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## Dark Soliton Qudits: A novel Quantum Information Platform in Bose-Einstein condensates

We study the possibility of using dark solitons in quasi-one-dimensional Bose-Einstein condensates to produce two-level or three-level systems (qudits) by exploiting the intrinsic nonlinear and coherent nature of the matter waves. We calculate the soliton spectrum and the conditions for a qudit to exist. We also compute the coupling between the phonons and the solitons and investigate the emission rate of the qudit in that case. Remarkably, the qubit lifetime is estimated to be of the order of a few seconds, being only limited by the dark-soliton “death” due to quantum evaporation.

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