Active mechanics and shape instabilities in axons

Neuronal cells are unique in their ability to span large length-scales. They do this by extending tubular processes known as axons and dendrites. Certain axons can reach lengths of the order of meters while maintaining an almost constant diameter of about a micro-meter. This optimum diameter seem to be set by an interplay between stresses in the plasma membrane and those arising from the axonal cytoskeleton. It can be shown that an inbalance of these stresses can lead to abnormal shape transformations like beading of axons. Such transformation occur in-vivo under a wide range of conditions like stretch injury, inflammation and neurodegenerative diseases.

Mechanical forces also play an important role in the development  of the neuronal cell. During development an axon initially grows due to the pulling force exerted by the growth cone and in the latter phase due to the expansion of the surrounding tissue. How stretching forces lead to growth is not clear. Apart from these slow growth responses (~ micron/minute) axons also exhibit unusual visco-elastic behaviour and active contraction at shorter times.

In this talk, we'll discuss some of the observed morphological transformations and mechanical responses of axons.