FeII AND MgII IN THE NEARBY INTERSTELLAR MEDIUM

Klaas S. de Boer and Heinz Lenhart
Astronomical Institute, University of Tübingen
D-7400 Tübingen, West Germany

ABSTRACT

UV spectra with 15 km s^{-1} resolution of bright stars have been searched for FeII and MgII interstellar lines. We present equivalent widths of absorption for 8 stars and find average line-of-sight densities n(FeII)= 4 10^{-8} and n(MgII)= 2 10^{-7} cm^{-3}. This represents approximately n(H)= 0.03 cm^{-3}.

INTRODUCTION

High-resolution echelle spectra have been obtained between 2000 and 3000A with the Balloon Borne Stellar Spectrograph (BUSS) in flights in 1976 and 1978. BUSS echellography is similar to that with the International Ultraviolet Explorer (IUE) satellite, but with the echelle orders crowding towards the longer wavelengths. The BUSS spectral resolution is about 3 10^4 (better than that of the IUE). Full details about the instrument are given by Kondo et al (1979) and Kamperman et al (1979). The BUSS data base, made available by the Space Research Laboratory in Utrecht on tape as wavelength calibrated spectra, consists of some 80 spectra of 55 stars brighter than V= 5 and with spectral types ranging from O9 to K5 of all luminosity classes. The BUSS spectra have a large range in quality (perfect spectra, some with very low signal, overexposed ones, reduced signal between 2500 and 2700A due to stratospheric Ozone absorption). For stars later than B0 stellar lines may appear. Only in stars of later type with large rotation or with large radial velocity can interstellar lines be separated from the stellar features. Examples of spectra are shown in Fig. 1. There are about 25 stars nearer than 100 pc in the data base of which 8 show unambiguously recognizable interstellar lines.

RESULTS

We have plotted the relevant portions of BUSS spectra with velocity scale (Fig. 2.) and assessed the presence of interstellar absorption. The FeII 2373.73 A line is in BUSS spectra near an instrumental flaw and is not useable. The zero-point of the BUSS velocity scale is known to about 50 km s^{-1}, but relative velocities to an accuracy of 5 km s^{-1}. The two interstellar components detected in the spectrum of κ Dra are separated by 37 km s^{-1}.

The equivalent widths of the lines detected were determined and the data are collected in Table 1. The accuracy of each determination was derived from the noise locally in the spectrum. The BUSS line strengths can be compared with those from other observations. For ζ Oph the agreement of our data with those from the Copernicus (Lugger et al 1982) is fair, while for α Vir the

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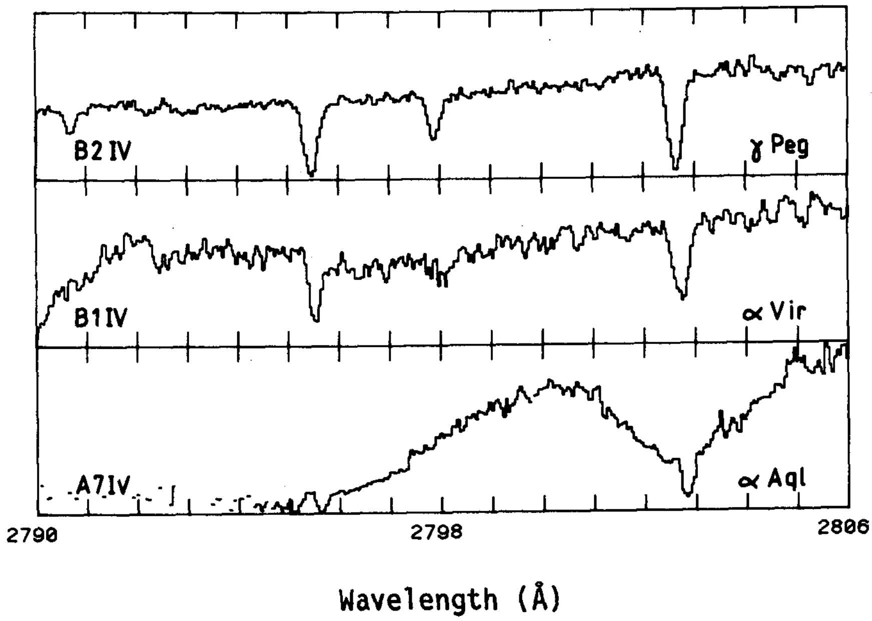

Fig. 1. The MgII region in BUSS spectra (linear intensity scale; echelle function not removed) showing the resonance lines near 2795.6 and 2802.7Å and the subsidiary lines near 2790.7 and 2798.0A. In γ Peg all MgII are essentially stellar, in α Vir essentially interstellar, in α Aql the narrow interstellar absorption is seen near the bottom of the stellar lines which are wide due to stellar rotation.

