Self-bound quantum droplets of atomic mixtures in free space

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Ultracold atomic systems are commonly found in a gas phase. However, self-bound quantum droplets have been recently theoretically predicted [1] and experimentally observed [2,5] as a new liquid-like phase.
At the origin of this new phase is the coexistence of repulsive and attractive forces that perfectly balance to generate the self-binding mechanism.
We report their experimental realization using a bosonic mixture, where spherical droplets form due to the balance of the attractive mean-field energy close to the collapse threshold and the repulsive first-order correction due to quantum fluctuations, the so-called Lee-Huang-Yang (LHY) term [1,2].
Thanks to an optical levitating potential with negligible residual confinement, we observe self-bound droplets in free space and we characterize the conditions for their formation as well as their equilibrium properties [2].
Differently from their analogue in dipolar systems [3,5] and confined mixtures [5], quantum droplets realized with bosonic mixtures in free space are predicted to show an unprecedented capability to spontaneously expel excitations and reach zero temperature.
The first observation reported in this word certainly open the way to further studies of the exotic properties of this new phase, like the measurement of the excitation spectrum and the collisions between two droplets.

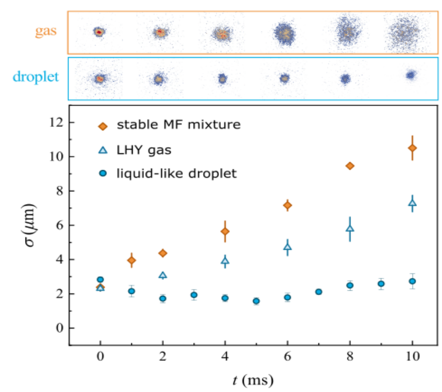

Figure 1: The time evolution of the size of the cloud in different regimes of interaction shows the evidence of a self-bound phase.

Keywords: BOSE-EINSTEIN CONDENSATES, QUANTUM FLUIDS AND SOLIDS, MIXTURE OF QUANTUM GASES

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