Collisional excitation of interstellar water molecules in laboratory

K. Dzenis[1,2], M. Louis[1], S.B. Morales[1], A. Bergeat[1], F. Herpin[2]
[1] *Collisions Moléculaires en Milieux Extrêmes (COMEX), Institut des Sciences Moléculaires, Université de Bordeaux, FRANCE*
[2] *Formation d'Étoiles et Milieu Interstellaire (FEMIS), Laboratoire d'Astrophysique de Bordeaux (LAB), Université de Bordeaux, FRANCE*
karlis.dzenis@u-bordeaux.fr

The 1986 Nobel Prize in chemistry was awarded to D. R. Herschbach for the development of the Crossed Molecular Beam (CMB) technique [1]. Further developments of the technique have enabled to experimentally study single molecular collisions in the near-cold regime (a few Kelvin) [2] which is important for probing processes that occur in extreme, non-equilibrium environments such as interstellar space. This technique allows to measure *cross sections* for collision-induced rotational transitions that are used to derive the corresponding rate coefficients. Accurate cross sections and rate coefficients are essential for interpreting and modelling molecular lines observed by astronomers, for example, in outflows of evolved stars.
In this poster, the CMB setup in the COMEX group is presented along with its application to study the rotational excitation of water, the third most ubiquitous molecule in interstellar medium (after H_2 and CO), and its isotopologues (*i.e.*, HDO, D_2O) by inelastic collisions with H_2. A pulsed beam of water of a few µs was rotationally cooled by supersonic expansion into a high vacuum chamber. Water molecules in their lowest ground rotational states were crossed with H_2 with a variable angle thus allowing to achieve collision energies in the range of 10-100 cm^{-1} (Figure 1). Integral cross sections for the rotational excitation of H_2O, HDO and D_2O by collisions with H_2 are presented and compared compared to theoretical computations at the quantum close-coupling level.

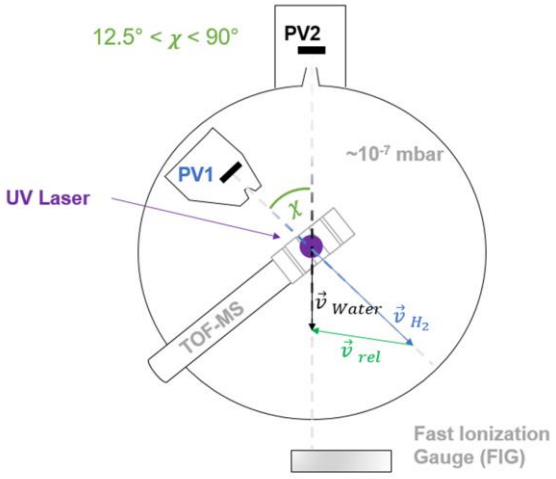

Figure 1. Scheme of the CMB experimental set-up at COMEX, Institut des Sciences Moléculaires.

[1] Herschbach, D. R., "Nobel Lectures in Chemistry 1981-1990", *World Scientific Publishing Co., Singapore,* 1992, p. 268
[2] C. Naulin & M. Costes., *Int. Rev. Phys. Chem.*, 2014, *33:4*, 427-446