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**Entanglement-based perturbation theory for highly anisotropic Bose-Einstein condensates** ALEXANDRE TACLA, CARLTON CAVES, University of New Mexico — We investigate the emergence of three-dimensional behavior in a reduced-dimension Bose-Einstein condensate trapped by a highly anisotropic potential. We handle the problem analytically by performing a perturbative Schmidt decomposition of the condensate wave function between the tightly confined direction(s) and the loosely confined direction(s). The perturbation theory is valid when the nonlinear scattering energy is small compared to the transverse energy scales. Our approach provides a straightforward way, first, to derive corrections to the transverse and longitudinal wave functions of the reduced-dimension approximation and, second, to calculate the amount of entanglement that arises between the transverse and longitudinal spatial directions. Numerical integration of the three-dimensional Gross-Pitaevskii equation for different cigar-shaped potentials and experimentally accessible parameters reveals good agreement with our analytical model even for relatively high nonlinearities. In particular, we show that even for such stronger nonlinearities the entanglement remains remarkably small, which allows the condensate to be well described by a product wave function that corresponds to a single Schmidt term.

Alexandre Tacla  
University of New Mexico

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