Crammed with charged DNA, pressure rises inside virus

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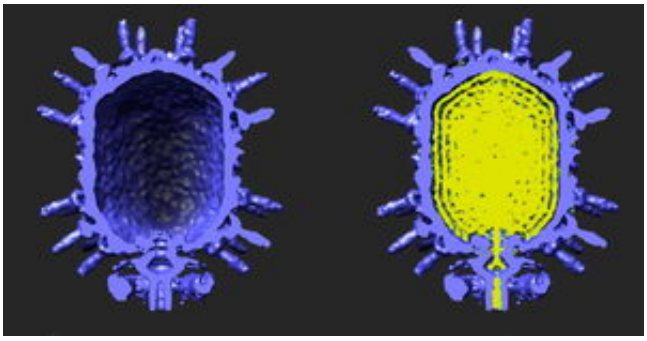

Image credit: Ye Xiang and Michael Rossmann, Purdue University.

It could be an artist's depiction of someone's stomach before and after a rather decadent meal. But it is a 3-D cryoelectron microscope reconstruction of the cross-section of a virus, before and after cramming itself full of its own DNA.

The virus, phi29, has a tiny motor that pumps its DNA into the capsid—outer shell—during the assembly process. The potential energy of the tightly coiled DNA may help phi29 inject its genetic material into the bacterial cells it infects.

Now a team led by physicists at the University of California, San Diego has used laser tweezers to measure the forces exerted by the motor as it pushes the DNA into the capsid.

“The virus’ motor has to do mechanical work to overcome two factors that create resistance,” said Douglas Smith, an assistant professor of physics at UCSD who headed the team that published the discovery this week in the early on-line edition of Proceedings of the National Academy of Sciences. “First, the DNA must be forced to bend. Second, the electrostatic repulsion of the DNA’s negatively charged backbone must be overcome. We found that the positively charged ions in the solution are critical to overcoming this repulsion. Without the right combination of positively charged ions, the virus could not force all of its DNA into the capsid.”

The researchers discovered that the forces in the capsid are slightly higher than predicted by theoretical calculations. They say this may be because the packed DNA is less ordered than assumed in the calculations.

Source: University of California - San Diego