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SIMULTANEOUS PHOTOMETRY AND RADIAL VELOCITIES OF DELTA SCUTI

It is well known that for some types of pulsating variable stars the application of the Baade-Wesselink method is connected with serious difficulties. Nevertheless, when applicable, this method is a good source of luminosities, radii, etc. for pulsating variables.

If we want to try to apply the Baade-Wesselink method to stars varying their light curves from one cycle to another and having not quite stable periods (like δ Scuti stars), we need to obtain photometric data and radial velocities practically simultaneously. In the literature such material is sparse.

During the recent years we are measuring radial velocities of pulsating variables using the CORAVEL-type spectrophotometer ILS designed by Tokovinin (1987). δ Scuti stars are on the boundary of the possibilities of this device: for main sequence stars we can measure velocities in the spectral type range F5-M5, it being possible to measure somewhat earlier type giants. On July 26/27, 1992 we tried to measure the radial velocity of the prototype star, δ Sct, at the 1-m reflector of the Simeiz International Observatory

Table 1
Radial velocities of Delta Scuti

JD hel 2448...	$V_{r\odot}$	σ	JD hel 2448...	$V_{r\odot}$	σ
830.289	-37.8	0.4	835.282	-40.9	0.4
830.293	-31.9:	0.5	835.284	-39.0	0.4
830.296	-37.8	0.4	835.286	-39.2	0.4
830.301	-37.7	0.2	835.308	-39.2	0.4
830.304	-38.2	0.4	835.311	-38.3	0.4
830.307	-38.9	0.3	835.325	-38.4	0.3
830.332	-43.0	0.9	835.328	-38.3	0.5
830.335	-44.2	0.7	835.345	-39.8	0.7
830.339	-44.4	0.9	835.348	-39.7	0.7
830.354	-57.1:	2.0	835.361	-46.6	0.8
830.354	-52.2:	2.3	835.364	-43.5	0.5
830.357	-52.2:	2.2	835.368	-48.6	0.5
830.357	-57.1:	2.0	835.384	-45.7	1.0
830.375	-47.6:	0.9	835.386	-48.1	0.7
830.378	-51.3:	1.0	835.388	-50.5	0.8
830.380	-48.4:	1.1	835.407	-43.0	0.7
830.398	-44.6	0.7	835.409	-47.2	0.8
830.401	-47.0	0.5	835.411	-46.3	0.7
830.404	-47.2	0.5	835.432	-43.9	0.9
			835.434	-43.1	0.8
			835.448	-42.1	1.3
			835.450	-42.3	0.9

Table 2
Photometry of Delta Scuti

JD hel 2448...	V	B-V	V-R
835.2941	4.75	0.39	0.32
835.3028	4.77	0.39	0.35
835.3104	4.77	0.40	0.32
835.3173	4.79	0.40	0.35
835.3269	4.79	0.39	0.34
835.3348	4.79	0.39	0.34
835.3381	4.79	0.38	0.34
835.3429	4.74	0.37	0.31
835.3516	4.76	0.35	0.35
835.3582	4.69	0.37	0.33
835.3635	4.66	0.37	0.30
835.3690	4.65	0.36	0.30
835.3772	4.62	0.32	0.29
835.3854	4.62	0.34	0.30
835.3907	4.60	0.33	0.28
835.3960	4.62	0.33	0.30
835.4043	4.59	0.35	0.29
835.4105	4.56	0.32	0.28
835.4167	4.62	0.36	0.29
835.4244	4.64	0.37	0.31
835.4322	4.62	0.35	0.31
835.4377	4.70	0.34	0.35

(Crimea, the Ukraine). The attempt was quite successful, so on July 31/August 1 we organized simultaneous photometric and spectroscopic observations at two telescopes of the Simeiz Observatory. The same 1-m reflector was used for radial velocities, and the photometric obsevations were done at the 60-cm reflector. The photometric conditions, rather typical for Simeiz, were far from being excellent, and we estimate the real accuracy of our results as $\pm 0^m.02 - 0^m.03$ in all filters.

Table 1 contains the radial velocities measured during the two nights, Table 2 the results of photometry during the second night.

We have covered with simultaneous photometric and spectroscopic observations practically a complete cycle of δ Sct ($P=0^d.194$). Then we have undertaken an attempt to use the Baade-Wesselink method (in its "maximum likelihood" version suggested by Balona, 1977, with subsequent iterations described by Coulson et al., 1986). In minor variance with the traditional approach, we approximated with trigonometric polynomials only the radial velocity curve, and then computed the radial velocity integral for the moments when the photometry had been acquired. It seems to us that this modification allows us to reduce the number of avoidable approximations, this being of particular importance for not strictly periodic variables. The unknown ($5 \log e/R_\odot$) in Balona's method (before iterations) for our observations is determined with rather poor accuracy (40 to 59 per cent for different combinations of magnitudes and colours), but the final results are in good agreement, their average being $<R>=1.9\pm0.1$ $R_\odot$. Though a somewhat larger radius would seem preferable, this value does not disagree too much with expectations for an F3III star. Frolov (1970) derived for δ Sct $<R>=2.9$ $R_\odot$ from its atmospheric parameters and quoted the value 3.7 $R_\odot$ from Bessell (1967). Estimates based on the star's luminosity ($M_V \sim +1.5$) and effective temperature lead to radius values about 3 $R_\odot$. On the contrary,

the value 8.4 $R_\odot$ from Rachkovskaya (1986), based on model atmospheres, is unexpectedly large.

It seems to us that, provided one obtains more accurate photometry, it is possible to use ILS radial velocities with simultaneous photometry for Baade-Wesselink determinations of radii for the large amplitude subgroup of δ Scuti variables.

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