Shaking down frozen helium: In a 'supersolid' state, it has liquid-like characteristics

May 12 2011

In a four-decade, Holy Grail-like quest to fully understand what it means to be in a "supersolid" state, physicists have found that supersolid isn't always super solid. In other words, this exotic state of frozen helium appears to have liquid-like properties, says a new paper published in the journal *Science* on May 13, 2011.

Why is this important? Understanding supersolid helium brings us closer to understanding its close cousins superconductivity and superfluidity.

Physicists had long thought that the unusual behavior of torsion oscillators containing solid helium meant that chilling helium down to temperatures near absolute zero prompts its transformation into a supersolid. It is certainly solid, but in this physical quest, there was a nagging question: Is it a true supersolid?

To gain new perspectives on solid helium, new research tools were needed. "Think of this analogy: when Galileo first peered through a telescope, he saw ears on Saturn. With improved technology, humanity began to understand those ears were actually rings around the planet. And with better technology, we saw the differences in the rings. To further understand solid helium, science had to invent new approaches," says Séamus Davis, Cornell professor of physics. "Helium is a pure material. We're gaining a new understanding of the fundamental issues of how nature works, of how the universe works."

In fact, in this paper, the researchers show instead a more prosaic explanation: There are moving defects in the solid helium crystals, and their relaxation time falls with rising temperatures. This is more consistent with the torsional oscillation (shaking) experiments conducted at Cornell.

The researchers learned that the unusual properties of solid helium do not reflect a clunky transition between the solid state and a supersolid state. It behaves like a dimmer switch and presents a smooth transition near absolute zero.

More information: "Interplay of Rotational, Relaxational, and Shear Dynamics in Solid ^{4}He," *Science* (May 13, 2011).

Provided by Cornell University