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INTRODUCTION

DPPC is the dominant lipid (45wt%) [1] in the alveolar monolayer (Fig.1). It is the only known lipid that can be compressed to ~70mN/m without monolayer collapse.

Here we present results from grazing incidence X-ray diffraction (GIXD) experiments. They reveal two distinct structural transitions in the chain lattice of DPPC. This confirms previous results from Langmuir isotherm measurements. Especially, the structural details of the second phase transition at high surface pressure ($\Pi \sim 50$ mN/m) were not reported so far. The physiological relevance of the findings is still under discussion.

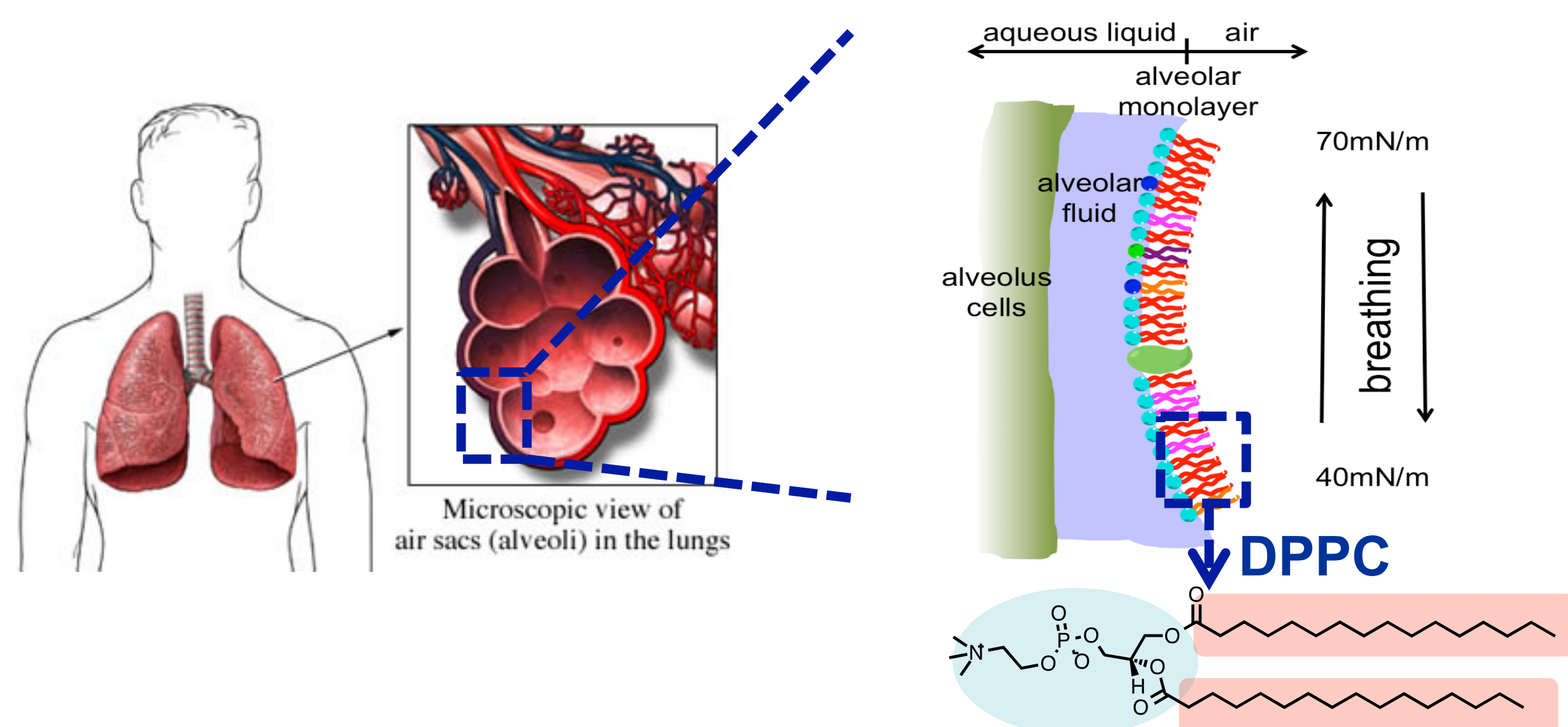


Fig. 1: Schematic view of the lung alveoli [2] (left), a model alveolar monolayer and its surface pressure variation during breathing process [1] (right), the structure of a DPPC molecular (below)

GRAZING INCIDENCE DIFFRACTION

GIXD experiments were performed at DORIS III (Hamburg, Germany) using beamline BW1.

