About Some Physical Properties of Water in Nanosistems and the Possible Mechanism of Superconductivity Induction by Water in Compounds $SrFe_2As_2$ and $FeTe_{0,8}S_{0,2}$

Ludmila Stepanovna Martseniuk, Aleksandr Stepanovich Martseniuk,
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Keywords: nanowater, coherent domains, SPE-effect, coherent water, near- surface water, EZ-water, water phases, water properties, hydrogen binding, ice, nanotube water, nanotube, ferriferous superconductors, high-temperature superconductors, layered superconductors, paramagnetic, antiferromagnetism, inducing of superconductivity, quasi-two-dimensional systems, two-dimensional superconductivity, Cooper pairs, exchange interaction, mechanisms of superconductivity, CDW-wave, coherence, neutron-diffraction analysis.

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О некоторых физических свойствах воды в наносистемах и возможные механизмы индуцирования водой сверхпроводимости в соединениях $SrFe_2As_2$ and $FeTe_{0,8}S_{0,2}$

Людмила Степановна Марценюк, Александр Степанович Марценюк,
Михаил Васильевич Курик

Аннотация. Работа посвящена анализу свойств воды, диффундировавшей в слоистые соединения $SrFe_2As_2$ и $FeTe_{0,8}S_{0,2}$. Впервые предложен механизм эффекта, недавно открытого японскими исследователями, стимулирования водой сверхпроводимости в этих соединениях. Для этой цели использовалась теория конденсации водных молекул в жидкое состояниие, развитая J.Preparata с позиции квантовой электродинамики. Вода, диффундировавшая в эти соединения, формирует наносистемы, - индивидуальные слои, аналогичные слоям железосодержащих соединений, и в некоторых свойствах подобна EZ-воде, которую хорошо описывает эта теория. Поэтому следует ожидать, что при низких температурах такая нано-вода будет отличаться от обычного льда.

Ключевые слова: нановода, когерентные домены, СПЕ- эффект, когерентная вода, приповерхностная вода, EZ-вода, фазы воды, свойства воды, водородные связи, лед, нанотрубочная вода, нанотрубки, железосодержащие сверхпроводники, высокотемпературные сверхпроводники, слоистые сверхпроводники, парамагнетизм, антиферромагнетизм, индуцирование сверхпроводимости, двумерные системы, двумерная сверхпроводимость, куперовские пары, обменное взаимодействие, механизмы сверхпроводимости, CDW-волны, когерентность, нейтронно-дифракционный анализ.

Про деякі фізичні властивості води в наносистемах і можливі механізми індукції водою надпровідності в з'єднаннях $SrFe_2As_2$ і $FeTe_{0,8}S_{0,2}$

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Анотація. Робота присвячена аналізу властивостей води, що дифундувала в шаруваті з'єднання $SrFe_2As_2$ і $FeTe_{0,8}S_{0,2}$. Вперше запропоновано механізм ефекту, недавно відкритого японськими дослідниками, стимулювання водою надпровідності в цих з'єднаннях. Для цієї мети використана теорія конденсації водних молекул у рідкий стан, розвинута J.Preparata з позицій квантової електродинаміки. Вода, що дифундувала в ці з'єднання, формує наносистеми, - індивідуальні шари, аналогічні шарам залізовмісних з'єднань, і в деяких властивостях подібна до EZ-води, яку добре описує ця теорія. Тому слід чекати, що при низьких температурах така нано-вода відрізнятиметься від звичайного льоду.

Ключові слова: нановода, когерентні домени, СПЕ- ефект, когерентна вода, приповерхнева вода, EZ-вода, фази води, властивості води, водневі зв'язки, лід, нанотрубкова вода, нанотрубки, залізовмісні надпровідники, високотемпературні надпровідники, шаруваті надпровідники, парамагнетизм, антиферомагнетизм, індукція надпровідності, двовимірні системи, двовимірна надпровідність, куперівські пари, змінна взаємодія, механізми надпровідності, CDW-хвилі, когерентність, нейтронно-дифракційний аналіз.

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1. Introduction

The researches of the water which has been carried out in a number of laboratories, have shown, that usual water is not the homogeneous medium, and will consist of two fractions distinguished on the properties. To such conclusions has come still Rontgen W.K, investigating in the laboratory the properties of water with application of x-ray radiation.

These results deny the standard concepts according to which water represents some intermediate state between solid and gaseous phases. Physical properties of water under the standard concept are determined in a stationary regime by static short-range forces of interaction, whence follows, that water should represent a homogeneous medium. Such point of view and now many researchers still adhere.

