INTERACTION OF MAGNETIC FIELDS WITH LIQUID STRUCTURES

I.P. SUSAK[1,2], A.S. SHIGAEV[2], O.A. PONOMAREV[2], E.E. FESENKO[2]

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[1]**Faculty of Physics, Tomsk State University**
(36, Lenina Ave., Tomsk 634034, Russia;
e-mail: susak@icb.psn.ru),

[2]**Laboratory of Biophysics of Receptors,**
Institute of Cell Biophysics, Russian Acad. Sci.
(3, Institutskaya Str., Pushchino, Moscow Region, 142290 Russia)

A mechanism of the interaction of a magnetic field with liquid is suggested. The mechanism of the influence of electromagnetic fields (EMF) on biological processes can result in either the change of rates of biochemical reactions due to the change of water properties in EMF, or the change of configurations of biologically active molecules, or both of them. For the soliton model of bulk knitted structures in a magnetic field, the statistical integral and the configurational contributions to free energy, entropy, and specific heat were calculated. It is shown that the concentration of solitons depends on external fields. In particular case of bulk knitted structures, for liquid water in the absence of a magnetic field, the obtained results are in good agreement with the experimental data. The phenomenon of memory of hydrogen — bonded systems is explained in terms of the continuum soliton concept of the structure of liquid.

Introduction

Many experiments studying the magnetic field effects on structural reorganizations of molecular liquids containing hydrogen bonds are most active today. It is important to observe the nonthermal action of electromagnetic fields of low intensity on liquid water, alcohols, gels, binary mixtures, living organisms. At present, there is no equipment allowing the observation of this action for the reason of tiny changes of physical and chemical parameters characterizing such systems, and the dilatation effect. Quantum non-dilatation theory (QND) is still not created. However, there are indirect measurements that allow one to suggest that such an interaction exists and is exhibited in the formation of stable structures with lifetime much larger than that of hydrogen bonds. Unfortunately, now there is only a "living" indication of such a phenomenon. The experiments on planarians have shown that some processes of vital activity vary in water which was processed with steady and alternate magnetic collinear fields comparable in intensity to a geomagnetic field [1]. Another, probably more reasonable way comes from results of molecular dynamics (MD) for such systems, although it is difficult to implement here the mechanism of interaction because of restrictions on the number of particles, which can be taken into account. The registration of the action on a system makes possible only a numerical solution on a finite interval of time with losses of collective effects [2]. We propose a qualitative study of properties of the action of a gauged field on a model, using asymptotical and operational methods and methods of a quantum field theory in statistical physics. The aim of our analysis is to find an expression for the effective Hamiltonian of knitted liquid, explore its connections with the parameters of liquid, and external electric, magnetic, and electromagnetic fields, while considering not only a model of liquid water, but also any fluid with H-bonds. The influence of EMF, if it presents, can be taken into account through the constant of EMF interaction with matter. We termed the substances containing chains of hydrogen bonds with 3 dimensional structure in the liquid state as bulk knitted structures. They resemble a tangle, in which different time-dependent processes take place, such as the formation and destruction of H-bonds, other dynamical bonds, and bonds, forming supermolecular structures and bond deformations. The behavior of the systems with H-bonds is important in transfer processes revealing a large amount of essentially non-linear and quantum effects. It is supposed that the structure of such systems is similar to a tangled band. The bands are tied by their edges between different parts, which builds up a three-dimensional net, a bulk knitted structure. DNA molecules, hydrogenous ferroelectrics, like triglycinsulphate and Rochelle salt, tied polymeric balls of linear and quasilinear polymers [3—7], fullerenes, and kumulenes have these properties. There are data that water also belongs to such systems [8]. There arise heterogeneous local structures of micron size.

