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Metallicity of the star HD80290(F3V)

Z. A. Samedov[1,2], G. M. Hajiyeva[2], Z. F. Aliyeva[1] and N.H. Samedova[2]
[1]-Faculty of Physics, Baku State University, Z. Khalilov 23, Baku AZ1148, Azerbaijan
[2]-Shamakhy Astrophysical Observatory of ANAS, Shamakhy AZ5626, Azerbaijan

zahir.01@mail.ru
haciyevagunay@yahoo.com
zaminaaliyeva@bsu.edu.az
nergizsemedova777@gmail.com

The atmospheres of the HD80290(F3V) star of the F spectral class were studied using the model and parallax methods. The effective temperatures T_{eff} and surface of gravity g of stars were determined based on a comparison of the observed and theoretically calculated values of the photometric quantity [c_1] and the equivalent widths of the spectral lines of the hydrogen Balmer series and the use of parallax. Based on the FeII lines, the microturbulence ξ_t and the metallicity [Fe/H] were determined. In the atmospheres of the stars, the metallicity is close to the metallicity in the Sun. This shows that the stars we studied and the Sun are formed from the same metallicity matter. This result is important from the point of view of the chemical evolution theory of the stars.

Keywords: F spectral class giant stars, fundamental parameters of stars

Introduction

In this work, the fundamental parameters of HD80290(F3V) star: effective temperature T_{eff}, the surface of gravity g, microturbulent velocity $\xi_{t,}$ and metallicity [Fe/H] were determined.

Knowing the effective temperature and surface of gravity, the models of stellar atmospheres are calculated and on the basis of these models, the chemical composition of stars is determined; in addition, the evolutionary parameters of stars: masses, radii, luminosities, and ages are calculated.

In astrophysics, microturbulence is considered a mechanism for broadening the spectral line. The equivalent width of the spectral line depends on microturbulence. Therefore, in order to determine the chemical composition, it is necessary to know the microturbulent velocity.

Metallicity is one of the main fundamental parameters of stars. According to the definition of this parameter, it is determined whether the star and the Sun are formed from the same or different metallicity matter and the problem of the correctness of the provisions of the modern theory of chemical evolution of stars is solved.

Note that only the effective temperature of the star HD80290(F3V) was determined by another author [1]. The velocity and metallicity of the rapid, microturbulent gravitational movement on the surface of this star are determined by us for the first time.

Observation material

The spectra of the star were obtained with the spectrograph ELODIE of the 1.93-meter telescope of the Haute Provence Observatory located in southeast France (R=56000, S/N=122). It covered the spectral range from 3850 Å to 6800 Å. The spectra were developed by the DECH software. The equivalent widths of spectral lines were measured. Equivalent widths of spectral lines of Balmer series of hydrogen: $W(H_\alpha)$=6.20Å; $W(H_\beta)$=6.76Å; $W(H_\gamma)$=9.24Å; $W(H_\delta)$=7.86Å were measured. The measured equivalent widths of the FeII spectral lines are given in Table 1.

Table 1. FeII lines studied in the spectrum of the star HD80290

λ, Å	χ, eV	log gf	W, mÅ	log ε
4002,07	2,77	-3,35	29	6,74
4128,74	2,57	-3,56	62	7,46
4178,85	2,57	-2,90	98	7,60
4233,16	2,57	-1,88	136	7,18
4273,32	2,69	-3,30	80	7,71
4278,13	2,68	-3,89	58	7,75
4303,17	2,69	-2,48	114	7,54
4369,40	2,77	-4,05	48	7,80
4385,38	2,77	-2,58	106	7,49
4413,60	2,66	-4,01	29	7,28
4416,82	2,77	-2,57	85	7,10
4489,19	2,82	-3,68	83	8,21
4491,40	2,84	-2,71	85	7,30
4508,28	2,84	-2,33	94	7,10
4515,33	2,83	-2,50	93	7,25
4520,22	2,79	-3,17	93	7,88
4522,63	2,83	-2,14	138	7,61
4541,52	2,84	-2,83	76	7,21
4555,89	2,82	-2,35	102	7,27
4576,33	2,83	-2,79	74	7,12

