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Tunneling, diffusion, and dissociation of Feshbach molecules in optical lattices

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The quantum dynamics of an ultracold diatomic molecule tunneling and diffusing in a one-dimensional optical lattice exhibits unusual features. While it is known that the process of quantum tunneling through potential barriers can break up a bound-state molecule into a pair of dissociated atoms, interference and reassociation produce intricate patterns in the time-evolving site-dependent probability distribution for finding atoms and bound-state molecules. We find that the bound-state molecule is unusually resilient against break up at ultralow binding energy Eb (Eb much smaller than the barrier height of the lattice potential). After an initial transient, the bound-state molecule spreads with a width that grows as the square root of time. Surprisingly, the width of the probability of finding dissociated atoms does not increase with time as a power law.

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