The off-specular diffraction intensity $I(Q_z, Q_{xy})$ (Fig.4) is proportional to the structure factor $S(Q_{xy})$ of the lateral lattice of the alkyl chains and to their molecular form factor $F(Q_z, Q_{xy})$.

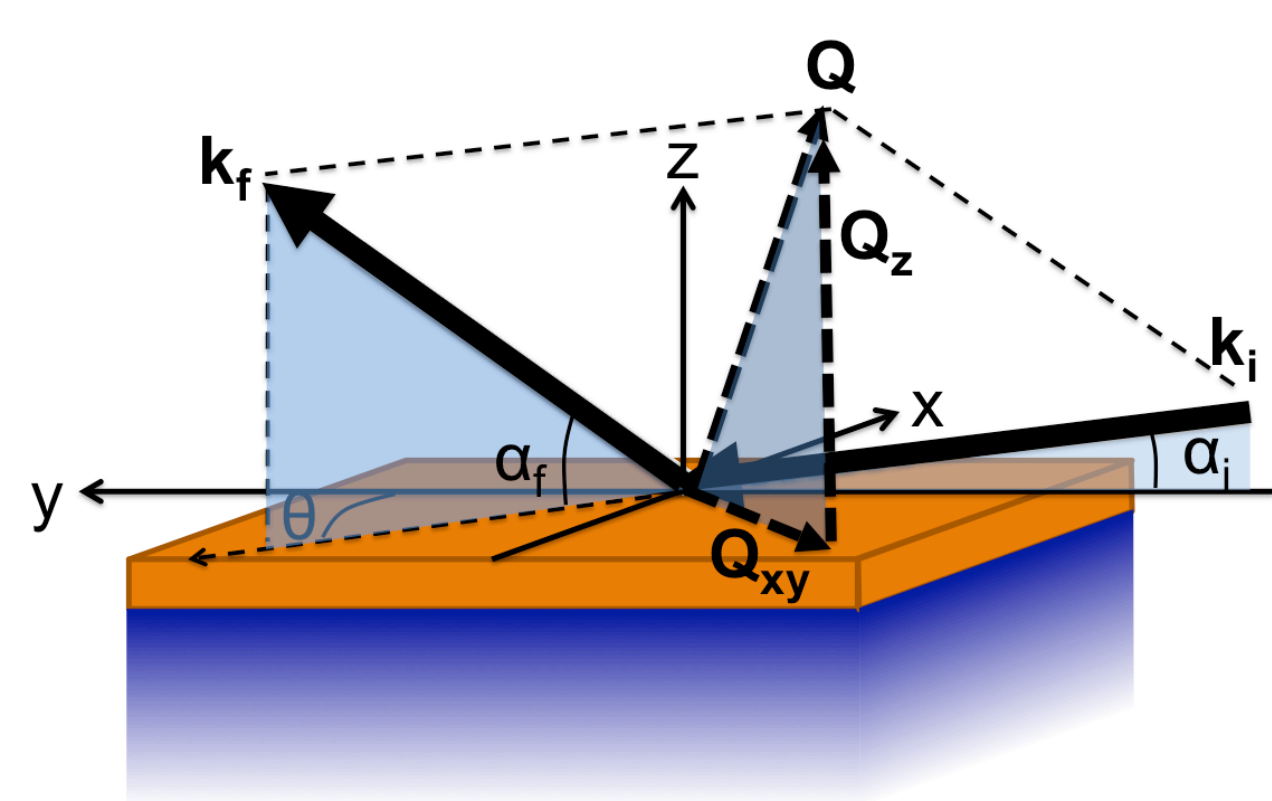
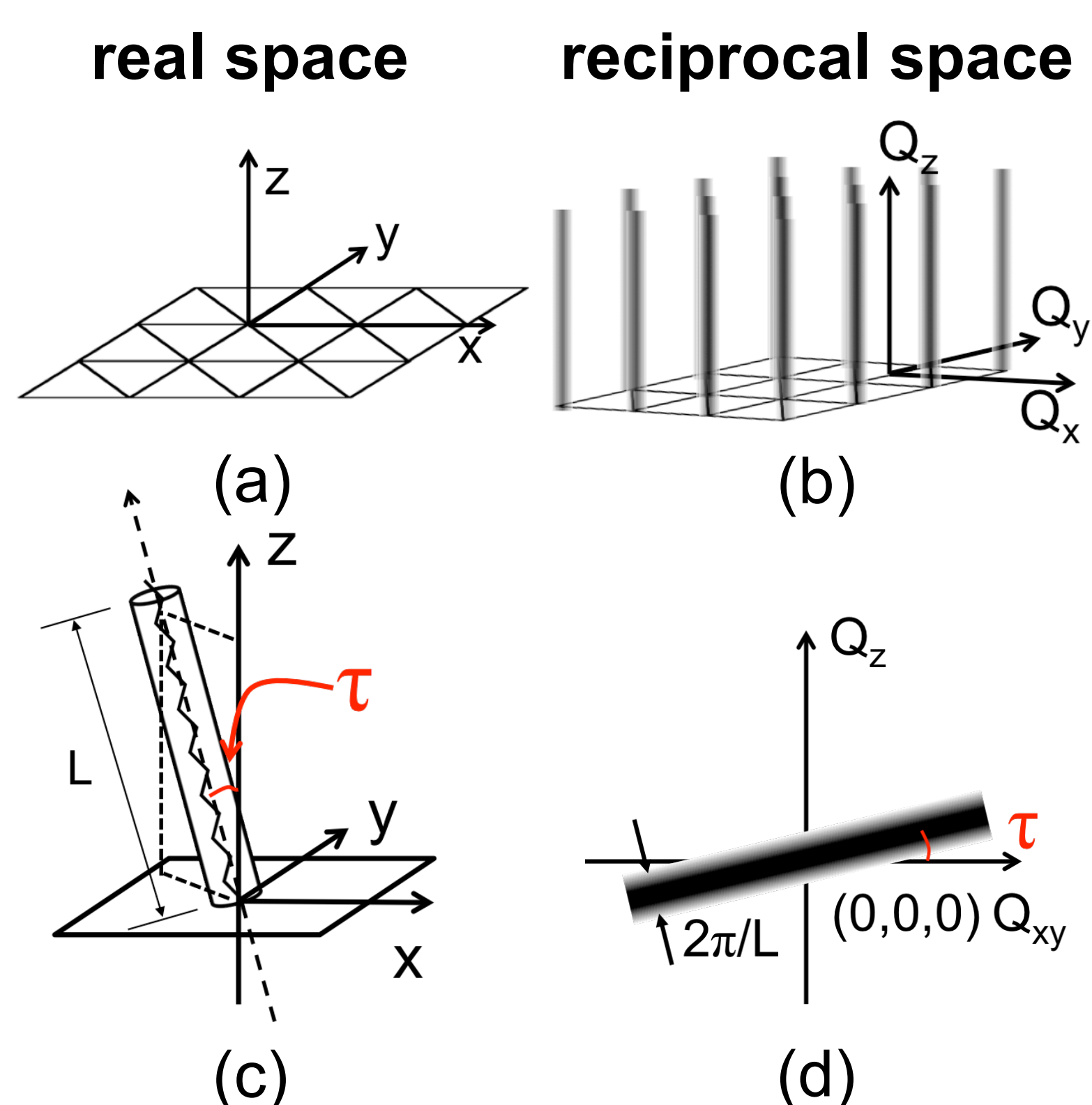


