Crossed-beam inelastic scattering experiments at energies approaching the cold regime

Astrid Bergeat*, Simon Chefdeville, Christian Naulin, Michel Costes

Université de Bordeaux, CNRS UMR 5255, Institut des Sciences Moléculaires, 33400 Talence, France

**E-mail: astrid.bergeat@u-bordeaux.fr*

Theoretical calculations predict that rotational energy transfer to small molecules, such as CO, by collisions with H_2 or He are dominated by resonance phenomena,[1] which can only be revealed at very low energies. Experiments conducted with a crossed, molecular beam apparatus with variable crossing angle allowed us to determine the integral cross sections as a function of the relative translational energy down to a few wavenumbers, *i.e.* below the thresholds of the {j = 0 - 1} CO transition at 3.85 cm^{-1}. The experimental results, which exhibit behaviours characteristic of quantum resonances, are compared to QM scattering calculations. The close agreement between experimental and theoretical (QM scattering) integral cross sections allows for complete assignment of the resonances observed for the CO(j=0) + He $\rightarrow$ CO(j=1) + He. Agreement with theory is shown to strongly depend on the characteristics of the potential energy surface (PES) used to perform the QM treatment. The ICS calculated with the new PES developed by P. Jankowski, A. R. W. McKellar and K. Szalewicz [2] for the CO(j=0) + p-H_2 $\rightarrow$ CO(j=1) + H_2 are in excellent agreement with our experimental data[3] on CO + p-H_2 and this PES was also used for our recent studies of inelastic scattering of CO with n-H_2, o-D_2 and n-D_2.

This work is supported by the French National Research Agency (ANR- **HYDRIDES,** ANR-12-BS05-0011-01 contract), the Conseil Régional d'Aquitaine (contract 2007.122) and the PHC Van Gogh ("Cold Collisions", n°28484TH).

[1] Simon Chefdeville, Yulia Kalugina, Sebastiaan Y. T. van de Meerakker, Christian Naulin, François Lique, Michel Costes, ***Science* 341 1094 (2013)**.
[2] Piotr Jankowski, A. R. W. McKellar, Krzysztof Szalewicz, ***Science* 336 1147 (2012)**.
[3] Simon Chefdeville, Thierry Stoecklin, Astrid Bergeat, Kevin M. Hickson, Christian Naulin, Michel Costes, **Phys. Rev. Lett., 109, 023201-5 (2012).**