Mechanics of actin filaments probed by magnetic colloids

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The actin polymer is central in cell biology : it is a major component of cytoskeleton and it plays a fundamental role in motility, division, mechanotransduction.... The polymerization of the monomer into semiflexible filaments is dynamically regulated by different proteins. It is well known that when the polymerization occurs just beneath the cell membrane it generates forces responsible for cell movement. However, the mechanism of force production is yet not fully understood. At a larger scale, actin filments form networks whose architecture is defined by the partners of actin and depends on the location in the cell. For example, in the structure which leads cell migration, the lamellipodium, the gel is branched due to its interaction with Arp2/3 protein complex. Determining the mechanical properties of such actin network is of crucial interest to understand how forces are generated and transmitted in living cells.

Using dipole-dipole interaction between magnetic colloids we can give insights both on force generation by isolated filaments and on the mechanics of the assembled gels. In a first experiment, we study the force-velocity relationship for a few isolated growing filaments. By doing this we show that the entropy coming from the anchoring point generates forces that are surprisingly large. In a second study we measure the elastic properties of actin networks grown from the surface of the colloids. The technique allows to obtain massive parallel measurements. We can thus investigate the relationship between different biologically relevant architectures of actin networks and their elastic properties.