Fig. 2: Geometry of a GIXD experiment. The value of the angle of incidence α_i is about 85% of the value of the critical angle α_c . The off-specular diffraction pattern reports on the in-plane lateral organization of the interfacial region (in orange).

Fig. 3: Representation of the monolayer as a 2D-crystal, in real and in reciprocal space

- a. in-plane lateral lattice of alkyl chains (see also fig. 6)
- b. $S(Q_{xy})$
- c. cylinder model of a chain tilted by angle τ
- d. $F(Q_z, Q_{xy})$



References

1. Schürch, S., M. Lee and P. Gehr (1992). "Pulmonary surfactant - surface-properties and function of alveolar and airway surfactant." Pure and Applied Chemistry **64**(11): 1745-1750.
2. Figure modified from "http://medicine.med.nyu.edu/pulmonary/node/674"

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LATERAL STRUCTURES of DPPC MONOLAYERS

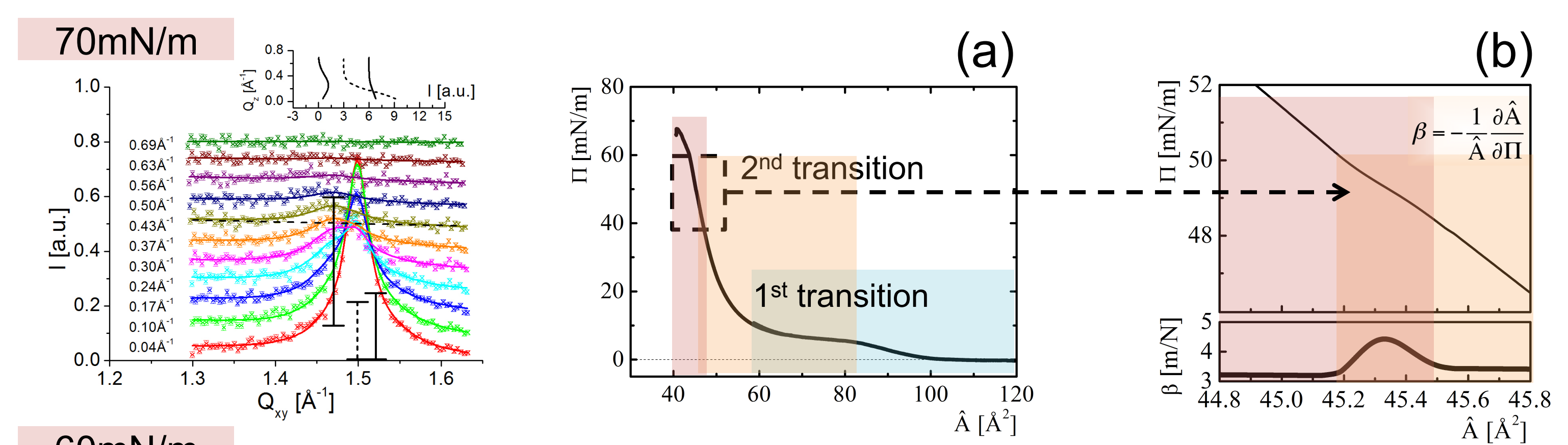


Fig. 4 : Phases of DPPC monolayers
a. Langmuir compression isotherm
b. zoom in to Langmuir isotherm, with corresponding compressibility β

color code:

ordered liquid B ordered liquid A disordered liquid

Fig. 5 (left): 2D-diffractograms of DPPC monolayers at several compression states. Bars denote the positions and the widths of the diffraction peaks. Solid and dashed pattern mark coexisting lattices.

