THE INVESTIGATION OF CEPHEIDS RT AUR, T VUL, κ PAV BY A TWO-COMPONENT "CURVE-OF-GROWTH" METHOD

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ABSTRACT. For 3 cepheids (RT Aur, T Vul, κ Pav) the physical and chemical parameters are obtained: spectral class, electron pressure, "microturbulent velocity", relative number of atoms in different chemical elements. The variations of this parameters with a phase are investigated.

Key Words: Stars: Cepheids: Individual: RT Aur, T Vul, κ Pav

The determinations of the spectrum forming layer temperature by different methods (from photometric data, hydrogen line profile, the level of a continuous spectrum, ionization temperature) fail to give consistent results. Because of this, it is practically impossible to construct a "curve–of–growth" by a classical method using one of these temperatures, even with a rather reliable system of oscillators strengths present. The analysis of numerous spectra of pulsating stars by a qualitative spectral classification method has shown that it is necessary to consider at least three levels of forming absorption lines present in every quasistationary state in the pulsating atmosphere: hydrogen, ionized calcium and other metals. Incidentally, each level has its own temperature called local one which in separate phases can coincide on all the levels or strongly differ among themselves. The empirical method of local kinetic temperature determination on levels of forming heavy element absorption lines is based on investigation by using a method of successive approximations of dependence of Fe I equivalent width intensities on excitation temperature in cepheids RT Aur, T Vul, κ Pav. (Fenina et al., 1990, 1991). The investigation of the three cepheids by a two–component "curve–of–growth" method (Fenina et al., 1988, 1990) has resulted in deriving a number of physical – chemical parameters and their phase variations: temperature, spectral type, electron pressure, turbulent velocity, relative number of atoms in different chemical elements. Phase variations in spectral characteristics in every cepheid show their own peculiarities which have not been displayed at all in investigation by the "curve–of–growth" method relative to the Sun and by the scanning method of UBV photometry. It is common for all the above cepheids to have two temperature levels which without mixing pass the stage of maximum light. To objectively estimate some physical parameters (relative number of atoms, electron pressure and turbulent velocity), a standard has been created on the basis of investigating stationary stars close in spectral type to RR Lyrae stars and cepheids. As an initial material equivalent widths for 10 stars have been used which were obtained by different authors from spectrograms with close dispersion 10 Å/mm.

Taking into account that each of stationary stars can show individual peculiarities their analysis has been done by a two–component "curve–of–growth".

Standardization of chemical composition

The question of chemical composition of atmospheres of RR Lyrae type stars and cepheids is of a principal importance as upon it depend conclusions drawn on chemical composition of stellar clusters and eventually on stellar evolu-

Table 1: Relative number of atoms of chemical elements

element	$\lg(N/H)$	σ	n	Sun	element	$\lg(N/H)$	σ	n	Sun
Al	5.24	0.96	6	6.49	Ni	4.67	0.42	3	0.22
Si	6.38	1.38	5	7.64	Sr	0.95	0.34	7	2.90
Ca	5.54	0.64	6	6.38	Y	1.48	0.56	7	2.24
Sc	2.01	0.58	14	3.06	Zr	1.71	0.66	10	2.56
Ti	4.12	0.35	15	5.06	Ba	1.14	0.79	4	2.11
V	3.47	0.47	12	4.00	La	1.22	1.08	6	1.10
Cr	4.69	0.64	14	5.64	Ce	0.49	0.32	4	1.60
Mn	5.37	1.10	7	5.40	Nd	0.63	0.39	3	1.40
Fe	6.60	0.39	13	7.64	Eu	0.23	0.18	3	0.50
Co	3.95	0.06	3	4.92					

tion trends. Chemical composition is adopted to imply a relative number of atoms in different elements per 10^{12} hydrogen atoms.