Essential advance in development of new view on essence of the phenomena in the water medium has been carried out due to two remarkable discoveries: to experimental detection of effect SPE [1] and to a theoretical prediction of existence of coherent regions (coherent domains) in water system [2]. Results of these works well supplement each other, but differ in theoretical interpretations. Convenient object for verification of the put forward positions is particular at the properties state of water – nanowater.

Nanowater is present in molecular formations of cellular systems, capillaries, membranes, etc., - as an adjoining layer of these systems, finding out surprising properties and determining all vital processes.

Features of water, adjoining to surfaces of solid systems, so-called EZ-water, from a position of quantum electrodynamics are investigated in work [3]. It is shown, that the positions, developed within the framework of such approach, completely describe experimentally observable phenomena. Therefore is of interest to expand this description and on such systems, where water located as one or several layers (the quasi-two-dimensional systems). We shall note, that recent openings of effect of superconductivity induction by water in compounds $SrFe_2As_2$ and $FeTe_{0,8}S_{0,2}$ [4, 5] (where the diffused water takes place the quasi-two-dimensional layers) still does not have satisfactory theoretical interpretation. Revealing of essence of this phenomenon is very important not only for physics of superconductivity, but also for understanding of a role of water in functioning alive organisms.

2. Appearance of superconductivity in compounds $SrFe_2As_2$ and $FeTe_{0,8}S_{0,2}$ under influence of water diffused in them

Compounds $SrFe_2As_2$ and $FeTe_{0,8}S_{0,2}$ [4, 5] belong to layered ferriferous materials, perspective for creation on their basis of high-temperature superconductors.

In work [4] the data of detection for the first time of superconductivity at diffusion of water in epitaxial thin film of undoped $FeTe_{0,8}S_{0,2}$ (thickness ~ 200 nm) are published, the scheme of it crystalline structures (fig. 1) is presented.

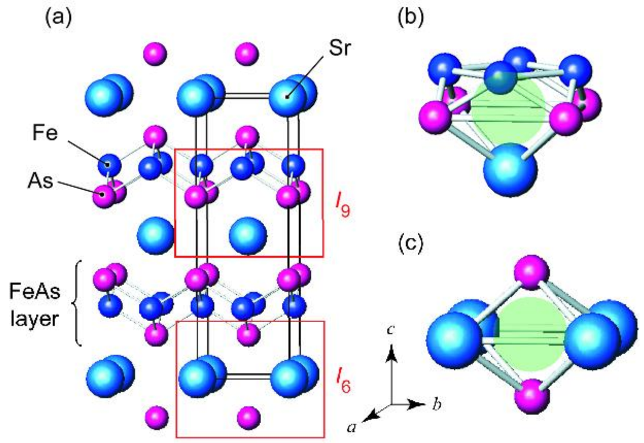

Fig.1. (a) Crystalline structure of $SrFe_2As_2$. The box indicates the unit cell. (b, c) Expanded views of the interstitial sites (b) I_9, which is surrounded by four As, four Fe and one Sr, and (c) I_6, which is surrounded by four Sr and two As..(Fig.1, is taken from [4])

As it is underlined in [4], $FeAs$ -layers of $SrFe_2As_2$, like similar on structure layers of other superconducting ferriferous compounds, are formed from $FeAs_4$-tetrahedrons and play a determining role in the mechanism of formation of a superconducting state. These compounds in undoped state have the phase transition accompanying with structural transition in antiferromagnetic phase, but in a state of superconductivity without doping or compression do not pass.

The $SrFe_2As_2$-compound, doped of cobalt, finds out superconductivity at $T_c = 20$ K. Undoped epitaxial thin films pass to an antiferromagnetic phase at

T_{ant} = 204 K and, at exposition in the atmosphere of environment at $T_c = 25$ K , find out the transition to superconductivity.

Authors [4], on the basis of the additional researches, carried out by them, have shown that only the vapors of water, diffused in a film of $SrFe_2As_2$ from an atmosphere, can induce a transition of undoped film to a superconducting state.

Researches of properties of $SrFe_2As_2$ -epitaxial films, containing diffused water molecules, have revealed that these films have also other distinctions from the samples doped by cobalt.

First, strong anisotropy properties of these films in magnetic field are found out, unlike film, doping by cobalt (the last demonstrate almost isotropic behavior). So, the value of temperature of superconducting transition made $T_c \leq 7$ K for H//C and ≤ 16 K for H//a, at a size of magnetic field H ≈ 9 T.

In opinion of authors [4] this means, that upper critical field is higher 9 T and that T_c is more sensitive to H//C, than to H//a.

