Mesoscopic theory for equilibrium properties of self-assembling particles in molecular solvents

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Mesoscopic theory motivated by the question of universal rules governing structure formation in various soft matter systems is briefly presented. Our aim is to develop formalism for predicting structure formation and phase transitions in mixtures with particles spontaneously forming aggregates, clusters, micelles etc., which can next form some kind of patterns in thermal equilibrium, including periodic structures. In the mesoscopic theory irrelevant degrees of freedom are eliminated, and the grand potential is expressed in terms of volume fractions of all components averaged over mesoscopic regions. The formalism combines density functional and statistical field theories [1,2]. Based on the properties of the (effective) interactions, we can predict whether separation into homogeneous phases or formation of inhomogeneous structures (aggregates) takes place. Predictions of the theory are illustrated on a few examples. In particular, universal sequence of basic patterns of aggregates for increasing volume fraction of solute particles is found [1].

[1] A. Ciach, "Universal sequence of ordered structures obtained from mesoscopic description of self-assembly", Phys.Rev.E, **78**, 061505 (2008)
[2] A. Ciach , "Mesoscopic theory for inhomogeneous mixtures``, Mol. Phys., **109**, 1101 (2011)