

FRACTIONAL SCHROEDINGER EQUATIONS, DYNAMICS AND DECOHERENCE

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We want to justify certain model equations proposed in the biophysics literature for charge transport on polymers like DNA and protein, so we consider a general class of discrete nonlinear Schroedinger equations on lattices, and prove that in the continuum limit, the limiting dynamics are given by a nonlinear Schroedinger equation (NLS) with a fractional Laplacian. In particular, a range of fractional powers arise from long-range lattice interactions in this limit, whereas the usual NLS with the non-fractional Laplacian arises from short-range interactions. We also obtain equations of motion for the expected position and momentum, the fractional counterpart of the well-known Newtonian equations of motion for the standard Schroedinger equation, and use a numerical method to suggest that the nonlocal Laplacian introduces decoherence, but that effect can be mitigated by the nonlinearity. Joint work with Gigliola Staffilani, Enno Lenzmann, and Yanzhi Zhang.