THEORETIC ESTIMATIONS OF THE SURFACE PARAMETERS FOR TWO CEPHEID STARS RT AUR AND SV VUL.

M.D. Suran
Astronomical Institute of the Romanian Academy,
Bucharest 75212, Romania

ABSTRACT. Surface parameters for two cepheid stars RT Aur and SV Vul are obtained using four different kinds of observational data: photometric, spectroscopic, theoretic and reduced ones. A detailed comparison between results has also been made.

1. INTRODUCTION

For the two stars, RT Aur and SV Vul, I collected and determined more data sets:

- observational (LL-Luck and Lambert, 1981; 1985), (SAO - unpublished material)
- theoretical, pulsational (C-Cox, 1979; S-Suran, 1986);
- reduced material (interpolation formulae from HP-Harris and Pilakowski, 1984; H-Harris, 1981; S-Suran, 1986 materials).

Because each set of determinations has:

- his own internal method of calculations;
- his own system of calibration of each measurable parameter;
- his own sets of systematic errors for parameters,

direct methods of comparison between these are not possible and only mean values could be obtained. The main parameters which must be determined are:

- effective temperature of the stars (T_e);
- surface gravity (g);
- turbulent velocity (ξ_t);
- chemical abundances (X_i or the paranthesis [.]).

2. PHYSICAL PARAMETERS DETERMINATION

I. Photometric Methods for temperature determinations: For the two stars, starting from the photometrical data (B, V) of Schaltenbrand and Tamman (1971) we could determine temperature scale and temperature variations using two different, extreme cases:

- method of reddened colours (Kraft, 1958);
- method of unreddened colours (DWC-Dean, Warren, Cousins, 1978), where I preffered a value $E_{B-V} = E_J$ (in DWC original notation).

The temperature so determined does not depend on the star pulsational phase.

II. Theoretical models: Using as input parameters (log(P), log(T_e)), we could, from the pulsational point of view, determine the theoretical models for the stars. I used two methods in calculations:

- "theoretical mass" method of Cox, 1979 (C);
- "post-theoretical mass" method of Suran, 1986 (S);

Results of the model calculations for the C case assume the solar abundance value Z = 0.02. For the S case we use two different compositions, Z = 0.01 and Z = 0.02. From theoretical calculations we could estimate: physical parameters (T_e, M, L, R, g); pulsational spectrum $P_{i\ (i=1,...)}$; chemical structure of the stars, assuming stationary envelopes in calculus.

III. Spectroscopic models: In this paragraph I discuss the collection of the spectroscopical data obtained by LL (1981, 1985) and Panchouk at SAO. Generally, spectroscopic results are obtained assuming an external determinations of (T_e, g, ξ_t) and an usage of an atmospherical model (LTE, NLTE) for the reduction of the stellar spectra.

In this case, triplets (T_e, g, ξ_t) are dependent on the phase of variation. Unfortunatelly, we have few spectral determinations, and we could not have estimated the importance of the phase effect in abundance calculations. The phase dependence of (T_e, g, ξ_t) make spectroscopic determinations less precise as the photometrical and theoretical ones.

IV. Reduced parameters: In our paper (Suran, 1986) other photometrical and spectroscopical data:

- theoretical (B_5, B_{10} in S notation);
- observational spectral (HP, LL);
- observational photometric (H), are used to derive useful relations concerning:
- abundance relations (Z - P);
- physical relations (q - P, q = T_e, L, M);
- chemical relations (q - Z);
- catalog relations (R_G - P, where R_G - star galactocentric distance);
- space distribution relations (abundance gradients) (Z - R_G), and hence a new class of parameters, "reduced" ones, could be obtained ($T_e^{B,P}$, $T_e^{B,R}$, $M^{B,P}$).

