As can be seen in Figure 2 our star lies in the same region where all of the new variables were found. Similar position in HR diagram and similar photometric behaviour make HR 8799 a possible candidate belonging to this type of variables.

A number of tools are at present being studied (Zerbi and Garrido, 1995) in order to achieve a better understanding of the behaviour of the whole sample and to select the most suitable between the proposed models. Such tools are based on comparison between colour and radial velocity curves that should present a different behaviour in the case of spots, binarity or pulsation. In addition frequencies close to an integer multiple of $1d^{-1}$, as that found in HR 8799 as well as in many other variables in the sample, suggest to avoid night/day cycle through a multisite campaign.

Any further observations should therefore be planned within a coordinated multisite campaign devoted to multicolor photometric observations and possibly with associated high resolution spectroscopy.

E. RODRIGUEZ[1]
F.M. ZERBI [1,2]

[1]– Instituto de Astrofísica de Andalucia, Apto 3004 E-18080 Granada, España

[2]– Dipartimento di Fisica Nucleare e Teorica, Universitá di Pavia, Via Bassi 6, I-27100 Pavia, Italia

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