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Pressure-driven Flow of Solid Helium[1]

JOHN BEAMISH, University of Alberta

Recent torsional oscillator measurements by Moses Chan's Penn State group showed evidence of "non-classical rotational inertia" for solid helium at temperatures below 200 mK. This discovery followed decades of theoretical speculation and experimental searches for "supersolidity" in helium. The experiments generated a great deal of interest but the origin and properties of such a state are still unclear. It would be very interesting to know whether supersolids share any of the other unusual properties of superfluids: persistent currents, second sound and quantized vortices. We have studied the response of solid helium to pressure changes in order to look for unusual flow properties that might be associated with supersolidity. The measurements involved both helium confined in the nanometer pores of Vycor glass and bulk solid helium, at temperatures as low as 30 mK. Pressure changes were generated with piezoelectrically driven diaphragm and flow was monitored with sensitive capacitive techniques. Near melting, solid helium flows very easily but we did not see any evidence of superflow at low temperatures. If helium does become a supersolid at low temperatures then its response to pressure gradients must be very different from that of liquid helium.

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