PHYS.ORG

A crack in the case for supersolids

June 21 2010

New experiments are casting doubt on previously reported observations of supersolid helium. In a paper appearing in the current issue of *Physical Review Letters*, John Reppy (Cornell University) presents research suggesting that prior experiments that seemed to show signs of supersolidity were in fact the result of the plastic deformation of normal helium.

Physicists have long known that helium can become a superfluid at low temperatures, allowing it to flow completely friction free, spontaneously climb walls, and exhibit other counterintuitive characteristics. Based on quantum mechanical calculations dating back to the 1970's, some physicists predicted similar effects in solid materials. In particular, they expected ultracold solid helium could become a mixture of normal solid and supersolid forms.

It wasn't until 2004 that physicists were able to devise a way to look for supersolid behavior in helium. They filled a hollow torsion pendulum (a type of pendulum that rotates rather than swinging back and forth) with helium, then measured the rate that it twisted as the helium was cooled. Because the periodic twisting rate depends in part on the amount of normal helium in the pendulum cavity, they expected that the period would change if some of the helium became supersolid. When researchers found the period change they were expecting, many physicists declared the hunt for supersolid helium had finally come to an end.

According to Reppy's experiments, which are the subject of a Viewpoint by John Beamish (University of Alberta) in the latest edition of *APS Physics*, the period change may have had nothing to do with supersolids at all. Instead, it's possible that the normal helium was deforming as the pendulum twisted. The conclusion is the result of a new pendulum design and methods to control the structure of the solid helium inside, which should allow physicists to tease out the effects of supersolid helium from the effects of deformations.

It's not yet clear that observations of supersolid helium were in error. Even if that's the case, the possibility that deformations are responsible for the period change in a helium-filled pendulum is nearly as intriguing to physicists as supersolid helium because it may result from a poorly understood phenomenon known as quantum plasticity. Only further research will determine whether supersolidity or quantum plasticity is responsible for the odd behavior of super-cold, solid helium.

More information: Nonsuperfluid Origin of the Nonclassical Rotational Inertia in a Bulk Sample of Solid 4He, John D. Reppy, Phys. Rev. Lett. 104, 255301 (2010) - Published June 21, 2010. Download PDF (free) physics.aps.org/pdf/10.1103/Ph … vLett.104.255301.pdf

Provided by American Physical Society