Nonlinear impurity in a lattice: Dispersion effects

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We examine the bound state(s) associated with a single cubic nonlinear impurity, in a one-dimensional tight-binding lattice, where hopping to first- and second-nearest neighbors is allowed. The model is solved in a closed form vìa the use of the appropriate lattice Green function, and a phase diagram is obtained showing the number of bound states as a function of the nonlinearity strength and the ratio of second- to first-nearest-neighbor hopping parameters. Surprisingly, a finite amount of hopping to second-nearest neighbors helps the formation of a bound state at smaller (even vanishingly small) nonlinearity values. As a consequence, the self-trapping transition can also be tuned to occur at relatively small nonlinearity strength, by this increase in the lattice dispersion.