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## **[4] The physics of knots: from shoelaces to surgical sutures**

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Even though most of us tie our shoelaces ‘wrongly,’ knots in ropes and filaments have been used as functional, structural mechanisms for millennia in sailing, climbing, and surgery. Still, knowledge on physical knots is mostly empirical, and there is a need for physics-based predictive models. For tight knots, highly nonlinear and coupled behavior arises from the intricate 3D geometry, large deformations, (self)contact, and friction. Furthermore, tight knots do not exhibit separation of the relevant length scales, precluding the usage of centerline-based rod models. Our precision experiments using X-ray computed tomography and mechanical testing have yielded unprecedented data, which we contrast to Finite Element simulations and analysis of ideal (geometric) strings. Building on this understanding, we have been collaborating with a surgeon to characterize, analyze, and rationalize the physics of surgical knots. These findings could have potential applications in the training of surgeons and control of robotic-assisted surgical devices.

**Primary author:** Prof. REIS, Pedro M. (Flexible Structures Laboratory, Institute of Mechanical Engineering, EPFL)

**Presenter:** Prof. REIS, Pedro M. (Flexible Structures Laboratory, Institute of Mechanical Engineering, EPFL)

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