HIGH RESOLUTION OBSERVATIONS OF MAGNESIUM II 2800 Å IN ALPHA CENTAURI A: 
THE DENSITY OF INTERSTELLAR MAGNESIUM II AND THE 
 STELLAR CHROMOSPHERIC PROFILES 

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ABSTRACT 
High resolution scans (< 0.10 Å) of the Mg II h and k lines in α Cen A have been obtained with the 
Copernicus satellite. The profiles are virtually identical with the solar profiles except for the presence of 
an absorption feature near line center in the h and k lines of α Cen A. We find that this absorption 
feature can be explained by interstellar absorption of Mg II along the line of sight. The average density 
of Mg II has been found to be 2.75 × 10^7 cm^-3, which is in good agreement with the 
previously determined values in the solar vicinity in the direction of β CMa and α Lyr. 

Subject headings: interstellar: abundances — stars: chromospheres — stars: emission-line — 
stars: individual — ultraviolet: spectra 

I. INTRODUCTION 
The Mg II h and k lines (22802.70 and 22795.53, respectively) in late-type stars contain information on the 
structure of the upper photosphere and lower chromo-
sphere (Kondo, Morgan, and Modisette 1976a, b; 
Weiler and Oegerle 1979, and references therein). The 

nearby G2 V star, α Cen A, is well suited for detailed 
chromospheric study and comparison with the Sun be-

cause of its brightness and similarity in spectral type. 
Previous studies of α Cen A based on the Ca II H and K 
lines suggest that the chromospheres of α Cen A and the 
Sun are virtually identical (Boesgaard and Hagen 1974; 
Ayres et al. 1976). However, a detailed comparison of 
the Mg II h and k lines between the Sun and α Cen A has been 

hampered by a lack of spectral resolution in the observa-
tions of α Cen A. Previous observations of the magnesium 
doublet in α Cen A by Dupree (1974) were obtained with 
the V2 photomultiplier tube on board Copernicus, which 
has a nominal spectral resolution of 0.5 Å. Recent IUE 
observations of α Cen A by Ayres and Linsky (1980) have 
a spectral resolution of ~ 0.20 Å at 2800 Å. However, the 
solar observations have much higher resolution. Kohl 
and Parkinson (1976) have presented solar Mg II h and k 
profiles with a spectral resolution of 0.028 Å. 

In addition to providing information on the stellar 
chromospheric profiles, high resolution observations 
make possible the study of interstellar Mg II. Additional 
information on the local density of interstellar material is 
important, since only a handful of measurements exists 
for stars within 3.5 pc (McClintock et al. 1978). 

In this paper, we present high resolution (< 0.10 Å) 
scans of the Mg II doublet in α Cen A obtained with the 
Copernicus satellite. In § II, the data are compared with 
the solar case. 

II. THE OBSERVATIONS 
Ultraviolet observations of α Cen A were obtained 
during 1979 April 10–13 with the UV spectrometer 
onboard the Copernicus satellite. The V1 photomultiplier 
tube was used to scan the Mg II h and k lines at 2802.7 and 
2795.5 Å, respectively. The instrumental profile full width 
at half-maximum is 0.075 Å, but the effective resolution is 
somewhat better than this because the data are sampled 
at 0.04 Å intervals. Therefore, the effective resolution is 
about 3 times better than can be obtained with the IUE. 

About 30 scans were obtained of the regions 
2793.2–2797.6 Å and 2800.4–2804.6 Å. Each individual 
scan was corrected for particle background using the 
technique developed by Weiler (1978), and noisy scans 
were deleted. The remaining 25 scans were averaged 
together and are shown in Figure 1. The data have been 
reduced in the rest frame of the star (v_r = -22 km s^-1). 

III. DISCUSSION 
In Table 1, we list widths, fluxes, and separations of 
features in the Mg II h and k lines. Full line widths at zero 
intensity were difficult to determine because of blending 
with absorption lines Mn I λ2794.817, Fe I λ2795.006, and 
Mn I λ2802.169. Nevertheless, our measured values of the 
full widths at zero intensity (FW0I) for the h and k lines
are comparable to the solar values. The full widths at half-maximum (FWHM) of the \( h \) and \( k \) lines, which are not as influenced by the blended absorption lines, are in very good agreement with the solar values. The Mg \( \text{II} \) \( h \) and \( k \) line fluxes are identical to the solar values.