3. ABUNDANCE DETERMINATIONS

Using the data sets of input parameters (T_e, g, ξ_t) determined in the previously paragraph, we determined abundances for the two stars. Thus, we have:

- assumed abundances, from theoretical calculations (Z=0.02 in C case, 0.01 and 0.02 in S case);
- observed spectral abundances from the reduction of stellar spectra (LTE or NLTE), differently in LL or SAO cases, depending on the atmospheric models used.
- calculated "reduced" abundances as: $[Z/X]^{B,P}$, $Z/X]^{B,R}$, $[A/H]^{HP,P}$, $[A/H]^{HP,R}$, (in S notation).

4. GENERAL CONCLUSIONS

Results obtained in preceding paragraphs are all collected in Tables 1 and 2. Inspection of the tables reveals some useful conclusions:

a) LL spectroscopic temperatures seem to be overestimated for the two stars, Also, SAO spectroscopic temperatures indicate a strong phase effect. Using the "mean" values of T_e (from Table 1), closely to the photometric temperature T_e^c, positions of the two stars in (T_{eff}, $(B-V)_o$) diagram are normal compared to others determinations (BK-Buser and Kurucz, 1978; BG-Bell, Gustafsson, 1978).

b) Generally, the photometric values for $\log(T_e)$ and $\log(g)$ are more exact than the spectroscopic ones which depends on the phase effect. From LL (1985) we know that the substitution of $\log(g_{th})$ instead of $\log(g_{sp})$ (0.3 dex) would remove some suspicious chemical correlations (C-O) and rise the (O) abundances near solar value. But such a substitution could also introduce significant disequilibrium for the metals. The equilibrium could not be restored even by increasing T_e. In this case only a NLTE atmospheric model could give reasonable results.

c) The abundances will depend on the star's galactocentric distance. In our case for the two stars RT Aur (8.8 kpc) and SV Vul (7.7 kpc) we estimate:

$$[Fe/H]_{RT\ Aur} - [Fe/H]_{SV\ Vul} = -0.233 \pm 0.05,$$

the value twice as expected theoretical, but with correct sign. In spite of our intrinsic observational error, the differences do not indicate a major discrepancy.

d) Comparison of the scatter of different kinds of technique and methods of observations, with the relative errors in the estimations of the parameters for the two stars, shows the internal consistence and the firmness of our investigational methods. The results show also that the "reduced" parameters obtained for the two stars are consistent (of the same precision) with others observational estimations (both spectroscopic and photometric ones). This shows that our simple interpolation formulae from S (1986) are realistic and make them very suitable for direct and rapid calculations of the atmospheric parameters for cepheid stars.

Table 1.

ESTIMATED PHYSICAL PARAMETERS FOR THE TWO CEPHEID STARS

Star:	RT Aur			SV Vul		
Type	T_e	log(g)	Fe/H	T_e	log(g)	Fe/H
LL(s)	6500.	1.50	0.10	6000.	1.00	0.25
SAO(s)	5800.	1.70	-0.27	5500.	2.20	-0.06
Cox(th)	6187.	2.03	0.	5038.	0.84	0.
B, DWC(th)	6187.	2.00	-0.3, 0.	5038.	0.82	-0.3, 0.
B, P(r)	6319.	1.92	-0.20	4647.	0.92	0.08
B, R(r)	6057.	-	-0.16	5937.	-	-0.13
HP, P(r)	6250.	-	-0.11	4736.	-	0.35
HP, Z(r)		2.09	0.12		1.15	0.19
Mean	6185.	1.87	-0.064	5270.	1.26	-0.055
	± 82.	± 0.10	±0.05	±207.	±0.12	±0.04

Table 2.

ABUNDANCE DETERMINATIONS FOR THE TWO CEPHEID STARS

Star	RT Aur	SV Vul
Type		
Fe/H ^{LL}(s)	0.10	0.25
Fe/H ^{SAO}(s)	-0.27	-0.06
X/Z ^{B,P}(r)	-0.20	0.08
X/Z ^{B,R}(r)	-0.16	-0.13
A/H ^{H,P}(r)	-0.12	0.35
A/H ^{H,P}(r)	0.12	0.19
A/H ^{H}(ph)	0.10	0.20
Fe/H ^{LL}(r)	-0.10	0.38
Mean	-0.064	0.158
	±0.05	±0.06

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