ISOTOPIC ABUNDANCES OF MAGNESIUM – ^{24}Mg, ^{25}Mg,^{26}Mg IN THE ATMOSPHERES OF G–K – GIANTS

V.V. Kovtyukh, N.S. Komarov, S.M. Andrievsky, I.F. Dulapchi

Astronomical Observatory, Odessa State University
T.G.Shevchenko Park, Odessa 270014 Ukraine, *val@deneb.odessa.ua*

ABSTRACT. The isotopic abundances of magnesium in the star of thin disk of Galaxy with various chromospheric activity were studied. We use the new data about molecular constants of radiation for isotopes ^{24}Mg, ^{25}Mg, and ^{26}Mg. Values close to solar ratios are generally found.

Key words: Stars: abundances ; stars: late type; stars: individual: BS 165, 168, 2990, 3705, 4301, 4932.

1. Introduction

Isotopic abundance ratios are regarded to be a powerful tool in the application to the stellar evolution studies. Especially it refers to the investigation of late giants, where obtained abundances of isotopes for some elements can much say about physical processes operating inside these stars and their evolutionary stage.

As reviewed by Tomkin & Lambert (1980), in massive stars, ^{25}Mg and ^{26}Mg are produced during He burning that includes thermal pulsing. ^{24}Mg is produced during carbon burning. Explosive carbon burning can produce all three Mg isotopes.

MgH spectra are useful tools for isotopic analysis because the isotopic splitting is frequently larger than the line width. The MgH features analysed here are Q- and R-branch lines of the (0,0) band of the $A^2\prod$ – $X^2\sum^+$ system. These features are those discussed by Tomkin & Lambert (1976) in their analysis of the Mg isotopic abundances in α Boo (Arcturus). This well-known visible region electronic system are detectable in stellar spectra over a large range of temperature and abundances (e.g. McWilliam & Lambert 1988; Barbuy 1985, 1987; Tomkin & Lambert 1976, 1980).

The combination of MgI and MgH lines has been shown to be a spectroscopic probe of surface gravity in six cool giant stars (Bonnel & Bell, 1993).

The solar isotope ratio ^{24}Mg, ^{25}Mg, and ^{26}Mg has been measured as 76:12:12 (Wallace et al., 1999), in agreement with the much better determined terrestrial ratio 79:10:11.

For the present study we selected the following giants having the different level of chromospheric activity: BS 165 (K3 III), BS 168 (K0 IIIa), BS 2990 (K0 IIIb), BS 3705 (K7 IIIab), BS 4301 (K0 IIIa), BS 4932 (G8 II-Iab).

2. The observations and analysis

RETICON spectra have been odtained with AURELIE spectrograph on the 1.52-m telescope of the Haute Provence Observatoire (France) in 1999. The resolving power $\lambda/\delta\lambda \sim 66{,}000$ and signal-to-noise ratio ≈ 500 for all the spectra. The observed wavelength region was 5105 - 5165 ÅÅ. Preliminary reduction of the spectra has been done using IHAP and DECH20 packages. The continuum levels were defined by straight-line fits to the nearest continuum points on either side of the absorption feature being measured.

The aim of the analysis is to estimate the relative abundance of ^{24}Mg, ^{25}Mg, and ^{26}Mg isotopes in each star from the relative strengths of its ^{24}MgH, ^{25}MgH, and ^{26}MgH lines. The spectral region studied is 5134–5138 Å comprising (0,0) and (1,1) vibrational transitions in the system $A^2\prod$ – $X^2\sum^+$ of MgH. The isotopic splitting of the (0,0) band MgH lines is about 0.1 Å.

The synthetic spectra were calculated using STARSP code described by Tsymbal (1994, 1995). Special attention was paid to accurate modelling of the isotopically shifted MgH lines in the vicinity of 5134 Å. For this purpose we specially calculated the oscillator strengths for corresponding transitions in MgH molecule and these oscillator strengths were also tested using observed solar spectrum.