In Figure 1, for comparison, we have also presented the solar \( h \) and \( k \) lines (plotted on the same scale as \( \alpha \) Cen A). The solar profiles observed by Kohl and Parkinson (1976) were smoothed in order to match the resolution of the \( \alpha \) Cen A data. The separation of the peaks (on either side of the central reversal) are comparable, but slightly larger in \( \alpha \) Cen A than in the Sun. The difference in the peak separations may be caused by interstellar Mg \( \text{II} \) absorption, which is clearly present in the observed \( \alpha \) Cen A line profiles at \(+10\ \text{km s}^{-1}\) with respect to the star. The fact that an absorption feature is present in both the \( h \) and \( k \) lines at exactly the same velocity shift from line center is strong evidence that the features have an interstellar origin. McClintock et al. (1978) find that interstellar hydrogen in the direction of \( \alpha \) Cen A has a velocity of \(+15\ \text{km s}^{-1}\) with respect to the star. For purposes of measuring the interstellar Mg \( \text{II} \) feature, we will assume that the underlying emission profile of \( \alpha \) Cen A is identical to the solar profile (as measured by Kohl and Parkinson). The measured equivalent widths of the absorption features are \( 32 \pm 5 \text{ mÅ} \) and \( 19 \pm 5 \text{ mÅ} \) for the \( k \) and \( h \) lines, respectively. The errors quoted here are mainly statistical errors inherent in the observed data. There is also some uncertainty in the continuum level, although this uncertainty is much less than the noise in the data. Using the “doublet ratio” technique with the curve-of-growth method (Spitzer 1968), these equivalent widths indicate a Mg \( \text{II} \) column density of \( 1.13 (\pm 0.3) \times 10^{12} \text{ cm}^{-2} \) toward \( \alpha \) Cen A. This results in an average Mg \( \text{II} \) number density of \( 2.75 (\pm 0.7) \times 10^{-7} \text{ cm}^{-3} \), which is quite reasonable. Kondo et al. (1978) have found Mg \( \text{II} \) densities of \( 3.0(\pm 1.0) \times 10^{-7} \text{ cm}^{-3} \) in the direction of \( \alpha \) CMa (2.6 pc) and \( \alpha \) Lyr (8.1 pc).
If we further assume that all free Mg atoms between us and α Cen A exist as Mg ii, that the depletion rate for Mg is 10 (Rogerson et al. 1973), and use the logarithmic cosmic number density of 4.58 for H/Mg (Allen 1973), we calculate a mean atomic hydrogen density of 0.10 ± 0.03 cm⁻³ toward α Cen A. Previously, Dupree, Baliunas, and Shipman (1977) obtained an interstellar H i density of

\[ n_H = 0.20 \pm 0.05 \text{ cm}^{-3} \]

from observations of the Lyα emission profile in α Cen A. McClintock et al. (1978) reanalyzed the data of Dupree et al. and found that a wide range of values for \( n_H (0.06 < n_H < 0.30 \text{ cm}^{-3}) \) could fit the observed Lyα line, although a value of \( n_H = 0.10 \text{ cm}^{-3} \) gave the best fit. Our result, based on observations of interstellar Mg ii, also supports this lower value of 0.10 for the local atomic hydrogen density.

### REFERENCES


**IV. SUMMARY**

High resolution scans of the Mg ii h and k lines in α Cen A have been presented and compared with the solar Mg ii h and k lines. The only substantial difference in the profiles seems to be the presence of interstellar Mg ii absorption in the spectra of α Cen A. Although we cannot rule out the possibility of an intrinsic difference in the profiles, we find that this absorption feature can be easily accounted for by interstellar Mg ii along the line of sight. If this assumption is correct, we then derive an average Mg ii density in the direction of α Cen A of 2.75 (±0.7) × 10⁻⁷ cm⁻³. This implies a hydrogen number density in the direction of α Cen A of 0.10 ± 0.03 cm⁻³.

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