Such structures were earlier called as large clusters or briefly clusters. Studying the action of EMF on multicomponent media, including living objects, we usually deal with nonlinear processes. The description of the primary mechanism of interaction for such systems is not possible, because of numerous parameters, and non-equilibrium nature of the dynamics of the system. Even neglecting such a property as immunity of a living organism does not allow the reduction of the set of equations to an exactly solvable one with fixed parameters and uniqueness of solutions. However, one may assume that, because water is a component of all such systems, it happens to be a receptor of actions of EMF in a wide range of frequencies and intensities. Electrical and magnetic fields as well as electromagnetic radiation influence the location of the points of phase transitions, shifting their temperature and smearing out the transitions themselves. Even fields of more than 10^6—10^7 V/m change the properties of narrow-band polymers [9, 10], being critical field values for ferroelectrics and for membranes [11, 12]. Therefore, such an effect may be associated with the appearance of solitons in a system that will determine the microscopic state of the macroscopic system. We managed to find the dependence of the field action through the change of the concentration of such one-soliton solutions. The work has been carried out in the multisoliton approximation for kinks, while the account of breather solutions will allow obtaining new solutions.

It is known that the liquid structure changes under the influence of constant and alternate magnetic fields, these changes being conserved during some tens of hours. These changes can be identified by kinetic properties, for instance by a change of viscosity, reaction rate characteristics of dielectric relaxation spectra, IR -, UV-spectra, and luminescence.

We suppose that the structure of liquid is defined by the quantity of solitons on the band, the soliton concentration, and by the concentration of ties in the system.

1. Effective Hamiltonian

We consider the liquid structure as a three-dimensional space formed from two-dimensional bands. The model is characterized by the following parameters: the molecular field energy proportional to the energy of H-bonds, transformation time of H-bonds proportional to the lifetime of one H-bond in liquid [13], and distances proportional to the size of a molecule. The model takes into account the interaction of neighbor molecules in space. The three-dimensional structure is assumed to be with elasticity defined analogously to that in the theory of nematics. Structure transformations are associated with transformations of H-bonds, and we call each structure break or disturbance as a topological defect, which has a dimension that can be fractional. Our model looks as quasi-polymeric liquid. Some molecules form band sections. Theirs edges are bound with each other by infrequent H-bonds. As a break of some H-bonds occurs, the transformation of the $3D$-structure is coming. The sections of molecules change their orientation according to the action minimum principle, and then a retieing is taking place. So, the model describes the isotropic medium which has local anisotropy. Instantaneous interactions of the edges of a chain composed by oriented segments are assumed to be much weaker than the interaction that builds the band itself. In the first approximation, these interactions are neglected, and the behavior of the band twisted in a ball is considered. The system is placed into the external electromagnetic field of low intensity. In such a system, solitons and breathers appear, which essentially influence its properties. Analytical form of breather and soliton solutions of the SG-equation is described in [14]. Consider the case where there are no breathers. Then the knitted system in the ground state is described by the Hamiltonian

$$H_0 = H_k^{'} + \sum_j \int_{-l_j/2}^{l_j/2} [\frac{1}{2} I\dot{\phi}_j^2(s,t) +$$

$$+\frac{1}{2}C\left(\frac{\partial\phi_j}{\partial s}\right)^2 + \frac{U}{2}(1-\cos 2\phi_j) +$$

$$+\frac{\mu^{'}}{l_j}\mu_1\cos\phi_j - \delta I H(t)\dot{\phi}_j]ds +$$

$$+\sum_{j>j_1}^{N} U(|r_j - r_{j1}|) + \sum_j U(r_j), \qquad (1)$$

where $H_k^{'}$ is the kinetic energy of the system minus the kinetic energy related to the collective coordinates of solitons, $\sum_j \int_{-l_j/2}^{l_j/2} \frac{1}{2} I\dot{\phi}_j^2(s,t)ds$ is the kinetic energy of a twisting band, $\sum_j \int_{-l_j/2}^{l_j/2} \frac{1}{2}C\left(\frac{\partial\phi_j}{\partial s}\right)^2 ds$ is the potential energy of interaction between elements of a band, $\sum_j \int_{-l_j/2}^{l_j/2} \frac{U}{2}(1-\cos 2\phi_j)ds$ is the potential energy of the

