Immersed Boundary Methods For Complex Fluid-structure Interaction in Sperm and Ciliary Motility

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Abstract

The motility of sperm flagella and cilia are based on a common axonemal structure. We describe a fluid-mechanical model for the ciliary and sperm axoneme. This fluid-mechanical model couples the internal force generation of dynein molecular motors through the passive elastic axonemal structure with the external fluid mechanics. As shown in numerical simulations, the model's flagellar waveform depends strongly on viscosity as well as dynein strength. We show an extension of our original model for Newtonian fluids to complex viscoelastic fluids in order to model mucus transport by cilia in the respiratory tract as well as sperm motility in reproduction. These immersed boundary models for sperm and ciliary motility in complex fluids explore continuum approaches such as Oldroyd-B as well as Lagrangian moving mesh methods.