# POPULATION INVERSION AND SUPRATHERMAL EXCITATION IN CARBON MONOXIDE

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We have investigated under which physical conditions (kinetic temperature, $H_2$ density, CO column density) the CO molecule shows suprathermal excitation and population inversion. The computations are based on a model in which the excitation is basically due to collisions with $H_2$ molecules. The collision cross-sections were taken from Green and Thaddeus (1976). The radiative transport in the molecular lines is treated in an on-the-spot approximation (see e.g. Kegel 1979)

$$J = S(1 - e^{-\tau}) + I_{bg}e^{-\tau}$$

in order to keep the computing time low enough to permit the investigation of a wide range of parameters. Our approximation of the radiative transfer is mathematically equivalent to a formalism involving an escape probability $\beta = e^{-\tau}$. This escape probability arises from the fact that the radiative transfer in the line wings is neglected.

For the $J = 1 \rightarrow 0$ line we find for $T_{kin} \gtrsim 20$ K suprathermal excitation, and for $T_{kin} \gtrsim 50$ K population inversion for $H_2$ densities about $10^4$ $cm^{-3}$ and not too large column densities. However, only weak masers ($|\tau|<0.1$) are found.

The calculations also give the parameter range in which the often-used assumption of LTE is justified. For $n_{H_2} \gtrsim 10^4 cm^{-3}$, LTE is a good approximation if $I(^{12}CO)/I(^{13}CO) \lesssim 20$. If $I(^{12}CO)/I(^{13}CO) \lesssim 4$, the $^{12}CO$ is always thermalized.

Most observed clouds seem to have physical conditions which allow the application of LTE analysis. We expect, however, that in clouds of lower density the LTE analysis will overestimate the CO column density by as much as a factor of 100.

## REFERENCES

Green, S., Thaddeus, P.: 1976, Astrophys. J. 205, 766.
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