

# Interstellar C IV and Si IV in the Direction of Loop I

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**Abstract.** Nearby late-B and early-A stars show clear IS absorptions in Mg II, C II and other lines (IUE spectra). Some of them, in the Sco Cen direction, also show absorption features at C IV and Si IV line wavelengths. We discuss the possible formation of these lines in an intermediate temperature gas region between the dense and cold H I wall and the hot ISM, a region that could be the collision interaction between the Local Bubble and the Loop I supershell. Some individual stellar spectra are presented and discussed.

## 1 The Observations

A sample of late-B and early-A stars in the direction of the Loop I were observed at high resolution by IUE some years ago (Freire Ferrero 1988). The stars of the sample are not known as been shell, Ae/Be or peculiar ones, and their spectral type is suitable to search for IS high ionized species because they have neither chromosphere nor corona (Freire Ferrero 1986 and references therein), and have in general high rotational velocities allowing to distinguish between broad stellar lines (enlarged by rotation) and sharp IS lines. Nevertheless, a very careful analysis of the UV stellar spectra must be done because metallic lines produce strong stellar spectral blends at the C IV and Si IV wavelengths (Kurucz 1974, Hubený et al. 1986, Freire Ferrero 1986). Typical spectra in the C IV and Si IV spectral regions are shown in Fig. 1 for HD 119921 and HD 119361 : we see large spectral features due to photospheric metallic blends and a very narrow component displaced a little from the line wavelength of C IV and Si IV doublets at the stellar reference frame. The displacements for both lines of the doublets are more or less the same. As we can see, the displayed spectra for both stars are practically the same but the stars are at different distances from the Sun.

From the measures of the residual absorption we can estimate column densities for C IV and Si IV species :

$$N(\text{C IV}) \approx 1.3 \cdot 10^{13} \pm 0.3 \cdot 10^{13} \text{ cm}^{-2} \text{ or } \log N(\text{C IV}) \approx 13.1 \pm 0.1$$

$$N(\text{Si IV}) \approx 7.5 \cdot 10^{12} \pm 2.5 \cdot 10^{12} \text{ cm}^{-2} \text{ or } \log N(\text{Si IV}) \approx 12.85 \pm 0.15$$

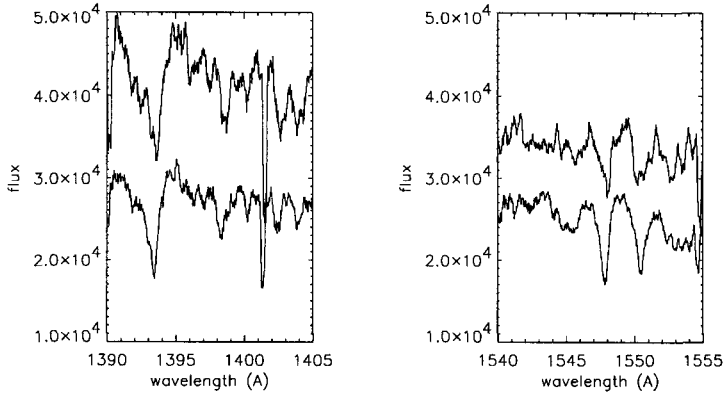


Fig. 1. Spectral similarities of HD 119921 and HD 119361

## 2 Discussion and Conclusions

Classical interpretation of similar spectra (for example from Be stars, Bruhweiler et al. 1989) attribute these absorption features to shells around these single stars. Nevertheless, it becomes difficult to support that shells give spectral signatures only in UV Si IV and C IV and not in the visible ( $H\alpha$  emission or absorption, metallic lines; Jaschek et al. 1988).

Indeed, the fact to consider the observed asymmetric features as entirely due to C IV and Si IV lines can mislead us because they can be interpreted as produced by stellar winds, which could be used as an argument for the presence of some kind of circumstellar (CS) matter around the stars. In fact, the broad features are simply photospheric metallic line blends (without any or very little C IV and Si IV contributions) as we mentioned before, and only the residual narrow absorption can have a non-stellar origin.

Deriving abundances from the broad features assuming that are only due to C IV and Si IV leads evidently to overabundances relative to normal IS abundances. Instead, values from the residual narrow absorptions lead to reasonable values.

Some differences were observed for some stars, between two IUE spectra taken at different epochs. but superposition of these spectra show clearly that the variations are of the same order as the IUE noise. Variability is sometimes interpreted as a qualitative characteristic of shell spectra even if now it could also be admitted for IS absorptions (Frisch 1995).

