Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Buckling Instability and Stress Propagation in Rods with Elastic Support ZI CHEN, Biomedical Engineering, Washington Univ. in St. Louis, WANLIANG SHAN, Mechanical & Aerospace Engineering, Princeton Univ., ANKITA GUMASTE, Neuroscience & Behavioral Biology, Emory Univ., WINSTON SOBOYEJO, Mechanical & Aerospace Engineering, Princeton Univ., CLIFFORD BRANGWYNNE, Chemical & Biological Engineering, Princeton Univ. — The cytoskeleton of living cells is a composite material consisting of a network of biopolymers including f-actin and microtubules (MTs). MTs are able to bear significant compressive loads in cells as a result of reinforced short wavelength buckling, due to the surrounding actin network. However, the length scale of compressive force propagation, even for macroscopic rods, remains poorly understood. Here we propose a minimal theory that incorporates elastic restoring forces from the surrounding network, elucidating the compressive force-dependence of the buckled rod shape. We identify a threshold length as the effective distance stresses can propagate in such network, and show that the decay length is tunable by modifying the longitudinal mechanical coupling coefficients. We test these predictions with experiments in macroscopic rods, and show that the degree of mechanical coupling directly controls the penetration depth of buckling, in agreement with theoretical and numerical predictions. Our results suggest that the length scale over which mechanical signals are transduced in cells may be actively controlled, and could provide design principles for novel types of fiber composite materials based on biomimetic control of the longitudinal coupling coefficients.

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Date submitted: 23 Nov 2011 Electronic form version 1.4