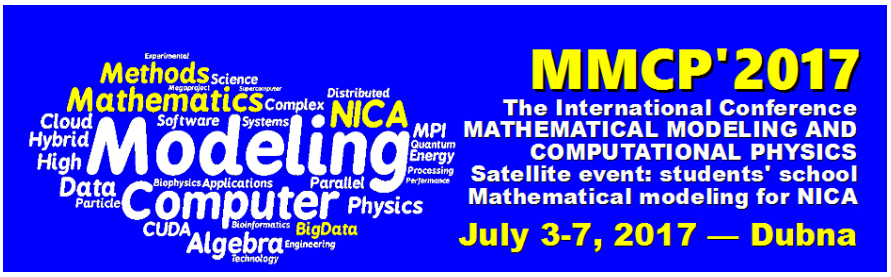

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Partial analytic integration of Cosserat PDE system describing dynamics of slender structures

Thursday, 6 July 2017 10:30 (30 minutes)

We apply modern computer algebra methods and software for the Lie symmetry analysis to the governing Cosserat system of twelve nonlinear partial differential equations (PDEs) describing dynamics of nearly one-dimensional flexible structures (rods, fibers, cables, etc.) and construct the general analytical solution to the kinematic part (six equations) of the system. The obtained solution depends on two arbitrary analytical vector functions, and we show that its knowledge helps to resolve stiffness of the governing Cosserat system. Based on this result we develope algorithms based on combinations of numerical (exponential integration) and analytical (solver of differential equations built-in Maple) treatments of the dynamical part of the governing PDE system. Our approach allows for larger step sizes compared to pure numerical solvers and at the same time combines efficiency and accuracy without sanctifying one for another. Based on this observation, we create a hybrid semi-analytical solver for highly viscous two-way coupled fluid-rod problems which allows for the interactive high-fidelity simulations of flagellated microswimmers, as a result of a substantial reduction of the numerical stiffness. Besides, we present in the talk experimental comparison of our method with the so-called $\alpha-$method, the best one among pure numerical methods developed for integrating Cosserat equations, and demonstrate superiority of our method.

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