Probing Pressure-Driven Protein Phase Behavior via In-Situ High-Pressure Scattering Methods

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Protein phase behavior is of critical importance to a range of research and industrial activities, including manufacturing high-protein fluid foods, formulation design, and crystallography. Proteins are extremely sensitive to temperature and pH variations, presenting a significant challenge in processing and stabilizing these materials while preserving advantageous material properties. High hydrostatic pressure (HP) processing has been used in various applications to deactivate microorganisms and sterilize a product stream while maintaining product integrity, or to confer desired properties such as texture, stability, or mouthfeel. Recent developments in spectroscopic and scattering sample environments allow for in-situ pressure experiments both in-house and at large scale facilities, providing a route to uncover mechanisms through which high pressure acts on protein solutions and dense phases. We have used a suite of complementary ambient pressure (AP) techniques, including light scattering, circular dichroism, and microscopy, to characterize structural and stability trends for a model protein under varying solution conditions. The present talk will further highlight the use of in-situ HP small-angle neutron and X-ray scattering for investigating pressure-driven structuration in the model protein solution, and explore the possibility of engineering predictive tools for pressure-assisted processing.