EUROMECH Colloquium 562
"Stability and control of nonlinear vibrating systems"
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Scope of Colloquium 562

Studies of the dynamics of nonlinear systems show that, when the nonlinearities are explicitly considered in the calculations, they allow a correct understanding of the behaviour that can be exploited to improve the performance. Both controlled and uncontrolled systems were considered and the stability issues were addressed. Modelling of the mechanical system was recognised as a key ingredient, and problems were formulated at either the macro or micro scale.

A plethora of nonlinear phenomena observed in macrostructures are waiting to be observed and exploited for mass sensing at the microscale. Pull-in, sudden collapse of electrostatic MEMS, or any other unsafe bifurcation, sub-critical pitchfork or cyclic fold bifurcation, can be used as mass detection mechanisms in binary chemical and biological sensors. At the macroscale, the large amplitude dynamics of rotating pendula, delayed van der Pol oscillators, and bistable oscillators might be exploited in energy harvesting applications. Moreover, the nonlinear dynamics and the modal stability of cables, beams, moving strings, discrete systems with a large number of degrees of freedom and towers, under both conservative and nonconservative actions, are being studied intensively with a view to discovering and understanding their rich bifurcation scenarios. To this end, also the study of classical paradoxical systems is alo being addressed.

Specific topics

Examples of specific topics discussed at Colloquium 562 are listed below.

Modelling issues in stability and bifurcation of dynamical systems The modelling of complex mechanical structures and the external actions are key to the analysis of the stability and post-critical behaviour of dynamical systems. Reduced models were shown to be valuable since, in a variety of applications they are able to capture the essential dynamical phenomena.

Unexpected phenomena in nonlinear dynamical systems Unexpected phenomena can sometimes manifest themselves in nonlinear systems. Examples discussed at the Colloquium were: tensile instability in beam-like structures; interactions between nonlinear normal modes and linear frequencies; static and dynamic stability of a thin rod under axial compression. Some celebrated paradoxes, related to follower actions in one-dimensional systems, were also addressed.

Vibration control in operational conditions In controlled systems, the task of vibration mitigation can be pursued using passive, active or semi-active strategies. Including nonlinearities in the design of the controllers is often a difficult process, which is however fundamental to ensure a correct performance. Relevant research efforts are dedicated to the development of simplified modelling techniques.

Motion tracking control The development of tension control strategies that allow a tethered satellite to be steered from one position to another in minimal time and allowing for tether oscillations was discussed.

Limit cycle control: When the control objective is stabilisation of a system by suppressing or reducing its limit cycle oscillations, the coupling of the main system with a nonlinear energy sink can be considered as an effective passive control strategy. The particular case in which the main system is an oscillator with hardening elasto-plastic behaviour was discussed.

Generalised continua Generalized continua were discussed in a dedicated session. They provide as a powerful tool for the description of newly conceived materials and complex structures, such as the biological systems. Metamaterials are among the most promising and rapidly developing research areas, and the link between theoretical aspects and new possibilities in computer-aided manufacturing is of great interest.