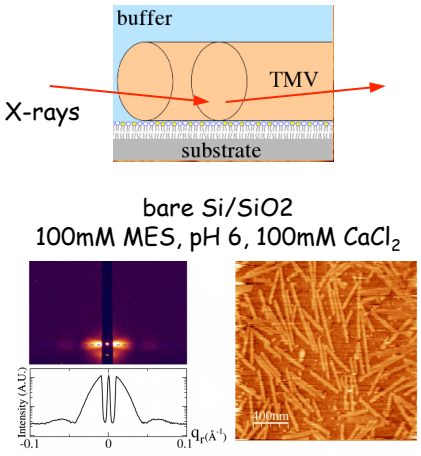
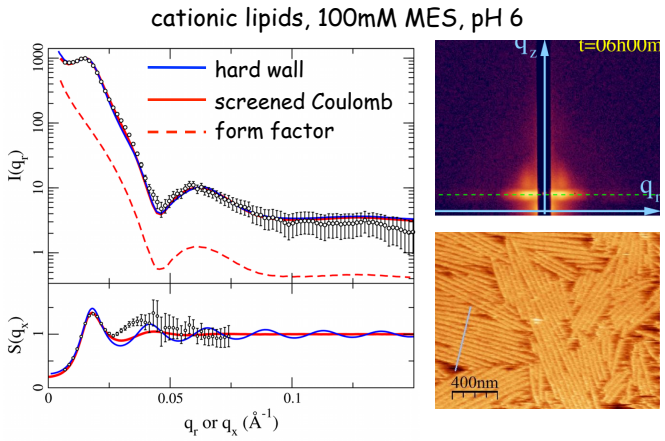
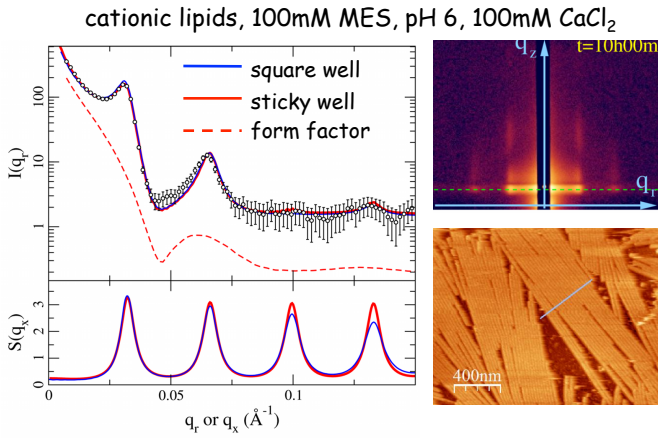
Structure and interaction in 2D assemblies of TMVs

Motivation: Self-assembly of nanoparticles in two dimensions is of broad scientific interest. The key factor that controls the self assembly process is the interaction between the particles. At the same time, the mobility of the particles is also important so that the system can evolve toward the thermodynamically favored ordered structure. The inter-particle interaction can be tuned by adjusting environmental chemical conditions. We will utilize a substrate-supported lipid monolayer to give mono-dispersed virus particles in-plane mobility. X-ray scattering can be used to characterize both the inter-particle interaction and the structure of the assembly.







Key result 1: Ordered assemblies of TMVs form on supported lipid monolayer but not on bare substrate, proving the importance of particle mobility in the process of self-assembly. Qualitatively, the presence of Ca^{2+} ions greatly improve structural order within TMV assemblies.

Key result 2: The scattering data from TMV assemblies formed **without** $CaCl_2$ can be well described by a structure factor based on either simple hard wall repulsion, or more realistically, screened Coulomb repulsion, with charge density on each TMV as a fitting parameter.

Key result 3: The scattering data from TMV assemblies formed **with** $CaCl_2$ can only be described by a structure factor based on inter-particle interactions that include a strong short-ranged attraction, in addition to hard wall repulsion.

Conclusion and significance: We have demonstrated a method to use substrate-supported lipid monolayer to facilitate 2D assembly of nanoparticles. We have also demonstrated the use of X-ray scattering to not only qualitatively characterize the ordering within the assembled structure, but also quantify the nature of the inter-particle interaction, which ultimately determines the structural order that can be achieved.

Structure and interaction in 2D assemblies of tobacco mosaic viruses L. Yang et.al. SOFT MATTER, 2009