Single molecule torque and twist measurements probe the key players of the central dogma

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Abstract:

Single-molecule manipulation techniques have provided unprecedented insights into the structure, function, interactions, and mechanical properties of biological macromolecules. While many single-molecule manipulation techniques naturally operate in the space of (linear) extension and force, recently a number of techniques have been developed that enable measurements of rotation angle and torque. These new methods provide exciting opportunities to probe biological important macromolecules. In particular, the helical nature of double-stranded DNA and RNA intrinsically links key processes such as replication, transcription, and genome repair to rotational motion and the accumulation of torsional strain.

In my talk, I will briefly review novel magnetic tweezers assays that enable direct measurements of single molecule torque and twist, notably magnetic torque tweezers [1-3] and freely-orbiting magnetic tweezers [4]. Using these techniques, we have for the first time mapped out the complete force-torque phase diagram for double-stranded RNA [5], discovering some similarities but also striking differences to its better studied cousin, DNA. In addition, I will briefly describe results on Rad51-DNA filaments [6], a key intermediate in DNA repair, and applications of novel magnetic tweezers techniques to probe nucleosome dynamics [7].

[1] Lipfert, et al., Nature Methods (2010)
[2] Lipfert, et al., Rev. Sci. Instrum. (2011)
[3] Janssen, et al., Nano Letters (2012)
[4] Lipfert, et al., Nature Commun. (2011)
[5] Lipfert, et al., submitted
[6] Lee, et al. NAR (2013)
[7] Vlijm, et al., submitted

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