Effects of Line Overlap in statistical equilibrium calculations of OH 18cm lines

Y. Ebisawa,[1] H. Inokuma,[1] Y. Watanabe,[1] N. Sakai,[1] H. Maezawa,[2] K. M. Menten,[3] and S. Yamamoto[1]

[1]*Department of physics, University of Tokyo, Japan*

[2]*Department of physics, Osaka Prefecture University, Japan*

[3]*MPIfR, Germany*

The 18 cm OH transition is the first spectral line of interstellar molecules detected in the radio wavelength region. It is the fine structure transition between the Λ-type doubling levels in the lowest rotational state (J=3/2, Ω=3/2), and consists of four hyperfine components (1612, 1665, 1667, 1720 MHz). It is well known that the relative population of the hyperfine structure levels can attain values that deviate from LTE values. In our observation toward eastward of Heiles Cloud 2 (HCL2), we found a clear absorption feature of 1612 MHz component. In order to interpret this, we conducted statistical equilibrium calculations. As a result, we found that intensities of the four hyperfine components of OH are sensitive to the temperature (Fig.1 left). Therefore, they can be used as a good thermometer for quiescent molecular clouds.

However, we recently observed 1720 MHz absorption feature in the northwest of Taurus Molecular Cloud-1 (TMC-1) (Fig.1 right). In order to interpret this 1720 MHz absorption feature, we again conducted statistical equilibrium calculations considering the effect of Line Overlap. As a result, we found that thermal Line Overlap could cause 1720 MHz absorption feature when the column density of OH is high, the temperature is high, the linewidth is narrow and there is no velocity gradient in the cloud. We also found that the effect of Line Overlap is negligible as long as the column density of OH is not so high. Therefore, we can safely use four hyperfine components of OH as a thermometer if the column density of OH is not so high.

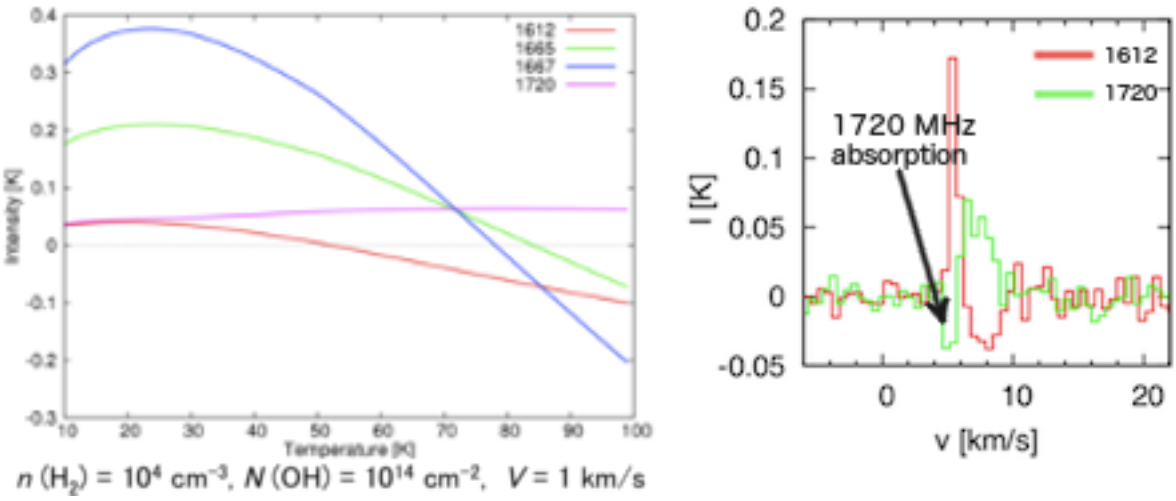

Figure 1: (left) Intensities of the four hyperfine components of OH as a function of temperature derived from the statistical equilibrium calculation. 1612 MHz line appears in absorption when the temperature is higher than 40 K. (right) Intensities of the 1612 MHz line and the 1720 MHz line observed in the northwest of TMC-1.The 1720 MHz line appears in absorption.