molecular field, $\sum\limits_j \int\limits_{-l_j/2}^{l_j/2} \frac{\mu'}{l_j}\mu_1 \cos\phi_j ds$ is the potential energy of the interaction of the dipole momentum of a water molecule with the dipole momentum of a band, $\sum\limits_j \int\limits_{-l_j/2}^{l_j/2} \delta I H(t)\dot{\phi}_j ds$ is the interaction of the magnetic field with a band, $\sum\limits_{j>j_1}^{N} U(|r_j - r_{j1}|)$ is the interaction between bands in the region of defects, $\sum_j U(r_j)$ is the interaction of a band with an external potential field, μ_1 is the dipole momentum of a water molecule, r_j is the location of the band in space, s is the distance along a band, $\phi_j(s,t)$ — rotation angle of a twisting band on the segment between the points jth and $(j+1)$th, which is of length l_j. At the points jth and $(j+1)$th, the band is tied with another one with a potential $U(|r_j - r_{j1}|)$, α is the angle between the vector $H(t)$ and director ds, I is the inertia momentum density corresponding to the twist per unit length of the band, C — band's constant elasticity, U is the density of the molecular field interaction energy, μ' is the magnitude of the ribbon dipole moment density, δ — the parameter of interaction of a polymer chain with the external magnetic field $H(t)$. Notice that the points jth and $(j+1)$th are not tied with each other. The dot over ϕ_j denotes time derivative. The term $U(r_i)$ is an external potential acting at the point jth with coordinate r_j. Suppose that, on the band's segment between the points jth and $(j+1)$th there are n_j solitons (i.e., we have an n_j — soliton solution). Suppose also that the concentration of solitons is not very high, so that we may consider solitons to be sufficiently distant from each other. Then

$$\phi_j(s,t) \approx \sum_{\alpha=1}^{n_j} \varphi_{j\alpha}(s,t), \qquad (2)$$

where $\varphi_{j\alpha}(s,t) = 2\arctan\exp(\gamma_\alpha(s - s_\alpha - v_\alpha t))$ — a single-soliton solution [15] threaded on the band's segment between the points jth and $(j+1)$th, $\gamma_\alpha = (1 - v_\alpha^2)^{-\frac{1}{2}}$, v_α is the velocity of solitons. Making use of Eq. (2) for Hamiltonian (1), we have

$$H_0 = H_k + \sum_j \int\limits_{-l_j/2}^{l_j/2} [\frac{1}{2}C \sum_{\alpha\alpha_1} \left(\frac{\partial\varphi_{j\alpha}}{\partial s}\frac{\partial\varphi_{j\alpha_1}}{\partial s}\right) +$$

$$+\frac{U}{2}(1 - \cos 2\sum_\alpha \varphi_{j\alpha}) + \frac{\mu'}{L}\mu_1 \cos\sum_\alpha \varphi_{j\alpha} -$$

$$-\delta I H(t)\sum_\alpha \dot{\varphi}_{j\alpha}]ds + \sum_{j>j_1}^{N} U(|r_j - r_{j1}|) + \sum_j U(r_j), \quad (3)$$

where H_k is the total kinetic energy of the system. We have presented a specific structure of the Hamiltonian. Thus, we have introduced the collective coordinate along a band. A part of other coordinates of bonds of a band in volume is missed. In this case, we have the potential pair interaction between isolated molecules, as in the method of molecular dynamics. The integration over s in (3) can be carried out explicitly, which leads to the effective Hamiltonian describing the system in terms of free particles, solitons, and interactions between them. The Hamiltonian does not depend on time, and, therefore, it may be calculated at any time. The simplest way to do that is to choose $t = 0$.

Now, let us rewrite (3) in the form

$$H_0 = H_k + \gamma\sqrt{CU}\sum_{j=1}^{N}\sum_{\alpha>\alpha_1}^{n_j} \frac{1}{\cosh\gamma\sqrt{\frac{U}{C}}(s_\alpha - s_{\alpha_1})} -$$

$$+2\sqrt{CU}\frac{1}{\gamma}\sum_{j=1}^{N}\sum_{\alpha=1}^{n_j} 1 + \sqrt{CI}\delta H(t)\sum_{j=1}^{N}\sum_{\alpha=1}^{n_j} v_\alpha +$$

$$+8\sqrt{UC}\frac{1}{\gamma}\sum_{j=1}^{N}\sum_{\alpha>\alpha_1>\alpha_2}^{n_j} \frac{\cosh^{-2}\gamma\sqrt{\frac{U}{C}}(s_{\alpha_2} - s_{\alpha_1})}{\cosh^2\gamma\sqrt{\frac{U}{C}}(s_{\alpha_2} - s_\alpha)} +$$

