Spectroscopy of bound states with matter-wave solitons

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Abstract:

We theoretically investigate the scattering of bright solitons in a Bose-Einstein condensate on narrow attractive potential wells. Reflection[1], transmission and trapping[2] of an incident soliton are predicted to occur with remarkably abrupt transitions upon varying the potential depth. Numerical simulations of the nonlinear Schrödinger equation are complemented by a variational collective coordinate approach. We also present pilot calculations of full quantum simulations based on the multi-particle Schrödinger equation. The mechanism for nonlinear trapping is found to rely both on resonant interaction between the soliton and bound states in the potential well as well as radiation of small amplitude waves. These results suggest that solitons can be used to probe bound states that are not accessible through scattering with single atoms.

References:

1. C. Lee and J. Brand, Europhys. Lett. **73**, 321 (2006).
2. T. Ernst and J. Brand, *Resonant trapping in the transport of a matter-wave soliton through a quantum well*, arXiv:0912.3019 (2009).