2:00-2:40

Effective Protein-Protein Interaction and Clustering Phenomenon in Solution Studied by Small-Angle Neutron Scattering.

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The bottleneck of protein crystallography is the lack of systematic methods to obtain protein crystals, which is partly due to imprecise understanding of the physical chemistry conditions that control the growth of protein crystals. A general knowledge and comprehension of the effective protein-protein interaction potential in solution and the resulting phase behavior thus becomes essential. It has been shown that the crystallization curves of some globular proteins appear to coincide with the phase diagrams of a hard sphere system interacting with a short range attraction [1,2,3]. Moreover, the study of the intensity distribution, I(Q), of some proteins measured with small angle neutron and X-ray scattering also suggests presence of a short-range attractive interaction between protein molecules besides the electrostatic repulsion induced by the residual charges in protein molecules [4,5,6]. The so-called DLVO potential, which has been successfully applied in many colloidal systems, meets some successes when applied to protein solutions [3,4,13], but is still not enough to explain all the phenomena [4,7,8,9]. Due to the complexity (anisotropic property, irregular shape, distributed charge patches, etc.), the full understanding of the properties of the effective interaction between protein molecules in solutions remains a challenge [8]. Recent measurements of small angle neutron scattering (SANS) intensity distribution, in protein solutions by my group at MIT and others show some interesting results [6,10,14]. First, besides the first diffraction peak, arising from the nearest neighbor inter-particle correlation in the liquid, there is an extra peak appearing at a much smaller scattering wave vector Q, due to the formation of well-ordered clusters inside the solutions. The appearance of this cluster peak is explained as due to the competition between the short-range attraction and the intermediate-range electrostatic repulsion in the effective protein-protein interaction potential in solution [5,11,12]. Secondly, a rising intensity as Q approaching zero is observed in both liquid-like and solid-like samples, which can be shown to be due to the presence of another weak, very long-range attractive interaction term, in addition to the already proven short-range attraction and intermediate-range electrostatic repulsion [12,14].

In this lecture, I shall show the results of a systematic SANS investigation of the clustering phenomenon and the newly found increasing low-Q intensity and its relation to the long-range interaction term.

Supplemental Readings:

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