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Equivalence of the sound velocity in water and ice at mesoscopic wavelengths

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IT IS generally assumed, for any material, that sound travels faster in the solid phase than in the liquid. This is true at least for waves of macroscopic wavelength, the dynamics of which depend on the elastic properties of the medium and, hence, on the presence or absence of long-range order. But at wavelengths approaching the typical interparticle distance, the dynamics should become insensitive to the long-range organization of the medium. Here we report inelastic X-ray scattering measurements in water and ice, which show that sound waves with wavelengths between 0.5 and 3 nm propagate at the same Velocity in both phases. The observed sound speed, which is greater than twice the hydrodynamic speed of sound in water, but less than that in ice, agrees with values obtained in previous measurements of 'fast sound' in liquid D_2O (ref. 1) and H_2O (ref. 2). These results show that, despite the fundamental structural and dynamical differences between water and ice, the dynamical response of the two phases is strikingly similar at very short wavelengths.

The liquid and solid states are thermodynamical concepts related to the time evolution of the relative positions of the