Microscopic Measurement of Flow of hcp Solid ^{4}He

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Although solid He does not exhibit supersolidity, there are nevertheless strong indications that individual crystallites can move in relation to the surrounding solid[1,2]. To try and observe such a flow of solid directly, we have constructed a sensitive "microphone" embedded in solid He contained inside a torsional oscillator. The microphone can detect vibrations down to the 10^{-11}m range, i.e. a few percent of a lattice constant. Our idea was that as the solid He flows past the microphone, the atomic corrugation would generate vibrations at a frequency $f = v/a$ where v is the flow speed and a is the lattice constant. For a speed of 10μm/sec, f falls in the 40-80 kHz range, depending on the direction of motion relative to the crystalline axes. The actual frequency was extracted from the time dependent signal using FFT. We indeed found that solid He can flow while maintaining its solid structure. From the data, we found that the flow is perpendicular to the c axis. In addition, our results reveal some microscopic aspects of the friction force between He crystals sliding past each other.

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