The Light Elements and Their Evolution
IAU Symposium, Vol. 198, *2000*
L. da Silva, M. Spite, J. R. de Medeiros, eds.

Interstellar D/H on the sightline of Sirius[1]

G. Hébrard, A. Vidal-Madjar and R. Ferlet

Institut d'Astrophysique de Paris, CNRS, 98 bis boulevard Arago, F-75014 Paris, France

C. Mallouris, D. York

Department of Astronomy and Astrophysics, University of Chicago, 5640 South Ellis Avenue, Chicago, IL 60637, USA

M. Lemoine

DARC, Observatoire de Paris-Meudon, UPR-176 CNRS, F-92195 Meudon Cédex, France

Abstract. We present observations of the binary Sirius A / Sirius B performed with HST-GHRS. Two interstellar clouds are detected on this sightline, one of them being identified as the Local Interstellar Cloud (LIC). Lyman α interstellar lines are also observed, but whereas the deuterium Lyman α line is well detected in the LIC with an abundance in agreement with that obtained by Linsky et al. (1995), no significant D I line is detected in the second cloud. The deuterium abundance which we measured in this cloud is $0 < (\mathrm{D/H})_{ISM} < 1.6 \times 10^{-5}$. Despite the large error bar, this sightline appears consequently as a good candidate for a low $(\mathrm{D/H})_{ISM}$.

Deuterium is a key element in cosmology and in galactic chemical evolution. The decrease of its abundance all along galactic evolution is a function, amongst other things, of the star formation rate. In order to measure the interstellar D/H ratio, representative of the present epoch, we introduced in Cycle 1 of HST a new type of target, white dwarfs in the high temperature range, for which the depth of the Lyman α photospheric absorption line is reduced, and whose stellar continuum remains smooth. These targets also allow the study of lines of other species, such as N I and O I, which are shown to be reliable tracers of H I in the ISM. We have already observed the white dwarf G191-B2B in HST Cycle 1 (Lemoine et al. 1996) and Cycle 5 (Vidal-Madjar et al. 1998) . Continuing that program, we present here ultraviolet observations of Sirius A and its white dwarf companion Sirius B performed with HST-GHRS in the frame of Cycle 6.

Our observations were performed in November 1996, using G140M and Echelle-A gratings. In our high and medium spectral resolution data, we have detected 10 interstellar lines toward Sirius A and/or Sirius B: N I 1200 Å triplet, O I 1302 Å, C II 1334 Å, Si II 1190 Å, 1193 Å and 1304 Å, D I 1215 Å and H I

[1]Based on observations with the NASA/ESA *Hubble Space Telescope.*

https://doi.org/10.1017/S007418090016663X Published online by Cambridge University Press

Lyman α. We completed our data set with Sirius A spectrum including Mg II and Fe II lines from HST-GHRS archives (Lallement et al. 1994).

The main results of our observations are the following:

• Two interstellar components are detected on the short (2.6 pc) Sirius line of sight, in agreement with previous study by Lallement et al. (1994). One is the Local Interstellar Cloud and we named the second the Blue Component (BC).

• The Lyman α lines do not present the same profile toward Sirius A and Sirius B, an extra absorption being observed in the blue wing of the Sirius A Lyman α line, and an extra absorption being observed in the red wing of the Sirius B Lyman α line. We interpreted these excesses respectively as the signatures of the wind from Sirius A and of the core of the Sirius B photospheric Lyman α line.

• A composite Lyman α profile was constructed from these two lines and fitted in order to measure the $(D/H)_{ISM}$ ratio in the two components. Our data are compatible with D/H ratio found in the LIC by Linsky et al. (1995), *i.e.* $(D/H)_{LIC} = 1.60 \pm 0.09^{+0.05}_{-0.10} \times 10^{-5}$. Our result is $(D/H)_{LIC} = 1.6 \pm 0.4 \times 10^{-5}$. In the other component, BC, we did not detected a significant D I line. The ratio we derived is $0 < (D/H)_{BC} < 1.6 \times 10^{-5}$.

• We did not detect the interstellar absorption of Si III at 1206.5 Å and C II* at 1335.7 Å. This implies a low electron density n_e, for which we found the upper limit $n_e \leq 0.05$ cm^{-3} in the LIC, assuming equilibrium between collisional excitation to excited-state C II* and radiative de-excitation to ground-state C II. Since measured values of the electron density are higher in the LIC toward other sightlines, the new value of n_e toward Sirius could point to inhomogeneities in the Local Interstellar Cloud (Ferlet 1999).

The data are thus consistent with $(D/H)_{BC}$ in the range 0 to 1.6×10^{-5}. The BC cloud is a candidate region for low $(D/H)_{ISM}$, but no definite conclusion about D/H can be made at this time. We intend to continue the study of the Sirius system until we can come to a definitive conclusion as to whether or not a low $(D/H)_{ISM}$ is present in the BC. In particular, it is critically important that this experiment be done again with deep HST-STIS observations to study the Lyman α line and FUSE observations to study the higher Lyman lines.

Details on these observations can be found in Hébrard et al. (1999).

References

Ferlet, R. 1999, A&AR 9, 153

Hébrard, G., Mallouris, C., Ferlet, R., Koester, D., Lemoine, M., Vidal-Madjar, A., & York, D. 1999, A&A 350, 643

Lallement, R., Bertin, P., Ferlet, R., Vidal-Madjar, A., & Bertaux, J.L. 1994, A&A 286, 898

Lemoine, M., Vidal-Madjar, A., Bertin, P., et al. 1996, A&A 308, 601

Linsky, J., Diplas, A., Wood, B.E., Brown, A., Ayres, T.R., & Savage, B.D. 1995, ApJ 451, 335

Vidal-Madjar, A., Lemoine, M., Ferlet, R., Hébrard, G., Koester, D., Audouze, J., Cassé, M., Vangioni-Flam, E., & Webb, J. 1998, A&A 338, 694

https://doi.org/10.1017/S007418090016663X Published online by Cambridge University Press