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Investigating the compaction of open ring stacks through real and numerical experiments

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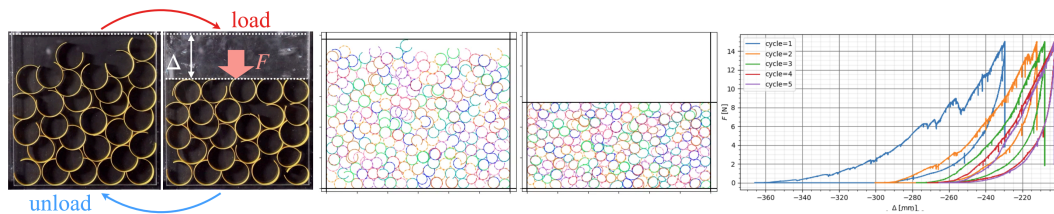


Fig. 1: Left: Our experimental set-up with 30 open rings. Center: Simulation of our set-up scaled up to 300 open rings. Right: Stress-strain plot from our simulation, for 5 consecutive compression cycles.

We investigate the mechanical response of a stack of bidimensional flexible open rings subject to compression cycles, by the means of experiments and simulations. To perform reliable and scalable simulations, we build a numerical model based on an unclamped version of the 2D super-helix [1] for open thin elastic rods, coupled to frictional contact constraints [2]. We carefully validate this numerical model, first against theoretical predictions given by the analysis of a single ring snap fit [3], second by comparing numerical and experimental results for an assembly of rings of moderate size (30 rings). Our excellent prediction results allow us to rely on the simulator for investigating the mechanical behaviour of a large collection of (300) randomly stacked rings, depending on their opening angle and their friction coefficient. In particular, we find that such a system, which acts as a disordered mechanical metamaterial, can absorb and store mechanical energy upon compression in a controlled fashion, exploiting large displacement and rearrangement of rings, snap-fits, and friction.

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