# 21COE 特別講演

## Multidimensional Nonlinear Optical Studies of Liquids: The Search for Life (Forces) on Earth

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One of the most important substances on earth is liquid $H_2O$; this seemingly simply liquid has a number of anomalous properties in relation to other liquids. These properties are inextricably linked to the high degree of hydrogen bonding in water that essentially breathes life into otherwise inanimate objects. To understand the special properties of water that are central to life, we require a direct observation of the intermolecular forces defining the dynamic structure of the liquid state. The problem is that the spectrum relevant to the hydrogen bonded interactions that dominate the many body potential of liquid water is relatively broad and featureless. In fact, one of the longest standing problems in spectroscopy is the nature of the unusually broad OH stretch frequency that reports directly on the degree of hydrogen bonding and dynamic structure of liquid water. This problem reduces to classic issues of the degree of inhomogeneous vs. homogeneous broadening; one that can not be resolved with linear spectroscopic methods. This talk will discuss latest advances in high order nonlinear spectroscopies to directly determine the many body potential of liquids in which both long range correlations as well as first shell interactions to build up a “droplet” many body potential that transcends local to bulk liquid properties. The emphasis will be on recent femtosecond 2D IR studies of the fully resonant hydrogen bond network of liquid H2O made possible for the first time with the advent of diffractive optics based nonlinear spectroscopy and nanofluidics. The findings reveal an incredibly fast loss of memory or correlations in the hydrogen bond network and rapid energy exchange among all the degrees of freedom. There appears to be no clear separation in time scales to use the typical modal basis descriptions for liquids and has important consequences in how we think about water‘s role in supporting biological functions.

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