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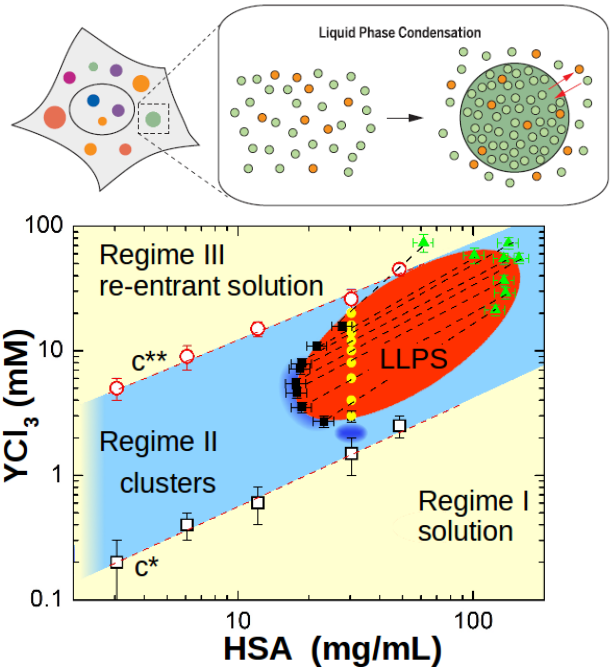
Bachelor/Master thesis in Protein Biophysics

Tuning Interactions in Protein Solutions

Living cells contain various types of condensed liquid-like structures through regulated phase separation. The rich intracellular phase behaviors including multiphase structuring and gelation from metastable liquids attract great attention in recent research.

In this project, we apply three different methods to generate LLPS in protein solutions: (1) by adding trivalent salts: the cation binding leads to strong attraction between proteins which induces a re-entrant LLPS; (2) by adding non-interacting polymers. Addition of a non-interacting polymers, such as polyethylene glycol (PEG), to a protein solution can induce various form of protein condensation as aggregation, LLPS, gelation and crystallization. The mechanism at the base of this phenomenon is known as depletion interaction [2]. By tuning the amounts and the kind of PEG in solution the phase behaviour of the solution can be accurately controlled. (3) by adding oppositely charged polyelectrolyte: in this case, the mixture undergoes a phenomenon called "coacervation", which refers to a LLPS driven by electrostatic attraction.



Top: Sketch illustration of LLPS in cellular organization, figure adapted from [1]
Bottom: phase diagram of HSA solution in the presence of YCl3 (adapted from [3]).

Topics and Methods:

- Determine the phase boundary of LLPS in representative systems;
- Study of highly concentrated protein solutions, gels and other condensed phases by scattering techniques
- Understanding of the protein-protein interactions and phase behavior in solution under the strong electrostatic coupling conditions. The goal is to determine phase diagrams.
- Methods: UV-vis spectroscopy, Static and dynamic light scattering (SLS/DLS), refractometry, video microscopy and image processing

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References and further information:

http://www.soft-matter.uni-tuebingen.de (see under publications and open positions)

1. Yongdae Shin, Clifford P. Brangwynne. "Liquid phase condensation in cell physiology and disease." *Science* 357 (2017): eaaf4382.
2. Marenduzzo, Davide, Kieran Finan, and Peter R. Cook. "The depletion attraction: an underappreciated force driving cellular organization." *The Journal of cell biology* 175.5 (2006): 681-686.
3. Fajun Zhang, et al. Soft Matter **8** (2012) 1313.