**A video course on**

**„Concepts in Soft Matter Physics“**

**-July 2019-**

This course is offered annually in the Master program ‚Computer Simulation in Science‘ as part of the Materials Science specialization. Students enrolled in the Physics Master may take this course in partial fulfillment of their ‚Fachliche Spezialisierung‘, where it is worth up to 9LP. Please be sure to consult with your prospective thesis advisor about your intention prior to taking the course.

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| Week 1 | Lec 1 | Review<br>thermodynamics | |
| W1 | Lec 2 | statistical Mechanics | |
| W2 | Lec 3 | Non-Equilibrium Thermodynamics:<br>transport in terms of fluctuation relaxation | R2014 |
| W2 | Lec 4 | continuation of transport in terms of fluctuation relaxation | R2014 |
| W3 | Lec 5 | balance equation approach to transport | R2014 |
| W3 | Lec 6 | Green-Kubo relations for the transport coefficients using the thermal conductivity as an example | |
| W4 | Lec 7 | entropy production in a steady state | R2014 |
| W4 | Lec 8 | chemical complexity and the second law versus evolution | R2014 |
| W5 | Lec 9 | Special Topics: Percolation, Fractals and Chaos – scale invariance without Hamiltonian<br>percolation | R2004,GT1995 |
| W5 | Lec 10 | fractals, chaos and scaling | R2004, GT1995 |
| W6 | Lec 11 | Polymer Statistical Mechanics:<br>a brief introduction, probability distribution of the end-to-end distance and Flory`s calculation of $\nu$ | RC2003, dG1979, W2009 |
| W6 | Lec 12 | rubber elasticity and characteristic ratio for chains of independent monomers | |
| W7 | Lec 13 | characteristic ratio in the cases of freely jointed, freely rotating and monomers with hindered rotation | |
| W7 | Lec 14 | transfer matrix and rotational isomeric state approximation | |
| W8 | Lec 15 | self-consistent field approach | |
| W8 | Lec 16 | lattice statistics of crowded polymers (solutions, melts and gels) | |
| W9 | Lec 17 | mechanical analysis of viscoelastic (polymer) materials | |
| W9 | Lec 18 | Rouse dynamics of a single chain | |
| W10 | Lec 19 | Reversible Supramolecular Assembly: Micelles, Vesicles, Membranes, Interfaces:<br>Examples and applications of reversible molecular self-assembly; equilibrium size distribution and critical micelle concentration | I2011, EW1999 |
| W10 | Lec 20 | phenomenology of growth and shape | |
| W11 | Lec 21 | surface tension, work of adhesion and wetting | |
| W11 | Lec 22 | computational aspects of surface tension | |
| W12 | Lec 23 | micellar solutions at higher concentrations – coupling of growth to shape and orientation for rod-like aggregates | C2000, GBR1994 |
| W12 | Lec 24 | liquid crystallinity | C2000, GBR1994 |
| W13 | Lec 25 | thermal shape fluctuation in the context of stability | GBR1994 |
| W13 | Lec 26 | Outlook – Computational Materials Science | |

**(Supplementary) literature:**


R2014: R. Hentschke (2014) *Thermodynamics*. Springer
R2004: R. Hentschke (2004) *Statistische Mechanik*. Wiley-VCH
GT1995: H. Gould and J. Tobochnik (1995) *An Introduction to Computer Simulation Methods: Applications to Physical Systems*. Pearson
I2011: J. Israelachvili (2011) *Intermolecular and Surface Forces. Elsevier*
EW1999: D.F. Evans, H. Wennerström (1999) *The Colloidal Domain – where Physics, Chemistry, Biology and Technology Meet. Wiley*
RC2003: M. Rubinstein, R. H. Colby (2003) *Polymer Physics.* Oxford
dG1979: P.G. deGennes (1979) *Scaling Concepts in Polymer Physics. Cornell Univ. Press*
W2009: C. Wrana (2009) *Introduction to Polymer Physics.* Lanxess
C2000: R. Hentschke, B. Fodi (2000) in *Supramolecular Polymers* (A. Ciferrri, Ed.). Marcel-Dekker
GBR1994: W.M. Gelbart, A. Ben-Shaul, D. Roux (Eds.) (1994) *Micelles, Microemulsions, and Monolayers*. Springer