

Micelles Hydrodynamics

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A micelle is an aggregate of lipid molecules dispersed in a liquid colloid. A typical micelle in aqueous solution forms an aggregate with the hydrophilic "head" regions in contact with surrounding solvent, while the hydrophobic tail regions are pointed toward the aggregate center. The aggregation is caused by hydrophobic and hydrophilic interaction of lipids with surrounding water molecules. In mechanical equilibrium conditions micelles are spherical in shape. The shape and size of a micelle are a function of the molecular geometry of its surfactant molecules and solution conditions such as surfactant concentration, temperature, pH, and ionic strength. In order to answer the question "why the shape of micelles are sphere in mechanical equilibrium conditions" it is necessary to consider the motion of micelles in fluid, induced by hydrophobic and hydrophilic interactions. In fluid dynamics material particles can be treated as a vertex of geometric figure and virtual layers as surfaces, and can be searched for equations of motion of such surfaces. The surfaces shall be called a differentially variational surfaces (DVS). We had proposed equations of motion of moving surfaces in aqueous solutions and applied it to analyze micelles morphology in fluid dynamics [1, 2]. Hydrophobic and hydrophilic interaction incorporates dispersive interactions, throughout the molecules, mainly related to electrostatics and electrostatics (Van der Waals forces), induced by permanent (water molecules) or induced dipoles (dipole-dipole interactions) and possible quadrupole-quadrupole interactions (for instance stacking or London forces) plus ionic interactions (Coulomb forces). The hydrophobic effect can be considered as synonymous with dispersive interactivity with water molecules and the hydrophilic one as synonymous with polar interactivity with water molecules. All these interactions have one common feature and can be unified as electro-magnetic interaction's dependence on interacting bodies' geometries, where by geometries we mean shape of the objects' surfaces [2, 3]. Analytical solution of simplified DVS equations, displayed all possible shapes of micelles spanning spheroids, lamellas, and cylinders. The equations can be applied to problems related to cell motility and growth factors and shows that, in the mechanical equilibrium conditions with the solvent, trace of the mixed curvature tensor is pressure divided on membrane tension [1, 2].

References

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