The tale of two self-assembly systems that ‘love’ to interact: striped particles and lipid bilayers

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In this talk we will discuss a novel physical chemistry phenomenon that we have recently discovered and that we are studying in depth. : When nanoparticles coated with structured self-assembled monolayers (composed of molecularly-thin striped domains of alternating composition – hereafter called ‘striped’ NPs) interact with fluid lipid bilayers, there exists a driving force for the fusion of these two systems. Studies with both lipid bilayers and cell membranes show that when similar particles coated with similar mixture of ligand molecules but with no structure on the ligand shell are exposed to lipid bilayers or cell membrane no noteworthy interaction takes place. Hence we believe that the structure present in the ligand shell of striped NPs is the true key to this novel form of interaction between these two self-assembly systems.

Preliminary results indicate that the fusion ultimately increases inter- and intra-molecular order within the lipid bilayer. We believe –and intend to prove- that this ordering is a key to the driving force for the fusion. This phenomenon has consequences in many fields. First, at the fundamental level, it evidences that when self-assembled (SA) systems under different order constrains interact, the outcome can be unexpected and not captured by the current knowledge. This is often the case in nature where a cell’s life cycle strongly relies on interactions involving different SA systems. Morphological similarities between our striped NPs and cell penetrating peptides (CPP) suggest that our preliminary results illustrate deep physical principles that regulate such interactions. Second, we find that the fusion process depends critically on the lipid bilayer fluidity, composition, geometry, and integrity. All of these topics will be discussed in the presentation.