4582,83	2,83	-3,08	63	7,18
4583,83	2,79	-1,81	131	7,15
4620,51	2,82	-3,00	52	6,86
4635,32	5,93	-1,48	25	7,37
4648,93	2,57	-4,58	21	7,57
4656,97	2,88	-3,58	44	7,32
4663,70	2,88	-4,42	36	8,00
4666,75	2,82	-3,20	63	7,28
4731,47	2,88	-3,07	68	7,27
4893,78	2,82	-4,16	22	7,37
4923,92	2,88	-1,56	147	7,13
4993,35	2,79	-3,58	40	7,15
				7,38±0.25

Effective temperature and surface of gravity

The effective temperature T_{eff} and the surface of gravity g of the stars were determined by the model and the parallax method. This method is described in details in [2,3].

The effective temperature and surface of gravity g were determined based on a comparison of the observed and theoretically calculated values of the photometric quantities [c_1] and the equivalent widths of the spectral lines of the hydrogen Balmer series and the use of the parallax method. The parallax method [2,3] is a completely new method for determining effective temperature and surface gravity. This method is very convenient because it does not depend on the selection of atmospheric models.

The index [c_1] is defined as [c_1]=c_1-0.2(b-y). This index is released from the absorption effect in interstellar space. The observation values of the quantity [c_1] are determined from the catalog [4]. The theoretically calculated values of the equivalent widths of the Balmer series are given in [5], and theoretically calculated values of quantity [c_1] are given in [6]. The parallax π of the star is taken from Gaia Early Data Release 3 (Gaia) [7] database. The diagram defining T_{eff} və logg is shown in Figure 1. Based on this diagram, HD80290(F3V) is assigned to the star: T_{eff}=6490K və logg=3.95. T_{eff}=6874K is given for the star HD80290(F3V) in [1].

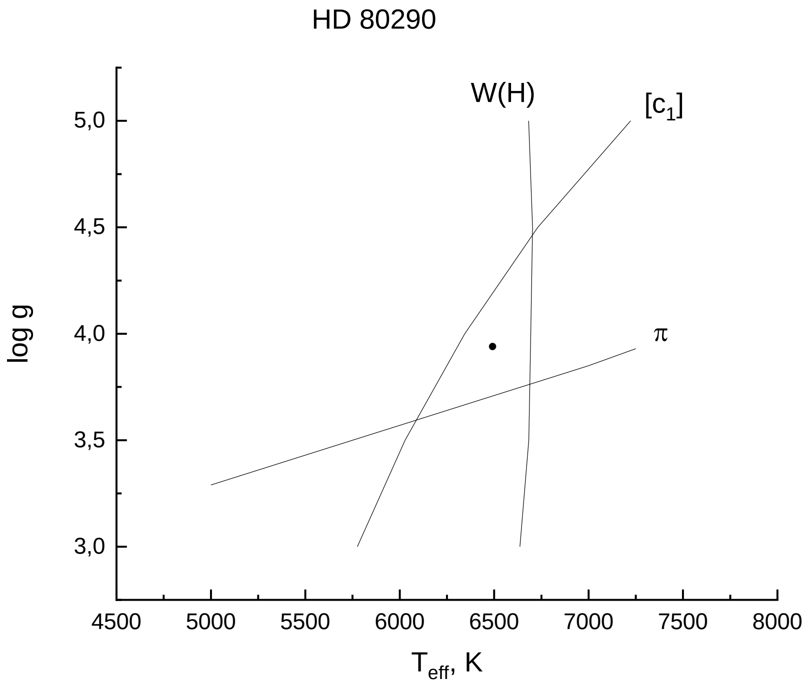

Figure 1. T_{eff} – logg diagram

The microturbulent velocity

The determination of the microturbulent velocity by the model method is based on the study of equivalent widths in a wide range of spectral lines of a neutral atom or ion of any element. Several values are given to the microturbulent velocity ξ_t, and the equivalent widths W_λ of the spectral lines of the considered element are calculated and compared with the equivalent widths measured from observation. Based on each spectral line, the abundance of the element logε is calculated for different values of the microturbulent velocity ξ_t, and the abundance of the element $log\varepsilon$ determines the microturbulent velocity ξ_t in the atmosphere of the studied star. According to the graph, it does not depend on the equivalent widths W_λ of its spectral lines. Note that the deviation from LTE does not affect the $FeII$ line. Therefore, the microturbulent velocity ξ_t and the iron abundance are determined by $FeII$ lines in the stellar atmosphere.

