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A mathematical model for pattern formation of microtubules in the presence of motor proteins

Microtubules, rigid protein polymers found in cells, can be organized into various patterns under the influence of motor proteins. Such patterns are crucial for normal cellular function and development. In this talk, I introduce an integro-differential equation model that describes how microtubules reorganize in space and time, in the presence of motor proteins, to form various patterns in two-dimensional space.

I first discuss the development of the model that is based on three key assumptions. In particular, our model describes how microtubules evolve in space and time under the assumptions that 1) microtubules can treadmill (they can shrink from one end at the same rate that they grow from the opposite end), 2) they can grow and shrink from their positive end, and 3) they can reorient themselves by interacting with motor proteins.

After describing the development of the model, I will present preliminary numerical and analytical results that describe how microtubule distributions evolve in time in two space dimensions. By exploring different regions of the model's parameter space we observe different patterns for the microtubules. In particular, microtubules interacting with high densities of motors tend to form bundled organizations (parallel arrays), while microtubules interacting with low densities of motors tend to form astral organizations (radial arrays).