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Sound velocity of neon at high pressures and temperatures by Brillouin scattering

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Abstract

In this study, we have determined the combined effect of pressure and temperature on the compressional-wave velocity (V_P) of Ne up to 53 GPa and 1100 K using Brillouin scattering in externally heated diamond-anvil cells. The phase transition from the supercritical fluid to solid phase was observed to cause a 10.5–11% jump in V_P, and the magnitude in the V_P contrast across the phase transition increases with temperature. In addition, we have observed an abnormal reduced increase rate of V_P with pressure in the supercritical Ne fluid at both 800 and 1100 K before the transition to the solid phase. V_P of the solid Ne exhibits a nonlinear increase with pressure at all the investigated temperatures. The elevating temperature was noted to cause an apparent reduction in V_P, yet the reduction in V_P caused by increasing temperature dramatically decreases at higher pressures. At 20 GPa, increasing temperature by 100 K can lower the V_P of Ne by 2.4%. Yet elevating temperature by 100 K can only reduce the V_P by 0.4% at 50 GPa. We further compare V_P of Ne to that of other rare gases, including Ar, Kr, and Xe. At 300 K, V_P of Ne shows a stronger dependence on pressure than both Kr and Xe. Moreover, increasing temperature can produce a greater reduction in V_P of Ne than that of Ar below 50 GPa. Our measured V_P of Ne is also useful for understanding the velocity structure of giant planets, such as Jupiter.

Keywords: Ne, sound velocity, high pressure and temperature, Brillouin scattering, rare gases