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Theory of Excluded Volume Effects in Tethered Particle Experiments DARREN SEGALL, ROB PHILLIPS, California Institute of Technology — Tethered particle motion is a class of single molecule experimental techniques that has been used to explore numerous macromolecular properties including the motion of kinesin and RNA polymerase; proteins synthesis of DNA and protein mediated loop formation in DNA. In this experimental technique an imagining bead is attached to the macromolecule of interest. Despite the diversity of experimental studies theoretical work regarding the relationship between the motion of the bead and that of the molecule is lacking. In this work we present a theoretical analysis of tethered particle motion. Our theoretical analysis reveals that the nature of the experimental protocol gives rise to a volume exclusion effect resulting in an effective force acting on the molecule. This effective force causes the molecule to swell changing its statistical properties and in some cases it biological functionality. Statistical properties of the tethered bead (experimentally measurable) are then related to that of the molecule (not observed). We then apply this theory to the analysis of dynamical macromolecular interactions. In particular, we demonstrate how the rate of loop formation of dsDNA generated by the lac-repressor protein is decreased due to the volume exclusion effect. Finally, we apply this theory to the analysis of protein digestion of DNA, revealing a simple manner in which tethered particle motion can be used to the study of such interactions.

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