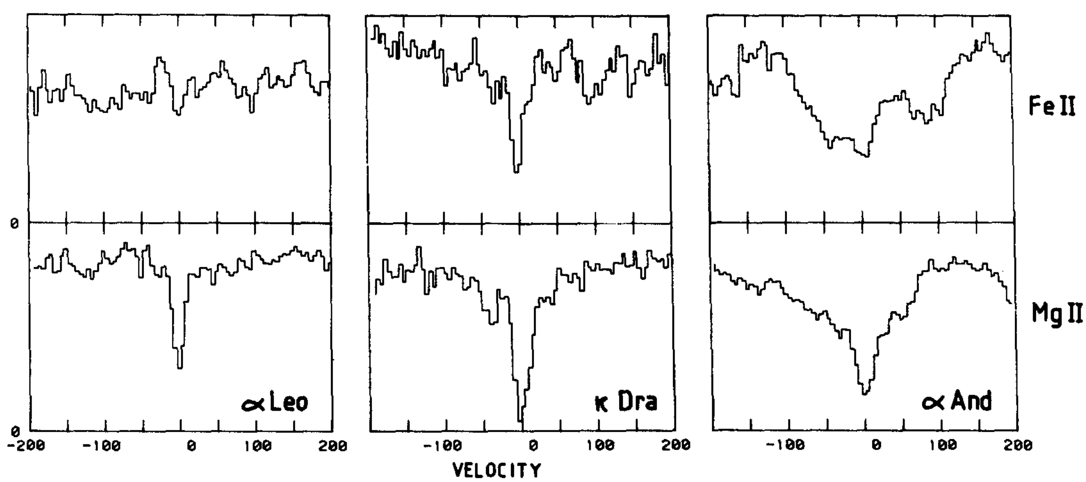

Fig. 2. For 3 stars the FeII 2382.03Å and the MgII 2802.70Å spectra are displayed showing the narrow interstellar absorption (shifted to 0 km s^{-1}).

Table 1. Eqivalent widths (mÅ) of interstellar FeII, MgII and MgI in nearby stars observed with the BUSS

	α And	α Leo	κ Dra	κ Dra	α Com	α Vir	δ Aql	α Aql	29 Cyg
HD	358	87901	109387		114378	116658	182640	187642	192640
V	2.06	1.35	3.87		5.22	0.98	3.36	0.76	4.97
Sp.T.	B8IVp	B7V	B6IIIp		F5V	B1IV	F0IV	A7IV	A2V
v sin i	56	329	249		28	159	85	242	37
BUSS image	VIII32	IX04	IX05	IX05	IX11	VIII1	VIII12	VIII04 VIII16	X05
FeII 2382.03	40 (5)	< 20	80	< 10	--	175 (20)	--	76 (20)	--
2599.40	55 (20)	--	--	--	--	--	100 (50)	63 (10)	--
2343.50	< 15	< 10	70 (20)	< 10	--	80 (10)	--	--	--
2585.88	--	--	--	--	--	--	80 (50)	34 (10)	--
MgII 2795.53	155 (20)	125 (10)	255 (15)	140 (15)	70 (20)	180 (30)	190 (20)	>185 (40)	present
2802.70	145 (20)	95 (5)	235 (20)	70 (15)	40 (20)	215 (10)	165 (40)	185 (15)	420 (100)
Mg I 2852.13	--	< 10	50 (10)	< 10	70 (20)	60 (10)	45 (10)	--	85 (20)

--= no continuum; ( )= estimated uncertainty; MgII 2795A less accurate in poor part of BUSS image
f-values for the listed FeII and MgII lines: log fλ= 2.98, 2.88, 2.55, 2.34, 3.22, 2.92 respectively.
BUSS flights were on: VII May 16, 1976; VIII Sep 19, 1976; IX May 8, 1978; X May 30, 1978.

BUSS line strengths are larger by 50% than those from Copernicus (Lugger et al 1982). For α Aql the BUSS Mg equivalent widths are 2 times the very uncertain ones reported from Copernicus (Kondo et al 1978). Toward α Leo the BUSS Mg lines are 30% stronger than those from Copernicus (Kondo et al 1978), but these in turn were 2 times as strong as those from other balloon payloads (Boksenberg et al 1975, Morgan et al 1978). For the moment we must leave these differences for what they are, even though they may have considerable effect on the derivation of interstellar gas densities.

Column densities (Table 2) were derived from plots of log fλ vs log Wλ/λ and comparison with standard single-cloud curves of growth. We assumed that MgII and FeII follow optical-depth relations with the same (effective) velocity dispersion b, and used FeII f-values from Nussbaumer et al (1981). Stellar distances are derived from the parallaxes as given by Uesugi and Fukuda (1982). For α And, α Leo and κ Dra a reliable Mg/Fe ratio is found, which averages at N(Mg)/N(Fe) = 10.

GAS DENSITIES

From the column densities and distances the ion densities can be calculated. In order to get to gas densities the abundances of free Fe and Mg have to be known. For Fe Savage and Bohlin (1979) found [Fe/H] = -6.0 in gas with little reddening; Mg has little depletion in such gas, was, however, never studied in detail, and we therefore assume [Mg/H] = -5.0 from our Mg/Fe column densities above. The gas densities so found are given with Table 2.

Table 2. Column densities of FeII and MgII derived from BUSS spectra

Name	δ Aql	α Aql	29Cyg	α And	κ Dra	α Leo	α Vir	α Com
l°	39.6	47.7	74.4	111.7	125.2	226.4	316.1	328.0
b°	- 6.1	- 8.9	1.2	-32.8	47.3	48.9	50.8	79.5
d(pc)	15	5	53	39	90	26	80	18
log N(FeII)	---	12.9	---	12.4	12.8	<12.1	13.1	---
log N(MgII)	13.3	>14.0	>14.3	13.3	13.8:	13.0	13.0	12.4
log n(H)	-1.3:	-0.3	>-0.9:	-1.8	-1.6	-1.9	-1.3	-2.3:

Gas densities are based on N(FeII), [Fe/H] =-6.0, and the distance; for δ Aql, 29 Cyg and α Com N(MgII) was used with [Mg/H] =-5.0

The average is n(H)= 0.03 cm^{-3}, while the number of determinations is too small to discriminate large scale directional differences.

When collecting from the literature all determinations of N(MgII) in the ISM within 100 pc, we find the average n(MgII)= 8 10^{-8} cm^{-3} for $90° < l < 270°$, and n(MgII)= 2 10^{-7} cm^{-3} for the directions toward the galactic center. These numbers convert (with [Mg/H] = -5) into n(H) = 0.014 cm^{-3}.

An account of all interstellar lines in the BUSS data base is in preparation.

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