



# Electrostatic Effects in Soft Matter and Biophysics

Edited by

Christian Holm, Patrick Kékicheff  
and Rudolf Podgornik

NATO Science Series

# Electrostatic Effects In Soft Matter And Biophysics

**Shigeyuki Komura, Takao Ohta**



## **Electrostatic Effects In Soft Matter And Biophysics:**

**Electrostatic Effects in Soft Matter and Biophysics** Christian Holm, Patrick Kékicheff, Rudolf Podgornik, 2001-11-30  
Proceedings of the NATO Advanced Study Institute Les Houches France 1-13 October 2000      **Electrostatic Effects in Soft Matter and Biophysics** Christian Holm, Patrick Kékicheff, Rudolf Podgornik, 2012-12-06  
Soft Condensed Matter commonly deals with materials that are mechanically soft and more importantly particularly prone to thermal fluctuation effects. Charged soft matter systems are especially interesting; they can be manufactured artificially as polyelectrolytes to serve as superabsorbers in diapers as flocculation and retention agents as thickeners and gelling agents and as oil recovery process aids. They are also abundant in living organisms, mostly performing important structural and functional tasks. The book describes the many areas in soft matter and biophysics where electrostatic interactions play an important role. It offers in-depth coverage of recent theoretical approaches, advances in computer simulation and novel experimental techniques. Readership: Advanced undergraduate level in physics, physical chemistry and theoretical biochemistry.

**Soft-Matter Characterization** Redouane Borsali, Robert Pecora, 2008-07-28  
This 2-volume set includes extensive discussions of scattering techniques: light, neutron and X-ray, and related fluctuation and grating techniques that are at the forefront of this field. Most of the scattering techniques are Fourier space techniques. Recent advances have seen the development of powerful direct imaging methods such as atomic force microscopy and scanning probe microscopy. In addition, techniques that can be used to manipulate soft matter on the nanometer scale are also in rapid development. These include the scanning probe microscopy technique mentioned above as well as optical and magnetic tweezers.

**Electrostatics of Soft and Disordered Matter** David S. Dean, Jure Dobnikar, Ali Naji, Rudolf Podgornik, 2014-05-02  
Recently there has been a surge of activity to elucidate the behavior of highly charged soft matter and Coulomb fluids in general. Such systems are ubiquitous, especially in biological matter, where the length scale and the strength of the interaction between highly charged biomolecules are governed by strong electrostatic effects. Several interesting limits have been discovered in the parameter space of highly charged many-particle Coulomb matter where analytical progress is possible and completely novel and unexpected results have been obtained. One of the challenges in highly charged matter is to correctly describe systems with finite coupling strength in the transition regime between weak and strong couplings. After studying the fluctuations of both, several theories have been developed that describe this experimentally highly relevant regime. At the same time, computer simulation algorithms and computing power have advanced to the level where all-ion simulations including many-body and polarization effects are possible; the new theories thus can be subjected to numerical confirmation. Another important question is the effect of the structural disorder on electrostatic interactions. It has recently been demonstrated both theoretically and experimentally that charge disorder can impose long-range interaction between charged or even uncharged surfaces. These interactions might become very significant in biological processes. Filling a void in the

literature this volume cross pollinates different theoretical and simulation approaches with new experiments and ties together the low temperature high coupling constant and disorder parameters in a unified description of the electrostatic interactions which largely determine the stability and conformations of most important biological macromolecules With striking graphical illustrations the book presents a unified view of the current advances in the field of Coulomb bio colloidal systems building on previous literature that summarized the field over 20 years ago Leading scientists in the field offer a detailed introduction to different modern methods in statistical physics of Coulomb systems They detail various approaches to elucidate the behavior of strongly charged soft matter They also provide experimental and theoretical descriptions of disorder effects in Coulomb systems which have not been discussed in any other book

**Non-equilibrium Soft Matter Physics** Shigeyuki Komura, Takao Ohta, 2012-02-03 Soft matter is a concept which covers polymers liquid crystals colloids amphiphilic molecules glasses granular and biological materials One of the fundamental characteristic features of soft matter is that it exhibits various mesoscopic structures originating from a large number of internal degrees of freedom of each molecule Due to such intermediate structures soft matter can easily be brought into non equilibrium states and cause non linear responses by imposing external fields such as an electric field a mechanical stress or a shear flow Volume 4 of the series in Soft Condensed Matter focuses on the non linear and non equilibrium properties of soft matter It contains a collection of review articles on the current topics of non equilibrium soft matter physics written by leading experts in the field The topics dealt with in this volume includes rheology of polymers and liquid crystals dynamical properties of Langmuir monolayers at the air water interface hydrodynamics of membranes and twisted filaments as well as dynamics of deformable self propelled particles and migration of biological cells This book serves both as an introduction to students as well as a useful reference to researchers

