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MODELING AND DISCRETIZATION APPROACHES FOR SLENDER CONTINUA AND THEIR INTERACTION

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ABSTRACT

Highly slender fiber- or rod-like components represent essential constituents of mechanical systems in countless fields of application. Examples are high-tensile industrial ropes and webbings, fiber-reinforced composite materials or synthetic polymer materials. On entirely different time and length scales, such slender components are relevant when analyzing the supercoiling process of DNA strands, the characteristics of carbon nanotubes or the Brownian dynamics within the cytoskeleton of biological cells. Often, these slender mechanical members can be modeled as 1D Cosserat continua based on a geometrically nonlinear beam theory. For all mentioned examples, mechanical contact interaction crucially influences the overall system behavior. Systems of this type are typically characterized by a large number of such components within representative volume elements, arbitrary orientations and orientation changes as well as high slenderness ratios of these components. Consequently, such systems provide considerable challenges for numerical solution schemes and state highest requirements with respect to computational efficiency and robustness.

The proposed mini-symposium invites contributions focusing on modeling and discretization approaches for slender continua and their interactions, both from method development and application point of view. Topics of interest include, but are not limited to:

- Different categories of geometrically nonlinear theories for slender continua (classical Simo-Reissner and Kirchhoff-Love beam theories, beam theories accounting for cross-section deformation or composite cross-sections, reduced beam or rope models etc.)
- Finite element formulations for geometrically nonlinear beam problems (geometrically exact, corotational, ANC or solid beam element formulations etc.)
- Alternative discretization schemes for 1D continua besides the FEM (FDM, IGA etc.)
- Parametrization, spatial interpolation and time integration schemes for large rotations
- Modeling and discretization approaches for beam-to-beam contact interaction (point-based, line-based and combined contact models)
- Modeling and discretization approaches for inter-molecular beam-to-beam interactions (e.g. due to covalent bonds, electrostatic /-dynamic interactions etc.)
- Meso- / Multiscale modeling of fibrous materials and other mechanical systems involving fibers / slender continua