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Oscillations of Eukaryotic Cilia and Flagella ARVIND GOPINATH, LAKSHMINARAYANAN MAHADEVAN, Harvard University — The undulating beat of eukaryotic flagella and cilia produces forces that move cells and cause locomotion. The timing mechanisms that generate these periodic undulations are still mysterious and the question of how these oscillations arise is still a subject of much research - both experimental and theoretical. Recent experimental results on paralyzed and reconstituted flagella offer new insight into the dynamical mechanisms that could result in sustained waveform generation. Motivated by these recent experimental results we propose a model that mimics the flagellar structure as motor driven elastic, inextensible filaments. We hypothesize that the oscillations arise due to motor (dynein) driven, constrained, relative sliding of parts of the flagella. The dynamical equations describing the evolution of the populations of attached and detached motors is actively coupled to the local configuration as well as local sliding velocities via strain and configuration dependent kinetic reaction rates. At the same time, the filament configuration is actively coupled to the motor densities via the dependence of the active internal torque densities on the motor populations as well as their internal state. Appropriate ensemble averaged force-velocity relationships for the motors completes the set of equations. Numerical solutions reveal onset of dynamical instabilities via Hopf-bifurcations with oscillatory waveforms emerging from a trivial base state corresponding to a straight, non-moving flagellum.

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