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The Many Faces of Ice and Nonlinear Interferometry.

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Ice is likely the most ubiquitous solid in the Universe, yet even here on Earth its surface contains many mysteries. At atmospheric pressure, the stable form of ice is hexagonal ice; known as I_h. This contribution will present data about (i) equilibrium growth at the ice-water interface, (ii) procedures to generate *any* targeted ice face, and (iii) vibrational spectra of the ice-air interface. Contrary to common belief, the stable ice-water interfaces does not consist of the basal face; rather it consists of pyramidal or prism faces. Growth results from a balance between the molecular density and the top half-bilayer configuration. Arguments reminiscent of Pauling's residual entropy of ice generate the configurational contribution. Prism faces are favored due to greater entropy. Ice grows cryptomorphologically: the macroscopic sample does not reveal the crystalline axes. Locating the crystal axes as well as generating authentic faces for fundamental studies use a combination of the birefringence of ice and etch profiles. Surface vibrational spectroscopy supports an ice model consisting of extended, cooperative motion and beyond-bonding-partner determination of hydrogen bond strength. The surface vibrational spectrum is probed with the nonlinear spectroscopy sum frequency generation (SFG). Currently, nonlinearity limits use of SFG to diagnose interactions. This limitation can be circumvented by measuring the full, complex spectrum. We will report initial results from a newly invented nonlinear interferometer that reveals the full complex spectrum.