Structural charaterization of nanoparticles and nanosystems

Exam topics

2017/2018. autumn semester

1. Definition of nanoparticles and nanosystems, morphological and size characteristics
2. Properties of nanoparticles which differentiate them from the macroscopic matter (thermodynamic characteristics, new properties: increased proportion of the surface, plasmon resonance)
3. Characterization of nanoparticles and nanosystems with transmission electron microscopy, sample preparation (replica creation with freeze fracture)
4. Characterization of nanoparticles and nanosystems using scanning electron microscopy
5. Characterization of nanosystems using tunnel and atomic force microscopy
6. Morphological and structural details of self-assembling systems (micelle, vesicle, membrane-mimetic layer systems, others (cubic, hexagonal)) and their phase-transition behaviours. Characterization of the transitions with differential scanning calorimetry
7. „Beams" used in scattering experiments on nanosystems (light, X-ray, electron, neutron) and their most important characteristics (mass, charge, velocity, transmission, penetration depth, type of interaction
8. Scheme of a scattering experiment. Cross-section, scattering variable[1].
9. Relation between structure and scattering[1]. Scattering contrast, phase problem.
10. Scattering of periodic systems: Bragg's law. Derivation from geometrical considerations[1]. Connection between the repeat distance and the scattering variable.
11. Primary results of small-angle scattering: scattering pattern and curve. Intensity and scattering variable[1].
12. Measuring small-angle X-ray scattering in the transmission setup. Structure and the most important components of a typical pinhole SAXS camera.
13. Radiation sources. Characteristic radiation and bremsstrahlung. Operation principle of the X-ray tube and a synchrotron.
14. Comparison of small- and wide-angle scattering/diffraction.
15. Scattering of a homogeneous sphere. The Guinier-approximation[1] and the Porod region. Radius of gyration[1]. Connection between the size of the scattering particle and its intensity[1].
16. Small-angle scattering of self-assembled lipid systems. Multi- and unilamellar vesicles. Characteristic quantities obtainable from SAXS experiments.
17. BioSAXS: solution scattering of proteins. Typical experimental routine. What makes a good sample? How to characterize the measurable quantities: size, shape, flexiblity.

[1]Derivation and mathematical formulae are generally not required, only where it is explicitly marked with a footnote sign.