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Mesoscopic Detailed Balance Representations of Nonlinear Physics[1] JEFFREY YEPEZ, AFRL, Hanscom Field, GEORGE VAHALA, William & Mary, LINDA VAHALA, Old Dominion University — We emphasize the similarity between entropic Lattice Boltzmann (ELB) and quantum lattice gas representations of nonlinear physics. At each space-time grid point, the excited state of a qubit encodes the probability that a mesoparticle moves along a lattice link. All the particle-particle interactions can be mapped onto a local unitary collision operator which locally entangles all the quibts at that node. This quantum entanglement is then spread throughout the lattice by unitary streaming. In the classical limit, there exists a fundamental discrete entropy function, and the collision operator is restricted that the post-collision distributions lie on a constant entropy surface and leads to a detailed balance ELB algorithm. This has been exploited in the solution of Navier-Stokes and MHD turbulence with div B = 0. On the other hand, with just 2 qubits/lattice site one can recovery the 3D Nonlinear Schrodinger equation of nonlinear optics and the Gross-Pitaevskii equation of BEC states under an appropriate unitary sequence of collide-stream. In particular, we examine solitary wave solutions of the GP equation and vortex nucleation.

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