**Chemical Electrostatics** Fernando Galembeck, Thiago A. L. Burgo, 2017-03-09 This book provides new clues for understanding electrostatic charging in solids and liquids resulting from the surge of research in this active area of science that is taking place since the 1990 s but is still largely unknown to most researchers lecturers and engineers Written by a leading researcher in this field this book describes the formation and properties of the Earth capacitor the production of environmental electricity and its effect on natural and anthropic systems and examines many situations in which water may play a decisive role in electrostatic behavior The authors present an informed critique of the long held assumption that pure substances should be electroneutral In this regard the authors show that charge partition and accumulation is expected considering the electrochemical potential under non zero electrostatic potential which prevails at Earth surface This book provides conceptual tools to guide the reader through the complexities and consequences of electrostatic phenomena while covering exciting current topics such as energy scavenging from the environment electrostatic based green production energy saving processes electrochemistry at the solid gas interface therapeutic electrostatic treatments applications in sanitation and pest control and control of atmospheric electricity and its use in

climate engineering      *Reflexive Polymers and Hydrogels* Nobuhiko Yui, Randall J. Mersny, Kinam Park, 2004-03-17 Despite their capacity to carry out functions that previously were unobtainable smart polymers and hydrogels tend to have painfully slow response times On the other hand biological systems go through phase changes at an extremely fast rate *Reflexive Polymers and Hydrogels* examines the natural systems that respond almost instantaneously to environmental stimuli and thus gives the reader an understanding of the mechanisms that govern these responses The book includes chapters on approaches and procedures for designing a synthetic flash system based on naturally occurring systems It also deals with some of the promising potential applications of flash systems in industry      **P.g. De Gennes' Impact On Science - Volume II: Soft Matter And Biophysics** Julien Bok, Jacques Prost, Francoise Brochard-wyart, 2009-07-29 This publication in two volumes is devoted to the scientific impact of the work of Nobel Laureate Pierre Gilles de Gennes one of the greatest scientists of the 20th century It covers the important fields for which de Gennes was renowned solid state magnetism and superconductivity macroscopic random media and percolation supersolids liquid crystals polymers adhesion and friction and biophysics The book brings together internationally renowned experts to contribute their perspectives on the significance of de Gennes works They have each selected a definitive paper which gives the state of the field at the time the paper was published highlights the paper's importance and provides an analysis of the development of the field right up to the modern day The insightful perspectives of these scientists make the book both unique and intriguing This is the second volume devoted to soft matter and biophysics      **Handbook of Lipid Membranes** Cyrus R. Safinya, Joachim O. Rädler, 2021-09-14 This handbook provides a unique overview of lipid membrane fundamentals and applications The fascinating world of lipids that harbor and govern so many biological functionalities are discussed within the context of membrane structures interactions and shape evolution Beyond the fundamentals in lipid science this handbook focuses on how scientists are building bioinspired biomimetic systems for applications in medicine cosmetics and nanotechnology Key Features Includes experimental and theoretical overviews on the role of lipids with or without associated biomolecules as structural components imparting distinct membrane shapes and intermembrane interactions Covers the mechanisms of lipid membrane curvature by peptide and protein binding and the roles of signalling lipids and the cytoskeleton in plasma membrane shape evolution Covers advanced X ray and force measurement techniques Discusses applications in biomedicine cosmetics and nanotechnology including lipid vectors in nucleic acid drug delivery in dermal applications and lipid based sensors and artificial biointerfaces Covers artificial membranes from block copolymers synthetic copolypeptides and recombinant proteins Includes an exciting section that explores the role of lipids in the origin of life in hydrothermal conditions This book is a highly informative companion for professionals in biophysics biochemistry physical chemistry and material and pharmaceutical sciences and bioengineering      **Modern Problems of Molecular Physics** Leonid A. Bulavin, Alexander V. Chalyi, 2017-12-21 This book presents a collection of selected lectures discussing current problems in molecular physics and reviews the main cutting

edge advances in condensed and soft matter physics It offers deep insights and a powerful basis for scientists and engineers to study complicated problems in physics chemistry biology and medicine The unification of experimental theoretical and computational methods allows milestone results to be achieved in areas such as ionic and electronic liquids magnetic liquid systems liquid systems with nanoparticles structural phase transitions and critical phenomena and small angle neutron and X ray scattering in liquids and liquid systems The lectures selected for this book were held at the 7th International Conference Physics of Liquid Matter Modern Problems PLMMP 2016 27 31 May in Kiev Ukraine

