Cold discrete breathers

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Discrete breathers are spatially localized modes of nonlinear lattices that are relevant in a many physical systems such as crystals and coupled optical fibers [1]. Since the demonstration of their existence [2] for a broad class of weakly coupled nonlinear lattices they have also been an important field of studies for the dynamics and statistical mechanics of nonintegrable Hamiltonian systems. Their persistence in time may appear surprising from the viewpoint of statistical mechanics as localization of energy in a few high-amplitude structures seems to be opposed to what is expected in the thermalization of nonintegrable systems. For systems with a second conserved quantity (e.g. the magnetization in the Landau-Lifshitz equation [3], the wave action (or modulus-square norm) in the discrete nonlinear Schrödinger equation [4-8]), the statistical analysis has shown that the thermal equilibrium state consists of two phases, one of low-amplitude phonons and one of high-amplitude discrete breathers in a certain energy range [3-8]. This statistical explanation of discrete breathers is not directly applicable to Hamiltonian systems without a second conserved quantity. One statistical approach [9] to explain the formation of breathers in such systems (in particular the discrete nonlinear Klein-Gordon equation) is based on an envelope equation (again of Schrödinger type) that possesses a second "almost conserved" quantity. From this, the formation of breathers can be explained in the same way as for systems with a conserved quantity. At variance to this approach, I will suggest a new statistical explanation of breathers in such systems without invoking a second conserved quantity.

References

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