$$+\mu'\mu_1\sum_j \exp\left(-\frac{2n_j}{l_j\gamma}\sqrt{\frac{C}{U}} + \ldots\right) + \sum_{j>j_1} U(|r_j - r_{j_1}|) -$$

$$-\frac{8\sqrt{CU}}{3\gamma}\sum_{j=1}^{N}\sum_{\alpha>\alpha_1}^{n_j} \frac{1}{\cosh^2\gamma\sqrt{\frac{U}{C}}(s_\alpha - s_{\alpha_1})} + \sum_j U(r_j), \quad (4)$$

where $\gamma = \bar{\gamma}_\alpha$. Below, we use this effective Hamiltonian for the description of the system, which consists of twisted bands between the points r_j, r_{j+1} and with the positions of solitons on them at the points s_α.

2. Free Energy

Free energy can be derived from the equation [3—6, 13]

$$Z = \exp\{-\beta F\} =$$

$$= \int \prod_{j=1}^{N} d\dot{r}_j \prod_{\alpha=1}^{n_j} dv_\alpha \exp\{-\beta H_k\} \left(\frac{1}{2\pi\hbar}\right)^{\sum_{j=1}^{N} n_j} \times$$

$$\times \exp\{-\beta\pi\sqrt{CI}\delta H(t)\sum_{j=1}^{N}\sum_{\alpha=1}^{n_j} v_\alpha\cos(\alpha)\}\frac{1}{N!}\times$$

$$\times\int\prod_{j=1}^{N} dr_j g_{1j}(|r_j - r_{j+1}|)g_j \exp\{-\beta\sum_{j=1}^{N}U(r_j)-$$

$$-\beta\sum_{j>j_1}U(|r_j - r_{j_1}|) - \frac{2\beta\sqrt{UC}}{\gamma}\sum_{j}^{N} n_j\}, \qquad (5)$$

here $\beta = \dfrac{1}{kT}$, T is the absolute temperature, k is the Boltzmann constant, and

$$g_{1j}(|r_j - r_{j+1}|) = \frac{1}{n_j!}\int\prod_{\alpha=1}^{n_j} ds_\alpha\times$$

$$\times\exp\left\{-\beta\left(\sum_{\alpha>\alpha_1}^{n_j}\Phi_{\alpha\alpha_1} + \sum_{\alpha>\alpha_1>\alpha_2}\Phi_{\alpha\alpha_1\alpha_2}\right)\right\}, \qquad (6)$$

where

$$\Phi_{\alpha\alpha_1} = \frac{\gamma\sqrt{UC}}{\cosh\gamma\sqrt{\frac{U}{C}}(s_{\alpha_1} - s_\alpha)} -$$

$$-\frac{8\sqrt{UC}}{3\gamma\cosh^2\gamma\sqrt{\frac{U}{C}}(s_{\alpha_1} - s_\alpha)},$$

$$\Phi_{\alpha\alpha_1\alpha_2} = \frac{8\sqrt{UC}\cosh^{-2}\gamma\sqrt{\frac{U}{C}}(s_{\alpha_2} - s_\alpha)}{\gamma\cosh^2\gamma\sqrt{\frac{U}{C}}(s_{\alpha_2} - s_{\alpha_1})}. \qquad (7)$$

The quantity g_j is determined from the equations [11, 12]

$$g_j = \left(\frac{3}{2\pi(\frac{l_j}{n_j})^2 n_j}\right)^{\frac{3}{2}}\exp\left\{-\frac{3}{2}\frac{(r_j - r_{j+1})^2}{n_j}\left(\frac{n_j}{n_l}\right)^2\right\}. \qquad (8)$$

