Non-equilibrium fluctuations of cell membranes: The effect of cytoskeletal motor activity on membrane dynamics

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Summary: A calculation for membrane deformation due to myosin motor activity below the membrane is presented. We show that the myosin motors activity can be the source for the non-thermal fluctuations.

The mechanics and non-equilibrium (i.e. molecular motor-driven) fluctuation spectrum of living cells remains an open problem. In this talk, we explore the question: What can one infer about the action of endogenous motors in the cytoskeleton by observing the height fluctuations of cell membrane? To address this, we treat the cytoskeleton as a uniform elastic half-space bounded by a membrane with a finite bending modulus and driven out of equilibrium by molecular motors (i.e. myosin). These motors produce transient and stochastic contractile stresses in the elastic bulk. We first calculate the induced undulations of the membrane-bound surface due to the action of a single molecular motor. Then, making assumptions about the spectrum of motor force fluctuations, we calculate the expected non-thermal contribution to the cellular membrane fluctuations due to the action of an ensemble of such motors. We also mention ongoing experimental tests of these ideas.

a) b)

Fig. 1. Deformations of a membrane lying on top an elastic medium. The deformations are due to a dipole force acting inside the elastic medium. We show the deformation for two different orientations of dipole forces: a) parallel to the membrane and, b) perpendicular to the membrane.