

Exploring Molecular-Cloud formation with OH 18 cm transition

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Recently, we found that the OH 18 cm transition can be used as an excellent thermometer of the molecular gas in a wide range of the H₂ density from 10² -10⁷ cm⁻² ([1] Ebisawa et al. 2015). The OH 18 cm transition consists of the four hyperfine components, and their relative intensities are sensitive to the gas kinetic temperature. For instance, we found a clear absorption feature of the 1612 MHz line against the cosmic microwave background (CMB) toward the translucent cloud eastward of Heiles Cloud 2 (HCL2). By using the statistical equilibrium analysis, we determined the gas kinetic temperature to be 53-60 K in this source, which is apparently higher than that of dense cores. This method was also applied to the dark molecular cloud L134N and the photodissociation region of the rho-Ophiuchi molecular cloud, and the existence of the warm molecular gas surrounding the dense cores were revealed. All these results suggest that the OH 18 cm transition traces a new class of warm molecular gas, which is possibly related to the formation processes of molecular clouds.

Then, we applied this technique to the outstanding straight structure in the northern part of HCL2 to explore its origin (Figure 1 left). Interestingly, we detected the 1720 MHz line in absorption toward the straight structure (Figure 1 right). According to our statistical equilibrium analysis, the 1720 MHz line absorption traces a dense and cold ($T_k < 30$ K) part of the cloud surrounded by a warm envelope gas. Combined analyses of OH, ¹³CO and C¹⁸O suggest that the straight structure would be formed by compression of a warm envelope gas extending to the southwestern part of HCL2. These results demonstrate that the OH 18 cm transition can be used to study molecular-cloud formation.

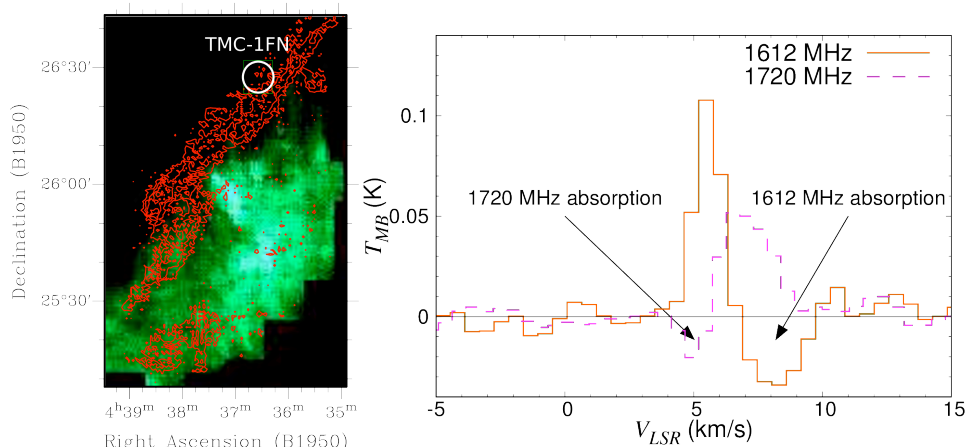


Figure 1: (left) The integrated intensity map of ¹³CO ($J=1-0$) (color) and C¹⁸O ($J=1-0$) (contours) in HCL2. (right) Spectra of the OH 18 cm transition observed toward TMC-1FN (white circle in the left panel).

References

- [1] Y. Ebisawa, H. Inokuma, N. Sakai, et al. 2015, ApJ, 815, 13