The multiplier g_j appears because the band is able to break at the twirl point in any direction. Between the points r_j and r_{j+1} of the band, there are n_j solitons, and they are distributed nearly uniformly on the chain's length l_j. Averaging out Eq. (5) over velocity, we get

$$Z = \exp\{-\beta F\} = \exp\{-\beta F_0\}\times$$

$$\times\exp\{\sum_j\frac{\pi^2}{4}\delta^2\beta^2 CIH^2(t)\langle v^2\rangle n_j\}\times$$

$$\times\frac{1}{N!}\int\prod_{j=1}^{N} dr_j g_{1j} g_j\exp\{-\beta\sum_{j=1}^{N}U(r_j)$$

$$-\beta\sum_{j>j_1}U(|r_j - r_{j_1}|) - \frac{2\beta\sqrt{UC}}{\gamma}\sum_{j}^{N} n_j\}, \qquad (9)$$

where F_0 — free energy for the system without interactions. Now begin with g_{1j}. Let us suggest that, although the expression for the energy is obtained with the use of asymptotics, it may be considered true for the model Hamiltonian in the whole domain of variables $s_{\alpha_1} - s_\alpha$. It is difficult to determine *a priori* the range of reliability of our results, but we will be guided by experimental data.

Thus, we have succeeded in the approximate calculation of all the integrals. At $n_j \gg 1$, we have

$$g_{1j} = (\frac{1}{c_j}\exp(\frac{\beta}{2}c_j(-\pi C + \frac{16}{3\gamma^2}C)-$$

$$-\frac{\beta^3}{3!}c_j^2(\pi C - \frac{16}{3\gamma^2}C)(2\gamma\sqrt{UC}C - \frac{8\sqrt{UC}C}{3\gamma}+$$

$$+\frac{256\sqrt{UC}}{27\gamma^3}C) - \frac{\beta}{3!}c_j^2\frac{32}{\gamma^3}\sqrt{\frac{C}{U}}C))^{n_j}, \qquad (10)$$

where $c_j = \dfrac{n_j}{l_j}$ is the linear concentration of solitons on the band. An analogical result is in [5]. Finally, the free energy per unit volume is

$$\frac{F - F_0}{V} = -c_1\frac{\pi^2\delta^2}{4kT}CI\langle v^2\rangle H^2(t) + c_1\frac{2\pi\sqrt{UC}}{\gamma} -$$

$$-c_1(-kT\ln c_0 + c_0\left(-\frac{\pi}{2} + \frac{8}{3\gamma^2}\right)C -$$

$$-\frac{c_0^2}{3!(kT)^2}\left(\pi - \frac{16}{3\gamma^2}\right)\left(2\gamma - \frac{8}{3\gamma} + \frac{256}{27\gamma^3}\right)\times$$

$$\times C^2\sqrt{UC} - \frac{32c_0^2}{3!\gamma^3}\left(\frac{C}{U}\right)\sqrt{UC}) + \frac{F_1}{V}. \qquad (11)$$

F_1 is the correction to the free energy for globular or ball states of bulk knitted structures and for LDW and HDW (low- and high-density water) [19]. We find $\dfrac{F_1}{V} = -\dfrac{kT}{4}\left(-3 + \sqrt{1 + 8A(T)c_0^2}\right)^2 n_0(T)$ for a globule and $\dfrac{F_1}{V} = -\dfrac{5kT}{3V}\ln V \to 0$ for a ball at $V \to 0$. Here, $c_1(T) = \dfrac{\sum_{j=1}^{N} n_j}{V} = c_0(T)\sum_{j=1}^{N}\dfrac{l_j}{V} = c_0(T)\sigma$, where σ is

the amount of bands intersecting the unit cross section. For a uniform liquid, this quantity is constant. It should be noticed that n_0, the concentration of ties, depends essentially on the purity of liquid and decreases with clearing. Let us multiply (11) by C and divide it by U^2. Let us introduce the notations

$$\begin{cases} \alpha_1 = -\sigma\dfrac{\pi^2\delta^2}{4k}\dfrac{I}{U}\bar{v}^2, \\ \alpha_2 = \dfrac{2\pi\sigma}{\gamma}, \\ \alpha_3 = k\sigma, \\ \alpha_4 = 2\sigma\left(\dfrac{\pi}{2} - \dfrac{8}{3\gamma^2}\right), \\ \alpha_5 = \dfrac{3\sigma}{3!k^2}\left(\pi - \dfrac{16}{3\gamma^2}\right)\left(2\gamma - \dfrac{8}{3\gamma} + \dfrac{256}{27\gamma^3}\right), \\ \alpha_6 = 3\sigma\dfrac{32}{3!\gamma^3}, \\ \alpha_7 = 8An_0k \end{cases} \tag{12}$$

