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Using dephasing to distinguish composite and elementary particles LEONID P. PRYADKO, University of California, Riverside, CLAUDIO CASTELNOVO, University of Cambridge, MARK I. DYKMAN, Michigan State University, RODERICH MOESSNER, Max-Planck-Institut für Physik komplexer Systeme, Dresden, VADIM N. SMELYANSKIY, Google — Many-body topological excitations like domain walls in 1D can be treated quantum mechanically as particles. We establish limits on such a description in the presence of weak dephasing. Specifically, we compare dynamics of a particle in a tight-binding model with weak on-site dephasing, and that of a kink separating two locally distinguishable domains. In the latter case, dephasing rate of the off-diagonal matrix elements ρ_{ab} of the density matrix is proportional to the distance $|a - b|$ from the diagonal, compared to a constant dephasing rate of such matrix elements for a single particle. We show that in a transport setting (quantum diffusion), with small density gradients, the dynamics of these two systems is nearly identical. The difference can only be seen when far off-diagonal matrix elements are important, as in the formation of a bound state, or in a two-path interferometer. We analyze the spectroscopic signature of a bound state of a domain wall, and suggest possible experimental signatures in spin chains.

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