A SEARCH FOR THE REPORTED Ti II λ3080 MULTIPLET EMISSION IN LATE-TYPE STARS

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Gurzadyan (1975), using a low-resolution objective-prism spectrograph, has reported the presence of both the multiplet Ti II λ3080 and the doublet Mg II λ2800 simultaneously either in emission or in absorption in late-type stars. Using the high-resolution spectrometers onboard Copernicus and BUSS, we find that stars which display Mg II λ2800 strongly in emission do not have a corresponding emission feature at λ3080.

Key words: emission-line search—late-type stars—UV spectroscopy

I. Introduction

The resonance doublet of ionized magnesium at 2795.5 Å and 2802.7 Å is a prominent feature in the near ultraviolet spectra of late-type stars. Nearly all stars later than type K0 (and a fair fraction of G stars) display this doublet in emission, which is indicative of chromospheric activity. Consequently, much has been learned about the chromospheres of late-type stars by studying the Mg II λ2800 doublet (Kondo 1972; McClintock et al. 1975; Weiler and Oegerle 1979 and references therein).

Gurzadyan (1975) has reported that a multiplet of Ti II at λ3080 and Mg II λ2800 appear simultaneously either in emission (in K and M stars) or in absorption (in F and G stars). Spectra presented by Gurzadyan (obtained with an objective-prism spectrograph (resolution ~ 25 Å) on the space observatory “Orion 2”) shows that the feature at λ3080, when in emission, appears to be as strong as Mg II λ2800. If the presence of the multiplet emission was confirmed, new insights into the chromospheric process would be obtained, since present knowledge would indicate that strong Ti II multiplet emission is not expected. Magnesium is about 200 times more abundant than titanium, and Mg II and Ti II have similar ionization potentials. However, if the Ti II multiplet is present in emission, a comparison of the strengths and profile shapes of the different members of the multiplet could lead to an understanding of the physical conditions and structure of the chromosphere.

We have investigated the presence of the reported emission feature at λ3080 in a few late-type stars using the Copernicus and BUSS ultraviolet spectrometers, which have much higher spectral resolution than the “Orion 2” instrument.

II. Observations

Multiplet no. 5 of Ti II consists of nine lines with a mean wavelength of ~ 3080 Å. The strongest lines have wavelengths of λ3072.97, 3075.22, 3078.64, and 3088.02 (the λ3072.97 line is a resonance line).

Gurzadyan (1975) has presented the spectra of two stars, SAO 040341 = HD 35496 (K2) and SAO 040296 = HD 34936 (K5), which show emission features at λ2800 and λ3080. Unfortunately, these stars cannot be observed with Copernicus or BUSS because they are too faint. Instead, we have observed two bright stars of the same spectral type, α Tauri (K3 III) and α Bootis (K2 III) which both display extremely strong Mg II h and k lines. The observational techniques and results are given below.

A. α Tauri

The Mg II k line at λ2795.5 and the λ3080 region were observed with the ultraviolet spectrometer onboard the Copernicus satellite (see Rogerson et al. (1973) for a description of the spectrometer). The V2 photomultiplier was used which resulted in a nominal resolution of ~ 0.50 Å. In order to increase the signal-to-noise ratio, many scans were obtained of each region. The individual scans were corrected for particle background using the procedures described by Weiler...
(1978) and averaged together. The \( \text{Mg II} \) \( k \) line, the \( \lambda 3070-\lambda 3080 \) spectral region, and the \( \lambda 3085-\lambda 3090 \) region for \( \alpha \) Tau are shown in Figures 1, 2, and 3, respectively. The \( \text{Mg II} \) emission line is very strong and yet there is no prominent emission feature in the \( \lambda 3080 \) region. The reader can see in Figures 2 and 3 that only at the expected position of \( \lambda 3088.02 \) is there even a hint of an emission line. In any event, it is difficult to understand how such a weak emission feature could have been detected by the objective-prism spectrograph used by Gurzadyan because of its low spectral resolution (\( \lesssim 25 \) Å).

B. \( \alpha \) Bootis

The K2 III star, \( \alpha \) Boo, was observed in 1976 with the BUSS system (Balloon-Borne Ultraviolet Spectrometer). This echelle spectrometer has a spectral resolution of \( \sim 0.1 \) Å (see Kondo et al. (1979) for a description of the instrument). The \( \lambda 2800 \) and \( \lambda 3080 \) spectral regions are shown in Figures 4 and 5, respectively. Again, the \( \text{Mg II} \) \( h \) and \( k \) lines are very strong and yet there is no corresponding strong feature in the \( \lambda 3080 \) region (Stencel and van der Hucht 1978).

C. Other Stars

We have also studied the spectra of a number of other late-type stars taken with the BUSS and IUE (International Ultraviolet Explorer) systems. In all cases where \( \text{Mg II} \) \( \lambda 2800 \) is in emission, there is no corresponding emission feature at \( \lambda 3080 \).

III. Discussion

The evidence presented in section II indicates that multiplet no. 5 of \( \text{Ti II} \) is not present as a strong emission feature in late-type stars that display \( \text{Mg II} \) \( \lambda 2800 \) in emission. However, we admit the possibility that the \( \text{Ti II} \) multiplet is present in the spectra of particular stars observed by Gurzadyan. Perhaps these stars are peculiar in some way. If not, then we can only speculate on the emission feature at \( \lambda 3080 \) in Gurzadyan’s data. One possibility is that heavy line blanketing pro-
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**Fig. 3**—Copernicus spectra of the \( \lambda 3085-\lambda 3090 \) region of \( \alpha \) Tau. Thirty scans have been averaged together to achieve a signal-to-noise ratio of \( \sim 10:1 \).

**Fig. 4**—BUSS spectra of the \( \lambda 2795-\lambda 3000 \) region in \( \alpha \) Boo.

roduces a “false” emission feature. A more likely possibility is that the feature has an “instrumental” origin. The simultaneous presence of the feature at \( \lambda 3080 \) in either emission or absorption with the \( \text{Mg} \ II \lambda 2800 \) feature suggests that some sort of internal reflection in the equipment may be occurring.

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**REFERENCES**