MODELING THE ULTRAVIOLET PHOTOSPHERIC SPECTRUM OF COOL GIANT STARS. II. GAMMA CRUCIS

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INTRODUCTION

The study of cool star chromospheres can be aided by modeling the ultraviolet photospheric spectrum. In essence, we extract the dominant photospheric contribution from the ultraviolet spectrum, thereby exposing the chromospheric component. This technique is very useful in identifying the contributing atomic transitions to both absorption and emission features. In particular, weak emission features can be differentiated from pseudo-continuum points in the spectrum. The total emission line flux has, up to now, been underestimated by researchers not accounting for emission line flux filling-in the absorption feature below the assumed continuum level. Including this additional flux may have a bearing on derived averaged quantities such as the electron temperature, particle number density and geometric extent of the chromosphere. We present here some results of modeling the spectrum of the M-giant star Gamma Crucis using similar techniques as those in the study of Arcturus (Carpenter and Wahlgren, this volume).

OBSERVATIONAL DATA

High-dispersion ultraviolet spectra were obtained from the IUE data archive. The spectrum chosen for this study, LWR1356, has very little saturation but does not contain enough signal shortward of 2600Å to make spectrum modeling useful for any purpose other than emission line identification. The spectral orders were merged and smoothed with a 5 pixel boxcar function. Comparisons made against the computed spectra show that the short wavelength edge of several orders is often low in flux and may be due to poor echelle ripple correction.
SYNTHEORIZING THE SPECTRUM

Synthetic spectra were generated using the SYNTHE code (Kurucz and Avrett, 1981) run on the GHRSVAX at GSFC. An LTE model atmosphere, defined by Teff=3800K and log g = 2.0 with solar metal abundances, was chosen from the model atmosphere grid of Brown et al. (1989) based on a M3.5III spectral type (Keenan and Pitts 1980). Due to the lack of ionized absorption lines in the ultraviolet spectrum it is difficult to assign a gravity solely from IUE data. No known abundance analysis exists for this star. Synthetic spectra were computed in 30A regions and include absorption from lines outside the computed region for any line that contributes at the level of one thousandth of the continuum opacity at the computation point.

The synthesized spectra were scaled to match absorption features in the observed spectrum. The scaling factor converts the flux per square cm at the stellar surface to that observed at the earth and accounts for the apparent stellar diameter and distance. Since the observed diameter of M-type stars may be wavelength dependent the scaling factors are not considered to be rigorously determined. Discrepancies were observed between the computed and observed spectra and can be attributed to incorrect atomic gf-values, and unidentified opacity sources (atomic and molecular) and weak emission lines. For example, the region from 2958 to 2965A lacks opacity in the computed spectrum, possibly due to molecular opacity not included in our line lists. Figure 1 presents a fit to a spectral region dominated by absorption features.

![Graph showing observed and computed spectra](image_url)

**Fig. 1** Observed (solid) and computed (dotted) spectra.
FLUORESCENCE MECHANISMS AND LINE IDENTIFICATIONS

Two new fluorescence mechanisms have been discovered as a result of modeling the ultraviolet photospheric spectrum. Carpenter et al. (1988) have listed fluorescence mechanisms observed in the spectrum of Gamma Crucis. The new mechanisms presented here are characterised by weak emission, unconfirmed without knowledge of the underlying absorption spectrum. The Fe I UV 6 multiplet (J=1) and the Fe I UV 48 multiplet (J=3) are pumped by chromospheric emissions from Fe II 2611.074A and Fe II 2714.413A, respectively. Other fluorescence processes may be occurring within the UV 48 multiplet but are less certain. Figure 2 displays the UV 6 fluorescence. Strong emission lines in this spectral region are dominated by Fe II. Other instances of fluorescence are inferred from the presence of single emission lines of neutral atomic species. Numerous new identifications of emission lines have been made with the aid of the ultraviolet photospheric absorption spectrum.

![Graph showing fluorescence within the Fe I UV6 (J=1) multiplet](image)

**Fig. 2** Fluorescence within the Fe I UV6 (J=1) multiplet

REFERENCES