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Experimental kinetics study of intramultiplet transitions in collisions of $C(^3P_J)$ with He and H_2 at 7K

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Abstract. Collision-induced fine structure transitions in atoms have been the subject of many experimental and theoretical studies because of their interest in both physical and chemical processes involved in different fields such as chemical lasers, combustion, atmospheric, and interstellar chemistry. Rates of excitation of fine structure transitions of atoms with a relatively high interstellar abundance such as carbon or oxygen, by collisions with helium or hydrogen are also valuable sources of information on conditions in interstellar clouds, where the temperature can be as low as 10 K. Ground-state atomic carbon is indeed an important tracer for studies on molecular clouds. For instance the relative population of neutral carbon atoms in excited fine-structure levels of the ground state is used to probe the density and the temperature in diffuse HI regions. The energy level separations, collisional excitation rate constants and spontaneous radiative decay rates are ideal for differentiating the various regimes of density and temperature expected in this part of the interstellar medium. Abundant ground-state atoms, especially C and O, also play an important role in cooling in interstellar clouds because their collisional excitation by H_2, H, or He to an excited fine structure level can be followed by radiative deexcitation.

The experiments have been performed using the CRESU (Cinétique de Réaction en Ecoulement Supersonique Uniforme) facility of Birmingham in which low temperatures (down to 7 K) are achieved by the expansion of a carrier gas through an axisymmetric convergent-divergent Laval nozzle. Helium, and for the first time in a CRESU apparatus, molecular hydrogen, have been used as carrier gases, as a quite high density of collisional partners was necessary to obtain the rate constants of the collision induced spin-orbit relaxation of the ground state atomic carbon. In both cases, the carrier gas was pre-cooled before the expansion using liquid nitrogen in order to obtain a temperature of the flow as low as 7 K. The kinetics study was achieved by monitoring the three levels of the carbon atom ground state, $C(^3P_J)$, by vacuum ultra violet - Laser Induced Fluorescence using two-photon resonant four-wave frequency mixing in xenon.

Our experimental results as well as comparison with previous theoretical calculations are presented in this poster.