DNA looping probabilities: an elastic rod model

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We evaluate approximations to the probability density function for the location and orientation of one end of an elastic rod at thermodynamic equilibrium with a heat bath. Our main motivation is to exploit elastic rod models for the approximated computation of DNA looping probabilities. A path integral formalism is adopted and quadratic fluctuations about a unique minimal energy configuration are considered. The appropriate expression is derived as a function of the energy of the minimizer and the Jacobi fields for the second variation of the energy functional, satisfying specific initial conditions. The theory is of quite general applicability as no assumption is made on the uniformity nor isotropy nor presence or absence of integral constraints arising in inextensible and unshearable models for DNA. As an example, we consider a uniform, non-isotropic, intrinsically straight and untwisted rod and we compute the probability density function of forming a circular loop.