



Experiment title: THE ROLE OF ELECTRO-STATICS IN THE ANOMALOUS HEIGHT FLUCTUATION SPECTRUM OF AMPHIPHILIC FILMS ON A DIVALENT CATION SUBPHASE

Experiment number:
SC-298

Beamline:

ID10

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Shifts:

14

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Report:

This experiment is part of a long term investigation of the statistical and elastic properties of two-dimensional organic monomolecular films down to very short in-plane length-scales. It was a continuation of the experiments SC-15 (6-11 October 1994), SC-54 (11-16 April 1995), SC-98 (4-9 October 1995) and SC-234 (11-16 December 1996). The aim of the experiment SC-298 was to investigate the possible electrostatic origin of the anomalous height fluctuation spectrum of amphiphilic films on divalent cation subphases, such as observed for arachidic acid on a Cd^{2+} subphase studied in experiment SC-54.

One possible interpretation of the origin of the non-trivial power-law behavior of the height-height fluctuation spectrum is due to specific divalent cation effects: the polarizability of the film and dipole interactions arising from ion condensation at the monolayer. The experimental method undertaken was to measure the surface diffuse-scattering spectrum for monomolecular layers of fatty acids at different surface pressures and different condensed phases on a divalent cation (Pb^{2+} , Cd^{2+} , Co^{2+} or Mn^{2+}) aqueous subphase at high pH.

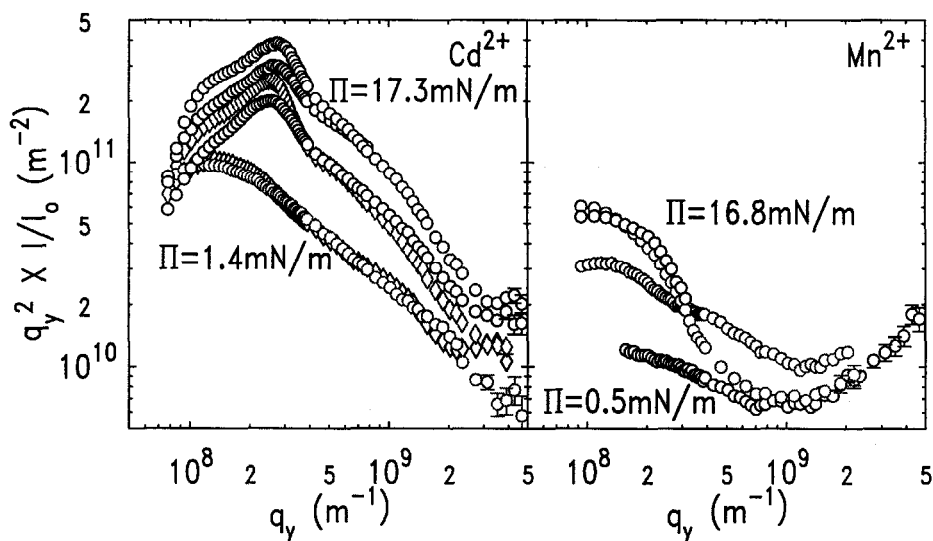
The experimental configuration used corresponded to that optimized during SC-234 in December 1996 to measure the surface diffuse-scattering with a wave-vector transfer in the plane of the surface. A new diamond C^* (111) monochromator used in a Laue-transmission geometry was installed with a new stress-free heat-sink mount and proved to be stable throughout the experiment. An SiC mirror (and reflection from the water surface) suppressed the higher harmonics. We modified our x-ray Langmuir trough so that it could be reversed and installed asymmetrically in order to maintain the "Troïka1" diffractometer detector-arm. An improved, high detector-slit made from W rods was installed at the end of a long vacuum flight-path which formed a collimator with a motorized 30 mm high slit at its entrance. Thus, the diffractometer resolution could be easily varied and optimized. The Ar gas-filled linear detector was used to discriminate surface from non-surface (bulk, vapor and window) scattering.

The diffractometer performed quite well and only minor improvements to the configuration will be used for future liquid surface-scattering experiments.

However, the present run was plagued by a deteriorating hutch beam-shutter operation which kept us, the floor coordinators, the beamline responsible and the safety group occupied. The opening of the beam shutter finally became inoperational late Sunday night and could not be resolved until later Monday morning. As a result of these problems, and despite the additional buffer time allocated by G. Gübel, only about 9 "shifts" were indeed available for the experiment.

The main results obtained during this experiment are:

- reproduction, confirmation and extension of the measurement of scattering from the bare water surface of SC-234.
- anomalous surface scattering when Cd^{2+} ions are present in the subphase at zero surface pressure, as observed in SC-54.
- strong buckling of the film under compression. The buckling wavelength $\sim 2\pi/2 \cdot 10^8 m^{-1} \sim 30$ nm does not change significantly under further compression, but the amplitude does increase.
- different behavior when Mn^{2+} ions are present in the subphase. Contrary to Cd^{2+} ions, Mn^{2+} ions are not expected to have a specific interaction with the monolayer. A much weaker buckling of the monolayer under compression is observed.



The peak at $2 \cdot 10^8 m^{-1}$ appears under compression and does not move with further compression. It is known from optical and diffraction studies that the film is composed of large monocrystalline domains. The film is homogeneous at scales $< 1 \mu m$ and the only possible source of scattering (i.e. refractive index inhomogeneities) are therefore surface corrugations.

Finally, as for SC-234 in December 1996, the experiments depend upon measuring diffuse-scattering intensities less than 10^{-7} of the incident beam. The background scattering from the subphase, vapor and trough windows must be systematically measured and subtracted; In order to obtain reasonable statistics, long counting-times (about 3 to 4 hours per measured spectrum) were necessary and the experiment was flux-limited. Thus, the **16-bunch** operation mode with only 45 - 90 **mA** in the scattering ring is not the most appropriate for these experiments.