Abstract Submitted
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DNA's Liaison with RNA Polymerase Physical Consequences of a Twisted Relationship IGOR KULIC, PHIL NELSON, University of Pennsylvania — RNA polymerase is the molecular motor that performs the fundamental process of transcription. Besides being the key- protagonist of gene regulation it is one of the most powerful nano-mechanical force generators known inside the cell. The fact that polymerase strictly tracks only one of DNA's strands together with DNA's helical geometry induces a force-to-torque transmission, with several important biological consequences like the "twin supercoil domain" effect and remote torsional interaction of genes. In the first part of the talk we theoretically explore the mechanisms of non-equilibrium transport of twist generated by a moving polymerase. We show that these equations are intrinsically non-linear in the crowded cellular environment and lead to peculiar effects like self-confinement of torsional strain by generation of alternative DNA structures like cruciforms. We demonstrate how the asymmetric conformational properties of DNA lead to a "torsional diode" effect, i.e. a rectification of polymerase-generated twist currents of different signs. In the second part we explore the possibility of exploiting the polymerase as a powerful workhorse for nanomechanical devices. We propose simple and easy to assemble arrangements of DNA templates interconnected by strand-hybridization that when transcribed by the polymerase linearly contract by tenfold. We show that the typical forces generated by such "DNA stress fibers" are in the piconewton range. We discuss their kinetics of contraction and relaxation and draw parallels to natural muscle fiber design.

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