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Dynamics of spin systems realized in trapped ions, atoms, and molecules from numerical cluster methods IAN G. WHITE, BHUVANESH SUNDAR, ZHIYUAN WANG, KADEN R. A. HAZZARD, Rice University — Interaction quenches drive interesting dynamics such as long-lived nonequilibrium quantum states and dynamical quantum phase transitions. We utilize numerical linked cluster expansions and moving-average cluster expansions (MACE) to calculate the quench dynamics of the magnetization and correlations in two-dimensional transverse field Ising and XXZ models evolved from a product state. Such dynamics are directly probed in ongoing experiments in ultracold atoms, molecules, and ions. Both numerical methods give more accurate results at short-to-moderate times than exact diagonalization for an equivalent computational system size. In addition, MACE and exact results coincide up to an error term which is provably constrained by a modified Lieb-Robinson bound. This furnishes a rare example of a numerical algorithm with a rigorous error bound. Beyond these quenches, we study dynamical quantum phase transitions in spin systems (as indicated by nonanalytic Loschmidt echo) and give preliminary results.

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