ACMS Applied Math Seminar

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Thursday, September 13, 2018
154 Hurley Hall
3:00 – 4:00 PM

Mathematical Modeling of Positioning and Size Scaling of Nuclei In Multi-nucleated Muscle Cells

The nucleus is the organizing center of a cell. We use multi-scale modeling to understand how dozens of nuclei in multi-nucleated muscle cells position themselves and adapt their size.

Positioning mechanisms involve cytoskeletal fibers, called microtubules, that interact with molecular motors to create forces. We perform large scale computational force screens with hundreds of coarse models to predict nuclear positions. Then we compare these to imaging data from Drosophila (fruit fly) muscle cells. To identify the most adequate model, we combine statistical with analytical methods, such as bifurcation analysis. Next we use a detailed agent-based mechanical implementation of the "winning model" for further validation.

Finally, we predict nuclear sizes by suggesting a space-sensing model based on reaction-diffusion equations. It correctly predicts scaling relationships between nuclei, the amount of space around them and the overall cell size.

Joint work with Stefanie Windner, Mary Baylies and Alex Mogilner