Wigner representation of interacting BECs in the Thomas-Fermi limit

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In 2017 the MAIUS-1 sounding rocket created the first Bose-Einstein condensate (BEC) in space [1] and realized matter-wave interferometry. Interference of atomic matter waves serves a high precision sensors probing gravity on ground as well as in space.

The Wigner distribution is a central concept in classical and matter-wave optics. Based on the truncated Wigner approach fast ray-tracing algorithms are used to optimize optical devices. Bose-condensed gases dominated by interactions are modeled by the Thomas-Fermi approximation [2]. Therefore, a phase-space description modeling the ground-state properties is particularly useful.

In the present contribution, we study the Wigner phase-space distribution of the ground state of a harmonically trapped Bose-Einstein condensate. We derive the momentum distribution in the Thomas-Fermi limit in d dimensions. Further, we provide an analytical approximation of the Thomas-Fermi Wigner function in one (Fig. 1) and three dimensions. These results are compared with numerical simulations of the full Gross-Pitaevskii equation.

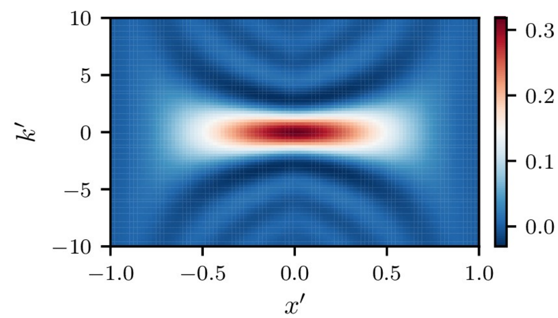

Figure 1: Thomas-Fermi Wigner function of a harmonically trapped Bose-Einstein condensate.

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Keywords: Wigner representation, Bose-Einstein condensates, phase-space distribution, matter waves

References

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