**DNA Interactions with Polymers and Surfactants** Rita Dias,Bjorn Lindman,2008-07-14 A broad overview of the interaction of DNA with surfactants and polymers Due to the potential benefits of biotechnology interest in the interaction between DNA and surfactants and polymers has become increasingly significant Now DNA Interactions with Polymers and Surfactants provides an extensive up to date overview of the subject giving readers a basis for understanding the factors leading to complexation between DNA and different cosolutes including metal ions polyelectrolytes spermine spermidine surfactants and lipids and proteins Topical coverage includes Polyelectrolytes physico chemical aspects and biological significance Solution behavior of nucleic acids Single DNA molecules compaction and decompaction Interaction of DNA with surfactants and cationic polymers Interactions of histones with DNA DNA DNA interactions The hydration of DNA amphiphile complexes DNA surfactant lipid complexes at liquid interfaces DNA and DNA surfactant complexes at solid surfaces The role of correlation forces for DNA cosolute interactions Simulations of polyions Cross linked DNA gels and gel particles DNA as an amphiphilic polymer Lipid DNA interactions Covering both theoretical and practical aspects of the subject DNA Interactions with Polymers and Surfactants is an ideal resource for chemists and biochemists working in gene and DNA delivery research in industry and academia as well as for cell biologists chemical engineers molecular biologists and development biologists in the pharmaceutical industry

**Numerical Computer Methods, Part D** ,2004-05-25 The aim of Numerical Computer Methods Part D is to brief researchers of the importance of data analysis in enzymology and of the modern methods that have developed concomitantly with computer hardware It is also to validate researchers computer programs with real and synthetic data to ascertain that the results produced are what they expected Selected Contents Prediction of protein structure Modeling and studying proteins with molecular dynamics Statistical error in isothermal titration calorimetry Analysis of circular dichroism data Model comparison methods

**Biophysical Tools for Biologists** John J. Correia,H. William Detrich III,2011-09-21 Driven in part by the development of genomics proteomics and bioinformatics as new disciplines there has been a tremendous resurgence of interest in physical methods to investigate macromolecular structure and function in the context of living cells This volume in Methods in Cell Biology is devoted to biophysical techniques in vitro and their applications to cellular biology Biophysical Tools for Biologists covers methods oriented chapters on fundamental as well as cutting edge techniques in molecular and cellular biophysics This book is directed toward the broad audience of cell

biologists biophysicists pharmacologists and molecular biologists who employ classical and modern biophysical technologies or wish to expand their expertise to include such approaches It will also interest the biomedical and biotechnology communities for biophysical characterization of drug formulations prior to FDA approval Describes techniques in the context of important biological problems Delineates critical steps and potential pitfalls for each method Includes full color plates to illustrate techniques

**Traffic and Granular Flow ' 03** Serge P. Hoogendoorn, Stefan Luding, Piet H.L. Bovy, Michael Schreckenberg, Dietrich E. Wolf, 2007-08-15 These proceedings are the fifth in the series Traffic and Granular Flow and we hope they will be as useful a reference as their predecessors Both the realistic modelling of granular media and traffic flow present important challenges at the borderline between physics and engineering and enormous progress has been made since 1995 when this series started Still the research on these topics is thriving so that this book again contains many new results Some highlights addressed at this conference were the influence of long range electric and magnetic forces and ambient fluids on granular media new precise traffic measurements and experiments on the complex decision making of drivers No doubt the hot topics addressed in granular matter research have diverged from those in traffic since the days when the obvious analogies between traffic jams on highways and dissipative clustering in granular flow intrigued both communities alike However now just this diversity became a stimulating feature of the conference Many of us feel that our joint interest in complex systems where many simple agents be it vehicles or particles give rise to surprising and fascinating phenomena is ample justification for bringing these communities together Traffic and Granular Flow has fostered cooperation and friendship across the scientific disciplines

