10 March, 2005

"Ultrafast Memory Loss and Energy Redistribution in the Hydrogen Bond Network of Liquid Water"

Nature March 10, 2005.

A team of researchers at the Max Born Institute in Berlin and the University of Toronto have solved a long standing problem in spectroscopy. As soon as the first InfraRed (IR) spectra were resolved and assigned to molecular structures it was noticed that of all molecules water showed an anomolously broad OH vibration, by more than an order of magnitude relative to most other molecular vibrations. (Perhaps it should not come as a surprise that water of all substances would show an anomoly, given all its other special properties relative to other liquids.) In the decades since we have come to realize that the water OH stretch is broadened by hydrogen bonding --- the "stuff of life". The question was whether the broad line shape is inhomogeneous (has different structures that persist) or homogeneously broadened (rapid interchange of structures/frequencies). This work was the first to be able to use multidimensional IR methods to inspect pure H_2O with all its possible interactions intact. This accomplishment was made possible by advances in diffractive optics to perform the laser experiment and by developing extremely thin cells for water, based on nanofluidics, in order to view such strongly absorbing media in the IR. If you inspect Figure 4 of this paper you will see the answer. Water is inhomogeneously broadened but (wouldn't you know water would have more surprises) the correlations or memory in its structral/spectral differences is lost essentially within 50 femtoseconds or less than 1/10 millionth of a millionth of a second....more than an order of magnitude faster than any other liquid.

This work has highlighted that liquid H_2O, a seemingly simple molecule, still holds surprises. It is interesting that we are willing to send probes to Mars to look for water as evidence for life, when we still don't know what it is about water that gives rise to life. This work has in essence sent a probe into water to observe the fundamental forces that are thought to be responsible. The German-Canadian collaboration has unearthed the incredibly fast memory loss (loss of correlations) and energy redistribution involving these forces in liquid H_2O. They suggest that these extraordinarily fast timescales act to stabilize biological systems.

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