Localized oscillations in nonlinear hamiltonian Klein-Gordon lattices. Breathers and Anderson modes

J. Cuevas, F. Palmero, J.F.R. Archilla, F.R. Romero. Nonlinear Physics Group. University of Sevilla
M.C. Muriel. Bifurcation Theory and Dynamical Systems Group.University of Cádiz

Introduction

- There are two different sources of localization in discrete lattices:
  - Anderson modes in disordered harmonic lattices [1]
  - Discrete breathers in homogeneous nonlinear lattices [2]

Objective

- Study of the conditions for which localized modes exists in disordered anharmonic lattices
- We undertake the problem estudying the possibility of connection of discrete breather with Anderson modes.

Model

$$H = \sum_{n=-N}^{N} \frac{1}{2} m_n \dot{u}_n^2 + V(u_n) + \frac{1}{2} C(u_n - u_{n+1})^2$$

$$V(u_n) = \frac{1}{2} \omega_n^2 u_n - s u_n$$

s=0: Linear disordered limit (Anderson modes)

s=1: Nonlinear ordered limit (discrete breathers)

$\omega_n = 1 + \rho(s) \frac{r_n}{2}$ (r_n :random vector)

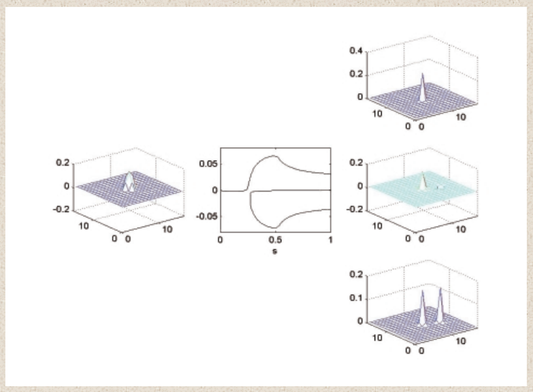
$\rho(s) = 1 - s^q, \quad q > 0$ (path function)

Connection of discrete breathers and Anderson modes

A solution in one of the limits is calculated and continued to the other limit keeping the action (phase space area) constant.

- The number of discrete breathers is huge compared to the number of Anderson modes.
- This fact suggest that the bifurcations in the path from breathers to Anderson modes should be turning points and pitchforks.
- It also appears period doubling bifurcations
- The Anderson modes of highest and lowest frequency are connected
- It has also been found the existence of isolas in the last case
- The random vector takes its values in a discrete random distribution

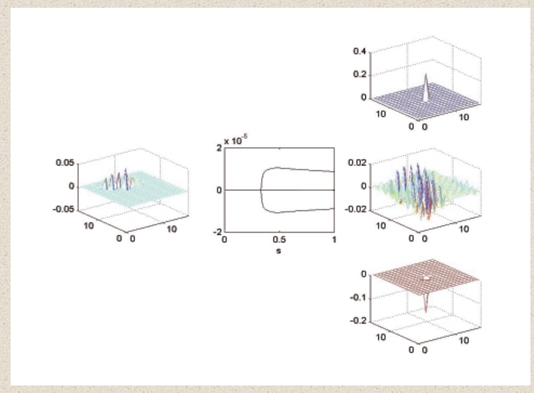
Broken pitchfork in the q=1/4 path (2d)



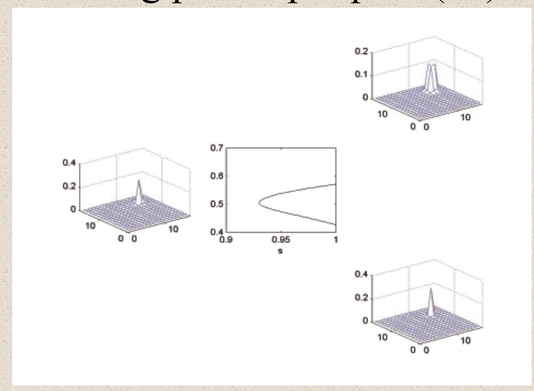
References

1. PW Anderson. Phys Rev 109 (1958) 1942
2. S Flach and CR Willis. Phys Rep 295 (1998) 181
3. FR Archilla, RS MacKay and JL Marín. Phys D 134 (1999) 406
4. J Cuevas, JFR Archilla, F Palmero and FR Romero. Jour Phys A 34 (2001) L1

Pitchfork+Period doubling. q=1 path (2d)



Turning point. q=1 path (2d)



Isola. q=1/4 path (1d)