Some problems from the Saleh lecture

June 23, 2015

1. An experiment: Find a rubber band. Stretch it, and quickly put it against your lip (which is quite sensitive to temperature). Note the temperature change, and explain why this happens.

2. Certain networks of stiff filaments (such as actin or microtubules), subject to a relatively large stress σ, show a power-law dependence of the differential modulus K on stress: $K \sim \sigma^{3/2}$. The differential modulus is defined as $K = d\sigma/d\gamma$, where the stress σ is the force per unit area applied to the gel, and the strain $\gamma = \Delta L/L$ is the relative extension change in response to the stress.

   Show that the power-law exponent of 3/2 results, in a relatively straightforward way, from assuming the network filaments respond to force following the Marko-Siggia elastic law. What would the exponent be if the filaments responded following the high-force FJC law?

   Note: it is argued that cells exist in this non-linear stiffening regime, due to the prestress derived from active contractile motors; see: Koenderink et al., 2009.

3. Consider a swollen polymer confined to a tube of diameter D. Use a blob model to calculate the dependence of extension, X, on diameter D, assuming $R_g \gg D \gg l$, where l is the Kuhn length. Repeat the calculation for a planar slit of width D; be careful here to think about what extension means for a slit.