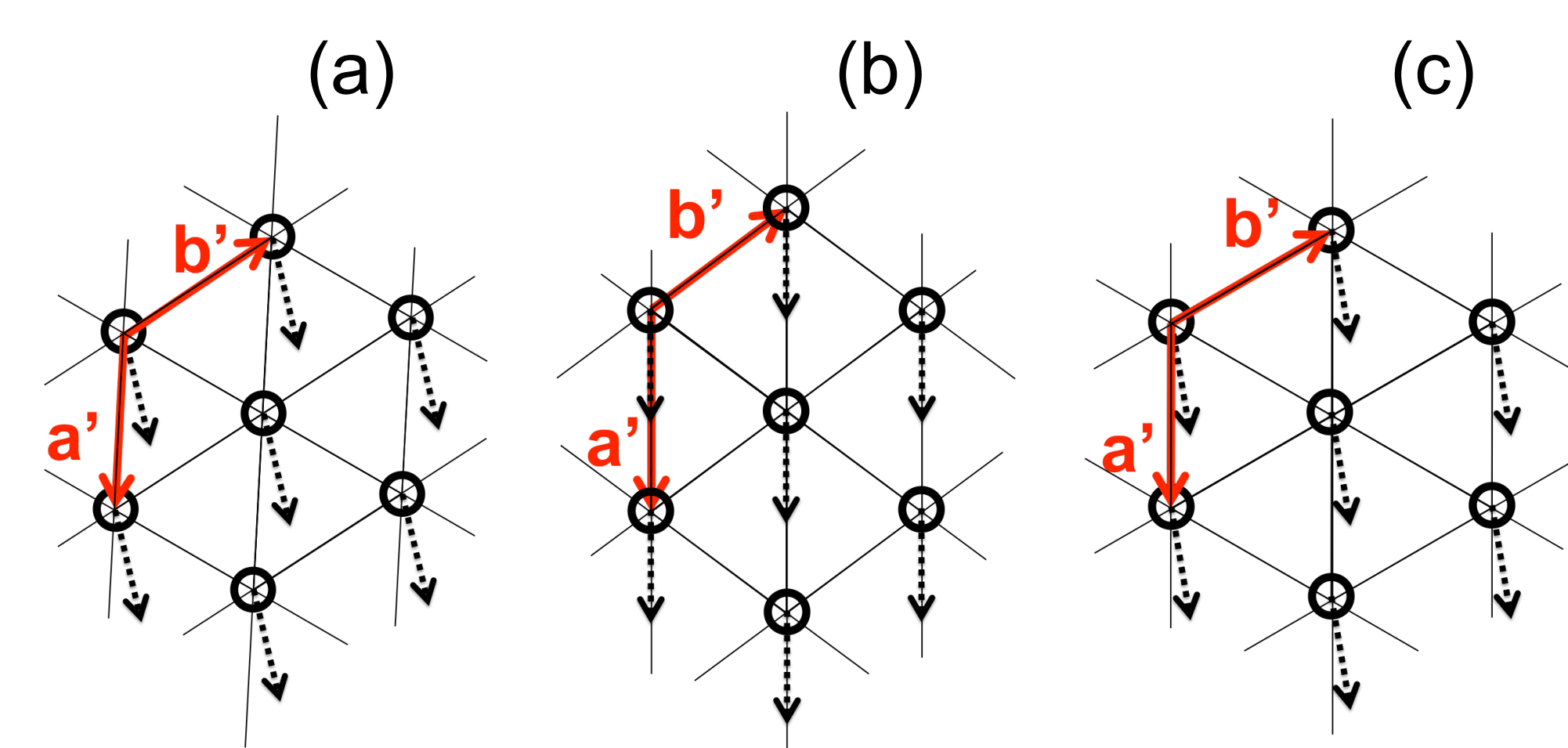


Fig. 6: Schematics of lipid chains packed in (a) an oblique, (b) a centered rectangular and (c) a rhombic 2D lattice. a' and b' represent distances between nearest neighbour chains. Dashed arrows denote the projection of tilted chains onto the xy -plane.

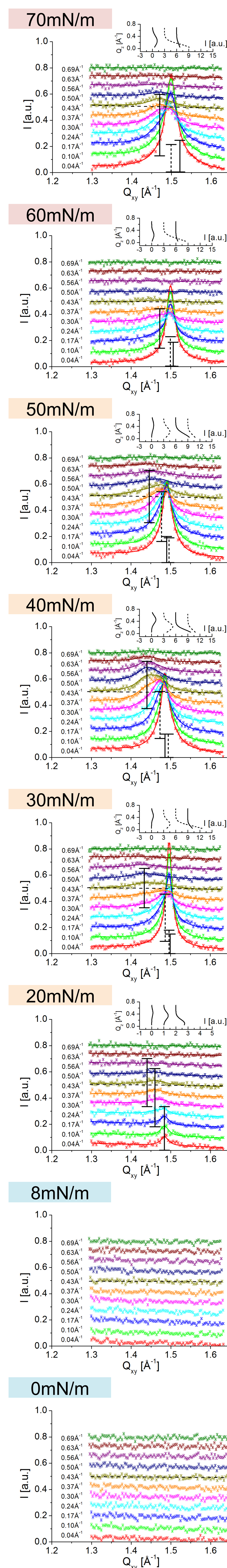


Fig. 7: The distances a' and b' , the tilt angle τ , and the diffraction intensity fraction f_l of the (coexisting) chain lattices as function of surface pressure.

color code:

oblique centered rectangular rhombic

CONCLUSION

- The results from grazing incidence X-ray diffraction confirm the **second phase transition of DPPC monolayers** at ~ 50mN/m and reveal the **structural details of the phase diagram**.
- The peculiar thermodynamic and structural features of DPPC monolayers are possibly connected to a **specific functional role of DPPC in the alveolar monolayer**.