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High-resolution imaging and spectroscopy of interfacial water at single bond limit.

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Hydrogen bond is one of the most important weak interactions in nature and plays an essential role in a broad spectrum of physics, chemistry, biology, energy and material sciences. The conventional methods for studying hydrogen-bonding interaction are all based on spectroscopic or diffraction techniques. However, those techniques have poor spatial resolution and only measure the average properties of many hydrogen bonds, which are susceptible to the structural inhomogeneity and local environments, especially when interfacial systems are concerned. The spatial variation and inter-bond coupling of the hydrogen bonds leads to significant spectral broadening, which prohibits the accurate understanding of the experimental data. In this talk, I will present our recent progress on the development of new-generation scanning probe microscopy/spectroscopy (SPM/S) with unprecedentedly high sensitivity and resolution [1,2], for addressing weak inter- and intra-molecular interactions, such as hydrogen bonds and van der Waals force. Based on a qPlus sensor, we have succeeded to push the real-space study of a prototypical hydrogen-bonded system, i.e. water, down to single bond limit. Combined with state-of-the-arts quantum simulations, we have discovered exotic nuclear quantum effects (NQEs) in interfacial water and revealed the quantum nature of the hydrogen bond from a completely new perspective [3]. [1] J. Guo et al., Nature Materials 13, 184 (2014). [2] J. Chen et al., Nature Communications 5, 4056 (2014). [3] X. Meng et al., Nature Physics 11, 235 (2015).