MAR10-2009-000839

Abstract for an Invited Paper
for the MAR10 Meeting of
the American Physical Society

Soft Brains, Signal Amplification through Noise, and Taking the Brain by its Horns

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For the brain's viscoelastic properties single cell measurements reveal the softness of neurons and Glial cells, which consequentially rules out the notion of Glial cells as structural support. In contrary the mechanosensitive neurons follow in their growth and development the even softer Glial cells by inverse durotaxis. The motion of growth cones, the leading motile structures of growing neurons, results from a competition of stochastic processes responsible for forward and backward movement. Noise tuning of the growth cone's stochastic fluctuations increases neuronal sensitivity to chemotaxis. The forces underlying the spatial interplay of random actin polymerization driving the forward motion and molecular motor-based retrograde flow responsible for stochastic retraction are measured either by applying conservation laws (continuity equation and force balance) to the cytoskeletal dynamics of GFP-actin transfected growth cones or by directly detecting these forces with AFM. By a simple mechanical lever arm effect weak optical gradient forces acting on the spike-like filopodia, the exploring "horns" of growth cones, are sufficient to control the direction of growth cones' stochastic forward motion.