THE ABUNDENCES OF NUCLIDES MAGNESIUM IN THE ATMOSPHERES OF ARCTURUS AND ALDEBARAN

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ABSTRACT. The abundances of nuclides magnesium in the atmospheres of Arcturus and Aldebaran thick and thin disks of Galaxy have been studied. The stars have various chromospheric activity. We used the new data on molecular constants of radiation for every electrically-vibrationally-rotating line of molecular system $A^2\Pi$-$X^2\Sigma$ for MgH. The synthetic spectra were calculated. The values determined are generally close, but not equal, to the solar ratios.

Key words: Cool stars: abundances isotopes: individual: α Boo, α Tau.

1. Introduction

The determination of the contents of nuclides both with small, and with large nuclear numbers, is necessary for testing the processes of nuclear fusion and radioactive decay and theories of the stellar evolution. The contents of nuclides in the atmospheres of giant stars should vary during their own evolution and the chemical evolution of interstellar medium as a result: of Supernova and Nova outbursts, of the matter outflow from the outer layers of stars at various stages of their evolution. The nuclides
H/D, ^{3}He/^{4}He, ^{6}Li/^{7}Li, ^{12}C/^{13}C
^{14}N/^{15}N,^{16}O/^{17}O/^{18}O,^{24}Mg/^{25}Mg/^{26}Mg,
^{28}Si/^{29}Si/^{30}Si, ^{35}Cl/^{37}Cl,
^{40}Ca/^{42}Ca/^{43}Ca/^{44}Ca/^{46}Ca,
^{46}Ti/^{47}TI/^{48}Ti/^{49}Ti/^{50}Ti,
^{90}Zr/^{91}Zr/^{92}Zr/^{94}Zr/^{96}Zr
would be originated as a result of those or other nuclear processes (s and r-processes of neutron capture, processes of burning of hydrogen and helium in the cores of stars and in higher layers of stars, proton capture etc.), and, therefore, their ratios of their abundance can differ from the ones in the Solar system, including the terrestrial crust and the atmosphere of the Sun. The determination of the contents of these nuclides in the atmospheres of stars at different stages of evolution will help to test processes of nuclear fusion for transitions from the branch of dwarfs (main sequence -MS) to the red giants branch (RGB), and, consequently, to the asymptotic giant branch (AGB). It is important for stars belonging to thin and thick disks of the Galaxy, which originated, a-priori, in different conditions. So the nuclides Mg could arise as a result of burning of carbon, or sequential caption of the α-particles, i.e. burning of helium. Tomkin and Lambert (1976, 1980) have shown, that ^{25}Mg and ^{26}Mg will be found as a result of burning of helium in the core of AGB stars and an outburst during a thermal pulsing, and ^{24}Mg - during carbon burning at the advanced stage of AGB. All three stable nuclides of Mg can arise during explosive burning of carbon. The MgAl and NeNa - cycles operate in the interior of MS stars. Their products are brought to the stellar atmospheres by convection after the transition to the RGB phase. The relations ^{24}Mg/^{25}Mg/^{26}Mg are 78.99/10.00/11.01 (de Bierve and Barnes, 1985) for the Solar system or for the terrestrial crust and for the solar corona 76/12/12 (Wallace et al., 1999), respectively. The star Gumbridge 1840 (very old subdwarf with a small mass) has the contents of isotopes Mg within limits ^{24}Mg/^{25}Mg/^{26}Mg = (0.88-0.94) / (0.07-0.03) / (0.05-0.03) (Tomkin and Lambert, 1980). The contents ^{24}Mg for this star is possible can reach even 100 % (Mewaldt and Lambert, 1989). These relations of isotopes essentially differ from the relations in the Solar system and in the terrestrial crust. The role of those or other nuclear processes can be changed during evolution of galaxies. The content of nuclides of a magnesium in the atmospheres of Arcturus (thick disk) and of Aldebaran (thin disk) have been investigated.

2. The synthetic spectra

Komarov and Shevchuk (1995) have shown for a branch of the giants, that the partial pressure of molecules - hydrides does not vary almost along this branch from T_{eff}=5000K, $\log g$ = 3.0 to T_{eff}= 3500K, $\log g$ = 0.75 dex. The determination of the contents of isotopes of a magnesium on electronic - vibration - rotation lines of the molecule MgH will depend on

fundamental parameters of atmospheres of researched stars very weakly, and will depend on an accurate of molecular constants and on blending by other atomic and molecular absorption lines.

For a research of the contents of nuclides of a magnesium, the Atlases of spectra of Arcturus and Aldebaran with the resolutions 0.02 and 0.08 Å have been used, respectively. The synthetic spectra have been calculated using the programs by Tsymbal (1995), kindly given to our operation. The models of atmospheres were selected from the grid by Kurucz (1992, 1993) interpolated on fundamental parameters of stars. The fundamental parameters were taken from Komarov (1999) and are given in the Table 1.

Table 1: The characteristics of stars and abundances isotopes Mg.

*	T_{eff}	logg	A_{Fe}	$^{24}Mg/^{25}Mg/^{26}Mg$
αTau	3800	1.67	7.65	88:5:7
αBoo	4350	1.73	7.05	80:10:10

For two investigated stars of the input data, were took identical sets of absorption lines.

The relative content of the nuclides Mg was determined using the synthetic spectra. The oscillator strength were changed (analog change of contents of nuclides Mg) to get best agreement of observational and theoretical spectra. The comparison with theoretical spectra was made after convolution with the apparatus function. The apparatus function is assumed to be a Gaussian with a half-width equal to the spectral resolution of the spectrographs, using which the spectra of Arctur and Aldebaran were received. The check was conducted using the method of comparison of the observational and calculated contours of absorption lines of iron.

3. Conclusion

In Table 1, the main result is given. The differences in the relative contents of nuclides of a magnesium for cold giant stars of thin and thick disks
of the Galaxy are within the limits of errors of their determination. For final conclusions, the study of the relative contents of nuclides of the magnesium, and nuclides of other elements, and for the greater number of stars - giants of thick and thin disks of a Galaxy, is necessary. As have been shown earlier, the processes of enrichment of atmospheres of stars by products of nuclear fusion (s-process) can happen at the stage of transition from the Main Sequence on the branch of the Giants.

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