Technique characterizes phases of superfluids changing to supersolids and back

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The researchers used evaporative cooling. This involved trapping dysprosium atoms in a cloud using lasers, which also formed an optical barrier. Importantly, the atoms in the cloud could escape if they had high enough energy. As they did so, the temperature of the cloud decreased, eventually reaching several hundred degrees Kelvin. The researchers then lowered the height of the barrier, which lowered the temperature in the cloud even more until the atoms left in the cloud formed a supersolid.

To characterize the phase changes, the researchers used both Faraday phase-contrast imaging and time-of-flight imaging. To gain a clear perspective on what was happening, the researchers had to run their experiment repeatedly while varying the rate at which the barrier was lowered. Using the two techniques, the researchers were able to measure the phase change modulation at a timescale of 150 ms. And in so doing, they were also able to see that density modulations associated with a solid phase came first in the process. Then, 40 ms later, characteristics of a superfluid became evident just prior to the cloud forming a supersolid.

The technique also allowed the researchers to characterize the phases involved as the superfluid reverted back to a superfluid. They found it started with restoration of continuous translational symmetry, which brought the system back to a superfluid and then back to a simple cloud. They noted that the superfluid phase lasted longer than the first phase, showing that the processes were not happening at the same time.