Secondly, embedding of water in crystalline structure of a film leads to compression of a film in a direction of an axis C , instead of to expansion as it is necessary to expect, proceeding from prospective possibilities of its disposition in crystalline structure.

Authors suppose, that molecules of water can be incorporation in the sites designated as I_6 or I_9, but, proceeding from the sizes of atom of oxygen and geometry of an disposition of sites, the most probable is incorporation of atoms of oxygen in the sites designated as I_9.

On the basis of preliminary calculation authors indicate, that the lattice in a direction of an axis C should have some expansion at such incorporation, instead of compression. However its thickness has decreased up to 190 nm.

The third difference is an appearance of certain amount of an impurity Fe_2As-phase which is found out at the X-ray structural analysis. Taking into account, that there are no literary data on existence of transition in a superconducting state for Fe_2As , authors [4] consider, that the principal cause of occurrence of superconducting transition is connected to compression of a lattice, occurring at diffusion of water that is equivalent to exhibit of the pressure, instead of appearance of an additional Fe_2As - phase. They do such conclusion on the basis of the message data that the application of the external pressure leads to origin of superconductivity with T_c, achieving at 35 - 38 K. However at such way of achievement of superconductivity are observed reduction of value $T_{crt.}$ of antiferromagnetic transition at increase the pressure. For films $SrFe_2As_2$, containing diffused water, a value $T_{crt.}$ is the same, as well as for just received samples, and T_c has smaller value, than at application of pressure. It means, that the mechanism of occurrence of superconducting transition other, than at external compression.

We shall notice, that by virtue of feature of site I_9 structure, molecules of water can occupy both the individual layers, oriented by an disposition of I_9, and double layers (the second layer settles down under the first and it is separated from the first by Sr). Presence of an impurity Fe_2As- of a phase, probably, testifies to such disposition of water layers, since molecules of water at incorporated in places, oriented by a site I_9, can displace two molecules of iron from the initial position.

Authors [4] though consider, that main mechanism, resulting to superconductivity, is a compression, however, do not exclude and the other possibilities, for example, possibility of the origin a sub product of reactions between $SrFe_2As_2$ and H_2O. It, in their opinion, will lead to interesting discovery, as any other phases, except of Fe_2As, $FeAs$ and amorphous phase, by X-ray measurements it has not been fixed, but any one of these phases is not a superconductor.

Thus, any of supposed reasons of origin of superconductivity in compound $SrFe_2As_2$ is not satisfactory and authors [4] also could not specify the reason of a lattice compression occurrence.

The induction of superconductivity in $SrFe_2As_2$, did not appear the unique phenomenon, such effect has found out by authors [5] and for compounds $FeTe_{0,8}S_{0,2}$.

The crystalline structure of compound $FeTe$ is similar to structure of compound $FeSe$, shown on fig. 2

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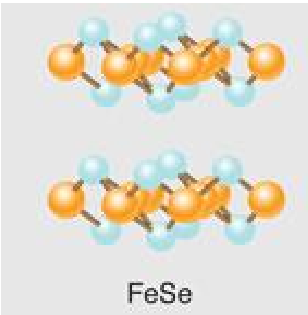

Fig. 2. The crystalline structure of $FeSe$. Orange colors - atoms of iron, blue - arsenic are shown (Fig. 2, is taken from a site: stone braker design works.com.)

Though the crystal structure $FeSe$ also does not contain intermediate planes, magnetic and superconducting characteristics of this compound are similar to other ferriferous superconductors. It confirms the assumption of researchers of these structures that the basic processes resulting to superconductivity, occur in two dimensional ferriferous planes.

Authors [6] carry out comparison of properties of not doped $FeSe$ and $FeTe$. The temperature of superconducting transition T_c of compound $FeSe$ (according to various references) is 8 K and depends on applied pressure.

$FeTe$, having as well as $FeSe$ tetragonal structure, passes in an antiferromagnetic state at 70 K and is not a superconductor.

Magnetic properties of compound $FeTe$ are suppressing by entering of additives of sulfur or selenium. However for $FeTe_{0,8}S_{0,2}$, grown by a method of solid-state reaction, the diamagnetism, corresponding to superconductivity, is not found out [5]. On curve dependence of resistance on the temperature, submitted by authors [5] for just grows up samples, the break is found out at 8 K, but zero resistance is not achieved. As the diamagnetic signal is not found out, authors connect this change of resistance not with origin of total superconductivity, but only with origin of filamentary superconductivity. The application of hydrostatic pressure does not lead to superconducting transition of $FeTe_{0,8}S_{0,2}$ polycrystal.