and the dimensionless concentrations. For the free energy in dimensionless parameters, we have

$$\frac{F-F_0}{V}\frac{C}{U^2} = \alpha_1 c_0\frac{H^2(t)}{T} + \alpha_2 c_0 + \alpha_3 c_0 T\ln c_0 +$$

$$+\frac{1}{2}\alpha_4 c_0^2 + \frac{1}{3}\frac{1}{T^2}\alpha_5 c_0^3 + \frac{1}{3}\alpha_6 c_0^3 + \frac{F_1}{V}\frac{C}{U^2}. \tag{13}$$

It remains to minimize the free energy at c_0, and to find out the soliton concentration. Varying the free energy by c_0, we obtain

$$\frac{\delta}{\delta c_0}\frac{F-F_0}{V}\frac{C}{U^2} = \alpha_1\frac{H^2(t)}{T} + \alpha_2 + \alpha_3 T(1+\ln c_0) +$$

$$+\alpha_4 c_0 + \frac{1}{T^2}\alpha_5 c_0^2 + \alpha_6 c_0^2 + \frac{\delta}{\delta c_0}\frac{F_1}{V}\frac{C}{U^2}, \tag{14}$$

where

$$\frac{C}{U^2}\frac{\delta}{\delta T}\left(\frac{F_1}{V}\right)_V = -\frac{kn_0}{4}\left(\left(-3+\sqrt{1+8A(T)c_0^2}\right)^2 -\right.$$

$$\left.-8A(T)c_0^2\left(1-\frac{3}{\sqrt{1+8A(T)c_0^2}}\right)\right) \tag{15}$$

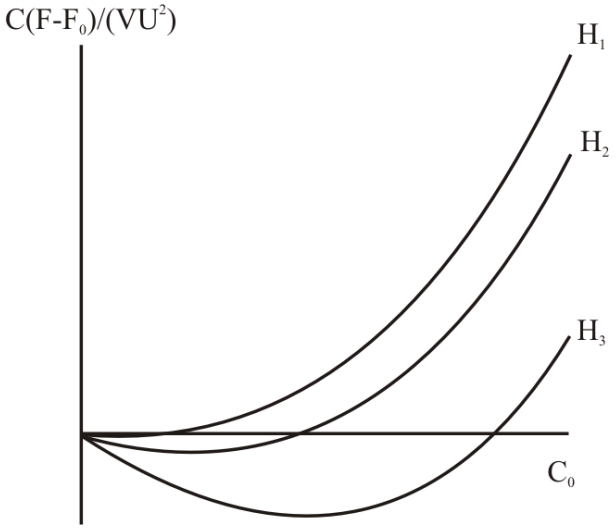

Fig. 1. Free energy as a function of the solution concentration at various magnetic field intensites, $H_1 = 0 < H_2 < H_3$. Equilibrium soliton concentration corresponds to the minimum of the free energy. Equilibrium soliton concentration is low in the absence of a magnetic field and rises in the presence of a magnetic field with increasing the magnetic field intensity

We get the solutions of Eq. (13) and determine $\dfrac{\delta C_p}{V}$ [16, 18]:

$$\frac{U}{C^2}\frac{\delta C_p}{V} = \frac{\pi^2\delta^2 I\bar{v}^2 H^2(t)c_0\sigma}{8kT^2U} + \frac{4kn_0A^2(T)c_0^2}{\sqrt{(1+8A(T)c_0^2)^3}} -$$

$$-\frac{\sigma}{k^2T^3}\left(\pi - \frac{16}{3\gamma^2}\right)\left(2\gamma - \frac{8}{3\gamma} + \frac{256}{27\gamma^3}\right)c_0^2. \tag{16}$$

The analysis of the statistical integral for knitted structures has shown that the soliton concentration increases with the magnetic field. In the absence of magnetic field, the system also has a certain amount of solitons with relative concentration that can be determined from Fig.1. Bulk interaction reduces the free energy proportionally to the amount of ties in the bulk.

