COMPARATIVE ANALYSIS OF PHYSICAL PARAMETERS OF RR LYRAE

Yu. S. Romanov, N. S. Zgonyaiko, S. V. Vasilyeva
Astronomical Observatory, Odessa State University,
T.G.Shevchenko Park, Odessa 270014 Ukraine
E-mail: root@astro.odessa.ua

ABSTRACT. For analysis of spectral observations of RR Lyrae obtained by Butler in 1974 with a dispersion of 8 Å/mm, a two-component "curve-of-growth" method is used which has been developed at the Odessa Astronomical Observatory. As a result, a number of physical parameters are obtained as well as their phase variations: temperature, spectral type, electron pressure, turbulent velocity. Parameters of T_{ex} and $\lg P_e$ have proved to be somewhat higher than the values found by Butler and correspond to the B9.1 – F0.9 range typical of this stellar spectral type.

Key Words: Stars: Variables: Atmospheres of-stars; Star: Individual: RR Lyrae

Table 1. Physical parameters of RR Lyrae

ψ	ϕ	T_{effBut}	T_{eff1}	T_{eff2}
0.109	0.004	6336	8087	10597
0.237	0.029	6271	7682	11175
0.062	0.148	5909	7682	
0.203	0.194			10783
0.295	0.267	6538	7879	
0.785	0.301	5691	7982	
0.295	0.338	6271	7879	
0.262	0.466	5691	7495	9173
0.272	0.540	5587	7495	8907
0.189	0.714	5638	6906	
0.236	0.799	5691	7405	
0.246	0.856	5691	7317	
0.246	0.962	6336	8656	

Spectrophotometric investigation of RR Lyrae at maximum Blazhko effect was carried out by a two-component "curve-of- growth" method by Romanov et al. (1991, 1993). As a result, a complicated variation in metal spectral types $Sp(M)_1$ and $Sp(M)_2$ has been found from ϕ phase in the B9.1- F0.9 range. Both curves show depression in the region ϕ= 0.90–0.94, minimum depression emerging somewhat earlier in upper curve $Sp(M)_2$ than in lower curve $Sp(M)_1$.

Scanty observations covering only an ascending curve of the light curve for fundamental pulsation in RR Lyrae do not permit to trace further variations in $Sp(M)_{1,\ 2}$ and other parameters of the atmosphere with ϕ- phase.

Due to the method of a two-component "curve-of-growth" (Fenina & Zgonyaiko 1992), spectrophotometric observations of RR Lyrae made by Butler (1974) and embracing the whole cycle of the star's fundamental oscillation near maximum Blazhko effect have been investigated. An the work by Butler (1975), from these observations some physical and chemical characteristics of RR Lyrae relative to the Sun are determined by using differential "curve-of-growth" analysis. An particular, some effective temperatures of a spectrum-forming layer of the star are found by comparing profiles of hydrogen lines H_γ with theoretical ones. Variations in effective temperatures obtained by him lie within F3.7–G2.0 spectral range which does not correspond to the spectral range of RR Lyrae given in GCVS (1985) and in the work by Romanov et al. (1991).

Ambiguous results of spectral classification enabled to compare physical parameters θ_{ex}, θ_{eff}, $\lg P_e$, V_t determined by Butler (1975) and found by us on the basis of a two-component "curve-of-growth" method.

In Tables 1,2 we summarized results of the

Table 2. Physical parameters of RR Lyrae (continued)

ψ	ϕ	θ_{exBut}	θ_{ex1}	θ_{ex2}	$\lg P_{eBut}$	$\lg P_{e1}$	$\lg P_{e2}$	V_{t1}	V_{t2}	$[V]_{FeI}+1.3$
0.109	0.004	0.97	0.76	0.58	0.03	1.62	3.39	2.95	2.95	1.71
0.237	0.029	0.98	0.80	0.55	-0.03	1.05	3.62	2.17	2.51	1.64
0.062	0.148	1.04	0.80			1.91		3.30		
0.203	0.194			0.57	-0.52		3.72		3.30	1.61
0.295	0.267	0.94	0.78		0.36	1.74		2.47		1.75
0.785	0.301	1.08	0.77		-0.95	1.44		2.47		1.58
0.295	0.338	0.98	0.78		-0.09	2.00		3.40		1.63
0.262	0.466	1.08	0.82	0.67	-0.48	1.31		4.15		1.63
0.272	0.540	1.10	0.82	0.69	-0.59	1.24	2.68	3.25	3.40	1.60
0.189	0.714	1.09	0.89		-0.68	0.55		4.07		1.70
0.236	0.799	1.08	0.83	0.67	-0.59	1.01	2.74	2.95	2.95	1.61
0.246	0.856	1.08	0.84		-0.49	1.24		4.07		1.61
0.246	0.962	0.97	0.71		0.08	2.05		2.95		1.63

given comparison. For six spectra, "curves–of–growth" are approximated by one parameter of excitation temperature θ_{ex}, the remaining contain two components each, with two dominating parameters of excitation temperature θ_{ex1} and θ_{ex2} respectively (columns 7 and 8).

In Tables 1,2 we also presented phases of the fundamental oscillation ϕ and those of Blazhko effect ψ of RR Lyrae calculated from data by Romanov et al. (1981); effective temperatures calculated on the basis of parameters θ_{ex} by using the formula

$$T_{eff1,2} = 0.8\frac{(5040)}{\theta_{ex1,2}} \qquad (1)$$

parameters of excitation temperature $\theta_{ex1,2}$ obtained from the two–component "curves–of–growth"; electron pressure according to Boltzmann–Saha equation $\lg P_{e1,2}$; turbulent velocities $V_{t1,2}$. Parameters with the index "But" are taken from the work (Butler 1974).

Comparison has shown that more effective temperatures correspond to the spectral range of GCVS. Electron pressure $\lg P_{e1,2}$ is lineally dependent on θ_{ex} and consistent with ionization equilibrium position in similar stationary stars. Turbulent velocities of the order of 3–4 km/sec correspond to the typical ones for the given stellar type.

References

Butler D.: 1974, *Lick Observ. Bull.*, Board of Studies in As. & Ap., **693**, 1.

Butler D.: 1975, *Ap.J.*, **200**, 68.

Fenina Z.N., Zgonyaiko N.S.: 1992.-In: *"Stellar magnetism, International Conference Proceedings"*, S.Peterburg, 234.

Kholopov P.N. et al. *Gen. Catal. Var. Stars*, Moscow, 1985, **1**.

Romanov Yu.S., Fenina Z.N., Vasilyeva S.V.: 1981, *Astrometriya i Astrofizika* (Kiev), **43**, 43.

Romanov Yu.S., Zgonyaiko N. S.: 1991, *Preprint UkrNIINTI*, **1057**.

Romanov Yu.S., Zgonyaiko N. S., Vasilyeva S. V.: 1993, *Peremenye zvezdy* (in press).