Abstract Submitted
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Breakdown of the scale invariance in a near-Tonks-Girardeau gas:

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Boston — In this Letter, we consider the elementary monopole excitations of the
harmonically trapped Bose gas in the vicinity of Tonks-Girardeau limit. Using
Girardeau’s Fermi-Bose duality and subsequently, an effective fermion-fermion odd-
wave interaction, we obtain the dominant correction to the scaleinvariance- pro-
tected value of the excitation frequency. We produce a series of diffusion Monte
Carlo results that confirm our analytic perturbative value for three particles. And
less expectedly, our result stands in an excellent agreement with the result of a hy-
drodynamic simulation of the collective excitations in the limit of a large number
of atoms (with the Lieb-Liniger equation of state as an input). The sub-leading
term in the near-Tonks-Girardeau expansion of the sum rule upper bound to the
also gives the same number. Surprisingly it was found that the usually successful
hydrodynamic perturbation theory predicts a shift that is 9/4 higher than its ab
initio numerical counterpart. We conjecture that the sharp boundary of the cloud
in local density approximation-characterized by an infinite density gradient-renders
the perturbation theory for the collective excitation frequencies inapplicable.