Imbalance in one-dimensional quantum droplets

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Abstract

Recently a whole new class of ultra-dilute quantum droplets has been produced in ultracold atomic laboratories with dipolar bosonic atoms [1] and bosonic mixtures [2]. These quantum droplets originate from a compensation between mean-field and quantum fluctuations [3]. Moreover it has been shown that by loading bosonic mixtures in an optical lattice a new type of strongly correlated paired quantum droplets can be formed [4].
We study strongly correlated droplets in a one-dimensional optical lattice for an imbalance bosonic mixture. In this situation not all bosons are paired and we encounter an interplay between pairs and individual atoms that leads to intriguing phenomena. For small imbalances, the quantum droplet is able to support a finite imbalance in density, thus showing an effective magnetization. As the imbalance increases, a critical point is reached at which the droplet expels the excess of particles and the magnetization is locked in the bulk, see Fig. 1.

References

[1] D. S. Petrov, Phys. Rev. Lett., 155302 (2015) 115.
[2] C. R. Cabrera et. al, Science 359 (2018) 301.
[3] I. Ferrier-Barbut et. al, Phys. Rev. Lett., 215301 (2016) 116.
[4] I. Morera et al., Phys. Rev. Res., 022008(R) (2020) 2.

Figures

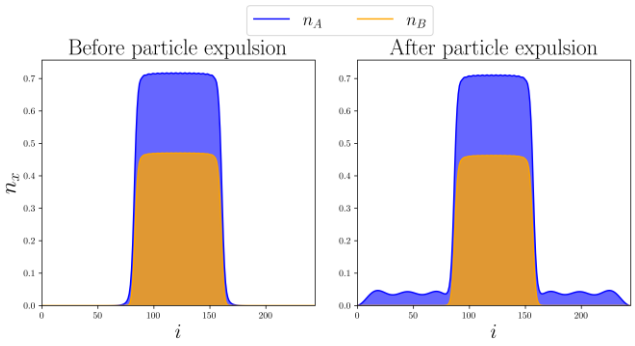

Figure 1: Particle densities as a function of the lattice site. Both plots show an imbalance between the number of particles of each specie. In the right, the imbalance is larger than the critical value and thus we observe an expulsion of particles outside the droplet.