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Abstract for an Invited Paper
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Cell Forces and Cytoskeletal Order Parameters

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Nematic, Smectic and Isotropic Order parameters have found wide-spread use in characterizing all manner of soft matter systems, but have not yet been applied to characterize and understand the structures within living cells, particularly cytoskeletal structures. Several examples will be used to illustrate the utility of such analyses, ranging from experiments on stem cells attached to or in various elastic matrices to embryonic heart tissue and simulations of membrane cytoskeletons under all manner of stressing. Recently developed theory will be shown to apply in general with account of cell contractility, matrix elasticity and dimensionality as well as cell shape and a newly defined "cytoskeletal polarizability." The latter property of cells is likely different between different cell types due to different amounts of key cytoskeletal components with some types of stem cells being more polarizable than others. Evidence of coupling to the nucleus as a viscoelastic inclusion will also be presented.

References: (1) P. Dalhaimer, D.E. Discher, T. Lubensky. Crosslinked actin networks exhibit liquid crystal elastomer behavior, including soft-mode elasticity. Nature Physics 3: 354-360 (2007). (2) A. Zemel, F.Rehfeldt, A.E.X. Brown, D.E. Discher, and S.A. Safran. Optimal matrix rigidity in the self-polarization of stem cells. Nature Physics 6: 468 - 473 (2010).