The "swollen phase" and the "anomalous swelling" in DPPC aqueous solution with ethanol

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Lipid bilayers are investigated by many researchers in these decades as model biological membranes not only from a viewpoint of biology but also of physics. They exhibit a richness of structures and phase equilibria depending on their environmental conditions such as water content, ionic strength, temperature, pressure, etc. A fluid lamellar phase (liquid-crystalline L_α phase) is a basic structure of biological membranes that appears at higher temperature. In this phase, bilayers are regularly stacked and flat on average, forming multilamellar vesicles. With decreasing temperature, several thermotropic phase transitions have been observed; a " main transition " from the liquidcrystalline phase to a gel (P'_β) phase and a " pre-transition " from the P'_β to another gel (L'_β) phase. In these gel phases, the hydrophobic tails of lipid molecules are extended and ordered, whereas the tails are conformationally disordered in the liquidcrystalline phase. In the middle-temperature P'_β phase, a two-dimensional lattice structure is formed in which the lipid bilayers are distorted by a periodic ripple in the plane of lamellae. Recently, the authors showed the existence of new " swollen phase ", in which the thickness of lipid bilayers is almost the same as in the gel phases and only the thickness of the water layer is larger than the other phases, is confirmed between the L_α phase and the $L_{\beta I}$ phase. [1] This phase is induced only by increasing pressure (without adding ethanol) and only by adding ethanol (without increasing pressure). The nature of this phase is similar to the anomalous swelling observed between the liquid crystalline phase and the ripple gel phase. [2]

References

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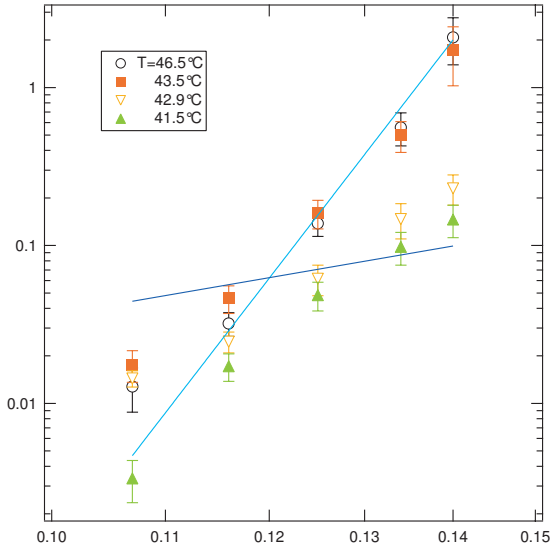

Fig. 1. The temperature dependence of the decay rate of the intermediate correlation function observed by NSE.