The extreme acoustic anisotropy and fast sound velocities of cubic high-pressure ice polymorphs at Mbar pressure

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We presented the first experimentally determined single-crystal elasticity model of ice up to 103(3) GPa, based on the sound velocity measurements of high-*P* ice polymorphs within multiple diamond anvil cells (DACs) using Brillouin spectroscopy. We have not observed any discontinuities of the P-wave (*Vp*) or S-wave (*Vs*) velocities over the entire *P* range. The elastic moduli of high-*P* ice show a close to linear *P* dependence. In comparison with the high-*P* silicate minerals in terrestrial planetary bodies, the *Vp* and *Vs* of ice exceed both bridgmanite and ferropericlase at *P*>80-90 GPa, counter-intuitively indicating the high-*P* ice, if exists in the deep terrestrial planets' interior, is not a slow phase. Instead, the high-*P* ice shows extremely strong elastic anisotropy, reaching 27% and 74% at 100 GPa for *Vp* and *Vs*, respectively. The presence of high-*P* ice in terrestrial planets' interior, even in small scale may lead to the observable anisotropic signatures, such as the 25% *Vs* anisotropy in the deep earthquake-generating zone in subducting slabs. We anticipate our measurements to serve as an important base for explaining and modeling the geophysical observations for various types of planetary bodies.

Keywords: high-pressure ice; elasticity; anisotropy; Brillouin spectroscopy