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Two-body correlations and natural-orbital tomography in ultracold bosonic systems of definite parity SVEN KROENKE, PETER SCHMELCHER, Center for Optical Quantum Technologies, University of Hamburg, Germany — Deep insights into the structure of a many-body state can often be inferred from its natural orbitals (eigenvectors of the reduced one-body density operator) and their populations. These quantities allow e.g. to distinguish a Bose-Einstein condensate from a correlated many-body state [1] and were utilized to understand many-body processes such as the decay of dark solitons due to dynamical quantum depletion [2].
We explore the relationship between natural orbitals, one-body coherences and two-body correlations for a certain important class of bosonic many-body wavefunctions with definite parity [3]. The strength of two-body correlations at the parity-symmetry center is shown (i) to characterize the number state distribution and (ii) to control the structure of non-local two-body correlations. A recipe for the experimental reconstruction of the natural-orbital densities based on two-body correlation measurements is derived. These results are applied to decaying dark solitons.
[1] O. Penrose, L. Onsager. *Phys. Rev.* **104**, 576 (1956). [2] R. V. Mishmash et al. *Phys. Rev. A* **80**, 053612 (2009); S. Krönke, P. Schmelcher. *Phys. Rev. A* **91**, 053614 (2015). [3] S. Krönke, P. Schmelcher. *Phys. Rev. A* **92**, 023631 (2015).

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