"A protein that acts like a paper ball: Non-monotonic mechanical effects in the disordered tails of neurofilament proteins"

The tail domains of neurofilament proteins are unstructured biological polyampholytes, containing a sequence of positive and negative charges that interact so as to modulate filament orientation and spacing in the neuronal axon. To determine the nature of attractive interactions between these domains, we carried out single-molecule force spectroscopy measurements on a polymerized construct of the shortest tail, NF-L. We find these interactions give rise to slow, non-equilibrium aging dynamics in our elastic measurements: sudden changes in force lead to long-term, logarithmic relaxation of the chain extension. We further observe a distinct memory effect in which prior application of a specific sequence of forces causes the chain extension to follow a non-monotonic trajectory with time. That is, the chain extension grows, peaks, and begins to shrink, all while tension is held constant. This is a specific example of the Kovacs effect, seen in a variety of glassy systems. I will discuss how recent work exploring the Kovacs effect in crumpled paper balls gives us insight into the molecular processes at work in the protein system.