Only the fairly weak lines are used when determining the microturbulent velocity ξ_t. These lines are formed in deep layers of the atmosphere, these layers are planeparallel and in the LTE form.

Knowing the effective temperature T_{eff} =6490K and surface of gravity logg=3.95 of the star HD80290, we calculate their models using Kurucz ATLAS 9 program.

Based on these models, the iron abundance $log\varepsilon(FeII)$ is calculated by giving different values to the microturbulent velocity ξ_t in the atmosphere of a star. The iron abundance is determined by comparing the values of the equivalent width of lines $FeII$ measured during the observation and calculated theoretically. The atomic data of spectral lines are taken from the VALD 3 [*vald.astro.uu.se*].

Fig.2 shows the dependence graphs of the abundance $log\varepsilon(Fe)$ determined based on the different equivalent widths of $FeII$ on the equivalent widths W_λ- in the atmospheres of the studied star.

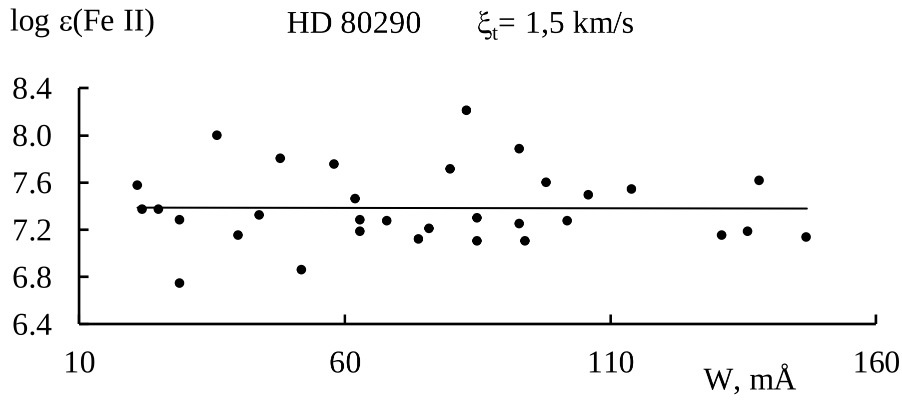

Figure 2. Determination of microturbulent velocity

As it can be seen from Fig.2, there is no correlation between $log\varepsilon(Fe)$ and W_λ for the star at $\xi_t = 1.5$ km/s. When analyzing the microturbulence on the basis of *FeII* lines, the abundance of the iron element *logε (Fe)* is determined simultaneously: $log\varepsilon(Fe)$=7.38±0.25 (HD80290). The abundance of iron in the sun is logε(Fe) =7.47 [8]. The metallicity was determined in the atmosphere of the star: [Fe/H] = -0.09.

As it is shown, the metallicity of the studied stars and the Sun is practically the same. This shows that the stars we studied and the Sun are formed from the same metallicity matter and this result is important from the point of view of the theory of the chemical evolution of stars.

Main results

1. The effective temperature and surface of gravity of F spectral class star HD80290 have been determined by model and parallax methods: T_{eff}=6490K, logg=3.95.

2. The microturbulent velocity has been determined in the atmospheres of stars: $\xi_t = 1.5$ km/s

3. The metallicity was calculated in the atmosphere of the star. It has been found that the iron abundance is close to the abundance in the Sun. This shows that the star we studied and the Sun are formed from the same metallicity matter. This result is important from the point of view of the chemical evolution theory of the stars.

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