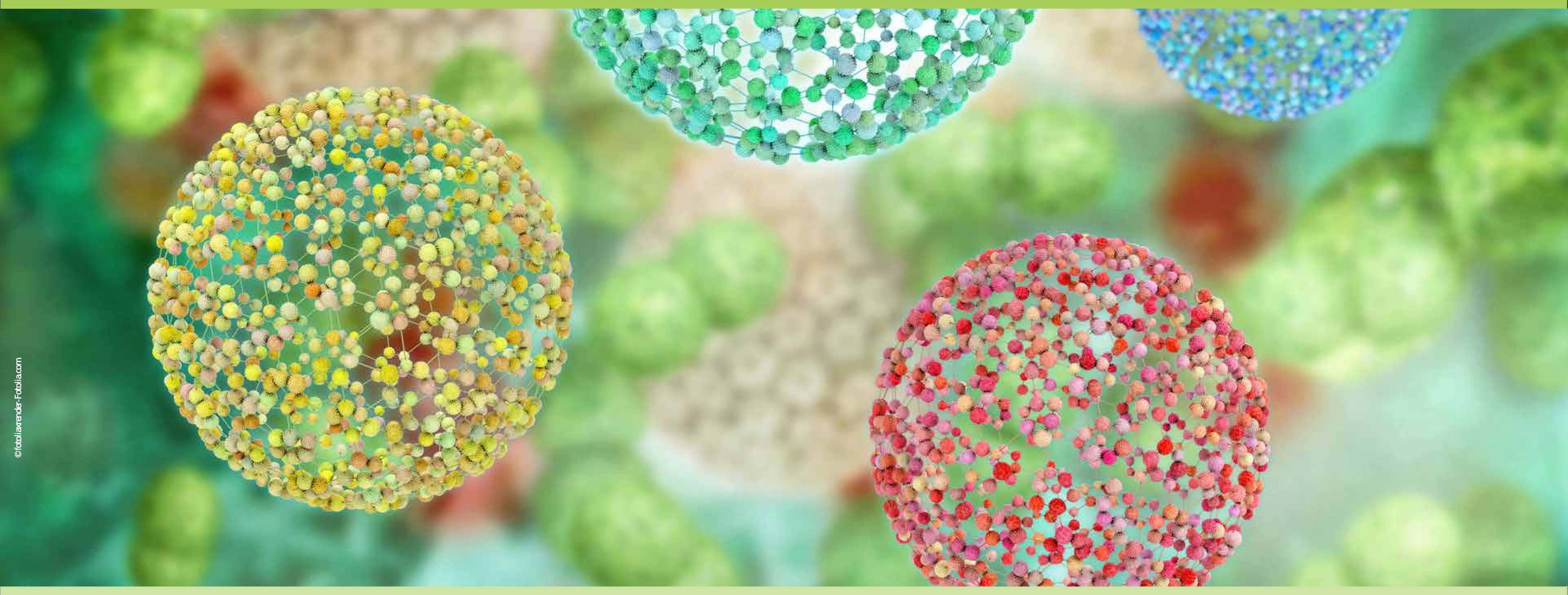
ILL Soft Matter Summer School

Institut Laue-Langevin, Grenoble, France
from 4 to 6 July 2023



Soft matter pervades into daily life under several forms: biological matter, foams, food products, ink, tires, and many others. In contrast to their very different appearance, all these systems are governed by the same, fundamental physical laws. Aim of the school is providing an overview of the forces governing the behaviour of soft matter systems and introducing the most relevant techniques to probe such interactions. The school proposes frontal lectures for doctoral students working in the field of soft matter given by recognized experts from all over Europe. Poster sessions will be opened for discussion on research topic and experimental results between students and invited lecturers.

Lecture 1: Introduction to colloid and interface science
Emanuel Schneck

In this lecture, we give an introduction to colloid and interface science. Its importance for technology and biological matter is illustrated and basic concepts are presented with a focus on colloidal forces such as van der Waals interactions, electric double layer forces, as well as solvent-, solute-, and polymer-induced forces.

Lecture 2: Physics of macromolecular systems
Julian Oberdisse

This lecture will address the basic physics of polymers. It will start with statistical properties of linear polymer chains, their conformation in space and its dependence on solvent properties and concentration. Each time, we will try to connect the relevant information to the one obtained by small-angle scattering experiments, like the radius of gyration, chain statistics, etc. Polymer solutions are not the only way to suspend chains, they can also be embedded in other matrices, forming polymer blends, the basic thermodynamics of which will be reviewed. When going into polymer materials, crosslinking is the fundamental chemical reaction, while physical bonds may also contribute, and the formation of gels and networks, as well as their thermal and mechanical properties, shall be discussed. If time is available, a short outlook on copolymers will be proposed.

Lecture 3: Computer simulation of molecular systems – Principles and example applications
Maria Reif

Computer simulations are widely used in the natural sciences to get insight into the behaviour of molecular systems at a microscopie level. ln this lecture, we will introduce the basic principles of Monte Carlo (MC) and Molecular Dynamics (MD) simulations based on a classical description of the energy of the system. We will get to know the basics of a molecular mechanics force field, have a look at how molecular configurations are generated in MC sampling and MD simulation and learn about how to analyse the simulations to extract, for example, structural and thermodynamic properties of interest. For instance, how can we characterize the structure of a salt solution or how can we calculate the free energy of binding of a drug molecule to a receptor protein?

Lecture 4: Hierarchical structures in food. Soft matter structure at various length scales
Milena Corredig

Food is characterized by complex hierarchical structures, interconnected over multiple length scales. A mechanistic understanding requires soft matter studies using molecular as well as colloidal soft matter tools. This lecture will bring some examples of how advanced physical techniques can help tackle important research questions, often using complementary methodologies.

Lecture 5: Introduction to Nuclear Magnetic Resonance
Alicia Vallet

In this lecture, we will present the basics of Nuclear Magnetic Resonance (NMR). Usable on solid as well as liquid samples, this polyvalent technique allows determining sample purity, structure of compounds, dynamics and molecular interaction at the atomic level. Used in many fields from biology to materials, as well as environment and food industries, NMR has the advantage of being quantitative and non destructive under certain conditions.

Lecture 6: Liquid foams: from the formulation to the characterization techniques
Anne-Laure Fameau

ln this lecture, we will introduce the basics of liquid foams: from the formulation, the generation and the characterization methods. At the end, we will illustrate how liquid foams can be used for a wide range of applications, not only as food or cosmetic products, but also for surface decontamination and in medicine due to their unique properties (rheological properties and imbibition).

Lecture 7: Electron Microscopy in Biology
Guy Schoehn

In this lecture, we will present the basics of electron microscopy and its application to biology. The latest instrumental and software developments that have led to the resolution revolution will be discussed. This revolution will be illustrated with concrete examples from research carried out on the EPN campus. Cellular electron microscopy and the current developments (tomography and FIB/SEM for example)

Lecture 8: Introduction to neutron scattering applied to soft matter
Sylvain Prèvost and Nicoló Paracini

In this lecture, an introduction to scattering techniques focused on small angle scattering and reflectometry will be given. The students will learn what information can be obtained for soft matter, food science and biology systems.