ESRF	**Experiment title:** COUPLING BETWEEN IN- AND OUT-OF-PLANE FLUCTUATIONS IN 2-DIMENSIONAL MONOMOLECULAR FILMS.	**Experiment number:** SC-98
Beamline: BL9-ID10	**Date of Experiment:** from: 2 October 1995 to: 6 October 1995	**Date of Report:** 29 February 1996
Shifts: 15	**Local contact(s):** J.-F. Legrand	*Received at ESRF:*

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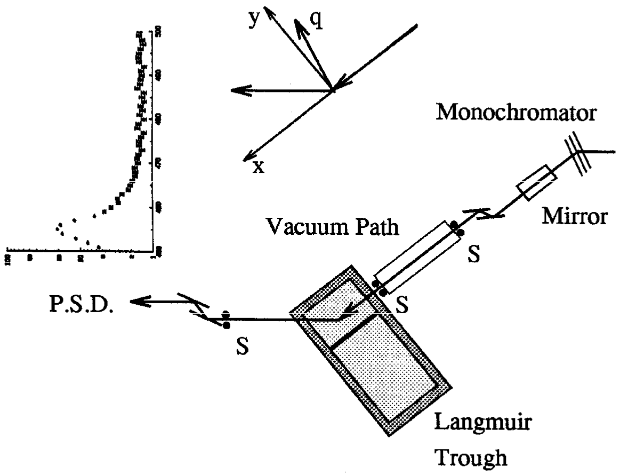
Report:

THIS IS ONLY A PARTIAL TECHNICAL REPORT WRITTEN TO HELP EVALUATING THE PROPOSAL "MOLECULAR ORIGIN OF THE BENDING ELASTICITY OF AMPHIPHILIC MONOLAYERS". A COMPLETE REPORT WILL BE SENT AS SOON AS A FULL DATA ANALYSIS IS TERMINATED.

The aim of experiment SC98 was to investigate the coupling between in- (phonons) and out-of-plane (capillary waves) fluctuations in 2-dimensional Langmuir films. This implied measuring Bragg singularity y profiles very precisely. To achieve this, we used the experimental setup schematically represented in the figure below:



In order to maximise the signal from the surface monolayer and to lower the background coming from the bulk liquid, the incidence is fixed below the critical angle for total external reflection by tilting a mirror (see figure). There is no resolution enhancement due to grazing incidence for in-plane scattering, and it is therefore necessary to impose severe constraints on the direct beam fall-off. Accordingly, the beam was defined using a channel-cut silicon monochromator yielding a q^{-3} fall-off of the intensity in the direct beam wings. A similar crystal was used as an analyser and the scattered intensity was recorded using a gas-filled position sensitive detector that was mounted vertically directly behind the channel-cut analyser. As the surface scattered intensity is peaked near the critical angle for total external reflection, the background can be easily *subtracted.* This is of considerable importance for future experiments, in particular at solid-liquid or liquid-liquid interfaces. Moreover, since the scattered intensity can be written in a simplified form as:

$$I(q) \propto F(q_z) \times \langle z(q_y) z(-q_y) \rangle ,$$

where $F(q_z)$ gives account of the normal z structure of the interface. The Fourier transform of the height-height correlation function, i.e. the capillary wave spectrum will be demonstrated below to be consistent with $\langle z(q_y)z(-q_y)\rangle \propto [\rho g + \gamma q^2 + K q^4]^{-1}$ in the case we investigated, as expected from the Helfrich Hamiltonian, where ρ is the density of water, γ the surface tension measured using a Wilhelmy plate, and K the bending rigidity modulus. In contrast to our previous experiments where the scattered intensity was recorded in the plane of incidence, the fluctuation spectrum determination is therefore completely decoupled from the structure determination, thus allowing a more direct and precise interpretation of the scattered intensity.

This is illustrated by the measurements on pure water and the CS phase of behenic acid presented below. Whereas the intensity scattered by the behenic acid film at small q_y is larger than the one scattered by the water surface, this is no longer the case at larger q_y. In the latter case the fluctuations of the film are then also limited by bending rigidity effects. A preliminary data reduction is consistent with a q^{-2} fall off of the intensity scattered by pure water and behenic acid in the small q_y regime and a q^{-4} fall-off at larger q_y values. The estimated value of the bending rigidity is $K = 180 \pm 10 k_B T$. The precision of the measurement is therefore much higher than in all the previous estimations.