**Multiscale Molecular Methods in Applied Chemistry** Barbara Kirchner, Jadran Vrabec, 2012-01-25 First Principles Based Multiscale Multiparadigm Molecular Mechanics and Dynamics Methods for Describing Complex Chemical Processes by A Jaramillo Botero R Nielsen R Abrol J Su T Pascal J Mueller and W A Goddard Dynamic QM MM A Hybrid Approach to Simulating Gas Liquid Interactions by S Yockel and G C Schatz Multiscale Modelling in Computational Heterogeneous Catalysis by F J Keil Real World Predictions from Ab Initio Molecular Dynamics Simulations by B Kirchner P J di Dio and J Hutter Nanoscale Wetting Under Electric Field from Molecular Simulations by C D Daub D Bratko and A Luzar Molecular Simulations of Retention in Chromatographic Systems Use of Biased Monte Carlo Techniques to Access Multiple Time and Length Scales by J L Rafferty J I Siepmann M R Schure Thermodynamic Properties for Applications in Chemical Industry via Classical Force Fields by G Guevara Carrion H Hasse and J Vrabec Multiscale Approaches and Perspectives to Modeling Aqueous Electrolytes and Polyelectrolytes by L Delle Site C Holm and N F A van der Vegt Coarse Grained Modeling for Macromolecular Chemistry by H A Karimi Varzaneh and F M ller Plathe

**Theory of Molecular Fluids** Christopher G. Gray, Keith E. Gubbins, Christopher G. Joslin, 2011-10-13 Existing texts on the statistical mechanics of liquids treat only spherical molecules However nearly all fluids of practical interest are composed of non spherical molecules that are often dipolar or exhibit other kinds of electrostatic forces This book describes

the statistical mechanical theory of fluids of non spherical molecules and its application to the calculation of physical properties and is a sequel to Theory of Molecular Fluids Volume 1 Fundamentals by C G Gray and K E Gubbins The emphasis is on the new phenomena that arise due to the non spherical nature of the intermolecular forces such as new phase transitions structural features and dielectric effects It contains chapters on the thermodynamic properties of pure and mixed fluids surface properties X ray and neutron diffraction structure factors dielectric properties and spectroscopic properties The book is aimed at beginning graduate students and research workers in chemistry physics materials science and engineering

**Frontiers In Electronics: Future Chips, Proceedings Of The 2002 Workshop On Frontiers In Electronics (Wofe-02)** Yoon Soo Park, Michael S Shur, William Tang, 2003-01-29 The 2002 Workshop on Frontiers in Electronics was the third in the series of WOFE workshops Over 70 leading experts from academia industry and government agencies reported on the most recent developments in their fields and exchanged views on future trends and directions of the electronics and photonics industry The issues they addressed ranged from system on chip to DNA doping from ultrathin SOI to electrotiles from photonics integration on the ULSI platform to wide band gap semiconductor devices and solid state lighting The rapid pace of electronic technology evolution compels a merger of different technical areas and WOFE 02 provided a unique opportunity for cross fertilization of the emerging fields of microelectronics photonics and nanoelectronics The workshop was informal and stimulated provocative views visionary outlooks and discussions on controversial issues

*Molecular Simulation Methods for Predicting Polymer Properties* Vassilios Galiatsatos, 2005-02-03 Among the thousands of synthesized polymers new polymeric substances and materials with new often unusual properties often arise Consequently this presents a problem in determining the physical properties of polymers and thus makes it difficult to ascertain how to synthesize polymers with desired properties This book discusses what molecular modelling can do to predict the properties of realistic polymer systems Organized by property each chapter will address the methods one may use to study the particular system Focuses on polymer properties rather than methods making it more accessible to the average scientist engineer All important polymers will be covered such as amorphous polymers semicrystalline polymers elastomers emulsions polymer interfaces and surfaces Chapters contributed by experts in the field Discusses current commercial software used in molecular simulation

**Nanobiomaterials Handbook** Balaji Sitharaman, 2016-04-19 Nanobiomaterials exhibit distinctive characteristics including mechanical electrical and optical properties which make them suitable for a variety of biological applications Because of their versatility they are poised to play a central role in nanobiotechnology and make significant contributions to biomedical research and healthcare Nanobio

[Ionic Interactions in Natural and Synthetic Macromolecules](#) Alberto Ciferri, Angelo Perico, 2012-01-04 This book is a comprehensive study of the subject of ionic interactions in macromolecules The first parts of the book review and analyze the conventional treatments of fixed charges e g in polyelectrolytes and polyampholytes including screening and condensation by mobile ions The interaction of ions with less



polar sites on the macromolecule e g amide bonds and the origin of the lyotropic effects focusing on binding versus condensation will also be extensively addressed The book also explores complex micellar organizations involving charged macromolecules e g DNA and low molecular weight ampholytes and strong protein associations The resulting structures are relevant to a variety of functional biological systems and synthetic analogs The contribution of electrostatic and hydrophobic interaction to the stability of proteins and other supramolecular structures will also be analyzed There are chapters on applications such as deionization and cosmetic formulation This 21 chapter book is divided into three sections Fundamentals Mixed Interactions Functions and Applications

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