Interaction of moving localized oscillations with a local inhomogeneity in nonlinear hamiltonian Klein-Gordon lattices

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Introduction

- Interaction of nonlinear localized excitations with local inhomogeneity can play an important role in the transport properties of a system
    - Interaction of a kink by an impurity in a continous Frenkel-Kontorova model [1]
    - Interaction of a discrete breather with an impurity in a discrete Klein-Gordon system with low nonlinearity [2]

Objective

- Interaction of a discrete moving breather with a local inhomogeneity in a discrete Klein-Gordon chain with arbitrary nonlinearity

Model

$$H = \sum_{n=-N}^{N} \frac{1}{2} m_n \dot{u}_n^2 + V(u_n) + \frac{1}{4} C_n [(u_n - u_{n+1})^2 + (u_n - u_{n-1})^2]$$

$$V(u_n) = D_n (e^{-u_n} - 1)^2$$

$$D_n = \frac{1}{2}(1 + \alpha \delta_{n,0})$$

$$m_n = (1 + \Delta m \delta_{n,0})$$

$$C_n = \frac{1}{2}(1 + \beta \delta_{n,0})$$

Simple model to study DNA dynamics, where u_n represents the transverse stretching of the hydrogen bonds connecting the two bases, D is the disociation energy of a base pair, and C is the stacking coupling constant
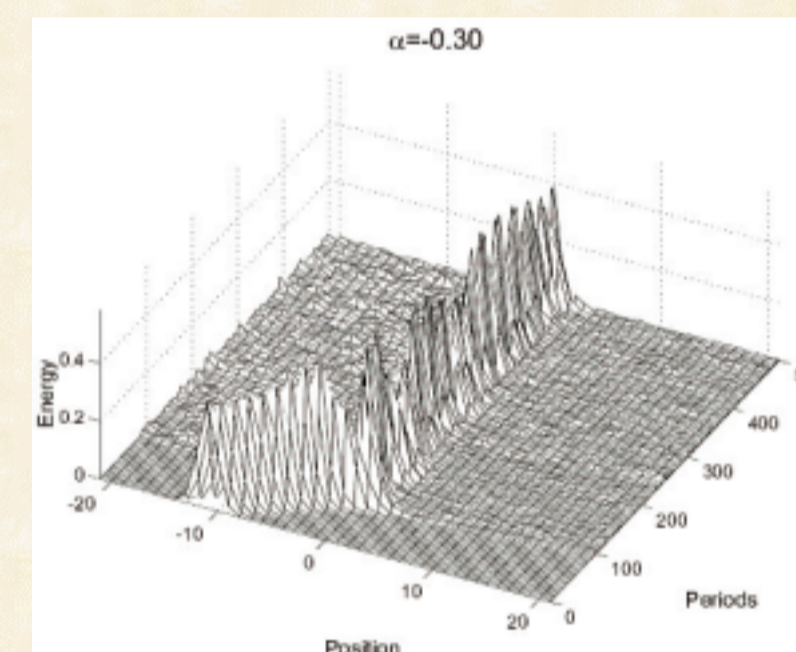
Inhomogenety in the mass

- $\beta = \alpha = 0$
- Equivalent to introduce the inhomogeneity in the well of the on-site potential

