

Analytic model for the dipole potential of a lipid layer

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Abstract

The larger permeability of cations than anions through a lipid bilayer can be rationalized by the positive sign of its dipole potential. That is, upon crossing the lipid headgroups into the hydrocarbon chain region the electrostatic potential increases by several hundred millivolts. We derive an analytic expression for the dipole potential of a lipid layer using an electrostatic model that is based on an extended version of the linearized Poisson-Boltzmann theory. The model highlights the ability of the lipid headgroups to render the dipole potential positive by inducing an orientational ordering of the solvent molecules. The contribution of the solvent over compensates the dipole potential due to the bare lipids. Our theoretical prediction compares accurately with measurements of the dipole potential we have conducted for mixed anionic-zwitterionic lipid monolayers at the air-water interface.