With increase of the soliton concentration, the value of this reduction decreases and becomes zero at $c_0^2 = A^{-1}$. Then the free energy reduces again. The temperature dependence of the free energy is shown in Fig. 2. With increase of the magnetic field, the free energy decreases.

The heat capacity of the system decreases with the increase of temperature, but grows with magnetic field (Fig. 3). Such a behavior of the system in a magnetic field is due to the fact that, with the enlargement of the

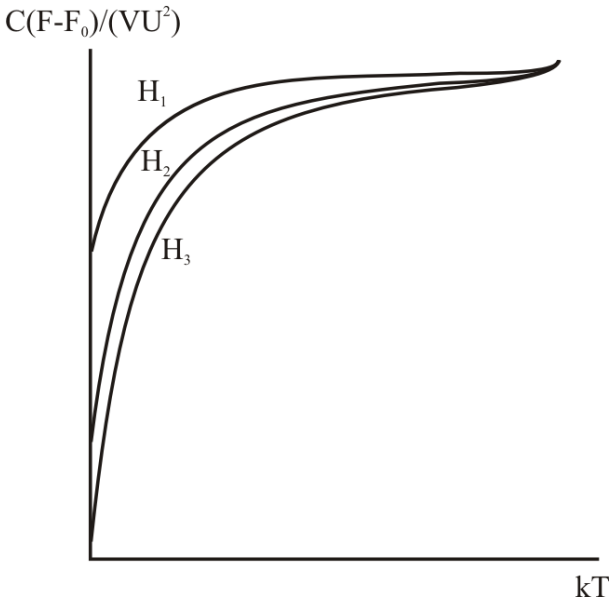

Fig.2. Free energy as a function of dimensionless temperature at the equilibrium soliton concentration at various magnetic field intensities, $H_1 = 0 < H_2 < H_3$

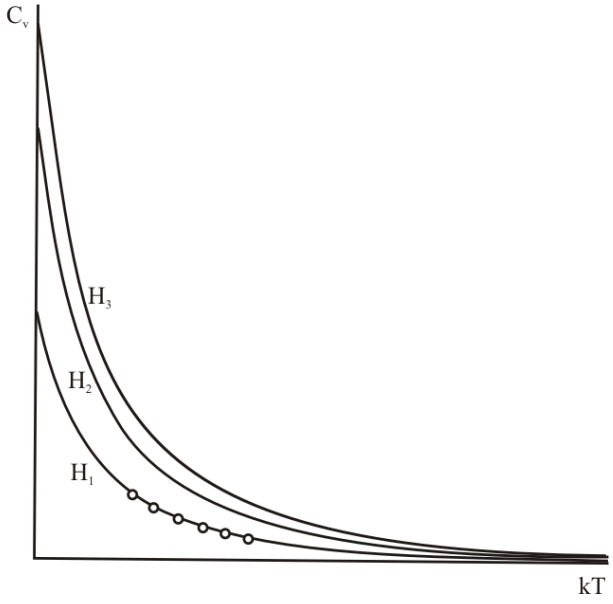

Fig. 3. Heat capacity of knitted systems as a function of dimensionless temperature at various magnetic field intensities, $H_1 = 0 < H_2 < H_3$. Circles show the published observed values for water [16, 17, 20]

field strength, the system acquires additional degrees of freedom corresponding to solitons.

