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Non-equilibrium Phenomena in Confined Soft Matter ...

Non-Equilibrium Phenomena in Soft Matter. From cell biology to polymer photovoltaics, macromolecular structures and functionalities are the result of non-equilibrium (meaning that the system is in a state that is not the global free energy minimum) processes. While very important, so far it has been challenging to characterize, manipulate and understand these non-equilibrium processes because of the lack of appropriate techniques and theoretical approaches.

Non-Equilibrium Phenomena in Soft Matter | Max Planck ...

The Non-Equilibrium Soft Matter group of Liesbeth Janssen focuses on the behavior of materials that are inherently out of thermodynamic equilibrium, ranging from glasses and gels to active and living matter. We use a combination of theory, analytical modeling, and computer simulations to study the structural, dynamical, and mechanical properties of such materials.

Non-Equilibrium Soft Matter – Liesbeth M. C. Janssen

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Non-equilibrium Phenomena in Confined Soft Matter ...

This book deals with those properties of non-equilibrium soft matter that deviate greatly from the bulk properties as a result of nanoscale confinement.The ultimate physical origin of these confinement effects is not yet fully understood. At the state of the art, the discussion on confinement effects focuses on equilibrium properties, finite size effects and interfacial interactions.

Non-equilibrium Phenomena in Confined Soft Matter ...

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Non-equilibrium Phenomena in Confined Soft Matter ...

Soft Matter, 2016, 12, 1517-1524 Article type. Paper. Permissions. Request permissions Exploiting non-equilibrium phase separation for self-assembly ... Here we show with

macroscopic experiments and computer simulations that the forces underlying such non-equilibrium segregation can be used to control the self-assembly of particles that lack ...

Exploiting non-equilibrium phase separation for self ...
The imposed non-equilibrium boundary conditions give rise to a variety of geometry-dependent scenarios; while long-range interactions are suppressed (except for a finite penetration depth) in the bulk of the colloid solution in 3D, they can persist in quasi-2D geometry in which the colloids but not the solutes are confined to a surface, resulting in the formation of clusters or Wigner crystals, depending on the sign of the interaction between colloids.

Non-equilibrium interaction between catalytic colloids ...
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Non-equilibrium Phenomena in Confined Soft Matter ...
Active matter systems exhibit rich emergent behavior due to constant injection and dissipation of energy at the level of individual agents. Since these systems are far from equilibrium, their dynamics and energetics cannot be understood using the framework of equilibrium statistical mechanics. Recent developments in stochastic thermodynamics extend classical concepts of work, heat, and energy dissipation to fluctuating non-equilibrium systems.

Quantifying the non-equilibrium activity of an active ...
The cytoskeleton (CSK) is a tensed fiber framework that supports, shapes and stabilizes the cell. The CSK is in a constant state of remodeling, moreover, which is an active non-equilibrium thermodynamic process. We report here that cytoskeletal remodeling involves reconfigurations that are not only sudden bu

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Non-equilibrium Phenomena in Confined Soft Matter ...
The examples above highlight the importance of non-equilibrium aspects in soft matter science, due to kinetically arrested states or external driving forces. A special class of materials is that of active matter. These are systems that are intrinsically out of equilibrium, because the particles continuously consume energy that is used for their ...

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Non-Equilibrium Soft Matter Physics: 4: Komura, Shigeyuki ...
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Non-Equilibrium Thermodynamics in Multiphase Flows (Soft ...
The primary purpose of this thesis is to study the effects of boundary conditions or confinement on both equilibrium and non-equilibrium soft matter systems via theoretical modelling. For equilibrium systems we have studied a system of colloidal particles in harmonic confinement, and for non-equilibrium systems we consider a system of self-propelled rods in both harmonic and hard wall confinement.

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.

