Abstract Submitted
for the MAR05 Meeting of
The American Physical Society

A physical basis for actin filament lengths in cytoskeletal networks: DENNIS DISCHER, PAUL DALHAIMER, TOM LUBENSKY — Actin filaments are typically crosslinked in cells by highly flexible proteins, leading to a wide range of cytoskeletal structures or microphases. Two-dimensional or membrane networks composed of actin and spectrin family proteins have been particularly well-characterized in both the red blood cell (RBC) – where actin filaments are short – and the outer hair cell (OHC) of the inner ear, where the filaments are long. General aspects of the phase behavior and anisotropic elasticity of these two systems are addressed here by simulating actin-like rods in two-dimensions crosslinked by a soft overlying network of spectrin-like chains. With short rods (per RBC), networks become glassy with compression whereas longer rods transition to a nematic phase. At zero applied pressure, a locked-in or quenched nematic emerges when actin length equals or exceeds crosslinker length (per OHC). Applying tension to quenched nematic states further reveals a soft response in the direction perpendicular to the director – the direction of sound propagation through the OHC. Properties such as isotropic surface elasticity of RBC and directional elasticity in OHC would seem respectively useful in flow through blood capillaries and sound propagation in the ear and thus follow from disparate actin filament lengths crosslinked at suitable densities.

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Date submitted: 06 Dec 2004 Electronic form version 1.4