

# OBSERVATIONS OF INTERSTELLAR HI TOWARD NEARBY LATE-TYPE STARS

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## ABSTRACT

High-dispersion Copernicus and IUE observations of chromospheric Ly  $\alpha$  emission are used to study the distribution of HI in the local interstellar medium. Interstellar parameters are derived toward 3 stars within 5 pc of the sun, and upper limits are given for the Ly  $\alpha$  flux from 9 other stars within 10 pc.

## INTRODUCTION

Interstellar HI may be detected as an absorption feature cutting into the chromospheric Ly  $\alpha$  emission of nearby late-type stars. McClintock *et al.* (1978) have detailed methods for deriving interstellar parameters from Copernicus Ly  $\alpha$  data. Landsman *et al.* (1984) have applied these methods to high-dispersion IUE observations of  $\alpha$  Cen A. Further discussion of the results in this paper is given by Landsman (1984).

## RESULTS

### Copernicus Upper Limits

The Copernicus data consist of repeated scans with the high-resolution U1 tube of the central 1.2 Å of the Ly  $\alpha$  emission. Listed in Table 1 are those observations for which the hypothesis of a featureless spectrum cannot be rejected at a confidence level greater than 90%. Upper limits have been expressed in terms of a typical solar flux of  $F_{\odot} = 4.3 \times 10^{11} \text{ ph cm}^{-2} \text{ s}^{-1} \text{ \AA}^{-1}$  at 1 Å. U..

70 Oph A (K0V, d=5.0 pc,  $l^{\text{II}}=30^{\circ}$ ,  $b^{\text{II}}=11^{\circ}$ ,  $V_r=-7 \text{ km s}^{-1}$ )

Reduced spectra from Copernicus observations of 70 Oph A in 1976 and 1978 are shown in Figure 1 along with typical error bars. Definite structure is seen longward of the expected emission center at 1215.67 Å. The asymmetric emission is not

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unexpected, since 70 Oph is only  $5^\circ$  from the direction of the incoming gas as defined by Crutcher (1982). To further model this low signal-to-noise data, the following assumptions were made; (1) a gaussian intrinsic stellar profile with a total flux less than 100 times solar, (2) a fixed ratio  $D/H = 2.0 \times 10^{-5}$ , and (3) a velocity dispersion  $b_{\text{HI}} < 20 \text{ km s}^{-1}$ . With these constraints, and acceptable fit to the data can be made if the intervening gas has a volume density  $0.04 \text{ cm}^{-3} < n_{\text{HI}} < 0.45 \text{ cm}^{-3}$ , and a heliocentric bulk velocity  $v_{\text{HI}} < -14 \text{ km s}^{-1}$ .

Altair (=  $\alpha$  Aql, A7IV,  $d=5.0 \text{ pc}$ ,  $l^{\text{II}}=48^\circ$ ,  $b^{\text{II}}=-9^\circ$ ,  $v_r=-26 \text{ km s}^{-1}$ )

The solid line in Figure 2 is from a large-aperture IUE observation (SWP 3427) of Altair, originally discussed from a chromospheric perspective by Blanco et al. (1980). Points contaminated by geocoronal emission have been deleted. The signal-to-noise is poor due to the existence of spectrograph scattered light. The dashed line in Figure 2 shows a Copernicus spectrum obtained on 20 Aug 1976, with the absolute flux level divided by a factor of two. After this scaling of the absolute flux, there is reasonable agreement between the two data sets. If the intrinsic stellar emission is modeled with a gaussian profile, then an upper limit can be set on the interstellar HI volume density of  $n_{\text{HI}} < 0.11 \text{ cm}^{-3}$ .

Procyon (=  $\alpha$  CMi F5IV-V,  $d=5.0 \text{ pc}$ ,  $l^{\text{II}}=214^\circ$ ,  $b^{\text{II}}=13^\circ$ ,  $v_r=-3 \text{ km s}^{-1}$ )

Figure 3 shows a Ly  $\alpha$  spectrum of Procyon derived from a large-aperture IUE observation (SWP6660). The removal of the substantial geocoronal contribution and the estimation of uncertainties followed the procedure in Landsman et al. (1984). Modeling of the data yielded 90% confidence limits of  $0.07 \text{ cm}^{-3} < n_{\text{HI}} < 0.2$ ,  $D/H > 0.8 \times 10^{-5}$ , and  $b_{\text{HI}} < 14 \text{ km s}^{-1}$ . These values are consistent with determinations using Copernicus data by Anderson et al. (1978). It is expected that substantially improved limits on interstellar parameters may be derived using small-aperture observations and co-addition of IUE spectra.

