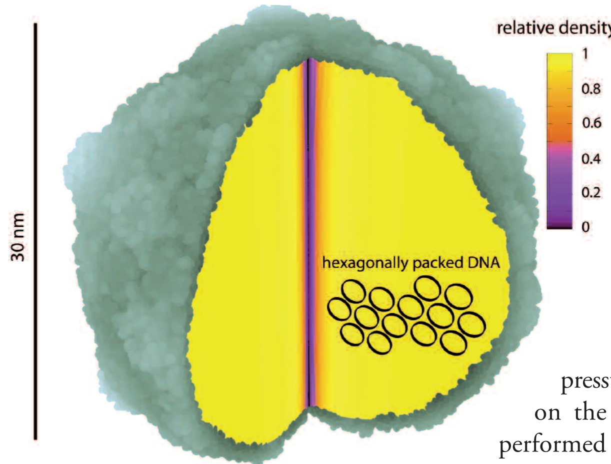
From bulk to encapsidated DNA:

energetics and density of DNA packed in bacteriophage capsids

The DNA that constitutes the genome of a bacteriophage is tightly packed in a protein shell called a capsid; this shell needs to withstand a large internal pressure from the closely packed DNA. Not much is known about the way the DNA is packed, so we have formulated a new theoretical approach to relate the density distribution of the DNA in the capsid to experimental data connecting osmotic pressure with the DNA density in the bulk. This has enabled us to determine the length of the packed DNA (packing fraction) as a function of the osmotic pressure - this is a quantity directly accessible in experiments. Somewhat surprisingly, we have found that the packing fraction can be reliably calculated even when neglecting the elastic energy of encapsidated DNA, which suggests that these experiments essentially probe the properties of the bulk DNA. Nevertheless, the elasticity of the DNA was found to influence the density distribution of the encapsidated DNA, inducing a very narrow cylindrical core that is depleted of DNA in an otherwise almost uniformly filled capsid. The radius of the depleted core (~1 nm) is small on the scale of the bacteriophage radius (~30 nm) and it diminishes with the increase of osmotic pressure. It has negligible influence on the packing fraction. We have performed packing fraction calculations for bathing solutions of different salts and concentrations. Our results, especially the predictions for $MnCl_2$ bathing solutions, should be easily tested in experiments. ■



▲ **General feature of our solution for the packed DNA density is the depleted narrow cylindrical core (black and magenta) in otherwise uniform distribution of hexagonally packed DNA (yellow). The protein shell (capsid) of a model bacteriophage virus is indicated in green.**

A. Šiber, **M. Dragar**, **V.A. Parsegian** and **R. Podgornik**, "Packing nano-mechanics of viral genomes", *Eur. Phys. J. E* **26**, 317 (2008)