Snakes, elastic guns and configurational forces

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When an elastic structure can change its configuration through a release of elastic energy, configurational forces are generated. This concept has been developed in a series of recent works involving: a clamped elastic rod [1], a problem of instability [2], the development of the so-called 'elastica arm scale' [3], the 'injection' of an elastic rod [4], the development of an elastica in the shape of a drop [5], and an example of torsional locomotion [6]. In the presentation serpentine motion within a smooth channel is theoretically investigated and fully validated by systematic experiments. The experiments are performed on an elastic rod, straight in its unloaded configuration, constrained within a rigid and frictionless curved channel. A proof-of-concept model for a channel is designed and realized, with the shape of an Euler spiral, in which friction is reduced to a negligible amount by using roller bearings.

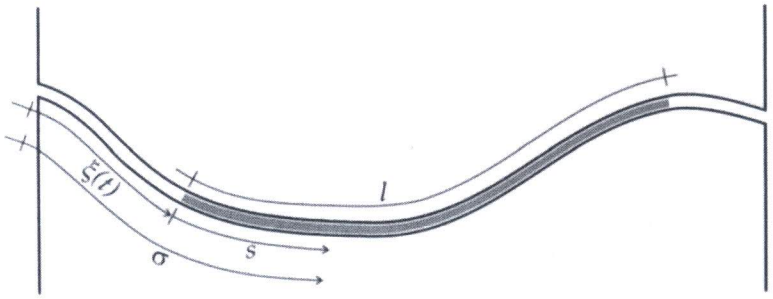

Figure 1: motion of an inextensible rod within a smooth and rigid channel.

A different release of elastic energy, related to a snap-through instability, is finally analyzed with the model of a so-called 'elastic catapult', in which an elastic clamped rod is assumed to move through a rotation of the clamp. This model finds applications in the design of soft robot arms.

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