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Tension-dependent dynamic microtubule model for metaphase and anaphase phenomena EDWARD BANIGAN, University of Pennsylvania, Dept. Physics and Astronomy, MICHAEL LAMPSON, University of Pennsylvania, Dept. Biology, ANDREA LIU, University of Pennsylvania, Dept. Physics and Astronomy — During cell division, chromosome pairs align at the center of a bipolar microtubule (MT) spindle and oscillate as MTs attaching them to the cell poles polymerize and depolymerize. Pairs later separate as shrinking MTs pull each chromosome toward its respective cell pole. We present a minimal model for these processes. We use the measured tension-dependence of single MT kinetics [1] and extrapolate for compressed MTs. We apply these to a stochastic many MT model, which we solve numerically and with master equations. We find that tension dependence enhances the speed of chromosome pulling by retracting MTs. The force-velocity curve for the single chromosome system is bistable and hysteretic. Above some threshold load, tension fluctuations induce MTs to spontaneously switch from a pulling state into a growing, pushing state. To recover pulling from the pushing state, the load must be reduced far below the threshold. This leads to oscillations in the two-chromosome system. Unlike other models, our model also captures breathing oscillations. We also explore how various components control chromosome dynamics through MT rate constants alone. [1] Akiyoshi et al. (2010) Nature 468, 576.

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