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Results of Measurements of Spin Lattice Relaxation Times in Liquids obtained in the Cracow Laboratory of Nuclear Magnetic Resonance

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Résumé. — On a présenté les résultats préliminaires des mesures des temps de relaxation spin-milieu: à 20° C pour l'eau desoxygénée $T_1 = (3.21 \pm 0.07)$ sec et pour le chloroforme desoxygéné $T_1 = (90 \pm 4)$ sec. On a examiné également la variation de T_1 avec la température pour ces mêmes liquides et pour les solutions de gélatine dans l'eau.

The preliminary results of the investigation of spin-lattice relaxation times in liquids obtained in the Cracow Laboratory of Nuclear Magnetic Resonance are described. We used the method of measurements presented in the previous communication by Hennel and Hryniewicz.

Spin-lattice relaxation time in very pure water

The Bloembergen, Purcell and Pound theory of the spin-lattice relaxation times [1] gave for pure water at 20° C $T_1 = 3.4$ sec. When to their calculation the correction made by Kubo and Tomita [2] is introduced and when the newest values of atomic constants are used the theoretical value of T_1 for water amounts 2.5 sec. As it is well known this value must be regarded as an approximate one because of the simplifications of the model on which base the theory of relaxation times is developed.

The experimental values published by Giulotto and collaborators for water at 20° C carefully purified from oxygen are (3.6 ± 0.2) sec [3] (3.5 ± 0.35) sec [4] and 3.1 sec [5].

In our measurements we used several samples of water sealed in glass and quartz tubes. The water was very carefully purified by a chemical method, made oxygen free by long boiling and sealed in vacuum. Our result at 20° C is (3.21 ± 0.07) sec.

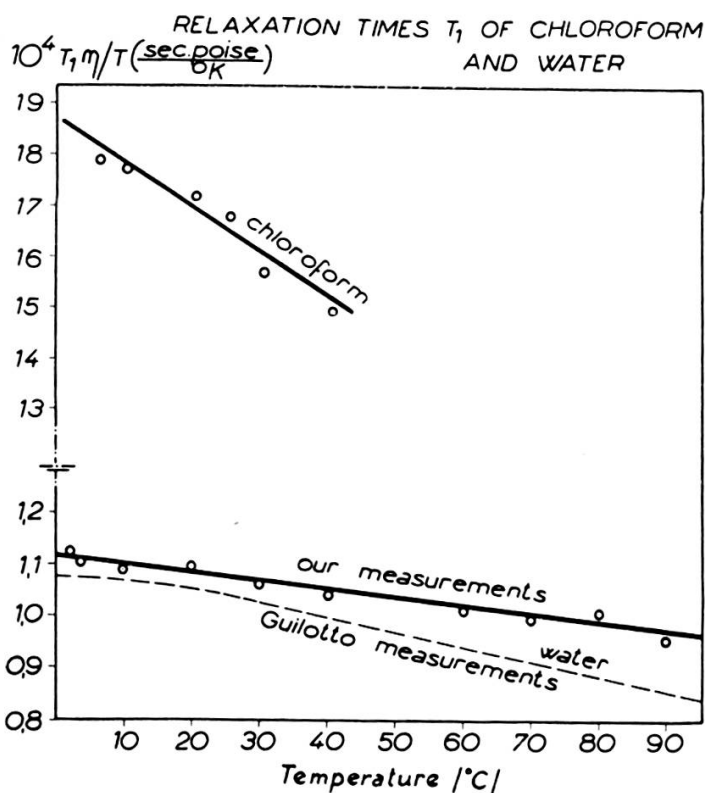


Fig. 1.

On the last Colloque Ampère, Giulotto presented the temperature dependence of the water relaxation time T_1 . He obtained a slow decrease of the expression $\eta T_1/T$ with increasing temperature, while the BPP theory predicts the constant value of this expression. We obtained the similar dependence as found by Giulotto. The results are represented on Fig. 1.

We tried to introduce to the theoretical value of T_1 the correction proposed by Seiden [6] based on the distribution of water molecules at different temperatures measured by Morgan and Warren [7] by means of X-ray diffraction. We obtained that while this correction changes the absolute value of T_1 , it cannot explain the temperature dependence of $\eta T_1/T$ given by the experiment.

