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ELEMENTAL ABUNDANCE ANALYSIS OF AM STAR 15 VUL (HD 189849)

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Previously well studied Am star 15 Vul (HD 189849) is re-analysed as a part of a series of papers that will be published by Turkish and Russian scientists collaboration.
The data is taken by Russian Turkish Telescope (RTT150) which is operated at TÜBİTAK National Observatory. The high resolution (R=40000) and high S/N (>100) spectra are analysed using mixed approach of the equivalent width analysis and the spectrum synthesis techniques. The synthetic spectrum approach is used in cases of the lines of an element are few for reliable statistics and/or special atomic physics is required to take into account, such as hyperfine structure. Whenever the line is available, the oscillator strengths are tested on the solar spectrum, The analysis is based only on the LTE approach.

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1. INTRODUCTION

An Am star spectrum is defined as a spectrum that showing the following properties: 1) Heavy – element spectral lines are stronger than those of non-metallic line A stars of the same hydrogen strengths, 2) The metallic lines indicate late A and early F type whereas Sc II and Ca II lines are too weak and corresponds to early A type, 3) H lines indicate somewhat earlier type than metalic lines [1].

Abundance analysis of the Am stars is an impotant effort to test the competing theories about their peculiarities. Because of that, in an homogenius way and carefully performed analyses of these stars are important. Due to this fact, sometime ago we have started to re-analyse a group of selected Am stars. 15 Vul is a well known Am star which is previously studied by different authors (see for example [2] and the references therein) and the first star in our analyses.

2. OBSERVATIONAL DATA AND REDUCTION

The spectra are taken with Coudé echelle spectrograph mounted on 1.5 meter «Russian - Turkish Telescope» (RTT-150), operating at TÜBİTAK National Observatory in Türkiye. Resolving power of the spectra is 40000 and signal to noise ratio is equal to or over 100, in the ∼3800 – 10000 ÅÅwavelength range. Standart Preliminary reduction (bias and dark reduction, flat fielding and CCD's back illumination correction) of the spectra is performed with MaximDL [3] and DECH [4] softwares. Continium fitting is achieved with IRAF's [5] spectool package by fitting mathematical curves to each echelle order.

3. ANALYSIS

The spectra are analysed using mixed approach of the equivalent width analysis and the spectrum synthesis techniques. The synthetic spectrum approach is used in cases of the lines of an element are few for reliable statistics and/or special atomic physics is required to take into account, such as hyperfine structure.

For the model calculation, initial effective temperature and surface gravity are calculated using different methods. The computer program of Napiwotzki et. al. [6] and uvbybeta photometry of Hauck and Mermilliod [7] give the effective temperature is 7870 K and the surface gravity as log g= 3.62 while IRFM temperature calibration for b-y and B-V colors [8] gives a mean Teff= 7620 K. A model independent calculation of surface gravity using Hipparcos parallax and standart formula for log g

$$logg = 4logT_{eff} + 0.4M_{bol} + log(M/M_{\odot}) - 12.51$$

gives log g= 3.5.

Spectroscopically consistent effective temperature and surface gravitiy determination is required to get excitation and ionization balance for iron lines. The NLTE corrections for iron lines are negligible for the calcuated initial effective temperatures and surface gravities (Sitnova T., private communication) and one can expect to achieve ionization balance for the iron lines. To do this one needs to perform abundance analysis for iron starting from the initial atmospheric parameters .

Line selection for the analysis has been performed preparing an unblended synthetic spectrum with the initial Teff and log g. For this purpose (as well as rest of the analysis), model atmosphere calculations has been done using Kurucz's ATLAS9 model atmosphere code [9] [10] and synthetic spectra are calculated with SPECTRUM [11] code. Then, observed spectrum, SPECTRUM's native line list and VALD [12] line list that extracted for the initial stellar parameters, has been mapped on the synthetic spectrum. The telluric line spectrum extracted from the Solar Flux Atlas of Wallace et. al. [13] is reduced to our resolution and also added to the plot. Figure 1. shows a portion of the plot. Hence, we were able to see that how much a line is blended with the other lines or whether it is contamined by tellurics or not.

Equivalent widths are measured with IRAF package and if required deblending has been performed. An example of such a measurement is shown in Figure 2. Abundances from the equivalent widths are calculated using ABUNDANCE [11] routine.

Figure 3a shows the analysis of Fe I lines for calculation of iron abundance using equivalent width method. Starting with the initial atmospheric parameters we have iteratively calculated a series of model atmospheres untill the excitation potentials of Fe I lines are independent of abundance with a least scatter around the mean, and reduced equivalent widths are independent of abundance around the mean, simultenously.

While the former requirement fixes the effective temperature the latter one provides microturbulance velocity. Meanwhile, changing the log g value of the model such that the Fe abundance from the Fe II lines is equal to abundance from Fe I lines gives the surface gravitiy of the model (see figure 3b). Hence, the final model has $_{Teff}$=7685 K, log g=3.09 and ξ=1.95 km/s. These values are close to earlier work of Bolcal et. al [14], except microturbulance velocity.

4. CONCLUTIONS

As the preliminary results, abundances of 28 element has been determined. Comparison of our results with the most recent analyses ([2] [15]) of the star (see figure 5.) shows that most of the elements up to iron are less abundant than solar ones and represents almost constant value of underabundance around 0.2 dex. This is not the case in previous studies and that might be due to improper line selection/identification, telluric line contamination and hyperfine structure that is not taken into account. Remaining abundances shows more or less same patern in all studies.

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