PhD thesis position within the framework of the Laboratory of excellence (Labex) Action (WP2: Wave propagation in structured materials)

Collective dynamics and soliton-based waveguides in periodic nonlinear lattices for vibration energy harvesting applications

Date advertised	27/05/2013		
Position type	PhD thesis		
Location(s)	FEMTO-ST Institute (Besançon - France)		
Supervisor(s) /Referent(s)	Manuel Collet (CNRS), Najib Kacem (UFC), Noureddine Bouhaddi (UFC)		
Start date	01/10/2013	**Duration**	3 years
Salary	About 1700 euros/month (gross salary)		

Job description

1. Context

The phenomenon of localization has attracted much recent attention in many applications in physics because of its important role in the qualification as well as quantification of system's operations. The localization can be generated either by the "disorder" in a lattice (Anderson localization) or by the interaction between the non-linearities and a discrete system. One of the most popular localization phenomena, that have attracted the interest of physicists, is the nonlinear energy localization. Such localized energy excitations, called intrinsic localized modes ILMs, also known as "discrete breathers" or "lattice solitons" can occur in defect-free periodic nonlinear structures, extending over only a few sites.

The remarkable property of solitons is their exceptional stability against disturbances. They are also able to occur spontaneously in a non-autonomous physical system even if the initial excitation does not exactly correspond to an ILM. Actually, if a system has characteristics that allow the existence of solitons, then an intense excitation will potentially lead to their creation. Therefore, solitons play a fundamental role in the properties of energy transport for a variety of fields such as optics, acoustics, and hydraulics.

2. Objective

The principal goal of this thesis consists in the functionalization of the localization phenomenon by modeling the collective dynamics of a vibrating energy harvester based on a periodic lattice of coupled nonlinear resonators. Particularly, we consider the case of mono-directional lattices of MEMS cantilevers having a geometric Von Kármán nonlinearity coupled linearly via the overhang and non-linearly by the Van Der Pol nonlinear damping. Then, the model will be extended to the case of bi-directional lattices and specifically for periodic arrays of CMUT (capacitive micromachined ultrasonic transducers). The devices will be fabricated in the clean rooms of MIMENTO.

3. Positioning and integration within FEMTO-ST

The use of solitons exists in several researches in optics and acoustics. It is very innovative and upstream in mechanics for vibration energy harvesting (VEH) using the collective dynamics of nonlinear periodic lattices. The implementation is therefore very challenging as it involves several scientific issues and requires prior advanced modeling. Collaboration with other departments of Femto-ST is envisageable. At the national and international levels, solitons are used in physics and acoustic insulation but to our knowledge few or no research teams are using it for VEH.

Candidates profile
The candidates should have a master degree in applied mechanics, physics or applied mathematics. They have to prove their relevant knowledge in the following disciplines: vibrations, nonlinear dynamics and advanced numerical methods. The candidate must perform extensive computer simulations and data analysis. A disposition for numerical work and programming is required. Proficiency in English is important.
Application
The application consists of ONE pdf-file comprising: - Curriculum Vitae with list of publications - Short summary of the master's thesis - Suggestion of two referees with contact details - Provide detailed explanation justifying your choice for this PhD project
Contacts
Najib KACEM Telephone: (+33)381666702 E-mail: najib.kacem@univ-fcomte.fr Noureddine BOUHADDI Telephone: (+33)381666056 E-mail: noureddine.bouhaddi@univ-fcomte.fr