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Quantum Dynamics of Dark and Dark-Bright Solitons beyond the Mean-Field Approximation SVEN KRÖNKE, PETER SCHMELCHER, Center for Optical Quantum Technologies, University of Hamburg, Luruper Chaussee 149, D-22761 Hamburg, Germany — Dark solitons are well-known excitations in one-dimensional repulsively interacting Bose-Einstein condensates, which feature a characteristical phase-jump across a density dip and form stability in the course of their dynamics. While these objects are stable within the celebrated Gross-Pitaevskii mean-field theory, the situation changes dramatically in the full many-body description: The condensate being initially in a dark soliton state dynamically depletes and the density notch fills up with depleted atoms. We analyze this process in detail with a particular focus on two-body correlations and the fate of grey solitons (dark solitons with finite density in the notch) and thereby complement the existing results in the literature. Moreover, we extend these studies to mixtures of two repulsively interacting bosonic species with a dark-bright soliton (dark soliton in one component filled with localized atoms of the other component) as the initial state. All these many-body quantum dynamics simulations are carried out with the recently developed multi-layer multi-configuration time-dependent Hartree method for bosons (ML-MCTDHB).

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