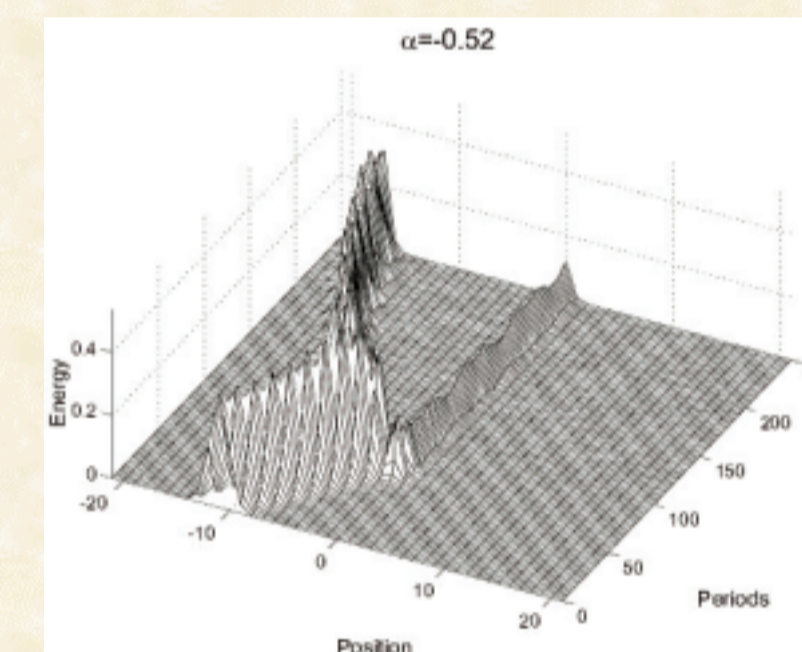## Inhomogeneity in the on-site potential
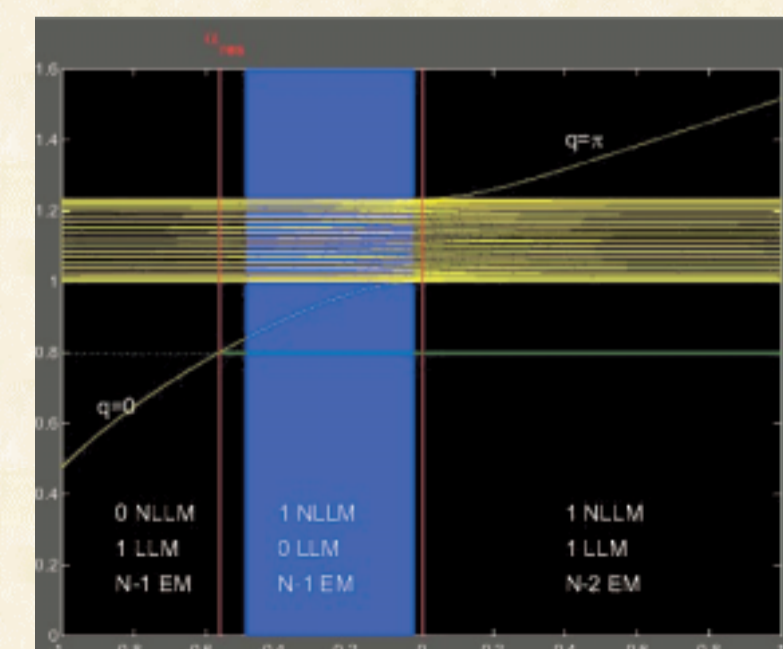
- $\beta = \Delta m = 0$
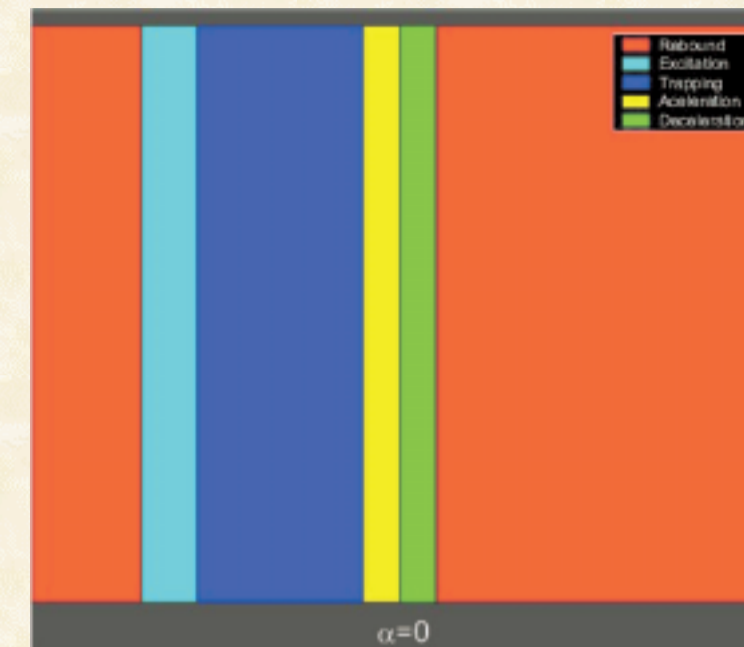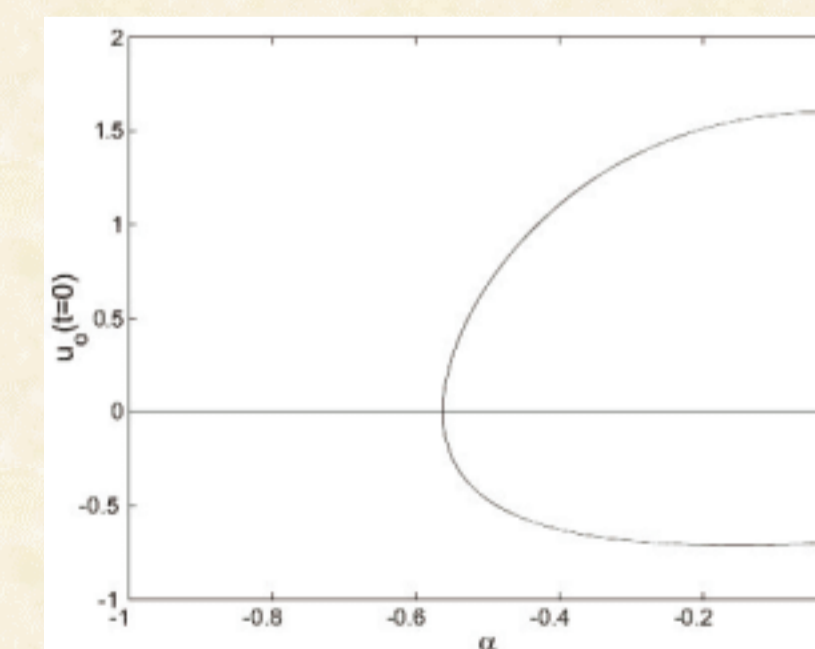

