Synopsis: Superfluid Shielding

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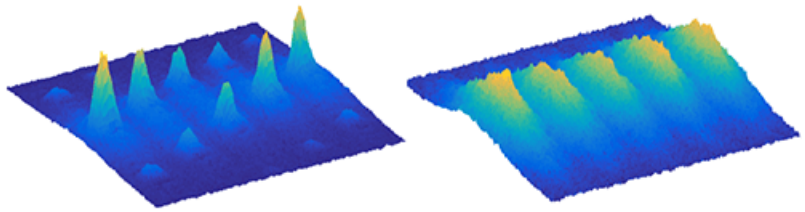
Separated Bose-Einstein condensates can be shielded from external forces if immersed in a superfluid bath.



William Cody Burton/MIT

Put an object with the same density as water in a bath, and it will become neutrally buoyant—it neither sinks nor rises. The upward force of the water on the object will counteract the gravitational force. Wolfgang Ketterle from the Massachusetts Institute of Technology, Cambridge, and colleagues have now shown that clouds of chilled atoms known as Bose-Einstein condensates (BECs) can, in some sense, be neutrally buoyant too. They found that immersing separated BECs in a superfluid bath, itself a BEC, shields them from disturbances such as external forces.

The researchers started with a BEC containing two components—each with all atoms in one of two spin states—in a common superfluid state. They then loaded this BEC into an optical lattice and applied a magnetic-field gradient to the system. This tilted the lattice and split one of the components into several BECs. In this setting, the quantum phases of the separated BECs evolve in a manner determined by the applied magnetic force, causing their interference pattern to undergo so-called Bloch oscillations. By contrast, the other component, which didn't feel the tilt, remains a connected superfluid and acts as a bath.

By monitoring the Bloch oscillations, the authors demonstrated that the superfluid bath greatly extends the relative phase coherence of the separated BECs. It turns out that the bath shields the separated BECs from external forces and from fluctuations in their self-interaction energy that would otherwise get them out of phase. This shielding occurs because the superfluid is free to change its density distribution in a way that cancels out these disturbances. The findings are particularly relevant for atom interferometry experiments, which rely on the phase coherence between quantum systems to produce precise results.

This research is published in ***Physical Review Letters***.

–Ana Lopes

Ana Lopes is a Senior Editor of ***Physics***.

Subject Areas

Atomic and Molecular Physics

Coherence Times of Bose-Einstein Condensates beyond the Shot-Noise Limit via Superfluid Shielding

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