



Introduction to Mechanics of Swelling

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Programme by days

lecture 1. Introduction to Foundational Physics of Mechanics of Swelling

- Material that swell: hydrogels & water (yes), rubber & water (no); which are the differences ?
- Short overview of basic thermodynamical issues: mixing and elastic energies.
- Flory-Huggins mixing energy, neo-Hooke and Arruda-Boyce elastic energies: from statistical to continuum mechanics.

lecture 2. Basic elements of mechanics of swelling

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- Gel body and body configurations: spatial and material description of mechanics.
- State variables and balance equations of forces and liquid mass.
- From the mixing and elastic energies to chemical potential, liquid fluxes and stresses.
- Boundary and initial conditions of the mechano-diffusion problem.

lecture 3. The free-swelling problem

- The equilibrium free-swelling state: controls and characteristics.
- Pressure balance and imbalance: osmotic versus mechanical pressure.
- An example of confined swelling.

lecture 4. The traction problem

- From the dry to the wet Rivlin traction problem: controls and characteristics
- Some comments on stability of solution: the role of the Flory-Huggins parameter.
- The uniaxial traction problem: controls and characteristics.

lecture 5. Swelling in active gels

- Which are active gels?
- The change of paradigm in the control of the solution.
- The free-swelling problem revisited.

References by lectures

- lecture 1. • M. Doi - *Soft Matter Physics*. Cambridge University Press, 2013 (Chapter 3).
 • L. Teresi - *Gel Dynamics*. Internal Report, 2016.
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 - M.E. Gurtin, E. Fried, L. Anand - *The Mechanics and Thermodynamics of Continua*. Cambridge University Press, 2010.
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 - P. Nardinocchi and L. Teresi - *On the active response of soft living tissues*. J. Elast. 88, 27-39, 2007.
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- lecture 5.
- Y. Ideses, V. Erukhimovitch, R. Brand, D. Jourdain, J. Salmon Hernandez, U. R. Gabinet, S. A. Safran, K. Kruse, and A. Bernheim-Groswasser - *Spontaneous buckling of contractile poroelastic actomyosin sheets*. Nat. Commun. 9, 2461, 2018.
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 - M. Curatolo, P. Nardinocchi, and L. Teresi - *Dynamics of active swelling in contractile polymer gels*. J. Mech. Phys. Solids 135, 103807, 2020.