

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