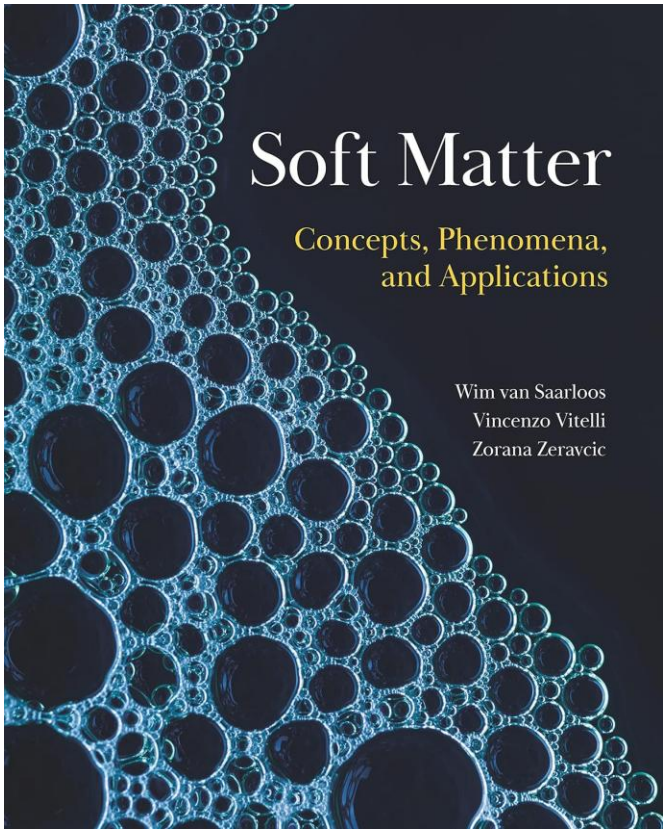
Soft Matter: Concepts, Phenomena, and Applications

Wim van Saarloos, Vincenzo Vitelli, Zorana Zeravcic

Princeton University Press, Princeton and Oxford, 2024
ISBN: 9780691191300



Imagine you find yourself in the middle of a giant jig-saw puzzle. Some of its pieces you have probably seen before, others are entirely new to you. Then, miraculously, all of the pieces start falling together, revealing an artwork full of unexpected connections. And in a perfect illustration of the maxim that the whole is more than the sum of its parts, even the pieces that looked familiar to you acquire an extra dimension – and new things to discover – when you suddenly see the bigger picture. That is how I felt while reading "Soft Matter" by Van Saarloos, Vitelli, and Zeravcic. lt is a wonderful book, kaleidoscopic in its design, combining in a riveting and seemingly effortless way the many diverse topics that together form the fascinating new field called Soft Matter.

The phenomenal diversity of the field, with its conceptual framework that spans multiple disciplines including physics, biology and chemistry, naturally constitutes a huge challenge to anyone who sets out to teach the subject. What to include? What to leave out? And how to blend everything together in a consistent way? The book by Van Saarloos, Vitelli, and Zeravcic – which grew out of lectures given at the Universities of Leiden and Chicago to a variety of

students at different levels – answers these questions in a superb way. The authors start with an engaging introduction on the scientific challenges, the strong societal relevance, as well as the sheer fun of Soft Matter. After this compelling opening chapter, Part I lies the foundations of the field: Fluid Dynamics, Elasticity and key elements of contemporary Statistical Physics, such as how to deal with fluctuations. Depending on the prior knowledge of the students, teachers can make their own choice about which topics need to be covered here. Part II contains the heart of the matter: Colloids, Polymers, and Liquid Crystals (three topics that will certainly be covered in any course) and a captivating chapter on Interfaces, Surfaces, and Membranes. Part III moves on to the advanced topics of Active Matter and Pattern Formation out of Equilibrium, providing excellent material for a graduate course or a series of state-of-the-art seminars in a summer school. Last but not least, Part IV gives a survey of new frontiers such as Designing Matter, Neural Network Architecture, Artificial Intelligence, and Artificial Life. This final part can be studied independently and forms a rich source for end-of-term assignments and student presentations. Thus, the authors offer the whole spectrum from the fundamental theoretical background to the forefront of current research.

Unifying themes throughout "Soft Matter" are its focus on the hydrodynamic approach and its open eye for applications in biological systems. Both of these themes are great strengths in themselves, and moreover make the book remarkably consistent given the enormous breadth of the field.

Apart from getting acquainted with a treasure trove of knowledge, the reader is also treated to an excitingly fresh and flexible *way of thinking* about Soft Matter: creative, out-of-the-box, and thorough at the same time. Written in a crystal-clear and friendly style – with scientific elegance, dexterity, and exceptional acumen throughout – this is a marvelous textbook which will take students and teachers alike on an intellectual adventure of the first order.

Mathematical modeling and physical insight go hand in hand on every page and I found it a delight to follow the authors from one eye-opener to the next, many of which happened to be (to my surprise and enthusiasm) on topics of my own expertise. Van Saarloos, Vitelli, and Zeravcic have the open-mindedness to address questions that are usually brushed aside and fully succeed in giving convincing answers.

The well-balanced choice of the core material, the uniquely accessible approach throughout, the thought-stimulating notes in the margin, the worked-out examples, the beautiful illustrations, the guided step-by-step exercises at the end of each chapter, the website that accompanies the book with videos and valuable extra material; all of these contribute to give "Soft Matter" the makings of an instant classic. A truly amazing accomplishment, which deserves a prominent place in every physics curriculum around the world.

Prof. Dr. Ko van der Weele, University of Patras, Greece