

Complex Fluids with Mobile Charge-Regulated Macro-Ions

What is Charge Regulation?

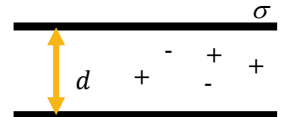
Modeling of *soft* immobile surfaces - boundary condition of the Poisson-Boltzmann equation:

Ninham and Parsegian 1971

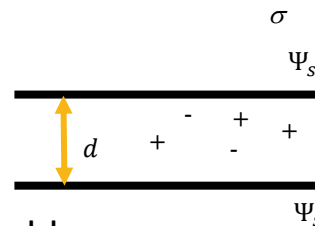
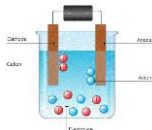
- Law of mass action (le Chatelier's principle)
- Free-energy formulation $F = F_{PB} + g_S$

Is Charge-Regulation a generalized b.c.?

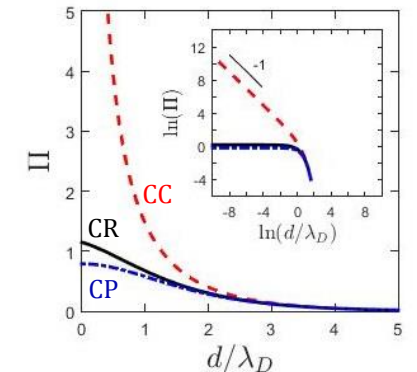
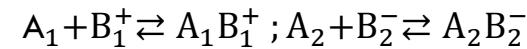
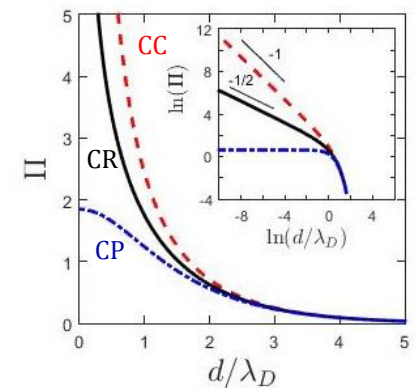
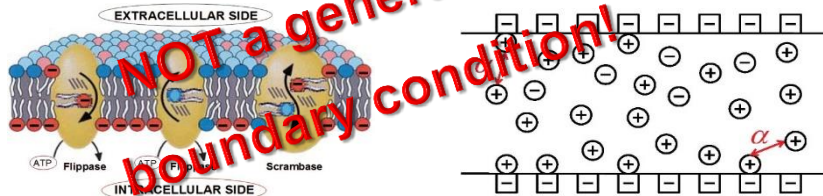
Constant charge (CC) - charged insulator



Constant potential (CP) - electrode



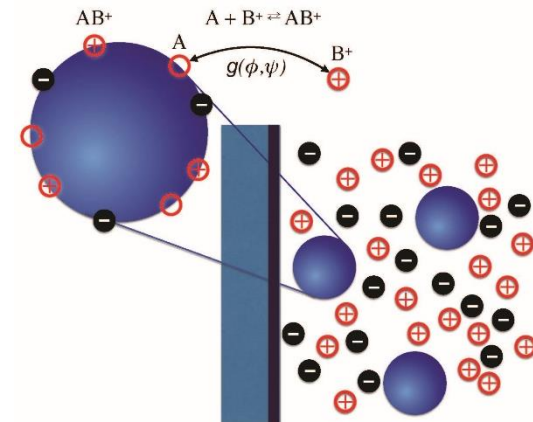
Charge regulation (CR) - surface with ionizable groups



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Relevant to solution of proteins with dissociable amino acids or charged nano-particles with dissociable surface groups

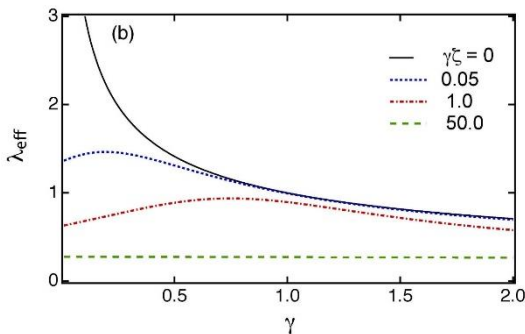
- *Mobile* ions and macro-ions in solution
- Charge-Regulation is no longer a fixed boundary condition!
- Macro-ions are taken as point-like -- ideal gas entropy



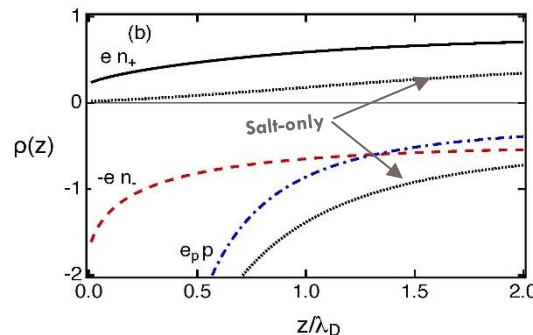
$$F = F_{PB} + g(\phi, \psi) + [p \ln(pa^3) - p] - \mu_p p$$

$$g(\phi, \psi) = \lim_{a \rightarrow 0} \frac{1}{4\pi a^2} \oint_{r'=a} d^2 r' g_S(\phi(r'), \psi(r'))$$

non-monotonous effective screening length



modified double-layer structure



buffering

