Dynamics and Instabilities of Interfaces and Fluid Membranes

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Dissipative structures and instabilities of biological membranes modelled by fluid interfaces or thin liquid films sandwiched between mixtures of fluids are manifold. The interface and the thin liquid films themselves are considered as deformable with arbitrary shape. The dissipative structures and instabilities can be induced by material exchange between the bulk mixtures, temperature gradients and surface chemical reactions which lead to a change in the surface tension. Moreover variations in the surface tension can be generated by temperature fluctuations and fluctuations of the surface density. The transport properties of the cell are important to obtain criteria for the growth of the cell, a stationary state or for the starve out of the cell. We describe the properties of the biological membrane by a thermodynamical field theory of discontinuous media [1,2,3]. To that we discuss balance equations for heat conducting and semipermeable liquid films from three-dimensional considerations [4]. If the thickness of the liquid film tends to zero we obtain the balance equations of the fluid interfaces as derived in a previous theoretical framework [1]. We investigate viscous fluids on the interface as well as extra- and intra-cellular viscous fluids. We give a systematic discussion of the constitutive equations of viscous materials and we discuss rigorously the restrictions which follow from an entropy inequality on interfaces [1]. We combine the constitutive equations with the balance equations to obtain field equations. Furthermore we discuss some thermodynamical processes and we give a theoretical study of stability and instability of model membranes. This is important to understand cell rupture and to find thermodynamical criteria of the cell rupture.

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2. Grauel,A., (1980), 353, in Liquid Crystals of One-and Two-Dimensional Order (Editors W.Helfrich, G. Heppke), Springer Series in Chemical Physics, Springer-Verlag, Heidelberg.
3. Grauel,A., (1981), appear in International Journal of Mathematical Modelling, part I and part II.
4. Grauel,A., (1981), preprint.