The Water Surface: Complex, Dynamic and Wet

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Water surfaces and interfaces are ubiquitous, not just in nature (e.g. at the boundaries of cells, in rain drops, oceans, rivers and lakes) but also in many technological applications (such as electrochemistry and photocatalytic water splitting). Water is a rather unique liquid, owing to its strong intermolecular interactions: strong hydrogen bonds hold water molecules together. At the surface of water, the water hydrogen-bonded network is abruptly interrupted, conferring properties on interfacial water different from bulk water [1].

We elucidate the structure and structural dynamics of interfacial water molecules, at both the surface of the liquid and solid ice, using surface-specific vibrational spectroscopy of interfacial water molecules, with femtosecond time resolution. Specifically, we find that the interface is structurally more heterogeneous and shows faster structural, but slower vibrational dynamics than bulk water [2,3]. For solid water, we show that surface melting of ice occurs in a bilayer-by-bilayer fashion [4], and that the control over the water interfacial structure and dynamics allow ice nucleating proteins to accelerate the nucleation of ice, through a subtle interplay of interfacial water arrangement and accelerated heat transport away from the surface [5].

References:

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