Compound Torsion Oscillator Driven Simultaneously at Two Frequencies

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A compound torsion oscillator (TO), having two resonant mode frequencies (492 Hz and 1163 Hz) and high Q ($0.5\sim1\text{x}10^6$), has become an important tool for studying the supersolid properties of ^{4}He loaded into the main TO bob. It would be interesting for example, to observe critical velocity effects driven by one mode and measured with the other. By simultaneously exciting both modes of this TO, we can observe how changes to the drive amplitude of one mode affect the sample response measured by the other mode. In order to determine the effects due to the sample, knowledge of "background" effects due to the unloaded TO itself is necessary. Thus a series of measurements of the unloaded TO were preformed. The resonant frequency and amplitude of both modes were measured at fixed temperatures (9.7, 23.5 and 56.5 mK) as the drive amplitude of one mode was varied while the other was held fixed, at a low drive amplitude. Unexpectedly, the resonant frequency of the fixed mode decreased as the drive amplitude of the varied mode was increased. In addition the amplitude of the fixed mode decreased as the amplitude of the varied mode was increased. This indicates that the mechanical properties of the TO are effected by increasing the drive amplitude. The change in frequency could be due to a change in the stiffness of the torsion rods at higher amplitude, while the change in amplitude could indicate an increase in internal friction. The varied mode shows similar effects as the drive amplitude is increases.