Experimental Soft Matter Physics 2017, overview

A	Definition of soft matter, self-assembly and the key interaction mechanisms: van der Waals attraction, steric repulsion, hydrogen bonding and the hydrophobic effect.
B	Colloids and their stabilization; gels and glasses
C	Liquid crystals, lyotropic and thermotropic, low molar mass and polymeric.
D	Peculiar properties of polymeric soft matter.
E	Key characterization techniques in soft matter physics
F	Biological soft matter

Experimental Soft Matter Physics 2017, syllabus

Week	Section	Dates	L#	Content	Who ?	Pages in Jones
1	A	21/02	1	Introduction to the course. Discussion of schedule issues. Definition of soft matter, overview of the main classes. Self-assembly versus self-organization, dynamic versus static self-assembly. Central role of entropy.	JL	1-4
1	A	23/02	2	Energy scales compared to covalent bonding energies. Van der Waals interactions: three types of attractive interactions and steric repulsion. The Hamaker constant and its application.	JL	5-7; 52-57
2	A	28/02	3	Hydrogen bonds. Hydrophobic effect, aromatic interactions. Ionic interactions and ion dissolution. The electric double layer.	JL	8; 136-137
2	B	02/03	4	Models for the electric double layer. The ζ potential and the hydrodynamic radius.	JL	
2	A	*02/03*	*E1*	*Exercise on van der Waals interactions, Hamaker constant, entropy, …*	*RJ*	
3	B	07/03	5	Poisson-Boltzmann theory and the concepts Debye screening length and ionic strength.	JL	58-60
3	B	09/03	6	Definition of colloids and overview of main classes. Preparation of colloids. Stability of colloidal liquids: Brownian motion vs. gravity and viscosity.	JL	49-52, 60-62
3	A	*09/03*	*E2*	*Exercise on hydrogen bonds, hydrophobic effect charged surfaces and ions in solution.*	*RJ*	
4	B	14/03	7	Sedimentation and centrifugation. Stabilization of colloids. Colloid flocculation/coagulation. DLVO theory (only introduction).	JL	31-32; 62
4		16/03	8+ E3	*Project work (experimental work in our lab encouraged): DLVO theory, Casimir force, Poisson-Boltzmann, colloid synthesis, jamming and gelation, percolation and its applications, wetting/dewetting and hydrophobicity/hydrophilicity, capillary phenomena, synthetic opals, Marangoni effect and coffee ring effect, Life at low Reynolds number, granular matter.*		
5	B	21/03	9	Depletion attraction. Surface/interfacial tension & Ostwald ripening. Surfactant self-assembly (beginning)	JL	62-68; 8-10
5	B	23/03	10	Supramolecular self-assembly of surfactants. Micelle formation and the packing parameter. Colloid crystallization (part 1).	JL	41-46; 16-26
5	B	*23/03*	*E4*	*Exercise on colloid basics, colloid preparation and stabilization/destabilization, …*	*YG*	
6	B	28/03	11	***Project presentations (beginning).***	JL	
6	B/C	30/03	12	***Project presentations (continued).*** Gelation and percolation.	JL	95-102; 136-145
6	B	*30/03*	*L1*	*Lab on colloid preparation and the properties of colloids.*	*JL*	
7	C	04/04	13	Liquid crystals: definition of key concepts and overview of classes, phases (nematics, smectics, columnar phases) and their building blocks. Typical molecule structures. Historical development.	YG	104-106
7	C	06/04	14	Nematic elasticity and director field deformations in nematics and smectics. Topological defects (beginning).	JL	104-106
7	C	*06/04*	*E5*	*Exercise on colloid crystallization, mixtures & phase diagrams, phase transitions, surfactant self-assembly, …*	*YG*	

Week	Sec-tion	Dates	L#	Content	Who ?	Pages in Jones
8		11/04	15	Topological defects (continued). The Volterra process. Phase transitions. The Landau expansion, the Landau rules and symmetry considerations in liquid crystals. The glass transition.	JL	
	E	13/04	16	Mixtures and phase diagrams. Colloid crystallization (part 2).	JL	
		13/04	*E6*	Mid-term exam.	*RJ*	
9				***Easter Holidays***		
10	C	25/04	17	Optical anisotropy (birefringence): general and specific to liquid crystals.	JL	111-114
	E	27/04	18	Characterization 1: polarizing optical microscopy. Fundamentals of the microscope. The Michel-Levy diagram and determination of birefringence, the use of phase plates.	JL	107-111; 122-128
		27/04	L2	*Lab on polarizing microscopy.*	YG	
10	C	02/05	19	Viscous, elastic & viscoelastic behavior, and connection to glass transition. Nucleation and growth, spinodal decomposition. Anisotropic viscous properties of liquid crystals. The Miesowicz and the rotational viscosities of nematics.	JL	114-115
	C	04/05	20	The response of nematic liquid crystals to electric fields and elastic relaxation after field removal. Liquid crystal displays.	JL	116-117
		04/05	*E7*	*Exercise on liquid crystal phase transitions, polarizing microscopy, nematic elasticity, liquid crystal topology, liquid crystal viscosity…*	*YG*	
11		09/05	21	The optics of the Twisted Nematic explained using the Poincaré sphere. Cholesteric phases and their peculiar optical properties: Mauguin-type polarization guiding, optical activity and selective reflection.	JL	
		11/05	22+ E8	Participation in soft matter physics conference *Twisted.*		
12	C	16/05	23	Surface anchoring of liquid crystals and the control of the bulk director field via boundary conditions. Langmuir films. Self-assembled monolayers.	JL	145-151
	C/D	18/05	24	More on lyotropic liquid crystals. Vesicles. Biomembranes. Block co-polymers and their self-assembly in water and without solvent.	JL	
	C	*18/05*	*E9*	*Exercise on liquid crystal response to electric/magnetic fields, LCDs, Poincaré sphere, twisted nematics, cholesterics, …*	*RJ*	
	D	23/05	25	Liquid crystal polymers/elastomers and their applications.	JL	73-77; 85-86; 151-157
		25/05 *26+E10*		Holiday		

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13	F	30/05	27	Biological soft matter 1: nucleic acids and their self-assembled structures, natural and artificial.	JL	159-164
	F	01/06	28	Biological soft matter 2: protein self-assembly.	JL	165-174
	D	*01/06*	*E11*	*Exercise on Langmuir films, self-assembled monolayers, biomembranes, block co-polymers, liquid crystal elastomers, biological soft matter. …*	*YG*	