THE SPECTRAL CHARACTERISTICS OF THE SRd STAR IS GEMINORUM

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Abstract. Radial velocity measurements of the SRd star IS Geminorum indicate a small variability (with an amplitude of about 15 km s^{-1}) with a time-scale of a few tens of days. The spectrum of this star does not show any peculiarity (i.e., emissions, variation in intensity of spectral features, weak metal lines). This fact casts doubts on the homogeneity of the SRd class. The possible subdivision of it between two different types of objects, one of Population I and the other of Population II is pointed out.

1. Introduction

The bright star HR 2512 is classified in the 1st Supplement to the third edition of the *General Catalogue of Variable Stars* (hereafter G.C.V.S., Kukarkin *et al.*, 1971) as an SRd variable with the name of IS Geminorum.

According to the definition of G.C.V.S. (Kukarkin *et al.*, 1969) the SRd stars are 'semiregular variable giants and supergiant of spectral classes *F*, *G*, *K'*, however some authors give for these objects a more precise definition. According to Rosino (1973) the SRd "are stars which do not verify all the requirements which define the RV Tauri-class"; in particular, they have stronger and more persistent hydrogen emission (and this fact was adopted by Preston *et al.*, 1963, to distinguish between RV Tauri and SRd stars). Moreover, Dawson and Patterson (1982) affirm that "while RV Tauri stars display large amplitude variations over a fairly constant period, the SRd stars show the reverse behaviour". The SRd stars are in addition considered metal poor objects with the kinematics of an old disk or halo population (Dawson and Patterson, 1982).

We know very few things about IS Geminorum, notwithstanding its brightness: its spectral type is K3 II and its $(B - V)$ index is 1.29 (Hoffleit and Jaschek, 1982). Also with respect to its light variations, which were observed mostly visually, there are controversial results: according to Wroblewski (1962) they could have a period of about 45–50 days, while the data of Bemporad (1912) seem to indicate a much shorter time-scale of variation. The only certain fact is that the light variations are not of regular nature and that they have a small amplitude (in the visual it is not larger than 0.3 mag.).

2. The Observations and Discussion

We observed it with the grating Boller and Chivens spectrograph mod. 31523, attached to the 137 cm-reflector of the Merate Observatory.

To study the radial velocities we obtained 12 spectra with a dispersion of 35 Å mm^{-1} and which cover a spectral range from 3900 to 4900 Å, on baked II-a-O plates. All the

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spectrograms are of good quality since an integrating exposure meter was used during the observations. The spectrograms were measured with the visual digitized comparator of the Merate Observatory, supplied with an Heidenhaim grating (1μ accuracy).

We adopted as preliminary rest wavelengths for the radial velocity determinations those suggested by Wright (1952) for spectra of comparable dispersion and spectral type, but taken with a prism spectrograph. Twenty-four lines were measured for each spectrograms. Their rest wavelengths were then adjusted, in order to gain internal consistency, with the iterative procedure proposed by Bossi (1983).

As in the literature there are not lists of wavelengths to be adopted for radial velocity measurements made on grating spectra of this dispersion and of late type stars, we give in Table I our adopted values. The successive columns list: (1) the wavelength adopted; (2) the uncertain on these values, obtained from the r.m.s. scatter in the different spectra; (3) the principal atoms that contribute to the formation of the observed line with the dispersion used.

TABLE I

λ Adopted	σ [Å]	Atom
4005.084	0.102	Fe I
4030.494	0.052	Fe I, Mn I
4046.060	0.074	Fe I
4063.514	0.064	Fe I
4071.652	0.021	Fe I
4077.816	0.134	Sr II, Fe I, Ti II
4092.418	0.079	Co I, VI
4102.304	0.083	Hδ, Fe I
4118.702	0.098	Fe I, Co I
4134.394	0.038	Fe I, VI
4144.045	0.053	Fe I
4191.712	0.050	Fe I
4202.113	0.048	Fe I, Ni I
4215.868	0.028	Sr II, Fe I
4235.773	0.050	Fe I, V I, Mn I
4254.120	0.050	Cr I
4260.294	0.046	Fe I
4307.765	0.111	Fe I, Ca I, Ti II
4314.597	0.016	Ti I, Nd II
4340.494	0.040	Hγ, VI
4404.783	0.027	Fe I, Ti I, VI
4415.244	0.020	Fe I, Mn I
4461.702	0.015	Fe I, Ti I, Mn I

The epochs of the spectra, the weighted mean radial velocities, and the r.m.s. internal errors are given in Table II and plotted in Figure 1. The r.m.s. deviation of the radial velocities is 6.4 km s^{-1}, while the mean internal error of each spectrum is 1.6 km s^{-1}. This is indicative, notwithstanding the small amplitude, of real variations. In fact the figure seems to indicate some trend in the variations, that, if real, could support a

