

^{12}CO , ^{13}CO AND CS OBSERVATIONS OF NGC 2146 AND IC 342

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We have observed the nuclear regions of the galaxies NGC 2146 and IC 342 in ^{12}CO and ^{13}CO J=1-0 and 2-1, as well as CS J=2-1 lines using the FCRAO 14m telescope. The multi-line data are used, in conjunction with radiative transfer model calculations, to estimate the physical conditions of the gas with the purpose of determining the difference between the two galaxies in terms of their gas component. We hope to examine if the gas temperature and column density are dependent on the infrared properties of a galaxy, and whether a warm and optically thin gas component exists in these galaxies, as has been suggested in the case of M82 (Knapp et al.1980), especially for NGC 2146 for which the starburst has been proposed to be a scaled-up version of M82 (Jackson and Ho 1988).

The results show that in the nuclear regions of the galaxies, the gas seems to be thermally coupled with the dust. The excitation temperature of CO estimated from the observed $T_A^*(^{12}\text{CO})/T_A^*(^{13}\text{CO})$ ratio tends to be higher in the galaxy with higher dust temperature (NGC 2146; $T_d \sim 45\text{K}$). The model calculations also indicate that in order to produce the observed intensity ratios, the gas needs to be warmer and denser in NGC 2146 than in IC 342 ($T_d \sim 35\text{K}$). The integrated ^{12}CO J=2-1/J=1-0 main beam brightness temperature ratio in NGC 2146 is 0.95 which implies that the emission originates from warm and optically thick gas, while the ratio in IC 342 appears to be slightly greater than one. It is found that the ^{12}CO J=2-1 opacity in IC 342 is significantly lower than that in NGC 2146. The ^{13}CO lines are optically thin in both cases. The CS J=2-1 emission has been detected toward the center of NGC 2146 and IC 342, which means the gas with $n(\text{H}_2) > 10^4 \text{ cm}^{-3}$ is present. The $^{12}\text{CO}/\text{CS}$ intensity ratio in IC 342 is 47, consistent with the value obtained by Mauersberger and Henkel (1989), and the ratio in NGC 2146 is only half of that in IC 342. These results lead us to suggest that the gas density toward the center of NGC 2146 is higher than IC 342.