Trapping regime

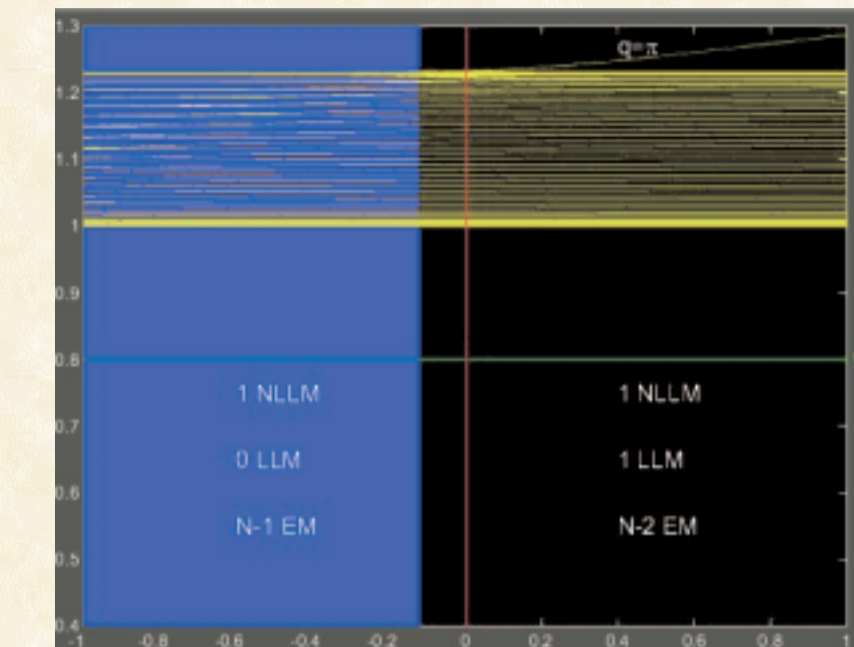Reflection with excitation

Linear modes

Bifurcation diagram

Inhomogeneity in the coupling

- $\alpha = \Delta m = 0$

Conclusions

- The breather traps for a wide range of parameters. It can be due to the resonance with a nonlinear local mode originated by the impurity Also, we observe that, in order to find the trapping phenomenon, the tails of the lineal local mode and the tails of the nonlinear local mode must have the same vibration pattern.
- The occurrence of trapping is essentially independent on the velocity of the moving breather.
- The breather can cross the impurity as long as the system is not very inhomogeneous

References

1. Interaction kink-impurity in continuous systems. Z Fei, YuS Kivshar, L Vázquez: PRA 45 (1992) 6019; PRA 46 (1992) 5214; OM Braun, YuS Kivshar: Phys. Rep. 306 (1998) 1.
2. Interaction moving breather-impurity K Forinash, M Peyrard, BA Malomed: PRE 49 (1994) 3400.
3. Moving discrete breathers in a Klein-Gordon chain with an impurity. J. Cuevas, F. Palmero, JFR Archilla and F Romero. Preprint