

Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Creation of superposition states in many-body systems by scattering JAMES DOUGLAS, KEITH BURNETT, University of Sheffield — When quantum systems interact with the environment the interaction typically leads to decoherence of the system's quantum state. Here we show that one mechanism of interacting with the environment—uncontrolled scattering of probe particles by a many-body system—can instead lead to coherent superpositions of the system particles. For a system of two particles scattering leads to relative localization of the particle positions, while for more than two particles the system particles localize relative to one another in a pairwise fashion allowing superpositions in position space. We simulate scattering and the creation of these superposition states for many-body systems in free space and trapped in optical lattices. The different superpositions created are signaled in the scattering distributions and could be detected by allowing the particle wavefunctions to expand and interfere.

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Date submitted: 07 Dec 2011

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