This book presents cutting-edge experimental and computational results and provides comprehensive coverage on the impact of non-equilibrium structure and dynamics on the properties of soft matter confined to the nanoscale. The book is organized into three main sections: · Equilibration and physical aging: by treating non-equilibrium phenomena with the formal methodology of statistical physics in bulk, the analysis of the kinetics of equilibration sheds new light on the physical origin of the non-equilibrium character of thin polymer films. Both the impact of sample preparation and that of interfacial interactions are analyzed using a large set of experiments. A historical overview of the investigation of the non-equilibrium character of thin polymer films is also presented. Furthermore, the discussion focuses on how interfaces and geometrical confinement perturb the pathways and kinetics of equilibrations of soft glasses (a process of tremendous technological interest). · Irreversible adsorption: the formation of stable adsorbed layers occurs at timescales much larger than the time necessary to equilibrate soft matter in bulk. The question is posed as to whether this process could be considered as the driving force of equilibration. In this section, the investigation of the physics of irreversible chain adsorption is accompanied by a detailed analysis of the molecular dynamics, structure, morphology, and crystallization of adsorbed layers. · Glass transition and material properties: the discussion covers a broad range of non-equilibrium phenomena affecting different families of soft materials - polymers, low molecular weight glass formers, and liquid crystals. In these systems, geometrical confinement induces the formation of non-equilibrium phases, otherwise not achievable via processing of bulk samples. The examples illustrated in this section show how non-equilibrium phenomena can be exploited as innovative processing parameters to fabricate novel nanomaterials with improved performance. Finally, the differences between experiments performed under equilibrium conditions and temperature scans from equilibrium to non-equilibrium states at the nanoscale are discussed.

Covering colloids, polymers, surfactant phases, emulsions, and granular media, Soft and Fragile Matter: Nonequilibrium Dynamics, Metastability and Flow (PBK) provides self-contained and pedagogical coverage of the rapidly advancing field of systems driven out of equilibrium, with a strong emphasis on unifying conceptual principles rather than material-specific details. Written by internationally recognized experts, the book contains introductions at the level of a graduate course in soft condensed matter and statistical physics to the following areas: experimental techniques, polymers, rheology, colloids, computer simulation, surfactants, phase separation kinetics, driven systems, structural glasses, slow dynamics, and granular materials. These topics lead to a range of exciting applications at the forefront of current research, including microplasticity of emulsions, sequence design of copolymers, branched polymer dynamics, nucleation kinetics in colloids, multiscale modeling, flow-induced surfactant textures, fluid demixing under shear, two-time correlation functions, chaotic sedimentation dynamics, and sound propagation in powders. Balancing theory, simulation, and experiment, this broadly-based, pedagogical account of a rapidly developing field is an excellent compendium for graduate students and researchers in condensed matter physics, materials science, and physical chemistry.

This book deals with those properties of non-equilibrium soft matter that deviate greatly from the bulk properties as a result of nanoscale confinement.The ultimate physical origin of these confinement effects is not yet fully understood. At the state of the art, the discussion on confinement effects focuses on equilibrium properties, finite size effects and interfacial interactions. However this is a limited vision which does not fully capture the peculiar behaviour of soft matter under confinement and some exotic phenomena that are displayed. This volume will be organized in the following three main themes. Equilibration and physical aging: treating non-equilibrium via the formal methodology of statistical physics in bulk, we analyse physical origin of the non-equilibrium character of thin polymer. We then focus on the impact of nanoconfinement on the equilibration of glasses of soft matter (a process of tremendous technological interest, commonly known as physical aging), comparing the latest trends of polymers in experiments, simulations with those of low-molecular weight glass formers. Irreversible adsorption: the formation of stable adsorbed layers occurs at timescales much larger than the time necessary to equilibrate soft matter in bulk. Recent experimental evidence show a strong correlation between the behaviour of polymers under confinement and the presence of a layer irreversibly adsorbed onto the substrate. This correlation hints at the possibility to tailor the properties of ultrathin films by controlling the adsorption kinetics. The book reports physical aspects of irreversible chain adsorption, such as the dynamics, structure, morphology, and crystallization of adsorbed layers. Glass transition and material properties: this section of the book focuses on the spread of absolute values in materials properties of confined systems, when measured by different experimental and computation techniques and a new method to quantify the effects of confinement in thin films and nanocomposites independently on the investigation procedure will be presented.

