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SOME PECULIARITIES OF NINE DELTA SCUTI STARS

On the basis of observational data published by Breger (1979), we have investigated various physical characteristics of 89 Delta Scuti stars. Several variables exhibit some peculiarities; these are considered in the present note.

1. The mode of radial pulsations was estimated in two ways by using both the absolute bolometric magnitude M_{bol} and the pulsation "constant" Q (Tsvetkov, 1982). It was difficult, however, to estimate the mode of six of the variables considered.

a. By comparison of the observed absolute bolometric magnitude M_{bol} ($= M_v$ + B.C.) with a known set of absolute bolometric magnitudes $M_{bol,n}$ we estimated the mode of each star. $M_{bol,n}$ were calculated from theoretical period-effective temperature-luminosity relations for the four lowest modes by using the observed period and effective temperature($n = 0,1,2,3$ corresponds to mode F, 1H, 2H, 3H, respectively, $M_{bol,0} > M_{bol,1} > M_{bol,2} > M_{bol,3}$). The difference between the two kinds of luminosities of a given star estimated in this way does not exceed 0.2-0.3 mag but for the six variables mentioned above, this difference is too large (see Table I).

b. We also estimated the modes by comparison of the observed pulsation "constant" Q with the mean values of the pulsation "constants" Q_n for the four lowest modes: 0.033, 0.025, 0.020, 0.017 days for mode F, 1H, 2H, 3H, respectively. The difference between the two kinds of pulsation "constants" for these six variables is also too large (Table I).

2. Three kinds of masses (in solar masses) are also listed in Table I: evolutionary masses $M_{e,I}$ and $M_{e,P}$, interpolated from the evolutionary tracks of Iben (1967) and Paczynski (1970), respectively, masses $M_g = g R^2/G$, computed from the stellar radii R and surface gravities g (G denotes the gravitational constant); pulsation masses M_Q, calculated by means of Faulkner's (1977) fitting formulae for a chemical composition (X,Y,Z) = (0.70, 0.28, 0.02).

Table I

Peculiar Delta Scuti variables

Star HR	Star HD	Name	M_{bol}	$M_{bol,0}$ or $M_{bol,3}$	Q (days)	$M_{e,I}$	$M_{e,P}$	M_g	M_Q
238	4818	V 526 Cas	2.32	1.02	0.072	-	1.70	1.56	0.35
515	10845	VY Psc	0.83	0.09	0.052	2.03	2.18	2.09	0.90
3662	79439	18 UMa	2.02	0.82	0.065	1.72	1.84	1.54	0.42
4746	108506	FT Vir	1.56	2.34	0.010	1.72	1.85	1.37	?
7020	172748	δ Sct	1.51	0.61	0.055	1.72	1.86	1.71	0.65
7859	195961	ρ Pav	2.43	1.81	0.045	-	1.64	1.28	0.72
1225	24832	DL Eri	1.29	0.82	0.045	1.81	1.96	2.00	1.09
3185	67523	ρ Pup	1.70	1.37	0.040	1.65	1.77	1.67	1.16
5017	115604	20 CVn	1.42	0.97	0.041	1.75	1.90	1.70	1.09

Note (according to Tsvetkov, 1982). For the first six stars without mode estimate: $M_{bol} - M_{bol,0} > 0,5$ and $Q > 0.045$ or (for FT Vir only) $M_{bol} - M_{bol,3} < -0.5$ and $Q < 0.012$. For the three last stars with a doubtful estimate of fundamental mode (F?): $0.3 < M_{bol} - M_{bol,0} \leq 0.5$ and $0.037 < Q \leq 0.045$.

It is evident from Table I that the pulsation masses M_Q are too small in comparison with the other two masses (the difference varies from about 2 to 5 times). One gets for FT Vir an abnormally large mass M_Q (not given in Table I). We note that for the "normal" Delta Scuti stars there is an agreement (within the limits of the accuracy of determination) between the estimates of these three kinds of masses.

