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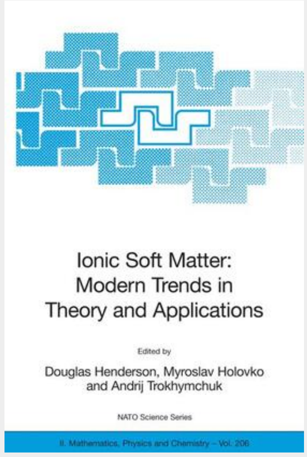
Ionic Soft Matter: Modern Trends in Theory and Applications

Proceedings of the NATO Advanced Research Workshop on Ionic Soft Matter: Modern Trends in Theory and Application Lviv, Ukraine, 14-17 April, 2004



106,99 €
99,99 € (zzgl. MwSt.)

Lieferfrist: bis zu 10 Tage

Artikelnummer: 9781402036620
Medium: Buch
ISBN: 978-1-4020-3662-0
Verlag: Springer Netherlands
Erscheinungstermin: 06.12.2005
Sprache(n): Englisch
Auflage: 2005
Serie: NATO Science Series II: Mathematics, Physics and Chemistry
Produktform: Gebunden
Gewicht: 1720 g
Seiten: 418
Format (B x H): 160 x 241 mm

Recently there have been profound developments in the understanding and interpretation of liquids and soft matter centered on constituents with sho- range interactions. Ionic soft matter is a class of conventional condensed soft matter with prevailing contribution from electrostatics and, therefore, can be subject to possible long-range correlations among the components of the - terial and in many cases crucially affecting its physical properties. Among the most popular representatives of such a class of materials are natural and synthetic saline environments, like aqueous and non-aqueous electrolyte - lutions and molten salts as well as variety of polyelectrolytes and colloidal suspensions. Equally well known are biological systems of proteins. All these systems are examples of soft matter strongly in?uenced, if not dominated, by long-range forces. For more than half of century the classical theories by Debye and Hückel as well as by Derjaguin, Landau, Verwey and Owerbeek (DLVO) have been at the basis of theoretical physical chemistry and chemical engineering. The substantial progress in material science during last few decades as well as the advent of new instrumentation and computational techniques made it apparent that in many cases the classical theories break down. New types of interactions (e.g. hydrodynamic, entropic) have been discovered and a number of questions have arisen from theoretical and experimental studies. Many of these questions still do not have de?nite answers.

Ionic soft matter is a class of conventional condensed matter in which the prevailing contribution is from electrostatics. Since electrostatic forces are found practically everywhere in nature, the development of appropriate and powerful theoretical tools to treat electrostatic forces, as well as a correct interpretation and understanding of observed phenomena, are extremely important issues at the frontiers of modern chemical and molecular engineering, biological and materials sciences, energy and environmental technological strategies. The presence of charge carriers (electrons, protons, ions, counter-ions, ionic surfactant micelles, charged latex, polystyrene and other colloidal particles) was found to be crucial in determining the physical properties of a variety of systems that include not only industrial colloidal suspensions but also living protein channels and biological DNA solutions. This book is for researchers interested in the statistical mechanical modeling of charged substance as well as for those working in chemical physics, physical chemistry, biophysics and environmental science. The book consists of state of the art reviews of the recent experimental, theoretical and simulation studies on ionic criticality, polyelectrolytes, proton transport in fuel cell membranes, and the design of DNA arrays. A significant portion of the book deals with discussions of the fundamental and applied problems of important phenomena such as ion association, ion adsorption, ion solvation, electrical double layer, thin colloidal film stability, ion collective dynamics, ion screening, etc. using a level of argumentation that is common and understandable for mathematicians, physicists, chemists, biologists and engineers. The book concludes with chapter on physical properties of fuel-containing materials from the inside of the troubled Chornobyl sarcophagus.