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Influence of probe shape on polymer configurations and entropic forces

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The free energy of long polymers is frequently dominated by entropy with the interaction energy playing a minor role. In the absence of an energy scale, the corresponding forces are then governed by the thermal energy scale k_BT and by the length scales associated with the experimental set-up. Recent advances in single molecule manipulation techniques have brought the accuracy of position and force determination into the range where the measurement of relatively small deformations becomes possible. In these situations the detailed shape of probes to which the molecule is attached must be taken into account. The behavior of a polymer of size R_0 attached to the rounded tip of a probe (sphere, paraboloid, spherocylinder) with radius of curvature R, differs qualitatively for large and small values of the ratio $s = R_0/R$. The scaled compliance (inverse force constant) S/R_0^2, is anisotropic and quite large in the direction parallel to the surface when $s \sim 1$ [1]. When a cone with a polymer attached to its sharp tip approaches a plate, then for cone-plate separation $h \ll R_0$ the polymer-mediated force between them [2] is given by $F = Ak_BT/h$. The coefficient A can be related to geometry-dependent correlation exponents of long polymers. We computed A for phantom polymers, and for self-avoiding polymers by ϵ-expansion, as well as by numerical simulations in 3 dimensions.

[1] R. Bubis, Y. Kantor and M. Kardar, Europhys. Lett. **88**, 48001, 2009.
[2] M. F. Maghrebi, Y. Kantor and M. Kardar, Europhys. Lett., *in press*, 2011 (arXiv:1109.5658).