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Investigation of aqueous suspensions of multilayer vesicles of phospholipids by Mandelstam-Brillouin spectroscopy at various temperatures

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Phospholipid vesicles serve as a model of cell membranes that can be used to study various processes taking place in cells. In the study of many questions related to the characterization of the membrane, for example, during the gel-fluid phase transition in the membrane, it becomes necessary to know its elastic properties and the speed of sound. Therefore, the development of non-contact and non-destructive experimental techniques that allow measuring the modulus of elasticity and the speed of sound in systems containing phospholipid membranes is an important task. Until now, a relatively small number of studies have been devoted to the study of the speed of sound in membranes by means of ultrasonic techniques limited to a megahertz range [1]. This range overlaps with the characteristic relaxation response of membranes, which complicates the interpretation of the experimental data. It is desirable to determine the speed of sound in the gigahertz range. An even more significant drawback of ultrasonic methods is the need for direct contact between the generator and the detector with the material being studied. The Mandelstam-Brillouin scattering spectroscopy (MBS), being a method of optical spectroscopy, is free of this shortcoming and allows one to determine the speed of sound in the gigahertz range. Previously, this technique was only used several times for phospholipid membranes. One of the most famous in this area is the work [2], performed on a multilayered sample prepared on a substrate. To date, MBS has not been used to determine the modulus of elasticity in suspensions of phospholipid vesicles

This work is devoted to the development of an experimental technique based on MBS spectroscopy for the study of aqueous suspensions of multilayer vesicles of phospholipids at different temperatures using the example of DPPC phospholipid (1,2-dipalmitoyl-sn-glycero-3-phosphocholine). From the dependence of the MBS spectrum on the sample thickness, the MBS spectrum was reduced to the single-scattering regime. Spectra of MBS suspensions of multilayer vesicles of phospholipids DPPC are obtained, positions MBS lines are determined. The temperature dependence of the position of the line, its change in the transition of the gel-fluid is studied. A comparison of the behavior of MBS lines of polycrystalline ice (T <0°C) and water (T> 0°C) reveals the contribution of phospholipid layers to the MBS spectrum. Analysis of the data made it possible to estimate the value of the elastic modulus and its dependence on temperature.

1. T. Heimburg, *Biochimica et Biophysica Acta*, **1415**, 147 (1998).
2. W. Manglkammer, J.K. Kruger, *J. Phys. IV* **129**, 65 (2005).