Using molecular alignment to track the collisional relaxation of a gas sample

G. Karras[1], F. Billard[1], J. Houzet[1], E. Hertz[1], B. Lavorel[1], J.M. Hartmann[2], O. Faucher[1]

[1] Laboratoire Interdisciplinaire Carnot de Bourgogne (ICB), UMR 6303 CNRS-Université de Bourgogne, 9 Avenue Alain Savary, BP 47 870, 21078 Dijon Cedex, France

[2] Laboratoire Interuniversitaire des Systèmes Atmosphériques (LISA), UMR 7583 CNRS-Université Paris Est Créteil, Université Paris Diderot, Institut Pierre-Simon Laplace, 94010 Créteil Cedex, France

One of the most effective ways used to induce post-pulse alignment in a molecular ensemble is by irradiating it with a short laser pulse. In the simplest scenario, a linearly polarized laser pulse with moderate intensity, far from any resonance with the molecular energy levels, is capable of aligning a molecule along its polarization axis. Since for most linear molecules their electric polarizability is anisotropic with respect to the plane of the molecular axis, its coupling with the electric field of the laser leads to their alignment through two-photon Raman-like transitions. The present work takes advantage of the polarization technique introduced originally by Renard et al [1] and demonstrates the use of molecular alignment as a tool for probing dissipative environments. The theoretical framework was originally proposed by Ramakrishna and Seideman [2] and developed further by Hartmann and Boulet [3]. Experimentally it has been already shown that under ambient and high pressure conditions [4] collisions between the molecules affect differently the permanent and the transient components of the alignment. Here, a preheat pulse is used to increase the rotational temperature of the molecules, which subsequently dissipate this energy to their translational degrees of freedom through elastic and inelastic collisions. As it is shown, due to rotational-translational R-T transfers, the averaged rotational energy is progressively reduced whilst the average translational is increased. The dissipation dynamics are tracked in a time interval of 500 ps, enough for the system to reach full Boltzmann equilibrium, by recording the induced molecular alignment in which the two aforementioned alignment components are differently affected.

References

/1/ V. Renard, M. Renard, S. Guérin, Y. T. Pashayan, B. Lavorel, O. Faucher, and H. R. Jauslin, Phys. Rev. Lett. 90, 153601
/2/ S. Ramakrishna and T. Seideman, Phys. Rev. Lett. 95, 113001.
/3/ J.M Hartmann. and C. Boulet, J. Chem. Phys. 136, 184302.
/4/ Th. Vieillard, F. Chaussard, F. Billard, D. Sugny, O. Faucher, S. Ivanov, J.-M. Hartmann, C. Boulet, and B. Lavorel, Phys. Rev. A 87, 023409, J. Houzet, J. Gateau, E. Hertz, F. Billard, B. Lavorel, J.-M. Hartmann, C. Boulet, and O. Faucher, Phys. Rev. A 86, 033419.