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Criticalities in crosslinked actin networks due to myosin activity

MICHAEL SHEINMAN, VU University

Many essential processes in cells and tissues, like motility and morphogenesis, are orchestrated by molecular motors applying internal, active stresses on crosslinked networks of actin filaments. Using scaling analysis, mean-field calculation, numerical modelling and *in vitro* experiments of such active networks we predict and observe different mechanical regimes exhibiting interesting critical behaviours with non-trivial power-law dependencies. Firstly, we find that the presence of active stresses can dramatically increase the stiffness of a floppy network, as was observed in reconstituted intracellular F-actin networks with myosin motors and extracellular gels with contractile cells. Uniform internal stress results in an anomalous, critical mechanical regime only in the vicinity of the rigidity percolation points of the network. However, taking into account heterogeneity of motors, we demonstrate that the motors, stiffening any floppy network, induce large non-affine fluctuations, giving rise to a critical mechanical regime. Secondly, upon increasing motor concentration, the resulting large internal stress is able to significantly enhance unbinding of the network's crosslinks and, therefore, disconnect the initially well-connected network to isolated clusters. However, during this process, when the network approaches marginal connectivity the internal stresses are expected to drop drastically such that the connectivity stabilizes. This general argument and detailed numerical simulations show that motors should drive a well connected network to a close vicinity of a critical point of marginal connectivity. Experiments clearly confirm this conclusion and demonstrate robust critical connectivity of initially well-connected networks, ruptured by the motor activity for a wide range of parameters. M. Sheinman, C.P. Broedersz and F.C. MacKintosh, Phys. Rev. Lett, in press. J. Alvarado, M. Sheinman, A. Sharma, F.C. MacKintosh and G. Koenderink, in preparation.