18 months post-doctoral position
at IMSIA, ENSTA ParisTech

Non linear dynamics and stability of chains of permanent magnets

One of the equilibrium configurations of a set of spherical or cylindrical magnets (magnetized along their diameter) is the straight chain, as illustrated in Fig. 1a. The stability of this equilibrium configuration depends on various parameters such as the external magnetic field, the gravity and the geometry of the elements of the chain. Fig. 1b thus illustrates the loss of equilibrium by buckling of a chain of cylinders when the stiffness induced by the magnetic interactions no longer succeeds in compensating for the gravity. If the magnets under consideration are now rectangular thin plates magnetized according to their thickness, a stable straight structure can be formed by holding the magnets with hinges. This structure can lose its stability by floating when it is immersed in an axial flow, as illustrated in Fig. 1c.

a b c

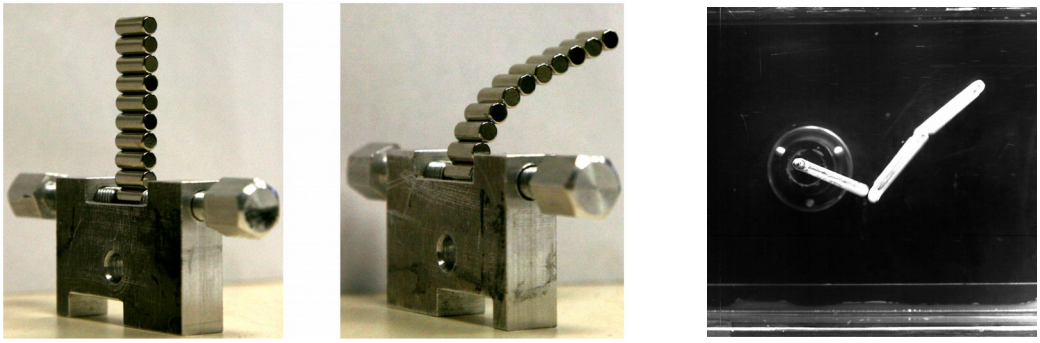

Figure 1 : (a,b) Buckling instability of a chain of cylindrical magnets. (c) Flutter instability of a chain of plane magnets in a water flow.

One of the research themes at IMSIA concerns the analysis of the dynamics and stability of these different types of chains made up of magnetized elements. A first application targeted by this work concerns the vibratory control. Indeed, by playing on the shape and properties of magnetization, the dynamic properties of these structures can be controlled. A second application concerns the harvesting of energy from the flows: by placing an induction loop in the oscillating magnetic field created by the fluttering structure of Fig. 1c, it is possible to convert the kinetic energy of the structure into electrical energy in a circuit.

The dynamics and stability of these systems have been studied in the linear framework during a recent PhD thesis in the laboratory [1, 2]. We now want to address the nonlinear modeling. First, we wish to focus our attention on the nonlinear dynamics of cylindrical magnet chains and their use as dampers.

Profile
The candidate should hold a PhD in structural mechanics, dynamics or fluid-structure interaction, possess a good knowledge of analytical tools and be interested by experimental works.

Application
Interested candidates are invited to contact:
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References
[1] Boisson, J., Rouby, C., Lee, J., & Doaré, O. (2015). Dynamics of a chain of permanent magnets. *EPL (Europhysics Letters)*, *109*(3), 34002.
[2] Lee, J. (2016) *Dynamique et stabilité d'une chaîne d'aimants. Application à la récupération d'énergie*, thèse de l'Université Paris-Saclay.