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Molecular Water Interaction of Ice-nucleating Microorganisms

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Ice nucleation (IN) at temperatures higher than -42 °C is part of our daily perception but only possible due to the interaction with particles which serve as nuclei. Among the most relevant ice nuclei are mineral dusts as well as organic macromolecules [1]. While the IN efficiencies of many of these substances have been quantified from freezing assays, the molecular level interactions between their surfaces and the adjacent water molecules are still not fully understood. Here we focus on the bacterium *Pseudomonas syringae*, a plant pathogen which uses its outstanding IN efficiency to cause frost damage to plants and to capture nutrients, and on fungi species showing similar abilities. The impact of such a variety of ice nucleating microorganisms is not limited to agriculture hence they appear as airborne particles and are contributory factors to atmospheric glaciation processes [1]. We study the temperature dependent alignment of water adjacent to the biomolecules using sum-frequency generation vibrational spectroscopy (SFG). Previous studies showed, that commercially available *P. syringae* (Snomax®) in heavy water increasingly order the interfacial D_2O-molecules when the solution is cooled down [3]. The result indicates that the bacterium's ability to order water is optimized to be enhanced at temperatures close to the freezing point. Here we demonstrate that the effect also occurs in the natural H_2O environment. Moreover we generalize the result by verifying them for the fungus *Fusarium acuminatum*, another IN active plant pathogen with enormous impact on European and American agriculture.

Literature:
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