ESRF	**Experiment title:** Supported bilayer in highly charged limit: beyond the Poisson-Boltzmann theory	**Experiment number:** SC-3590
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Shifts: 18	**Local contact(s):** Jean-Sébastien Micha	*Received at ESRF:*

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Report:

Electrostatic intercations between highly charged systems, when correlations between couter-ions are not neglectible, is highly challenging of physics. Theoretical work and numerical simulations are complex [1]. They have shown the limits of the Poisson-Boltzmann theory [2, 3], where strong correlations between the ions could change the repulsive interaction to an attractive one, but these effects are difficult to observe experimentally. We have begun experiments on fully charged double bilayers where a highly repulsive potential is expected. We have first shown by using Neutron reflectometry at the ILL that the deposition of charged double bilayer on solid substrate was still feasable (see exp. report 8-02-427). We have then performed preliminary x-rays off specular experiments on BM32 line of the ESRF (see exp. report 32-02 716) and we observed highly surprising effects:

- The structure of double bilayer is clearly observed, with a surprisingly small water thickness between the bilayers (¡ 1 nm);
- The bilayers appears to be rigid and strongly correlated.

These results are incompatible with the Gouy-Chapman regime, where one should observe repulsion between the membranes. We believe that our experiments give us unique opportunities to shed light on this fundamental question. By using well controlled systems, and powerfull off-specular reflectivity experiments we will simultaneously determine interaction potential and bilayer intrinsic properties in various systems: charges asymmetry, ionic strength modification...

During the experiment, we have made systematic specular and off-specular reflectivity experiments on fully charged floating bilayer of DPPS on 7 differents samples, changing temperature from gel to fluid phase (see Figure 1 for an example) and investigating the effect of salt. We obtained very reproducible and nice measurement, confirming our previous results with neutrons and x-rays on the structure of the sample. Off-specular data are specially interesting, because they give us access to the interaction potential between the layer, and also to their bending rigidity and surface tension. Data analysis is still in progress, and we need to modify deeply the model we used for calculating the correlation between bilayers.

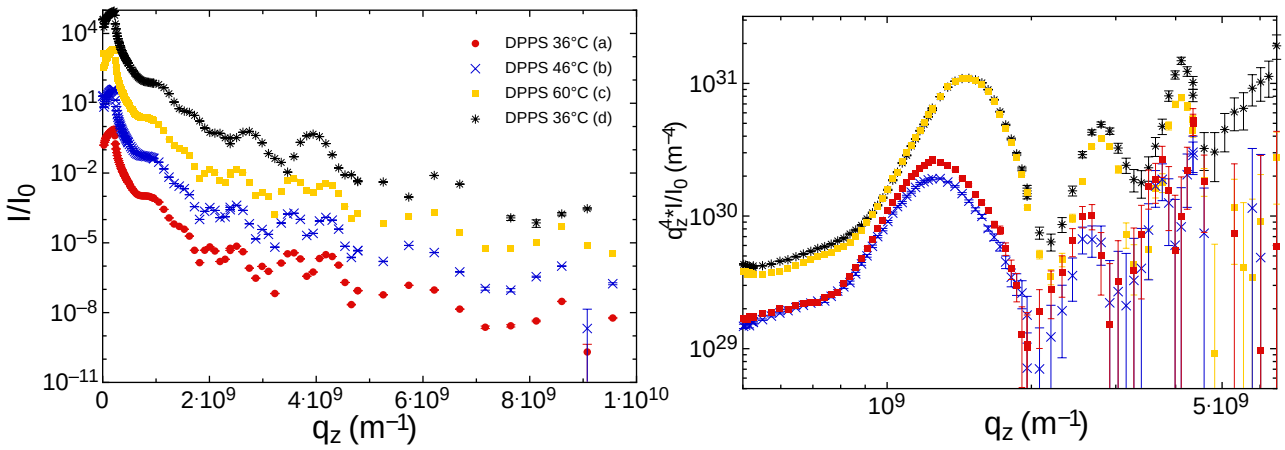

Figure1: Specular reflectivity (Left) and off-specular reflectivity (Right) for double DPPS bilayers at different tempratures.

The results are highly promissing and they could help us to have a deep understanding of electrostatic interactions between strongly correlated objects like lipid bilayers.

References

[1] D. Andelman *Handbook of biological physics*, Elsevier Science (1995). [2] A. Moreira, and R. Netz, Binding of Similarly Charged Plates with Counterions Only, *PRL*, 87:078301, 2001. [3] P. Attard, D. J. Mitchell and B. W. Ninham, *The Journal of Chemical Physics*, 8, 4987-4996 (1988).