This book aims to cover a broad range of topics in statistical physics, including statistical mechanics (equilibrium and non-equilibrium), soft matter and fluid physics, for applications to biological phenomena at both cellular and macromolecular levels. It is intended to be a graduate level textbook, but can also be addressed to the interested senior level undergraduate. The book is written also for those involved in research on biological systems or soft matter based on physics, particularly on statistical physics. Typical statistical physics courses cover ideal gases (classical and quantum) and interacting units of simple structures. In contrast, even simple biological fluids are solutions of macromolecules, the structures of which are very

complex. The goal of this book to fill this wide gap by providing appropriate content as well as by explaining the theoretical method that typifies good modeling, namely, the method of coarse-grained descriptions that extract the most salient features emerging at mesoscopic scales. The major topics covered in this book include thermodynamics, equilibrium statistical mechanics, soft matter physics of polymers and membranes, non-equilibrium statistical physics covering stochastic processes, transport phenomena and hydrodynamics. Generic methods and theories are described with detailed derivations, followed by applications and examples in biology. The book aims to help the readers build, systematically and coherently through basic principles, their own understanding of nonspecific concepts and theoretical methods, which they may be able to apply to a broader class of biological problems.

Non-equilibrium thermodynamics is a general framework that allows the macroscopic description of irreversible processes. This book introduces non-equilibrium thermodynamics and its applications to the rheology of multiphase flows. The subject is relevant to graduate students in chemical and mechanical engineering, physics and material science. This book is divided into two parts. The first part presents the theory of non-equilibrium thermodynamics, reviewing its essential features and showing, when possible, some applications. The second part of this book deals with how the general theory can be applied to model multiphase flows and, in particular, how to determine their constitutive relations. Each chapter contains problems at the end, the solutions of which are given at the end of the book. No prior knowledge of statistical mechanics is required; the necessary prerequisites are elements of transport phenomena and on thermodynamics. “ The style of the book is mathematical, but nonetheless it remains very readable and anchored in the physical world rather than becoming too abstract. Though it is up-to-date and includes recent important developments, there is a lot of classical material in the book, albeit presented with unprecedented clarity and coherence. The first six chapters are actually a very good introduction to the theory underlying many phenomena in soft matter physics, beyond the focus on flow and transport of the later chapters of the book. ” Prof Richard A.L. Jones FRS, Pro-Vice-Chancellor for Research and Innovation, University of Sheffield

This book focuses on the assembly, organization and resultant collective dynamics of soft matter systems maintained away from equilibrium by an energy flux. Living matter is the ultimate example of such systems, which are comprised of different constituents on very different scales (ions, nucleic acids, proteins, cells). The result of their diverse interactions, maintained using the energy from physiological processes, is a fantastically well-organized and dynamic whole. This work describes results from minimal, biomimetic systems and primarily investigates membranes and active emulsions, as well as key aspects of both soft matter and non-equilibrium phenomena. It is shown that these minimal reconstitutions are already capable of a range of complex behaviour such as nonlinear electric responses, chemical communication and locomotion. These studies will bring us closer to a fundamental understanding of complex systems by reconstituting key aspects of their form and function in simple model systems. Further, they may also serve as the first technological steps towards artificial soft functional matter.

The physics of non-equilibrium many-body systems is one of the most rapidly expanding areas of theoretical physics. Traditionally used in the study of laser physics and superconducting kinetics, these techniques have more recently found applications in the study of dynamics of cold atomic gases, mesoscopic and nano-mechanical systems. The book gives a self-contained presentation of the modern functional approach to non-equilibrium field-theoretical methods. They are applied to examples ranging from biophysics to the kinetics of superfluids and superconductors. Its step-by-step treatment gives particular emphasis to the pedagogical aspects, making it ideal as a reference for advanced graduate students and researchers in condensed matter physics.