# Physical Kinetics

<table>
<tr><td>Unit Title</td><td colspan="3">Physical Kinetics</td></tr>
<tr><td>Level of Study</td><td colspan="3"></td></tr>
<tr><td>Credit Value</td><td></td><td>ECTS Value</td><td></td></tr>
<tr><td>Home Department</td><td colspan="3">Department of Theoretical Physics</td></tr>
<tr><td>Home Faculty</td><td colspan="3">Physics Faculty</td></tr>
<tr><td>Unit Co-ordinator</td><td colspan="3">Denis S. Goldobin</td></tr>
<tr><td>Key Words</td><td colspan="3">Physical Kinetics, non-equilibrium thermodynamic system, Phenomenological theory of weakly non-equilibrium systems, the general half-phenomenological laws, Kinetic Boltzmann equation, the lattice–Boltzmann methods, Fokker-Planck equation.</td></tr>
<tr><td>Brief Summary</td><td colspan="3">Physical kinetics deals with transport processes in non-equilibrium thermodynamic systems.<br>1) Phenomenological theory of weakly non-equilibrium systems;<br>2) Kinetic Boltzmann equation (KBE) and calculation of transport coefficients from the first principles;<br>3) Fokker-Planck equation for Brownian particles and stochastic systems.</td></tr>
<tr><td>Indicative Content</td><td colspan="3">Physical kinetics deals with transport processes in non-equilibrium thermodynamic systems. According to the methodological approaches and the specificity of considered physical systems, three branches are distinguished:<br>(1) Phenomenological theory of weakly non-equilibrium systems: Here, one studies the constrains for the general half-phenomenological laws, the basic form of which was (historically) empirically established for ‘simple’ systems. Thermodynamic cross-effects (e.g., thermal diffusion) and the Onsager reciprocal relations are considered.<br>(2) Kinetic Boltzmann equation (KBE) and calculation of transport coefficients from the first principles: Microscopic consideration of thermodynamic systems can be rigorously performed within the</td></tr>
</table>

| | |
|---|---|
| | framework of KBE—an equation for the evolution of the probability density in the particles' configuration space. KBE allows also a rigorous calculation of the transport coefficients for the transport laws from part (1). The knowledge of KBE yields a useful background for dealing with the lattice–Boltzmann methods widely employed for the numerical simulation of transport processes in distributed systems.<br>(3) Fokker-Planck equation for Brownian particles and stochastic systems: Formalism of the Master equation and resulting Fokker-Planck equation is an efficient tool for description of not only Brownian and nano-particles (magnetic monodomain particles and similar elements of smart composite materials), but also noisy nonlinear systems and the self-organization phenomena in networks (ranging from biological to social systems). The basic theory of this tool and its application to specific systems are in the focus of this part of the course. |