Phase Behavior of Interacting Treadmilling Microtubule Rods on Cell Cortex

(Talk #9)

Xin-chen Jiang[1], Xia-qing Shi[1], Yu-qiang Ma[1, 2]

[1]Center for Soft Condensed Matter Physics and Interdisciplinary Research, Soochow University, PR China

[2]National Laboratory of Solid State Microstructure and Department of Physics, Nanjing University, PR China

***Email of Presenting Author: jxcjxc10@sina.com**

In plant cells, because of lacking microtubule organizing center like centrosome in animal cells, the self-organization of cortical microtubules (CMTs) during different phases of cell cycle is a long-standing mystery in cell biology [1, 2]. Recently, with the emergence of new experimental results [3, 4], several interesting models reveal the mechanism of the formation of cortical microtubule nematic array [5, 6]. Here, we consider a model of CMT rods on a 2D-substrate with exclude-volume effect. We explicitly take into account of microtubule width in our simulation, which was neglected in previous models. We find that, with the increase of microtubule width, discontinuous disorder-order transition is delayed. The system initiates a continuous transition before the final discontinuous jump of nematic order parameter. We establish a phase diagram, and further analyze the effects of dynamic events like microtubule catastrophe and zippering on the nature of phase transitions. We find that the well-known zippering event, which was considered a dominant factor giving cortical array, actually doesn't necessarily enhance the global nematic order. With the increase of critical zippering angle, it enhances the formation of small microtubule bundle. At the same time, these small bundles can block each other and make the system globally isotropic. Under certain conditions, the competition between these two factors gives rise to an optimal zippering critical angle for global nematic order.

References:

[1] D.W. Ehrhardt & S.L. Shaw, Annu. Rev. Plant Biol. 57 859-875 (2006).
[2] G.O. Wasteneys & J.C. Ambrose, Trends in Cell Biology 19 62-71 (2009).
[3] S.L. Shaw, R. Kamyar & D.W. Ehrhardt, Science 300 1715–1718 (2003).
[4] R. Dixit & R. Cyr, Plant Cell 16 3274–3284 (2004).
[5] S.H. Tindemans, R.J. Hawkins & B.M. Mulder, Phys. Rev. Lett. 104 058103 (2010).
[6] X. Shi & Y. Ma, Proc. Natl. Acad. Sci. U. S. A. 107 11709-11714 (2010).