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Entropy driven aggregation of adhesion sites of supported membranes

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Supported lipid membranes are useful and important model systems for studying cell membrane properties and membrane mediated processes. One attractive application of supported membranes is the design of phantom cells exhibiting well defined adhesive properties and receptor densities. Adhesion of membranes may be achieved by specific and non-specific interactions, and typically requires the clustering of many adhesion bonds into "adhesion zones". One potential mediator of the early stages of the aggregation process is the Casimir-type forces between adhesion sites induced by the membrane thermal fluctuations. In the talk, I will present a theoretical analysis of fluctuation induced aggregation of adhesion sites in supported membranes. I will first discuss the influence of a single attachment point on the spectrum of membrane thermal fluctuations, from which the free energy cost of the attachment point will be deduced. I will then analyze the problem of a supported membrane with two adhesion points. Using scaling arguments and Monte Carlo simulations I will demonstrate that two adhesion points attract each other via an infinitely long range effective potential that grows logarithmically with the pair distance. Finally, I will discuss the many-body nature of the fluctuation induced interactions. I will show that while these interactions alone are not sufficient to allow the formation of aggregation clusters, they greatly reduce the strength of the residual interactions required to facilitate cluster formation. Specifically, for adhesion molecules interacting via a short range attractive potential, the strength of the direct interactions required for aggregation is reduced by about a factor of two to below the thermal energy kT.