Recycling Intergalactic and Interstellar Matter
IAU Symposium Series, Vol. 217, 2004
Pierre-Alain Duc, Jonathan Braine and Elias Brinks, eds.

CO-to-H_2 Abundance Ratio of the Foreground Gas of the Carina Nebula

Shinn, Jong–Ho

Dept. of Physics, Korea Advanced Institute of Science & Technology, Korea

Seon, Kwang–Il

Korea Astronomy Observatory, Korea

Lee, Dae–Hee

Satellite Research Center, Korea Advanced Institute of Science & Technology, Korea

Min, Kyoung–Wook

Dept. of Physics, Korea Advanced Institute of Science & Technology, Korea

Abstract. We analyze CO and H_2 absorption lines of the foreground molecular cloud in the Carina nebula. We use *HST-STIS(Hubble Space Telescope - Space Telescope Imaging Spectrograph)* & *IUE (International Ultraviolet Explorer)* INES data to analyze the A-X (v=0→2) absorption band of CO for several hot stars toward the Carina nebula, while 9 stars of them have *FUSE (Far Ultraviolet Spectroscopic Explorer)* spectra to analyze the (v=0→4) vibrational band in the Lyman series of H_2. The column densities of CO and H_2 varies in the vicinity of $N(CO) \sim 10^{13} cm^{-2}$ and $N(H_2) \sim 10^{19} cm^{-2}$, respectively. The resultant CO-to-H_2 abundance ratio is about 10^{-6}. We investigate the variation of the abundance ratio according to the relative position of the target stars to morphology the molecular cloud in the Carina nebula.

1. Introduction

The Carina nebula (NGC 3372) is a huge H II region which produces a large ultraviolet (UV) radiation field and strong stellar winds, spanning more than four square degrees at a distance of about 2.2 kpc (Tovmassian et al., 1995). This kind of environment causes not only systematic expansion of the giant H II region (Walborn et al., 1984), but also heavy interaction with the surrounding large molecular cloud which is left after star formation. Besides, Walborn and Hesser (1975), Laurent et al. (1982) and Walborn et al. (1998) assert the existence of a cold, low-velocity cloud near the Sun in the direction of the Carina nebula. We investigate the CO-to-H_2 abundance ratio of two such clouds — a foreground cloud and the Carina cloud.

2. Observation and Analysis

We use three kinds of data: *HST-STIS & IUE* INES data are used to analyze the CO A-X (0→2) band and *FUSE* data are used to analyze the H_2 Lyman (0→4) band. We coadd all available individual spectra to improve the S/N ratio except for the *HST-STIS* data which consists of only one spectrum. We obtain N(CO) and N(H_2) through χ^2 minimization while fitting the line profile and via the curve of growth method. In the *HST-STIS* data and *FUSE* data, each rotational absorption line can be resolved so we use a χ^2 minimization line profile fitting method. In contrast, in the *IUE* data the rotational absorption lines are unresolved so the curve of growth method was used. We use a Doppler parameter in the range 1–3 $\mathrm{km\,s^{-1}}$ for the CO analysis and 4–5 $\mathrm{km\,s^{-1}}$ for the H_2 analysis.

3. Results

Table 1 is our result. It shows that the CO–to–H_2 abundance ratio of the foreground gas is in the range of 10^{-6} and its value differs according to the position within the cloud. Walborn (1998) asserts that the existence of CO is evidence of foreground gas toward the Carina nebula. Therefore, we assume that CO lies in the foreground.

Table 1. CO-to-H_2 Abundance ratio & column density

Star	$N(CO)_{fore}$ $\times10^{13}\mathrm{cm^{-2}}$	$N(H_2)_{fore}$ $\times10^{19}\mathrm{cm^{-2}}$	$N(H_2)_{carina}$ $\times10^{19}\mathrm{cm^{-2}}$	$\frac{N(CO)}{N(H_2)}_{fore}$ $\times10^{-6}$
HD303308	5.879 ± 0.294	10.535 ± 2.635	6.795 ± 1.7	0.55804
HD92809	10.48 ± 0.1287	11.81 ± 1.673	11.81 ± 1.673	0.88738
HD93206	1.599 ± 0.078	4.162 ±0.449	3.33 ±0.359	0.38419
HD93222	2.029 ± 0.254	3.146 ± 0.356	5.033 ± 0.57	0.64495
HD93249	9.371 ± 0.1318	10.339 ±0.913	10.339 ± 0.913	0.90637
HD93308	9.854 ± 0.1313	4.953 ± 0.93	9.907 ± 1.861	1.9895
HD93403	10.63 ± 0.126	16.361 ±2.588	16.361 ± 2.588	0.64972
HD93843	4.013 ± 0.1231	6.607 ± 0.944	-	0.60739
HD94910	5.828± 0.127	-	-	-
V* V572 Car	6.275 ± 0.351	7.454 ± 0.856	11.181 ± 1.283	0.84183

References

Laurent, C., Paul, J. A., & Pettini, M. 1982, ApJ, 260, 163

Tovmassian, H. M., Hovhannessian, R. Kh., & Epremian, R. A. 1995, Rev. Mex. A&A (Ser. Conf.), 2, 83

Walborn, N. R. & Hesser, J. E. 1975, ApJ, 199, 535

Walborn, N. R., Danks, A. C., Sembach, K. R., Bohlin, R. C., Jenkins, E. B., Gull, T. R., Lindler, D. J., Feggans, J. K., Hulbert, S. J., Linsky, J., Hutchings, J. B., & Joseph, C. L. 1998, ApJ, 492, L169

Walborn, N. R., Heckathorn J. N., & Hesser, J. E. 1984, ApJ, 276, 524

https://doi.org/10.1017/S0074180900197438 Published online by Cambridge University Press