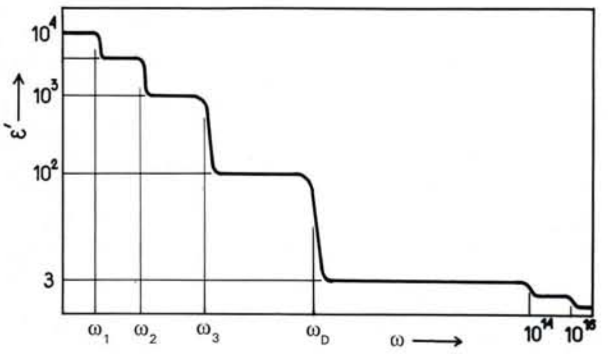

Fig. 7 — Frequency dependence of the real part of the dielectric permittivity of ice. "Steps" at ω_1, ω_2, ω_3 and ω_D correspond to the motion of charge carriers of four different types.

cates the depth of the superionic surface layer. Fig. 8 illustrates the ice surface structure.

Mechanical Properties of Ice

In a number of natural phenomena, in which ice is subjected to alternating mechanical stresses — drift of temporary ice, compression of sea ice, *etc.*, electromagnetic radiation is emitted. This has already found practical application, for example, in air reconnaissance of the regions of compression of sea ice for navigation and for forecasting the drift of temporary ice. However, until recently the nature of this radiation was enigmatic. Ice possessing a structure with a "statistical" (from the disordering of H_2O molecules) symmetry centre cannot be piezoelectric and emit RF waves when vibrated.

In our experiments, ice subjected to non-uniform elastic stresses demonstrated a pseudo piezo effect. It turned out that proton charge carriers, deforming the ice lattice around themselves, produced a noticeable dilatation. In other words, ions H_3O^+ and OH^-, L- and D-defects occupy volumes different from those of H_2O molecules. In the presence of elastic-stress gradients, the charge carriers move along them like an air bubble along a pressure gradient in water. Hence, in non-uniform fields of elastic stress, electric currents arise that can quite easily be measured, and they suffice to explain the RF emission of ice. In practice, ice becomes piezoelectric not only in the presence of temperature gradients but also impurity concentrations [9] which are common in natural conditions.

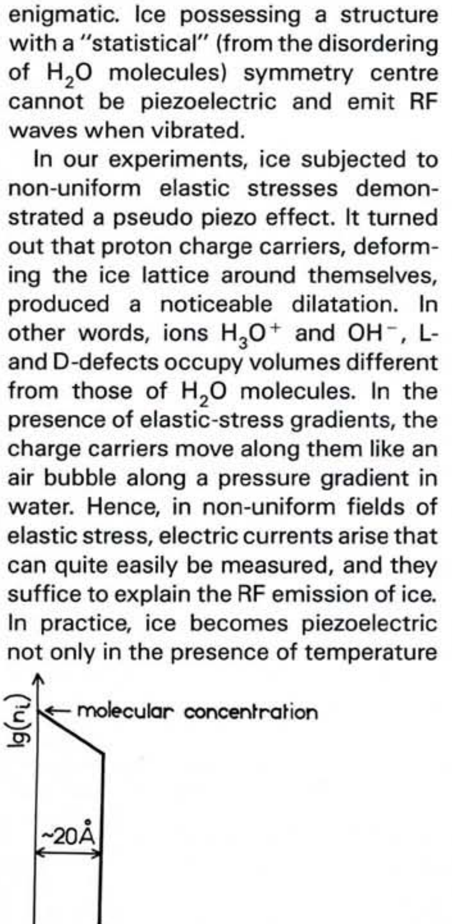

Fig. 8 — Distribution of charge carrier concentration near the ice surface.

Dislocation currents, observed by Petrenko and Whitworth during plastic deformation of ice can now be attributed to the charge-carrier dilatation in ice. Charge carriers can be trapped by fields of non-uniform stresses existing around dislocations, the dislocations become electrically charged and by their motion generate electric currents. Carrier concentrations near such dislocation cores can exceed by several orders the mean values in the bulk. These must be taken into account in the description of the dislocation motion conditions, as shown by Petrenko and Ryzhkin.

Finally, we have solved rather accurately the problem of the reorientation of H_2O molecules in ice under the action of elastic stresses, so creating a theory of inelastic relaxation of ice. One important outcome from this work has been a theory of propagation of sonic waves.

This short review of some recent results presents only a small part of the intensive studies in ice physics now being carried out across the world. We can expect this fascinating field of solid state physics to provide us with many important fundamental results which will find practical applications in future.

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