Spin-lattice relaxation time in pure chloroform.

The chloroform molecule contains only one proton so the main role in the spin-lattice relaxation plays the intermolecular interaction. The intramolecular interaction between proton and chlorine nuclei, estimated

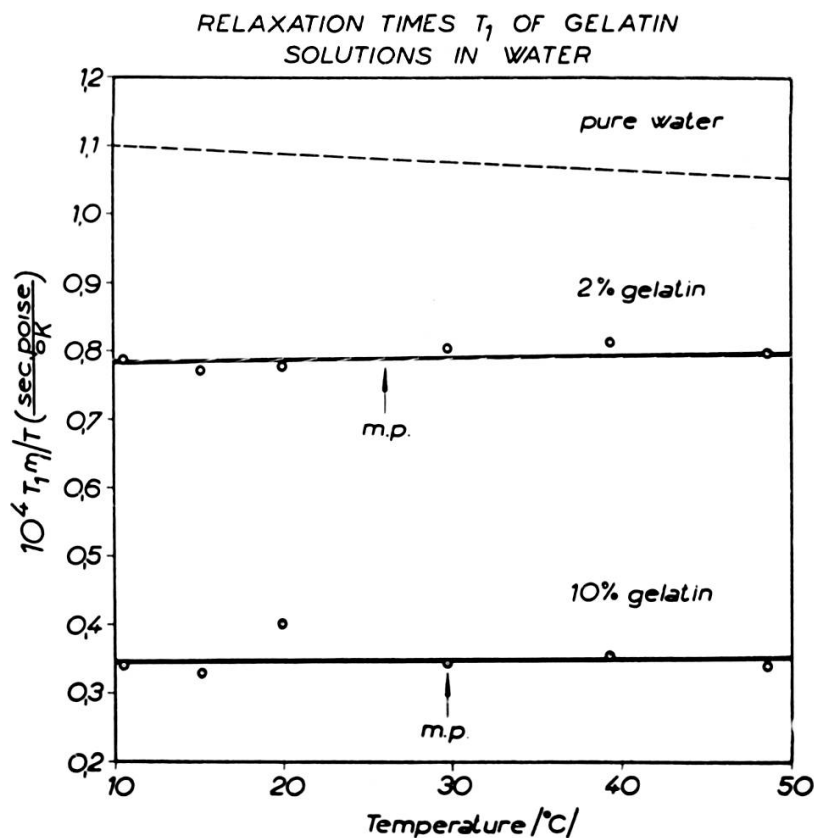


Fig. 2.

on the base of BPP theory, is small one. In this case can be expected the much longer T_1 than for two or more proton molecules. Our measurements gave for pure chloroform free of oxygen at 20° C $T_1 = (90 \pm 4)$ sec. The temperature dependence of $\eta T_1/T$ shown also on Fig. 1 is much higher than for water. Between temperatures 5° C and 40° C $\eta T_1/T$ decreases by c. 18 per cent. The decrease for water over the same range of temperatures amounts only c. 6 per cent. The measurements of the temperature dependence of T_1 for other liquids are in preparation to answer the question if the observed decrease of $\eta T_1/T$ is connected only with the translational part of the spin-lattice relaxation time.

Spin-lattice relaxation times in water solutions of gelatin.

On Figure 2 is shown the temperature dependence of spin-lattice relaxation times for different concentrations of gelatin solutions in water.

For calculation of $\eta T_1/T$ expressions the viscosity of a pure water was taken. It is clearly seen from the diagrams, that $\eta T_1/T$ calculated in this manner is nearly constant over a rather wide range of temperatures. It means that though the macroviscosity of the gelatin solution changes much more than that of water, the relaxation in water is governed by its own viscosity. It is worthwhile to notice that at the melting point of gelatin, where is a big jump of the macroviscosity, no jump of T_1 can be observed. Our results prove that for investigated concentrations the main part of water molecules can be regarded as free filling the cavities between gelatin molecules.

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