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Non-equilibrium thermodynamic effects during cell division

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A mitotic spindle is a regular structure within a cell consisting of oriented microtubule fibers. It plays a fundamental role in chromosome separation during cell division. Forming a spindle pattern is a major structural step towards mitosis. We have developed biophysical non-equilibrium thermodynamic models to describe in vitro chromosome driven spindle formation experiments in *Xenopus* extracts. Our first 2D model calculations [1] successfully described the order of events seen in some of the *Xenopus* extracts experiments, where the chromosomes are replaced by chromatin-covered micrometer magnetic beads. I will describe more realistic 3D improvements in our modeling analysis, which include microtubule contact forces and excluded volume [2, 3]. There are, however, a number of challenges that must be addressed for spindle modeling to continue to be a useful tool for understanding this fundamental biological process, in particular the biophysical simulation times. In this talk I will describe some important problems needing better biological data and hypothesis. I will also discuss our most recent numerical algorithmic improvements that are expected to greatly increase the simulations speed and thus allowing a more realistic representation of the experimental situation in *Xenopus* extracts. [1] S. C. Schaffner and J. V. Jose, PNAS, 103, 11166 (2006), [2] *ibid* in “Methods in Cell Biology” (Elsevier- Academic Press)(2008)and [3]*ibid*(to be published).