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Energy localization on q-tori, long term stability and the interpretation of FPU recurrences

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We focus on two approaches that have been proposed in recent years for the explanation of the so-called FPU paradox, i.e. the persistence of energy localization in the `low-q' Fourier modes of Fermi-Pasta-Ulam nonlinear lattices, preventing equipartition among all modes at low energies. In the first approach, a low-frequency fraction of the spectrum is initially excited leading to the formation of `natural packets' exhibiting exponential stability, while in the second, emphasis is placed on the existence of `q-breathers', i.e periodic continuations of the linear modes of the lattice, which are exponentially localized in Fourier space. Following ideas of the latter, we introduce in this paper the concept of `q-tori' representing exponentially localized solutions on low-dimensional tori and use their stability properties to reconcile these two approaches and provide a more complete explanation of the FPU paradox.

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