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Packaging of Polyelectrolytes in Viral Capsids: The Interplay Between Polymer Length and Capsid Size[1]

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Each particle of the Cowpea Chlorotic Mottle Virus (CCMV) has a very small "parts list," consisting of two components: a molecule of single-stranded RNA and a 190-residue protein that makes up the 28-nm diameter icosahedral capsid. When purified viral RNA and capsid protein are mixed in solution at an appropriate pH and ionic strength, infectious wild-type viruses form spontaneously. Virus-like particles (VLPs) are formed when the protein self assembles around other anionic polymers such as poly(styrene sulfonate) (PSS). Under different pH and ionic strength conditions the capsid protein can assemble by itself into empty capsids, multishell structures, tubes and sheets. To explore the effect on virion size of the competition between the preferred curvature of the protein and the size of the packaged cargo we have examined the formation of VLPs around PSS polymers with molecular weights ranging from 400 kDa to 3.4 MDa. Two distinct sizes are observed – 22 nm for the lower molecular weights, jumping to 27 nm at 2 MDa. While under given conditions the size of PSS in solution is directly determined by its molecular weight, the self-complementarity of RNA makes its solution structure dependent on the nucleotide *sequence* as well. We have therefore employed Small-Angle X-ray Scattering and Fluorescence Correlation Spectroscopy to examine the sizes of viral and non-viral RNAs of identical lengths. A model for the assembly that includes both the self-interactions of the polyelectrolyte and the capsid proteins and the interactions between them provides insight into the experimental results.

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