Abstract Submitted
for the MAR08 Meeting of
The American Physical Society

Coupled Translational and Rotational Fluctuations of Tethered Beads ANDREW SPAKOWITZ, SHAFIGH MEHRAEEN, Stanford University — Single-molecule manipulation plays an important role in determining the physical mechanisms responsible for biological function. Establishing a robust method of predicting the fluctuating behavior of a tethered bead provides insight into how to maximize the signal-to-noise ratio to improve experimental resolution. We theoretically address the behavior of single-molecule experimental apparatuses. Our theory is amenable to addressing a variety of different bead-tether systems, thus providing a basis for comparing and contrasting these different experimental setups and for adapting the theory to the specific experimental system of interest. Fluctuations in both the location and orientation of the bead are incorporated in the theory; we explore their coupled effect on the observed behavior in single-molecule systems. The physical behavior of the tether molecule is described using the wormlike chain model. Making use of our exact solutions for wormlike chain model statistics, our current treatment achieves exact precision for the polymer behavior, apart from the approximations that are inherent to the wormlike chain model. We find that the impact of rotational fluctuations on the bead motion is largest when the radius of the bead is comparable to the length of the chain tether. We explore the impact that chain length and bead radius have on the resolution of single-molecule experiments and how to maximize the signal-to-noise ratio.

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Date submitted: 02 Dec 2007 Electronic form version 1.4