In Table 1 are shown average values of the parameter of a relative number of different atoms lg(N/H), their mean quadratic deviations and a number of estimations n. For comparison, solar data from the work by Gurtovenko and others are given (1989). Within 3σ the relative number of atoms in different elements agrees with the solar one. One can suggest that it is a natural dispersion inherent to different stationary stars. In case a deviation in the relative number of some elements in the atmosphere of a pulsating star exceeds natural dispersion, it is suggestive of their deficiency or excess on the whole or in separate phases. The investigation of a diagram of $\lg(N/Fe)_* - \lg(N/Fe)_{st}$ from different chemical elements in stars of the standard and cepheids RT Aur, T Vul, κ Pav has shown that in cepheids the dispersion is much larger than in stationary stars, incidentally it changes depending on the phase of light variation.

Standardization of electron pressure

From lines of neutral and ionized iron, electron pressure $\lg P_e$ for stars of the standard and cepheids T Vul, RT Aur, κ Pav has been determined. As a result, the dependence of $\lg P_e$ on θ_{ex} is shown to be linear and for stationary stars approximated by equation:

$$\lg P_e = -9.118\theta_{ex} + 7.775$$

For cepheids approximated by equation:

RT Aur $\lg P_e = -5.600\theta_{ex} + 4.705$

T Vul $\lg P_e = -8.125\theta_{ex} + 7.536$

κ Pav $\lg P_e = -2.747\theta_{ex} + 1.365$

Linearity of $\lg P_e$ dependence on θ_{ex} testifies to the existence of ionization equilibrium in the atmospheres of cepheids, in each phase the state may be accepted as being quasistationary.

Standardization of "microturbulent velocity"

The term of "microturbulent velocity" is defined in the given case as a difference in the $\lg W_\lambda/\lambda$ scale which arises between a theoretical and an experimental "curves-of-growth" and has a dimension of km/sec. These data are burdened with errors related to an instrumental contour of spectral lines (depth) and to the equivalent widths rise as the effective temperature drops (Megin, 1984). In order to empirically take into account the temperature influence on V_t km/sec a dependence of "microturbulent velocity" for stationary stars on Sp(M) – spectral type, as measured from Fe I lines, i.e. on temperature has been constructed. The derived dependence is of linear character, at least within B5 – G0 range and approximated by the equation of the form: $V_t = 7.147\theta_{ex} - 2.617$ The derived mean dependence is used for estimation of proper "microturbulent velo-

cities" of three cepheids κ Pav, T Vul, RT Aur. The scattering of proper "microturbulent velocities" for cepheids was proved to be in order of ± 2 km/sec.

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RAPID PHOTOMETRY OF THE HD 197406 (WN7): SEARCHING FOR FLARE ACTIVITY IN WOLF–RAYET STARS

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ABSTRACT. We have undertake a study of Wolf-Rayet star HD 197406 in order to test an existence of stable periodic changes of light curve, which can arise as result of interaction of rotating compact companion and fast, dense, hot stellar wind. The observations of this star have been carried out in August and October 1991, and in August 1993 at the high–altitude Observatory Peak Terskol (3100m) North Caucasus with the help of 60cm telescope and high–speed double–channel photometer. The HD 197406 was monitored in UBV and moderate–band filters, that cover the range of pure continuum (central wavelength 4270Å and FWHM 100Å) and the range of He II 4859Å line (central wavelength 4870Å and FWHM 140Å). Star BD +52°2783 (Sp B9) was used as a reference star. Monitoring of two stars, HD 197406 and BD +52°2783, was carried out simultaneously in two parallel channels at the same filters with the integrating times from 0.05 sec to 1.0 sec continuously during from 10 min to 1.5 hour. Besides, we observed the Wolf–Rayet star simultaneously in two channels in different filters. The obtained data reveal a flare variability at the pure continuum during about 1.5 min. In this case, the flares last about 1.0 sec and reach 0.2–0.3 magnitude. Variability of light curve in U,B and range of He II 4859 Å line also is detected. On the other hand, the stable periodic changes of light curve isn't detected with confidence. Therefore, such variability seems to arise rather as a result of magnetic field action on the surface of star, than as result of interaction of rotating compact companion with stellar wind. New observations of HD 197406 are needed, especially at the range of strong He II 4686 Å line, in order to clarify the physical situation.

Key words: Stars: HD 197406 – star: Wolf–Rayet – stars: flare – stars: photometric.