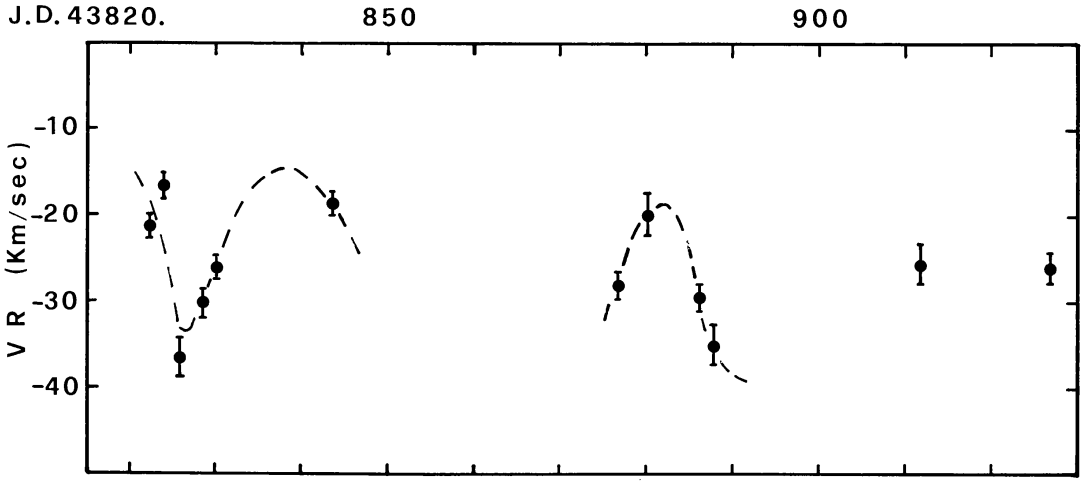

Fig. 1. The radial velocities of IS Geminorum plotted vs time.

TABLE II

Hel. Julian Day	Radial velocity [km s^{-1}]	σ [km s^{-1}]
2443822.59	−21.1	1.6
824.54	−16.3	1.6
825.54	−37.4	1.9
828.57	−29.8	1.0
830.49	−26.0	1.0
843.52	−18.4	0.8
876.50	−27.8	1.4
880.47	−19.7	2.3
886.54	−29.7	1.3
887.52	−34.5	2.4
911.42	−25.3	2.5
926.40	−25.8	1.7

TABLE III

Characteristics of the red spectrograms

Julian Day	Dispersion Å mm^{-1}	Instrument	Photographic emulsion
2443887.43	35	B & C Spectr.	098–04
3889.33	35	B & C Spectr.	098–04
3954.33	35	B & C Spectr.	098–04
4275.44	10	Echelle Reosch + Westinghouse Image Intensifier	103–a–D
4929.52	35	B & C Spectr. + Varo Image Intens.	II–a–D
4930.54	35	B & C Spectr. + Varo Image Intens.	II–a–D
4943.58	18	B & C Spectr. + Varo Image Intens.	II–a–D

time-scale around 20 days. If we suppose that the variations are sinusoidals, then we obtain from the data variance a peak to peak amplitude of 17 km s^{-1}.

As many SRd stars show Balmer emission, seven spectrograms, centred on the Hα line were taken on different epochs. Table III give the characteristics of these spectrograms. All of them, but the fourth, which was taken with the Reosch Echelle spectrograph at the 182 cm reflector of the Asiago Observatory, were taken at the Merate Observatory.

None of these spectrograms shows the presence of emission around the Hα line, and neither the blue nor the red spectrograms show variations in the intensity of the spectral features.

Finally, a comparison of the intensities of metal lines in the spectra of IS Geminorum with those in the spectra of standard *K* giants, shows that they are of normal intensity, so that IS Geminorum can be considered a Population I object.

3. Conclusions

IS Geminorum can be considered a Population I K3 giant which show small amplitude light and radial velocity variations. The time-scale of these variations seems to be of the order of few tens of days.

In conclusion, IS Geminorum does not conform to the more detailed definitions of the SRd stars given in the introduction. Probably there are two types of stars inside the G.C.V.S. definition: a group of high luminosity objects (classes Ia and Ib) with weak metal lines and Balmer emission, probably belonging to Population II or to an old disk population, which are the continuance of the Population II period-luminosity relation toward longer periods (Rosino, 1973), and a group of Population I giants (classes II and III), which does not show spectral peculiarities.

In this last group we may tentantively put beside IS Geminorum, VW Draconis (Biskupski and Kaczmarek, 1962), CE Virginis (Dawson, 1979; Mantegazza, 1983b) and 39 Ceti (HR 373, Olsen, 1974).

We observe that while the stars of the first group have periods which are generally longer of one hundred days, those of the second group have periods of the order of few tens of days.

Finally we point out that the G.C.V.S. includes in the SRd class some spurious objects. We cite the cases of UW Librae, that is according to its DDO colours on G0V star (Dawson, 1979); UU Herculis, which according to Preston *et al.* (1963) is an RV Tauri star of group *B*, and according to Sasselov (1983a, b) could be the prototype of a class of *F*-type variable supergiants; CO Aurigae which is a double-mode Cepheid (Mantegazza, 1983a); S Vulpeculae which could be a Cepheid (Fernie, 1970).

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