The 896th IMS colloquium

Structure and dynamics of water molecules at the water-air and ice interfaces

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Date & Time: 2017/1/16 (Mon.) 16:00-
Place: IMS Research Building Room 201

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 the solid (ice) phases, 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 dynamics than bulk water [2]. We show that surface melting of ice occurs in a bilayer-by-bilayer fashion [3], and that the control over the water interfacial structure and dynamics allow ice nucleating proteins to enhance the nucleation of ice, through a subtle interplay of interfacial water arrangement and accelerated heat transport away from the surface [4].

References:

[1] Bonn, M.; Nagata, Y.; Backus, E.H.G.; Angew. Chem.-Intern. Ed. 2015, 54, 5560.

[2] van der Post, S. T.; Hsieh, C.-S.; Okuno, M.; Nagata, Y.; Bakker, H. J.; Bonn, M.; Hunger, J. Nat. Commun. 2015, 6, 8384.

[3] A. Sanchez et al., Proc.Nat. Ac. Sci. USA 2016, doi: 10.1073/pnas.1612893114

[4] Pandey, R., et al., Science Advances 2016, 2, e1501630.

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