#### References

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Table 1  
Copernicus Ly  $\alpha$  Upper Limits

Star	Sp.T.	dis (pc)	Day	Year	Upper Limit	
					Cts (14 s) <sup>-1</sup>	F/F <sub>⊙</sub>
$\beta$ Hyi	G2IV	6.3	197	1976	2.1	2.8
$\delta$ Eri	K0IV	8.8	300	1976	1.6	4.3
$\delta$ Pav	G8V	5.7	199	1976	1.3	1.4
$\eta$ Boo	G0IV	9.3	110	1976	1.3	1.4
$\zeta$ Her	G0IV	9.8	174	1976	1.0	3.3
$\eta$ Cas	G0V	5.7	304	1976	1.5	1.6
			299	1978	1.0	3.5
$\mu$ Her	G5IV	7.5	213	1976	1.3	2.4
			197	1978	1.3	5.4
$\tau$ Cet	G8V	3.5	264	1976	1.4	0.6
			267	1977	1.3	0.7
40 Eri	K1V	4.8	198	1976	1.6	1.2
			297	1978	1.4	3.5

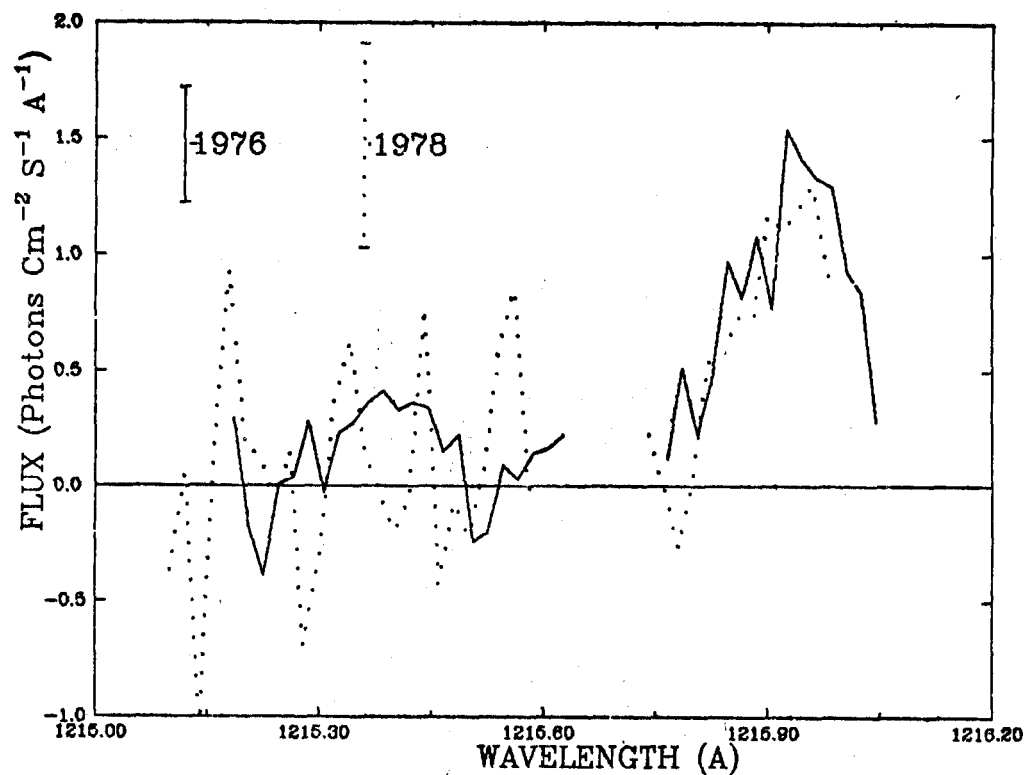


Figure 1: Copernicus spectra of 70 Oph A in 1976 and 1978.

