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Modelling of cross-linked actin networks – influence of geometrical parameters and cross-link compliance

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A major structural component of the cell is the actin cytoskeleton, in which actin subunits are polymerized into actin filaments. These networks can be cross-linked by various types of ABPs (Actin Binding Proteins), such as Filamin A. We evaluate the passive response of cross-linked actin filament networks by use of a numerical and continuum network model.

For the numerical model, the influence of filament length, statistical dispersion, cross-link compliance (including that representative of Filamin A) and boundary conditions on the mechanical response is evaluated and compared to experimental results. It is found that the introduction of statistical dispersion of filament lengths has a significant influence on the computed results, reducing the network stiffness by several orders of magnitude. Actin networks have previously been shown to have a characteristic transition from an initial bending-dominated to a stretching-dominated regime at larger strains, and the cross-link compliance is shown to shift this transition.

The continuum network model, a modified eight-chain polymer model, is evaluated and shown to predict experimental results reasonably well, although a single set of parameters cannot be found to fully predict the characteristic dependence of filament length for different types of cross-links. Given the vast diversity of cross-linking proteins, the dependence of mechanical response on cross-link compliance signifies the importance of incorporating it properly in models to understand the roles of different types of actin networks and their respective tasks in the cell.