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Bilinear control of Schrödinger equations with confining potentials

We will discuss the control problem for linear and nonlinear Schrödinger equations with confining potentials, where the controls are given by applying spatially homogeneous fields. For quadratic potentials it can be shown that the equation is not controllable; the manifold of reachable states is finite-dimensional. On the other hand, K. Beauchard (2005) recently proved that the (linear) Schrödinger equation with an infinite square well (particle in a box) is controllable in the vicinity of the ground state. We will discuss some open problems and conjectures deriving from these observations.