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A 2D Bose gas to study quantum hydrodynamic instabilities

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Hydrodynamic instabilities in classical fluids, often characterized by the exponential growth of a well-defined pattern, are encountered in many mundane situations: the development of ocean waves, the periodic array of water droplets in a spider web or the mushroom-like clouds resulting from volcano eruptions are all examples of such instabilities. Increasing our understanding of the underlying mechanism of these instabilities has a strong impact in modeling fluid dynamics in a broad scenario and in fundamental problems such as the transition from laminar to turbulent flow. In the context of quantum fluids, quantum hydrodynamic instabilities (QHI), analogous to those of classical fluids, are related to the superfluid properties of these systems offering a new approach when studying superfluidity. Thanks to their high degree of control and simple detection techniques, ultracold atomic gases are ideal platforms to engender and observe such QHI. In this work, we present the design of a new experimental setup capable to address the specific conditions for the onset of different hydrodynamic instabilities in a 2D Bose gas. Combining the flexibility of the optical potentials created with the use of a DMD with the capability of tuning the atomic interactions offered by potassium-39, we aim to initially observe the onset of the quantum Rayleigh-Taylor instability and follow its dynamical evolution.

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