CHARACTERIZATION OF CATION-ZWITTERIONIC LIPID INTERACTIONS: SMALL ANGLE NEUTRON/X-RAY SCATTERING AND DENSITOMETRY STUDY

S. Kurakin,[1,2] O. Ivankov,[1,3,4] V. Skoi,[1,5] A. Kuklin,[1,5] and N. Kučerka[1,6]

[1]*Frank Laboratory of Neutron Physics, Joint Institute for Nuclear Research, Dubna, Russian Federation*
[2]*Institute of Physics, Kazan Federal University, Kazan, Russian Federation*
[3]*Taras Shevchenko National University of Kyiv, Kyiv, Ukraine*
[4]*Institute for safety problems of nuclear power plants NAS of Ukraine, Kyiv, Ukraine*
[5]*Moscow Institute of Physics and Technology, Dolgoprudnyi, Russian Federation*
[6]*Department of Physical Chemistry of Drugs, Faculty of Pharmacy, Comenius University in Bratislava, Bratislava, Slovakia*

E-mail: ksa18@list.ru

The study of interactions between divalent cations and lipid membranes is one of the key goals of membrane biophysics, since it is supposed that ions affect structure of phospholipid bilayers and modulate the insertion and binding of proteins. Lipid-ion interactions are determined by a set of both external and internal factors associated with the membrane structure. One of the most significant structural parameters is the average lateral area of a phospholipid in the lipid bilayer, which characterizes the packing density of lipids and it is of decisive importance in assessing intermolecular interactions occurring in lipid membranes. In this regard, SANS, SAXS, and densitometry were used in this work to study the structural changes in model lipid bilayers composed of zwitterionic phospholipids of various lateral areas (DMPC, POPC, DOPC) upon the addition of biologically relevant Ca^{2+} and Mg^{2+} cations. Based on the obtained structural parameters of these lipid bilayers, various mechanisms of lipid-ion interactions were proposed, which are apparently governed by the lateral area, namely, lipid packing density related to the average interlipid distance [1], [2]. In the bilayers with a close packing of phospholipids (e.g., DMPC), the interlipid distance is small enough that it leads to the formation of lipid-ion-lipid bridges. This causes a membrane condensing in lateral direction. On the other hand, in a less densely packed lipid bilayer (e.g., DOPC), ions predominantly interact with lipids by forming separated lipid-ion pairs, which fluidizes the bilayer by enlarging its lateral area and reducing the thickness. In the case of POPC with a lateral area of ~ 64 $Å^2$, the average interlipid distance is approximately equal to the cutoff length of lipid-ion interactions, leading to a mixed type of interactions, where the two effects on the lipid bilayer structure are mutually compensated.

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