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Phase Transitions in Model Biomembranes

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Phase transitions in the organic/inorganic layered structure compounds, which have been known as the representative model biomembrane, have been studied by employing ^{1}H nuclear magnetic resonance. Two types of layered structure compounds have been studied; $C_{10}H_{21}NH_3Cl$ and $(C_nH_{2n+1}NH_3)_2SnCl_6$. The phase transitions in these systems are driven by the alkylammonium chains, which represent a smectic lipid layer embeded in a crystalline matrix. C10H21NH3Cl undergoes an irreversible phase transition ($\iota \to \delta$ transition) from an interdigitated to a noninterdigitated chain configuration and the $\delta \to \alpha$ transition is accompanied by the smectic *C* to smectic *A* transition in the lipid bilayer. $(C_nH_{2n+1}NH_3)_2SnCl_6$ has a similar interdigitated chain configuration to $C_{10}H_{21}NH_3Cl$ but undergoes two reversible phase transitions; the reorientational order-disorder transition and the conformational transition. The reversibility and the irreversibility seems to be also reflected in the nematic order; the nematic order in $C_{10}H_{21}NH_3Cl$ has 2D nature but that in $(C_nH_{2n+1}NH_3)_2SnCl_6$ 3D nature. The rigid and the mobile parts of alkylammonium chain correspond to the transition from the interdigitated to the noninterdigitated chain configuration and the smectic *C* to smectic *A* transition, respectively. The overall critical dynamics is well described using the kinetic Ising model. In the light of the kinetic Ising model we can ascertain a dimensional crossover from 3D to 2D at the $\iota \to \delta$ transition in $C_{10}H_{21}NH_3Cl$. A low frequency (kHz range) fluctuation was observed both in $C_{10}H_{21}NH_3Cl$ and in $(C_nH_{2n+1}NH_3)_2SnCl_6$. The low frequency fluctuation seems to be associated with the slow motion of large chain segment. The soliton-like collective kink motion is a strong candidate for the fluctuation, which is very important in relation to the matter transport in the cell membrane.