2D-Ising like critical behavior in mixtures of water/organic solvent/antagonistic salt

K. Sadakane

Faculty of Life and Medical Sciences, Doshisha University

Mixtures of water and organic solvents near the lower critical solution temperature (LCST) generally exhibit only disordered concentration fluctuations without forming ordered mesoscale structures. We have previously demonstrated that the addition of an antagonistic salt induces a highly ordered concentration fluctuation phase in such mixtures. Furthermore, we found that the critical behavior in this phase belongs to the 2D-Ising universality class despite the system being three-dimensional. These findings suggest that antagonistic salts fundamentally modify both the static structure and critical dynamics of concentration fluctuations [1].

Our current research aims to clarify the statistical-mechanical mechanism by which antagonistic salts induce the HOCF phase and the emergence of 2D-Ising-like criticality. As an important step toward this goal, the present iNSE experiment was designed to investigate the dynamics of concentration fluctuations in D_2O/3-methylpyridine/$NaBPh_4$ and D_2O/2-butoxyethanol/$NaBPh_4$ mixtures.

Because of the limited beam time and the complexity of the measurements, the planned dynamic measurements around the critical point could not be completed during this experimental run. Instead, we performed a feasibility study using the lamellar phase of the D_2O/3-methylpyridine/$NaBPh_4$ system at room temperature, where sufficiently strong neutron scattering is available. The effect of adding 2 mmol/L NaCl was also examined.

Figure 1 shows the obtained iNSE results. The relaxation rate, Γ, exhibits an approximately cubic dependence on the scattering vector, Q, i.e., $\Gamma \propto Q^3$, which is consistent with the prediction of the Zilman–Granek model for membrane undulation dynamics. Although the present measurements are preliminary, the results demonstrate that reliable iNSE measurements can be performed for this system and provide a solid basis for future investigations.

In future beam times, we will extend the measurements to the vicinity of the critical point in order to determine the dynamic critical behavior of concentration fluctuations and to clarify the relationship between the high-ordered concentration fluctuation phase and the observed 2D-Ising-like universality.

[1] K. Sadakane *et al*., Soft Matter **7**, 1334 (2011).

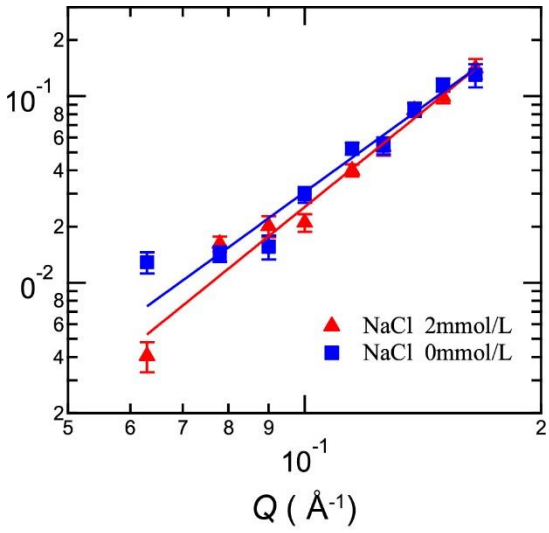

Fig. 1. iNSE results for the lamellar phase of the D_2O/3-methylpyridine/$NaBPh_4$ system without NaCl and with 2 mmol/L NaCl. The relaxation rate shows an approximately Q^3 dependence, consistent with the Zilman–Granek model.