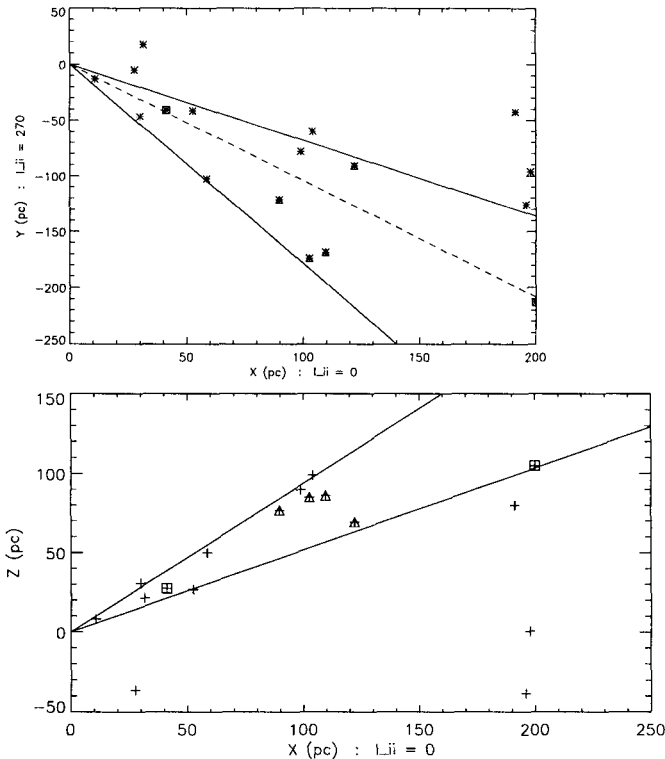
Even though IS and CS lines could be difficult to disentangle, the above discussion favors the IS interpretation for the narrow C IV and Si IV features observed. In addition, plotting the observed stars in galactic coordinates and taking into account the best estimated parallaxes, we discover that the observed IS absorptions are not randomly distributed. In fact (Fig. 2) IS absorptions are concentrated into the direction of the Loop I structure. Recent

**Table 1.** Data on observed stars

..... Star .....	$l_{II}$ ....	$b_{II}$ ....	d (pc) ..	Sp T ...
HD 109573	299.73	+22.91	118.	A 0 V
HD 110073	300.53	+22.83	202.	B 8 pII/III
HD 111597	302.75	+28.87	55.6	A 0 IV
HD 111774	303.04	+23.19	201.	B 7/B 8 V
HD 113852	306.46	+26.91	151.	A 0 III/IV
HD 115892	309.42	+25.79	16.8	A 2 V
HD 119361	313.20	+19.76	292.	B 8 III
HD 119921	315.28	+25.29	58.	A 0 V
HD 121847	321.66	+35.45	126.	B 8 V sh
HD 125248	330.06	+39.52	120.	A 0 pCrEu
HD 125473	321.73	+21.71	67.	A 0 IV
HD 125745	323.33	+24.46	152.	B 8 V
HD 142165	347.51	+22.15	196.	B 6 IV n
HD 147152	334.01	+0.13	220.	B 6 IV
HD 149485	327.24	-9.37	233.	B 7 V n
HD 152614	28.73	+30.66	36.	B 8 V
HD 209952	350.00	-52.47	28.	B 7 IV

work on the IS medium (Frisch 1995) confirms that the Sun is embedded into a low H I density medium and that there is a neutral gas wall at a distance of  $40 \pm 25$  pc in the direction of Loop I ( $N_H$  goes from  $\approx 10^{18}$  cm $^{-2}$  to  $\approx 10^{21}$  cm $^{-2}$ ; Cox and Reynolds 1987, Centuri3n and Vladilo 1991, Egger and Aschenbach 1996).

The nearby star showing C IV and Si IV IS absorption is HD 119921 at a distance corresponding to the presence of the H I wall (Centuri3n and Vladilo 1991). The more natural interpretation is that these ions are the result of an evaporative and conductive interface between the cold (H I wall) and the hot ISM (McKee and Ostriker 1977) or gas swept up by radiative shocks from SN at the origin of Loop I and interacting with the Local Bubble (Egger and Aschenbach 1996). This second explanation is supported by the observed X-ray shadow (0.1 - 2.0 keV) by ROSAT, corresponding to an annular enhanced H I feature attributed to the collision between the Local Bubble and the Loop I supershell (Egger and Aschenbach 1996). Colliding very hot gas forms dense colder structures than the original gas, and probably intermediate temperature transition regions develop also between the coldest and the hottest ones. The IS C IV and Si IV can be produced at  $T \approx 5 \cdot 10^4$  K in this intermediate temperature zones. We will complete this work with the new parallax data from HIPPARCOS and the reviewed IUE observations from the IUE Final Archive, when delivered.



**Fig. 2.** The stars observed are displayed in galactic coordinates X,Y,Z. The squares are HD 119361 and HD 119921 showing the higher IS absorption and the triangles a mid absorption. The other stars do not show this IS absorption from IUE spectra.

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