Thermalisation in Water Nano-droplets

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The evaporation of a water molecule occurs through the breaking of one or several hydrogen bonds. These hydrogen bonds are responsible for many remarkable features of water. At the macroscopic scale, water is known for its exceptional ability to thermalize a system, while at the microscopic level, a high-speed transfer of vibrational energy via hydrogen bonds is observed. What happens for only a small number of water molecules?

In the experiment carried out with the device DIAM at IPN Lyon, the relaxation of protonated water nanodroplets is observed after electronic excitation of one of its molecules [1-6]. The implementation of a velocity map-imaging (VMI) method associated with the Correlated Ion and Neutral Time-Of-Flight (COINTOF) technique allowed us to measure the velocity distributions of molecules evaporated from mass- and energy-selected protonated water nanodroplets [3, 4]. The behaviour of the measured velocity distributions shows that even for extremely small water nanodroplets, a complete energy redistribution before evaporation prevails and the velocity distributions of these events are close to those expected for macroscopic droplets from around ten water molecules. However, these measurements of the velocity distributions also feature a distinct high-velocity contribution corresponding to the evaporation of a molecule before complete redistribution of energy [1,5]. The measured velocity distributions for heavy water nanodroplets show a proportion of these non-ergodic events more important than for normal water. The measurements carried out with different target atoms show that the proportion of non-ergodic events decreases with decreasing the energy deposited in the droplet.

References

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