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Mg II h AND k LINES IN THE GHRS SPECTRA OF α Ori

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Abstract. We dearchived the echelle spectrum of α Ori from HST archive and compared it with prediction of BLE model of chromosphere.

1. INTRODUCTION

The resonance doublet of singly ionized Mg, occurring at 2795.5 Å (k) and 2802.7Å (h) frequently displays emission cores in stars later than F spectral type. Mg II h and k lines are much better diagnostics of the physical properties in the stellar chromospheres than usually used Ca II H and K lines, because of the larger abundance and higher ionization potential of magnesium.

The noncoronal supergiant α Ori (Betelgeuse, HD 39801, M2Ia^{b}) is one of the most studied late type star. Copernicus observations of MgII h and k lines in the spectrum of the α Ori were analyzed by Bernat and Lambert (1976), and IUE observations by Basri and Linsky (1979), Dupree et al. (1984).

This paper is our first attempt of using HST data and multi-level radiative transfer code known as MULTI.

2. OBSERVATIONS AND REDUCTIONS

We dearchived the echelle spectrum taken with Goddard High Resolution Spectrograph on April 27, 1991 within GTO program No.1195. Duration of four expositions was 656 seconds in the accumulation mode with the small scientific aperture. Observations covered wavelengths between 2790.74 and 2805.72 Å in the twentieth order of ECH-B. Spectra were processed with standard procedures by STScI software except for the vacuum-to-air corrections to the wavelengths, which we applied according to :

$$\lambda_{air} = \lambda_{vac}/f(\lambda_{vac}),$$

where

$$f(\lambda) = 1.0 + 2.735182 \times 10^{-4} + 131.4182/\lambda^2 + 2.76249 \times 10^8/\lambda^4 .$$

We also rescaled fluxes to stellar surface using equations (2) and (3) from Jevremović and Vince (1994).

3. MODEL CHROMOSPHERE, ATOMIC DATA AND LINE FORMATION CODE

There are two published models of chromosphere of α Ori : Basri et al. (1981;BLE) and Hartmann and Avrett (1984). The first model was constructed by fitting Mg II k, CaII K and H profiles and CII $\lambda\lambda$ 1334, 1335 resonance lines fluxes assuming hydrostatic equilibrium which results plannar geometry. The second model tried to explain chromospheric extent and formation of Alfven wave driven stellar wind. In our calculations we used the first, BLE model, because our version of MULTI maintains only plannar geometry and problems with output fluxes described in Hartmann and Avrett's paper.

The model chromosphere was interpolated in the logarithm of the mass column density on to a depth grid of 80 points to ensure good convergence properties. Since the model chromospheres are essentially linear relationships between temperature and logarithm of mass column density, the interpolation procedure should not introduce any significant errors.

For the calculation of Mg II h and k lines we used 6 level + continuum model of atom. The energy levels and oscillator strengths we used were taken from Black et al. (1971) and the collisional rates from Mendoza (1981). In Table I :re presented atomic data for magnesium that are used in our calculations.

TABLE I
Atomic data for magnesium

Level	Energy (cm^{-1})	Statistical weight g
1	0.0	2
2	35669.5	2
3	35761.0	4
4	69805.4	2
5	71489.5	6
6	71490.3	4
cont.	121267.4	1

The computations were carried out using a multi-level non-LTE radiative transfer program known as MULTI (Carlson 1986, Carlson 1991). We used version 2.0 dearchived from CCP7 Computer Program Library. The line radiation intensities were calculated under the assumption of complete redistribution.

Background opacities are calculated using opacity package from LINEAR (Auer et al. 1972)

4. RESULTS

In Fig. 1. is presented the HST spectrum of α Ori. However the Mg II h and k lines are contaminated by clearly visible MnI and FeI absorption features. Fig. 2. presents results of our calculation for Mg II h and k line formation. We can conclude that the BLE model does not describe well the chromosphere of α Ori and an improvement of the BLE model is necessary.

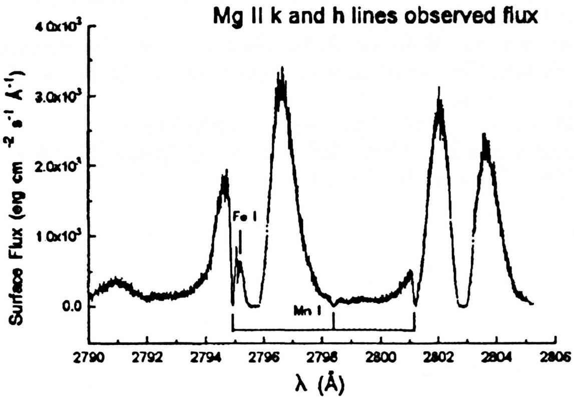

Fig. 1. The HST spectrum of α Ori

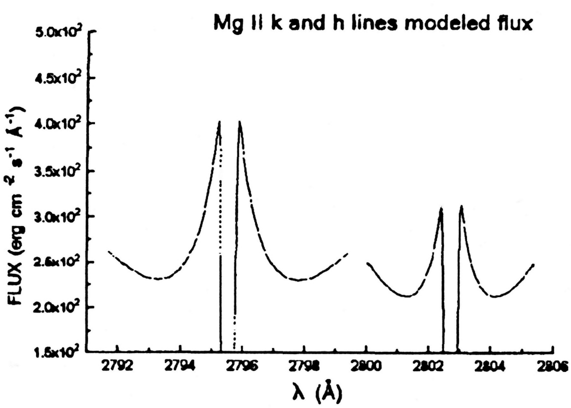

Fig. 2. Results of our calculation for Mg II h and k line formation

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