INVITED

IN IVA-2

Observation of Superflow in Solid ^{4}He

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At temperatures below 2.176 K, liquid ^{4}He enters into a superfluid state and flows without any friction. There is strong evidence that Bose-Einstein condensates in dilute gases also exhibit superfluidity. Perhaps it is counter to intuition, but superfluid like behavior is thought possible even in solid helium. We employed a torsional oscillator technique and found evidence of superflow in bulk solid ^{4}He (1) and solid ^{4}He confined in porous Vycor glass (2). The effect appears as a drop in the resonant oscillation period as the sample cell is cooled below about 0.2 K. A series of control experiments reveals that the effect is due to irrotational superflow as in superfluid helium. The supersolid fraction in the low temperature limit is about 1.5%. It has a "universal" temperature dependence that is different from that of the superfluid transition in liquid and different from that of a weakly interacting Bose gas. The supersolid fraction is strongly attenuated with increasing oscillation speed, indicating that the critical velocity is extremely low. This observation has been replicated in other laboratories and more recently a heat capacity peak that coincides with the onset of superflow has been reported.