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Charge-regularization effects on polyelectrolytes

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When electrically charged macromolecules are dispersed in polar solvents, their effective net charge is generally different from their chemical charges, due to competition between counterion adsorption and the translational entropy of dissociated counterions. The effective charge changes significantly as the experimental conditions change such as variations in solvent quality, temperature, and the concentration of added small electrolytes. This charge-regularization effect leads to major difficulties in interpreting experimental data on polyelectrolyte solutions and challenges in understanding the various polyelectrolyte phenomena. Even the most fundamental issue of experimental determination of molar mass of charged macromolecules by light scattering method has been difficult so far due to this feature. We will present a theory of charge-regularization of flexible polyelectrolytes in solutions and discuss the consequences of charge-regularization on (a) experimental determination of molar mass of polyelectrolytes using scattering techniques, (b) coil-globule transition, (c) macrophase separation in polyelectrolyte solutions, (c) phase behavior in coacervate formation, and (d) volume phase transitions in polyelectrolyte gels.