Applied Soft Matter Physics 2016, 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
G	Granular soft matter

Applied Soft Matter Physics 2016, syllabus

Week	Section	Dates	L#	Content	Lecturer	Pages in Jones
1-2	A	23/02	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.	VJ	1-4
		24/02	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.	VJ	5-7; 52-57
		24/02	3	Hydrogen bonds. Hydrophobic effect, aromatic interactions. Ionic interactions and ion dissolution. The electric double layer.	VJ	8; 136-137
		25/02	*E1*	*Exercise on van der Waals interactions, Hamaker constant, entropy, …*	JP	
	B	25/02	4	Models for the electric double layer. The ζ potential and the hydrodynamic radius.	JL	
3		2/03	5	Poisson-Boltzmann theory and the concepts Debye screening length and ionic strength. DLVO theory (only introduction).	JL	58-60
	A	*02/03*	*E2*	*Exercise on hydrogen bonds, hydrophobic effect charged surfaces and ions in solution.*	*VJ*	
	B	03/03	6	Definition of colloids and overview of main classes. Preparation of colloids. Stability of colloidal liquids: Brownian motion vs. gravity and viscosity. Sedimentation and centrifugation. Stabilization of colloids.	JL	49-52, 60-62
		09/03	7	*Project work (experimental work in our lab encouraged): DLVO theory, Casimir force, Poisson-Boltzmann, colloid synthesis, jamming*		

Week	Sec-tion	Dates	L#	Content	Lecturer	Pages in Jones
4		*09/03*		*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.*		
5	B	10/03	8	Surface/interfacial tension & Ostwald ripening. Colloid flocculation/coagulation.	JL	31-32; 62
		16/03	9	Depletion attraction. Colloid crystallization. Mixtures and phase diagrams (beginning).	JL	62-68; 8-10
		16/03	*E3*	*Exercise on colloid basics, colloid preparation and stabilization/destabilization, …*	*JP*	
		17/03	10	Mixtures and phase diagrams (wrap-up). Phase transitions. Glass formation.	JL	41-46; 16-26
6	B	23/03	11	***Project presentations.*** Viscous, elastic & viscoelastic behavior, and connection to glass transition. Nucleation and growth, spinodal decomposition.	VJ	10- 23; 26-40
	B	*23/03*	*L1*	*Lab on colloid preparation and the properties of colloids.*	*JP*	
	B/C	24/03	12	Gelation and jamming. Percolation. Supramolecular self-assembly of surfactants; the packing parameter and its relation to micelle vs. bilayer	JL	95-102; 136-145
				Easter Holidays		
7	C	06/04	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.	JL	104-106
		06/04	*E4*	*Exercise on colloid crystallization, mixtures & phase diagrams, phase transitions, surfactant self-assembly, …*	*VJ*	
		07/04	14	Optical anisotropy (birefringence): general and specific to liquid crystals.	JL	
8		***12/04, 8:00-9:30 ?***	15	The Landau rules and symmetry considerations in liquid crystals. Molecular arrangements and phase symmetries, liquid crystal phase transitions and appropriate order parameters.	JL	107-111; 122-128
	E	13/04	16	Characterization 1: polarizing optical microscopy. Fundamentals of the microscope. The Michel-Levy diagram and determination of birefringence, the use of phase plates.	JL	
	E	*13/04*	L2	*Lab on polarizing microscopy.*	JL	
9	C	**20/4, 11:30-13:00**	17	Director field deformations and nematic elasticity. Surface anchoring and the control of the bulk director field via boundary conditions. Topological defects in nematic and smectic phases. ***Shift because of Scientific writing on 21/04.***	JL	111-114
		20/04	18	Anisotropic viscous properties of liquid crystals. The Miesowicz and the rotational viscosities of nematics.	VJ	
	C	20/4	*ME*	*Mid-term exam*	*VJ*	
		27/04	19	Dielectric, conductive and magnetic anisotropy of liquid crystals and their response to electric and magnetic fields.	JL	114-115

Week	Sec-tion	Dates	L#	Content	Lecturer	Pages in Jones
10	C	*27/04*	*E5*	*Exercise on liquid crystal phase transitions, polarizing microscopy, nematic elasticity, liquid crystal topology, liquid crystal viscosity…*	*VJ*	
		28/04	20	Liquid crystal displays: how do they work? Other electrooptic applications of liquid crystals.	JP	116-117
11	C	04/05	21	Cholesteric phases and their peculiar optical properties: Mauguin-type polarization guiding, optical activity and selective reflection.	JL	
		04/05	*E6*	*Exercise on liquid crystal response to electric/magnetic fields, LCDs, …*	*JP*	
	C	05/05	22	More on lyotropic liquid crystals. Vesicles. Emulsions and foams. Langmuir films.	VJ	145-151
12	D	11/05	23	Block co-polymers and their self-assembly in water and without solvent. Rubbers; in particular liquid crystal elastomers and their potential applications.	VJ	73-77; 85-86; 151-157
	C/D	*11/05*	*E7*	*Exercise on cholesterics, lyotropic liquid crystals, vesicles, Langmuir films, …*	*JP*	
	C/F	12/05	24	Self-assembled monolayers. Biomembranes.	VJ	174-176
13	E	17/05	25	Characterization 2: electron microscopy, light and x-ray scattering, rheology, probe microscopy.	JL	
	F	18/05	26	Biological soft matter 1: nucleic acids and their self-assembled structures, natural and artificial.	JL	159-164
	D/F	*18/05*	*E8*	*Exercise on block co-polymers, liquid crystal elastomers, self-assembled monolayers, biomembranes…*	*VJ*	
	F	19/05	27	Biological soft matter 2: protein self-assembly.	JL	165-174
	G	19/05	28	Granular soft matter	JL	
	E-G	*25/05*	*E9*	*Exercise on characterization tools, biological and granular soft matter. …*	*VJ*	