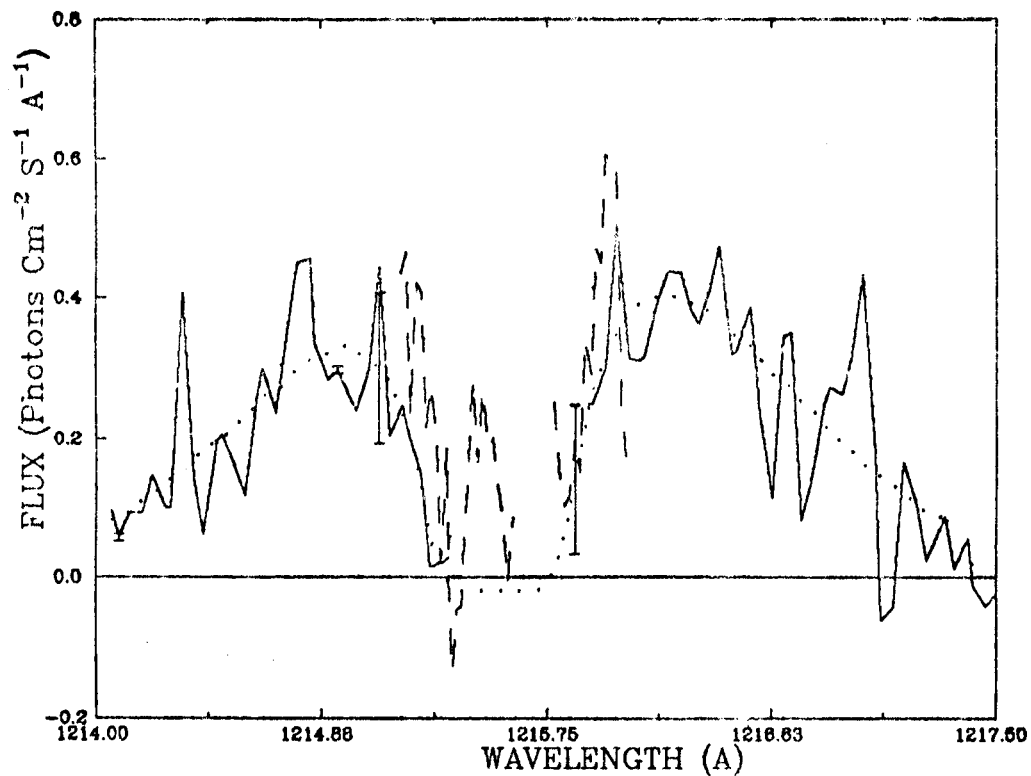


Figure 2: IUE (solid line) and Copernicus (dashed line) spectra of Altair with a best model fit (dotted line)

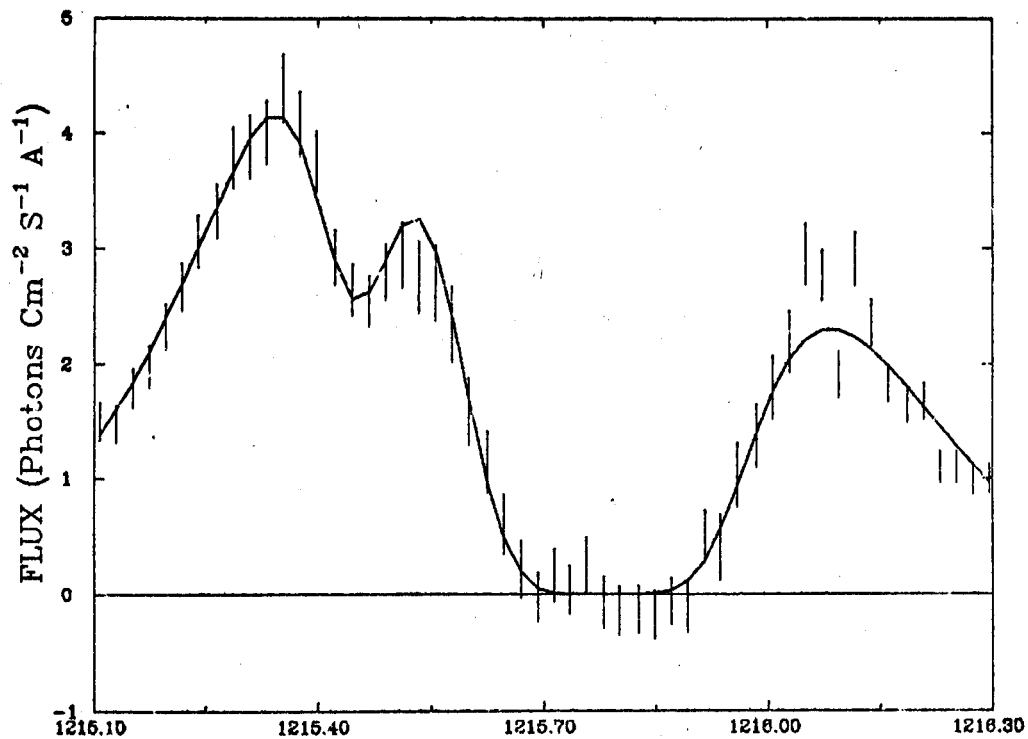


Figure 3: IUE spectrum of Procyon with a best model fit