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ABSTRACTS OF AUSTRALASIAN PHD THESES

THE COLLOID PHYSICS OF PHOTOSYNTHETIC MEMBRANES

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In this thesis a number of problems connected with the colloid physics of photosynthetic membranes are examined.

These membranes exist in regularly stacked arrays in solution inside the plant chloroplast. They can be modelled as flat charged plates in an electrolyte, with specific adsorption of ionic species in solution onto the plates. A method is developed for calculating the free energy of interaction between these membranes. The Poisson-Boltzmann equation is used to describe the solution between the plates, with boundary conditions being specified by the adsorption constants of the ionic species onto the plates. This leads to an integral equation for the free energy of interaction between them.

Since an explicit solution to this equation cannot be found, a numerical technique for calculating the force between the plates is developed. This method is then used to explain a number of experimental observations on photosynthetic membranes. The attractive van der Waals force between the membranes is calculated using the pairwise summation approximation, and this together with the repulsive electrostatic force is used to calculate the equilibrium spacing of the membranes. For equilibrium of these stacks to occur under dark conditions, it is concluded that extensive binding of divalent ions to the membrane surface must occur.

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The second half of the thesis is concerned with the light-scattering problem of a fluorescent dye molecule embedded in a biological cell. The molecule is modelled as a classical dipole with an arbitrary position and orientation inside a sphere of uniform dielectric constant. The appropriate boundary value problem is solved to derive expressions for the inelastically scattered fields observed outside the particle due to a single radiating dipole inside it, by expanding the fields in terms of vector spherical harmonics.

It is shown that the angular light-scattering pattern obtained from this particle is a sensitive function of the position and orientation of the emitting dipole within the sphere; and this fact should be taken into account in making experimental observations.

The model is extended to consider the effect upon coherent scattering of embedding fluorescing molecules within small dielectric spheres. In this case the scattered radiation field is obtained by integrating the earlier results over the particle.