

On DNA packaging and ejection from elastic lambda phage capsid

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In recent years, advanced atomic force microscope and optical tweezers experiments have demonstrated that mechanical interaction between the elastic capsid outside and the DNA chains confined inside a bacterial phage plays an important role in its life cycle. In order to understand this fundamental biological phenomena, we adopt an unified nonlinear continuum and statistical mechanics model by taking into account the effects of DNA bending deformation, electrostatic repulsion between DNA-DNA strands and nonlinear elastic deformation of the capsid to show that the predicted relation between packaging force, inhibited osmotic pressure and remaining DNA length in the capsid is in better agreement with previous experiment than that based on previous models by treating the capsid as a rigid shell. Based on this model, we also find that the size of lambda-phage is in an optimal state with respect to the mechanical strength of the capsid and ejection force of the DNA chain.

Keywords: DNA package, DNA ejection, lambda phage, elastic capsid, optimal state