CH^+ SPECTRUM AND DIFFUSE INTERSTELLAR BANDS TOWARD HERSCHEL 36 EXCITED BY DUST EMISSION

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All electronic CH^+ interstellar absorption lines so far observed had been limited to the $R(0)$ transition starting from the J = 0 ground level; this is because of the very rapid $J = 1 \rightarrow 0$ spontaneous emission with the life time of $\sim$ 140 s. We have observed the $R(1)$ and $Q(1)$ lines of the $A^1\Pi \leftarrow X^1\Sigma$ band from the excited J = 1 level 40.08 K (27.86 cm^{-1}) above the J = 0 level toward Herschel 36 indicating high radiative temperature of T_r = 17.5 K. The high temperature is most likely due to far infrared dust emission from the Her 36 SE.[a] We have also observed the R_1(3/2) line of CH starting from the excited fine structure level J = 3/2 which is 25.76 $-$ 25.57 K above the J = 1/2 level.

The effect of high radiative temperature is also noticed as unique lineshapes of diffuse interstellar bands (DIBs) observed toward Her 36. We have examined seven DIBs including λ 5780.5, λ 5797.1, λ 6190.0, and λ 6613.0 that are correlated with each other with correlation coefficients $>$ 0.93. While for ordinary sightlines the lineshapes of these DIBs are more or less symmetric, those toward Her 36 show a long tail toward the red. This is due to far infrared pumping of high J rotational levels of polar carriers of the DIBs by the dust emission. We have developed a model calculation of relaxation taking into account of both radiative and collisional processes. A linear molecule with about 6 carbon atoms can explain some of the DIBs. For the DIBs we have examined, probably the carriers are of this size since we cannot explain the large difference between the DIBs toward ordinary sightlines and toward Her 36 with larger molecules.

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[a] Goto, M., Stecklum, B., Linz, H., Feldt, M., Henning, Th., Pascucci, I., and Usuda, T. 2006, ApJ, **649** 299.