M2 Internship: Modeling spindle oscillations across nematode evolution

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Abstract: The mitotic spindle is a microtubule-based structure that elongates to accurately segregate chromosomes during cell division. In the one-cell embryo of a model organism, the nematod C. elegans, the spindle orients along the cell polarity axis during mitosis. As the spindle elongates, it becomes asymmetrically positioned, giving rise to two daughter cells of unequal size and fate. Many other nematode species also undergo an asymmetric first division, due to the asymmetric positioning of mitotic spindle. However, it was recently discovered in a research group from LBMC/ENSL that this conserved output phenotype (the asymmetric positioning) is achieved by a very different combination of spindle movements between species [1]. This suggest that cryptic changes in the mechanical forces and/or material properties of the spindle have occured across nematode evolution.

The aim of the present internship is to set up a single mechanical model being able to explain the variability of experimental observations obtained from about 120 strains of nematodes (corresponding to 42 different species). In other words, we will try to identify a single model being able to reproduce the dynamics of spindle elongation in every species, just by tuning its parameters. The internship will start by a deep analysis of existing data in order to identify parameter correlations among species. The typical data consist of the time-dependent positions of the two centrosomes (i.e. the two ends of the spindle), as well as the precise shape of the cell. During spindle elongation, most of the species show transverse oscillations and longitudinal drift motion of the centrosomes, with variable amplitudes and synchronizations across species. The basis of the mechanical model will be the model proposed by Grill and co workers [2] being able to describe the 1D transverse oscillations of a single centrosome. In order to describe the motion of the two centrosomes, we will therefore incorporate as a first improvement of the model some coupling between the two oscillators.


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