"Mechanical forces in axon bundling and circuit development"

During neural development, the growing axons are guided by a variety of mechanisms to reach the appropriate targets. Much literature has focused on axon guidance by spatially distributed chemical cues. More recently, it has become appreciated that mechanical tension within the axons (arising from internal cytoskeletal activity as well as external pulls) governs several important aspects of axon growth and circuit formation.

After an introduction covering these aspects, I will discuss our recent work on the mechanisms of axon bundling. The formation of bundles contributes to the robustness of axon targeting in many neural systems, and is classically thought to be controlled by the growth cones. We observed that axons growing in primary cell culture can form large bundles by a series of “zippering events” in which axons shafts progressively adhere to each other, without direct involvement of the growth cones. We analyzed this novel mechanism in detail, and showed that the zippering/unzippering arises from the competition of two forces: the axon mechanical tension and the force of axon-axon adhesion. I will relate these results to some in vivo observations from previous literature.