Dislocation Model for the TO-Period Anomaly

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The anomaly of the torsional-oscillator (TO) period observed originally by Kim and Chan,[1] i.e. the nonclassical rotational inertia (NCRI), has been ascribed to the supersolid transition of hcp ^{4}He inside the TO. Day and Beamish[2] has observed a similar anomaly in the shear modulus of solid helium, which can be well described by pinning of dislocations by ^{3}He impurities. In order to explain both anomalies on the same basis, I have proposed a dislocation-vibration model[3] for the NCRI. According to this model the period change is proportional to ΛL^2, where Λ is the dislocation density and L is the temperature-dependent average pinning length. By modifying the model from a delta-function distribution function for the network pinning lengths to continuous distribution functions, such as an exponential one, the observed amplitude dependence and hysteresis of the TO period can be reproduced. Moreover, an actual distribution of the network pinning lengths is determined from the experimental data.[4]

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