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Strong-coupling ansatz for the one-dimensional Fermi gas in a harmonic potential JESPER LEVINSEN, AIAS Aarhus University, Monash University, PIETRO MASSIGNAN, Institute of Photonic Sciences, Barcelona, GEORG BRUUN, Aarhus University, MEERA PARISH, London Centre for Nanotechnology, Monash University — The one-dimensional (1D) Fermi gas with repulsive short-range interactions provides an important model of strong correlations and is often amenable to exact methods. However, in the presence of confinement, no exact solution is known for an arbitrary number of strongly interacting fermions. Here, we propose a novel ansatz for generating the lowest-energy wavefunctions of the repulsive 1D Fermi gas in a harmonic potential near the Tonks-Girardeau limit of infinite interactions. We specialize to the case of a single $\downarrow$ particle interacting with $N_\uparrow$ particles, where we may derive analytic forms of the approximate wavefunctions. Comparing with exact numerics, we show that the overlap between the wavefunctions from our ansatz and the exact ones in the ground-state manifold exceeds 0.9997 for $N_\uparrow \leq 8$. Moreover, the overlap for the ground-state wavefunction at strong repulsion extrapolates to ~ 0.9999 as $N_\uparrow \to \infty$. Thus, our ansatz is essentially indistinguishable from "numerically exact" results in both the few- and many-body limits.

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