Vibrational and rotational quenching of CO by collisions with H, He, and H_2

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Abstract

Collisional quenching of molecular species by atoms and molecules is an important process in a variety of astrophysical environments. Advanced atmospheric modeling and spectral synthesis of extrasolar giant planets (EGPs), brown dwarfs (BDs), photodissociation regions (PDRs), and other cool astrophysical environments requires an extensive array of accurate molecular data, i.e. state-to-state cross sections and rate coefficients. A large portion of the data is either currently unavailable (as the requisite experiments or calculations have not been carried out) or the available data are insufficient to meet the demands required by the modeling applications. Comprehensive experimental and theoretical studies of such processes are now becoming feasible.

Due to their astrophysical importance as these species are the most common ones in a wide range of astronomical sources, collisions of CO with H, He, and H_2 have been the subject of numerous experimental and theoretical studies. Accurate data for state-to-state cross sections and rate coefficients for these systems are crucial to quantitative models of astrophysical environments. In this work, quantum mechanical scattering calculations have been performed for the rovibrational and rotational relaxation of CO in collisions with H, He and both para-H_2 and ortho-H_2 in their rovibrational ground states using the close-coupling approach and coupled-states approximation.

Cross sections and rate coefficients for the quenching of the v=0-2, j=0-10 levels of CO will be presented and comparisons with previous calculations and measurements, where available, be provided. This work was partially supported by NASA grant NNG04GM59G from the Origins of Solar Systems Program.

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