The wavelengths for the MgH lines are given in Barbuy (1987). The line list includes the MgH lines, as well as the atomic and C_2 contaminating lines. We adjusted further our synthetic C_2 lines to the calculated spectrum of Arcturus as calculated by Tomkin & Lambert (1976) using the same stellar parameters as those authors.

The convolution step for the instrumental profile was chosen by fitting thin atomic lines present in the observed region. A value of 0.08 Å for the FWHM was adopted in all cases.

Fig.1 illustrate the computations. The isotopic com-

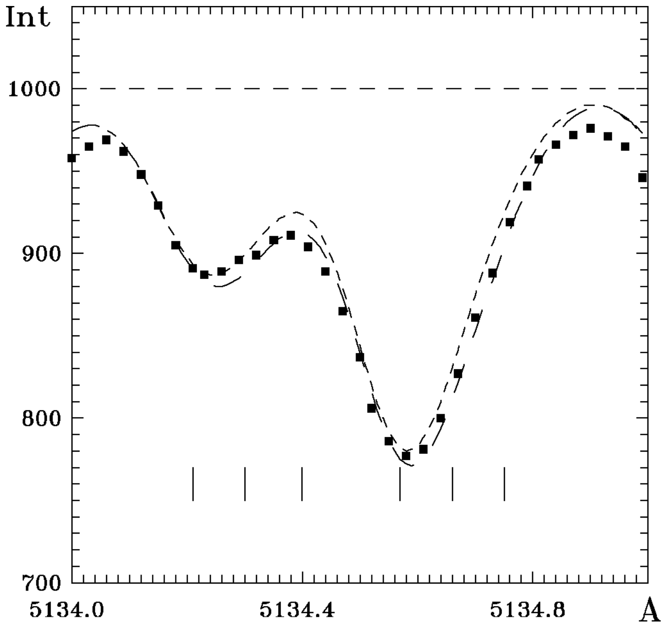

Figure 1: BS 168. Fitting of the observed spectrum (squares) with a synthetic spectrum computed with ^{24}Mg:^{25}Mg:^{26}Mg=79:10:11 (long dashed line) and 70:15:15 (short dashed line)

ponents are seen as red asymmetries on line.

We stress here the importance of the fact that the isotope ratios are rather independent of a precise model atmosphere. Effective temperatures $T_{\rm eff}$, surface gravities logg and metallicities [Fe/H] for the program

Table 1: The program stars, atmospheric parameters and isotopic abundances.

Name	BS	Teff	logg	[Fe/H]	Abund.
δ And	165	4640	1.8	0.22	68:11:21
α Cas	168	4950	2.6	0.24	72:14:14
β Gem	2990	4970	2.6	-0.09	84:8:8
α Lyn	3705	3860	1.2	-0.29	74:13:13
α UMa	4301	4940	2.6	-0.05	82:9:9
ϵ Vir	4932	5100	2.8	-0.08	88:6:6

stars were derived using various methods (in particular, we applied the new method developed by Komarov et al. (1996)).

The model atmospheres are obtained by interpolation in the grids by Kurucz (1992). We adopted V_t = 2.0 km/s. The carbon abundances were obtained from a fitting to the unblended 5135.6 $C_2(0,0)$ feature.

For all giants, the profile of the MgH lines are calculated for the different isotopic compositions (the terrestrial composition is presently considered to be 78.99:10.00:11.01 (Lambert & McWilliams, 1986))

The list of stars, together with basic stellar parameters and the isotopic abundances are given in Table 1.

3. Conclusion

The isotopic stellar and terrestrial abundances appear to be very similar in all giants belonging to the thin disk. Perhaps, a two giants (BS 165, 168) of the sample show ^{25,26}Mg isotopes in proportions higher than terrestrial. This might be explained by a mixing with helium shell burning material.

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