INTERPLAY OF ROTATIONAL, RELAXATIONAL, AND SHEAR DYANMICS OF SOLID ^{4}HE

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One explanation for the unusual rotational dynamics of solid ^{4}He hypothesizes a classic supersolid, with the shift in torsional oscillator frequency ω_0 upon increasing temperature and/or rim-velocity being due to the supersolid critical temperature T_c and velocity V_c. A very different explanation postulates inertially-active crystal excitations whose smoothly diverging relaxation times $\tau(T)$ generate the observed effects upon passing through the condition $\omega_0\tau = 1$. To distinguish between them, we map solid ^{4}He rotational and relaxational dynamics throughout the velocity-temperature plane and find them everywhere consistent with the $\omega_0\tau = 1$ mechanism but with contributions from both thermally and mechanically stimulated excitations. Moreover we find that τ diverges smoothly with no evidence for the sudden changes signifying the V_c or T_c of a supersolid phase transition. Finally, we show that the relative influence of T and V on the rotational inertia is identical to the relative influence of T and shear strain ε on the ^{4}He shear modulus. This implies strongly that the rotational dynamics of solid ^{4}He are due to the generation (presumably by inertial shear strain for which $\varepsilon \propto V$) of the same type of microscopic excitations that are generated by direct shear strain.