ESRF	**Experiment title:** Interactions between charged membranes	**Experiment number:** 32-02 716
Beamline: BM32	**Date of experiment:** from: 17 Nov. 2010 to: 23 Nov. 2010	**Date of report:** 12 Feb. 2012
Shifts: 18	**Local contact(s):** Micha Jean-Sébastien	*Received at ESRF:*

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Report:

The understanding of the interactions between charged lipid bilayers is not only crucial for biology, it is also a fascinating problem for physicist. Indeed, the interactions between charged fluctuating membranes are still not fully understood. The Poisson-Bolzmann theory can describe the behavior of the charged membranes depending on the Debye and Gouy-Chapman lengths, but only few experiments were done to test the limits of this theory. Our model system, made of two supported bilayers, showed in this experiment its abilities to test these limits.

The aim of the experiment was to measure the elastic and structural parameters of supported bilayers with different Debye and Gouy-Chapman lengths. To reach this goal we planed to systematically vary the charge rate by changing the ratio between DSPC and DPPC, and to vary the salt concentration into the bulk water. We focused first on fully charged bilayer. We then investigated the effects of charge screening on the low charge density limit. Because of unexpected but interesting effects in this limit, we needed to spend more time than expected, and we were thus not able to vary the surface charge density as previously planed.

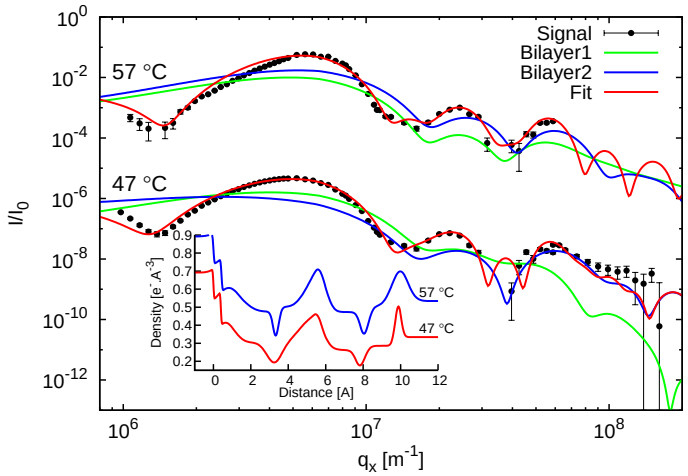

Fig. 1 :Off-specular reflectivity of a fully charged DPPS double bilayer in gel and fluid phases and best fit.

We focused first on fully charged double bilayers :

- we measured a very small water thickness (< 7 $\mathring{A}$), confirming previous experiments of neutron reflectivity
- the bilayers thicknesses and the electronic densities of the PS heads are in good agreement with numerical simulations (Pandit et al) and previous experiments of X-ray diffraction (Jing et al.)
- charged membranes are more rigid than those made of zwitterionic lipids at the same temperature, which is coherent with results from Petrache et al.
- we measured for the first time the curvature of the interaction potential between two fully charged bilayers, and showed that they are strongly correlated and then fluctuate in phase

We studied then zwitterionic membranes (DSPC) with different ionic strengths. Our DSPC double bilayers are known to have a high interbilayer water thickness (d_w =20-30 $\mathring{A}$) and a low curvature of the interaction potential, which cannot be explained by the usual models. We showed that adding salt to the bulk water led systematically to smaller water thicknesses, and higher curvatures of the potential. This effect is now well understood : the low surface charge of the membrane due to dissociation of DSPC (amphoteric lipids) leads to a repulsion between the membranes. This electrostatic interaction is screened with salt in solution.

The beamline BM32 was working well and the beamtime was used at 100%. Sample preparation was also satisfactory, according to both quantitative (transfer rates reproducibly $> 95\%$) and qualitative criteria.