

**LV 704161, SS 2022**

**Seminar mit Bachelorarbeit: Experimentalphysik**

**Themenauswahl der Forschungsgruppe**

# **Ultracold Quantum Matter Theory**

**Betreuung:**

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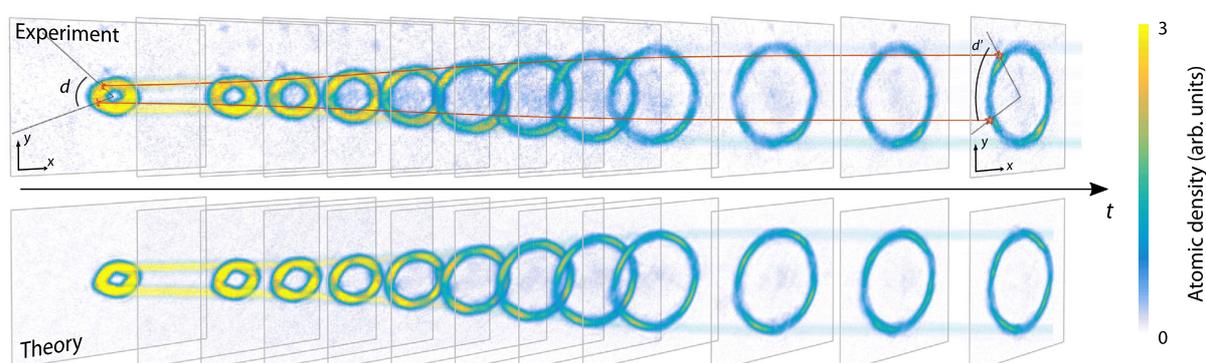
- ~~Supersonic expansion of a quantum gas~~

Bereits zugewiesene Projekte werden durchgestrichen, neue Projekte können laufend hinzugefügt werden.

## Supersonic expansion of a quantum gas

Can concepts of an expanding universe be studied in the lab by analogy? A remarkable experiment by Eckel et al. forced an ultra-cold quantum gas to expand hypersonically, after which they observed redshifts of the long-wavelength excitations, as well as the production of topological defects.

This thesis will first introduce the fundamental concepts of quantum gases and their possible excitations, such as sound waves, solitons and quantized vortices. There will be an optional theoretical component to explore the interplay of such excitations by conducting dynamic computer simulations using existing code. Then the experiment by Eckel et al. will be presented and discussed.



Supersonic expansion of a Bose-Einstein condensate ring. Experiment (top) versus theory (bottom). Figure taken from Eckel et al..

### Literature:

- *A Rapidly Expanding Bose-Einstein Condensate: An Expanding Universe in the Lab*, S. Eckel, A. Kumar, T. Jacobson, I. B. Spielman, and G. K. Campbell, [Physical Review X 8, 021021 \(2018\)](#)
- *A Primer on Quantum Fluids*, Carlo F. Barenghi and Nick G. Parker, Springer (2016) ([open access version here](#))
- *Bose-Einstein Condensation and Superfluidity*, L. Pitaevskii and S. Stringari, Oxford University Press (2016) ([available in university library](#))

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