In Fig. 3, there are experimental values of configurational heat capacity in the absence of electromagnetic field, taken from [16] and recounted in terms of our dimensionless variables with the use of parameters peculiar to water. There is a sufficiently good agreement of the theory with the experiment. Notice that Fig. 3 corresponds to the heat capacity behavior for any knitted system, not only for water. If the heat capacity of water in a magnetic field were known, Fig. 3 would allow us to determine the parameter interaction of water with the magnetic field. Unfortunately, we do not have such data. Describing liquid as a continuous medium, we conclude that the minimal energy in the model of liquid corresponds to the absence of deformations in it. In liquid water, such a state with minimal energy or the ground state is the configuration with uniform orientation in the whole bulk — hexagonal ice (Ih) for our model. Any deviation of the director distribution from uniform (i.e., the same in the whole bulk) is connected with the presence of an additional elastic energy in the model of liquid, that is, may be implemented only by external influence connected, for example, with the surfaces of a chosen segment, external electric and magnetic fields, etc. In the absence of these influences or after the termination of their action, the liquid tries to return to the state with a uniform director orientation. In the soliton model of liquid, when it is affected by an external magnetic field, turnings of certain band segments occur, which leads to the deviation of the director orientation distribution from uniform. There appears some addition to the free energy. Liquid in a magnetic field has a state in which it can remain for a long time $t_c \gg t_H$, where t_H is the hydrogen bond lifetime. The system will continue to be in the state with this energy until an external perturbation moves it to some other state, or until the temperature changes. The addition to the free energy in the soliton model of liquid is conditioned by soliton and breather concentrations. They become apparent already at low values of the magnetic field intensity.

Summary

We suggested that the configuration of molecular bands of water varies in the EMF, as well as the lengths of H-bond chains. The field orients water bands in the three-dimensional space and, at a sufficient number of interactions, a local order of directions originates. The EMF interacts with this flow changing the conformational state of a part of the band without the substantial change of the energy. The change of properties of the system starts after a certain induction period necessary for the shift of a considerable part of

particles in a new conformational state. It may imply that the knitted structures, those liquid water belongs to, have unique properties that can be explained by the existence of solitons and breathers. Many properties of water are explained in terms of the continual soliton conception of water structure. Moreover, the structures of different knitted liquids under different magnetic fields can be described in terms of a shift of solitons and breathers. Soliton models provide good description of such systems. We have calculated the statistical integral, which allows one to compute configurational contributions to the internal energy, heat capacity, and entropy of knitted structures (including liquid water) within the wide temperature interval and in the presence of magnetic fields. The calculated heat capacities for the liquid water without magnetic field are in good agreement with the experiment [20]. The analysis of other characteristics in the presence of a magnetic field is supposed to be done in a new paper.

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ВЗАЄМОДІЯ МАГНІТНОГО ПОЛЯ З РІДИННИМИ СТРУКТУРАМИ

І. П. Сусак, О. С. Шигаєв, О. О. Пономарьов, Є. Є. Фесенко

Р е з ю м е

Розглянуто механізм дії магнітного поля на рідину. Механізм впливу електромагнітного поля на біологічні процеси може полягати або в зміні швидкостей біохімічних реакцій під впливом зміни властивостей води в ЕМП, або в конформаційних змінах біологічних макромолекул під впливом того ж фактора, а може включати обидва фактори одночасно. Для солітонної моделі об'ємних зв'язаних структур в магнітному полі обчислено статистичний інтеграл та конфігураційні внески у вільну енергію, ентропію і питому теплоємність. Показано, що концентрація солітонів залежить від зовнішніх полів. У частинному випадку об'ємних зв'язаних структур отримані результати добре узгоджуються з експериментальними даними. Пояснено ефект пам'яті в системах з водневими зв'язками у рамках континуальної солітонної концепції будови рідини.

ВЗАИМОДЕЙСТВИЕ МАГНИТНОГО ПОЛЯ С ЖИДКИМИ СТРУКТУРАМИ

И. П. Сусак, А. С. Шигаев, О. А. Пономарев, Е. Е. Фесенко

Р е з ю м е

Рассмотрен возможный механизм воздействия магнитного поля на жидкость. Механизм влияния электромагнитного поля

на биологические процессы может заключаться либо в изменении скоростей биохимических реакций под влиянием изменения свойств воды в ЭМП, либо в конформационных изменениях биологических макромолекул под влиянием того же фактора, а возможно, включает оба фактора одновременно. Для солитонной модели объемных связанных структур в магнитном поле вычислены статистический интеграл и конфигурационные вклады в свободную энергию, энтропию и удельную теплоемкость. Показано, что концентрация солитонов зависит от внешних полей. В частном случае объемных связанных структур полученные результаты находятся в хорошем согласии с экспериментальными данными. Объяснен эффект памяти в системах с водородными связями в рамках континуальной солитонной концепции о строении жидкости.