Femtoscopy

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Physical, chemical and biological processes often appear complex because we look at them on an extended timescale, during which many steps in the process are integrated. Despite the rich history of chemistry over two millennia, the real time observation of actual atomic motions involved in chemical reactions is very recent. Chemical bonds form, break, and evolve with awesome rapidity. Whether in isolation or in any other phase, this ultrafast transformation is a dynamic process involving the mechanical motion of electrons and atomic nuclei. The speed of atomic motion is of the order of 1 km/s and, hence, the average time required to record atomic-scale dynamics over a distance of 1 Å is in the range of 100 femtoseconds (fs). The very act of such atomic motions, the way reactions unfold and pass through their transition states, is the focus of the field of femtochemistry.Funded by an ERC-Starting grant (Femtoscopy), we build up a new laboratory for ultrafast spectroscopy from scratch. This is a highly interdisciplinary; research line, toiling over challenging problems in which the traditional distinction between biology, chemistry and physics is smeared out by the common ultra short timescale. Our realization of a non conventional pump probe setup for vibrational spectroscopy in the range 320-520 nm, is reported in Optics Express. Based on Stimulated Raman Scattering with broadband detection we reach the femtosecond timescale with energy resolutions which would pertain to the picosecond time domain in the Heisenberg sense. See our Chem Phys Chem paper on the ultimate resolution limit of this approach. Among our recent achievements, the experimental measurement of the ultrafast photo-induced dynamics of the exchange energy in a Heisenberg antiferromagnet, reported in Nature Photonics and the sub-picosecond energy flow in a biomolecule, appeared in Nature Chemistry .