Data for three variables with a doubtful estimate of fundamental mode (F?) are also listed in Table I. For these stars, the above considered peculiarities are smaller but yet considerable.

Because of the indicated peculiarities, the nine variables in Table I have been excluded from our investigations of various semiempirical relations for Delta Scuti stars.

Thus, we confirm and extend our results from an earlier note (Tsvetkov, 1979), in which the variables δ Sct and ρ Pup were considered. The former star has been discussed time and again (see, e.g., references in the cited note). As to ρ Pup, a transient Ca II K chromospheric emission at a phase of maximum outward acceleration as well as a bump in the radial velocity curve were observed in this star (Dravins et al., 1977). The variables FT Vir and ρ Pup are situated outside the instability strip (towards the lower effective temperature), the latter star has an unreliable absolute visual magnitude M_v (Breger, 1979). Five of the six variables (excepting FT Vir)

without a mode estimate have a very low luminosity for their period. VY Psc and DL Eri pulsate with more than one period (Breger, 1979).

The indicated peculiarities of the variables in Table I may be due to various causes: the observational data are not accurate, the ordinary photometric calibrations are not applicable to these stars; the considered variables may belong to another type of variable stars, nonradial oscillations may be excited in them, etc.

The star FT Vir is a special case. Its very low Q value of 0.010 day may be due to nonradial pulsations in a high overtone p_k. From Tables 17.2 of Cox (1980) for linear, adiabatic, nonradial oscillations of polytropes with a polytropic index $2 \leq \nu \leq 4$ ($\ell = 2$), one may estimate a mode p_7 for FT Vir. It is interesting to note that Kurtz (1982) estimated a similar mode (p_6) from the value of Q = 0.011 day for the "rapidly oscillating Ap star" 21 Com (Kurtz, 1982, Musielok and Kozar, 1982, Garrido and Sânchez-Lavega, 1983). Moreover, Kurtz suggests that perhaps many B, A, F, G stars oscillate in p modes of low ℓ, high k as does the Sun.

One can note in this context that both radial and nonradial oscillations may be excited in models of Delta Scuti stars (Dziembowski, 1977). Some sort of mode coupling might account for the complicated observed behaviour of many of these objects. From the observational point of view, some real Delta Scuti variables (in particular, 1 Mon = HR 2107 = HD 40535) perform probably nonradial pulsations (see Section III and Table III in Breger, 1979).

New detailed observations and theoretical investigations are required in order to understand the peculiarities of the stars considered in this note.

TS.G. TSVETKOV
Department of Astronomy
University of Sofia
Anton Ivanov Street 5
1126 Sofia, Bulgaria

References:

Breger, M.: 1979, Publ.Astron.Soc.Pacif. 91, 5
Cox, J.P.: 1980, "Theory of Stellar Pulsation", Princeton University Press.
Dravins, D., Lind, J. and Särg, K.: 1977, Astron.Astrophys. 54, 381
Dziembowski, W.: 1977, Acta Astron. 27, 95
Faulkner, D.J.: 1977, Astrophys.J. 218, 209
Garrido, R. and Sânchez-Lavega, A.: 1983, Inf.Bull.Var. Stars, No. 2368
Iben, I.: 1967, Ann.Rev.Astron.Astrophys. 5, 571
Kurtz, D.W.: 1982, Monthly Notices Roy.Astr.Soc. 200, 807
Musielok, B. and Kozar, T.: 1982, Inf.Bull.Var. Stars, No. 2237
Paczynski, B: 1970, Acta Astron. 20, 49
Tsvetkov, Ts.G.: 1979, Inf.Bull.Var. Stars, No. 1548
Tsvetkov, Ts.G.: 1982, Soviet Astron.J. (Astron. Zh.) 59, 1103

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"In the discussion of FT Ori I should have noted that J. Tomkin was, in fact, the first to observe line doubling in that system. I am collaborating with him in the analysis of our spectroscopic material."

C.H. LACY