The $FeTe_{0,8}S_{0,2}$ samples which have lain on air at room temperatures more than 20 day, found out the diamagnetic signal corresponding to total transition of compound to superconductivity. At increase the time of exposition the signal increased, and resistance, in comparison with virgin samples, decreased. Reduction of resistance is indicating on increasing of density of carriers at increase the time of exposition till 110 day.

One more essential change of samples, at their exposition on air was the compression of a lattice. The following parameters of compression have been specified in work for virgin samples: a = 3.8114 (8) and c = 6.2421 (21) Å; for exposing on air at room temperature during 200 day, - a = 3.8097 (8) and c = 6.2307 (20) Å.

Authors [5] had been carried out the additional researches, similar described in [4] which have revealed, that only molecules of water, diffused in samples $FeTe_{0,8}S_{0,2}$, bring to superconductivity of polycrystals of this compound. Authors [5] have not been able to reveal the exact reason of effect of induction by water of superconductivity, however put forward some possible variants, indicating herewith, that the mechanism of such effect for $FeTe_{0,8}S_{0,2}$ polycrystal should be same, as well as for film $SrFe_2As_2$ and, most likely, is connected to observable reduction of the sizes of a lattice.

3. About the nature of appearance of superconductivity in ferriferous superconductors

As is known [6], impurity of magnetic materials negatively influence upon parameters of a superconducting state of usual superconductors. It is stipulate by that magnetic impurity possess own magnetic moment, which interacts with the magnetic moment of one of Cooper pairs electrons and reorients its direction, what destroys the coupled state of pair.

Existence of high-temperature superconducting of ferriferous compounds was revealed in 2008 and, despite of huge number of researches, the mechanism of pairing of electrons in these compounds is not opened. The standard theory BKS, created for the description of processes in earlier known superconductive compounds, is not sufficient as denies possibility of origin of superconductivity in magnetic materials. Nevertheless, as follows from references, exactly magnetism can be responsible for the unusual mechanism of superconductivity in these compounds.

As the majority of these compounds have phase transition in an antiferromagnetic state, there is an assumption, that the antiferromagnetic state precedes superconducting, and they compete among itself. Usually to suppression of an antiferromagnetic state apply doping. Compression changes parameters of a crystalline lattice that influences upon magnetic ordering and also can suppress antiferromagnetism.

Theoretical development of models of high-temperature superconductivity resulted in the appearance of a wide spectrum of various assumptions; however the theory of origin of superconductivity in these compounds is far from completion.

At first, in connection with discovering of new superconductors, the possibility of using the standard theory of electron-phonon interactions for explanation the mechanism of Cooper pair's formation was researched. So, in work: [6] theoretically has been shown, that if to use the model of electron-phonon interactions, the temperature of transition in a superconducting state for iron chalcogenides, to which pertains and $FeTe$, will not exceed 1 K. Taking into account, that value of critical temperature is much higher, it means, that the given compounds are belonged to superconductors with the unusual mechanism of pairing. In this work also it is shown, that properties of compounds $FeSe$, $FeTe$ и FeS are similar by configuration of a Fermi's surface, phonon spectrum, and magnetism with compounds on a basis $FeAs$. Authors consider that superconductivity is caused by spin fluctuations of SDW-type (spin density waves).

In work [6] are also brought the calculated data about structure of Fermi surface. It is shown, that Fermi's surface has complicated character and consists from cylindrical electronic section in corners of zone Brillouin and section of cylindrical hole surfaces in the center of a zone. Such structure is caused by quasi-two-dimensional an electronic structure of ferriferous superconductors. The further experimental researches, which have been carried out by various methods, have confirmed these calculations.

For estimation the possibility of electron-phonon mechanism of coupling researches the isotopic effect in these compounds [7] has been carried out. If takes place the electron-phonon mechanism, dependence of the critical temperature on mass of an isotope (at replacement of a superconductor isotope) should be inversely proportional to a square root of an isotope mass m, i.e. $T_c \sim 1/m^{\alpha}$ where α = 0,5.

For an estimation of parameter α usually use more convenient formula:

$$\alpha = -\frac{m}{\Delta m}\frac{\Delta T_c}{T_c} \tag{1}$$

For compound $Ba_{1-x}K_xFe_2As_2$ $(\mathrm{x} = 0,4)$ with $T_c = 37\ K$ the researches of isotopic effect have been carried out and appeared, that at replacement of iron ^{56}Fe by an isotope ^{54}Fe the value α is approximately equal 0,35. In opinion of authors, it means, that the electron-phonon mechanism of formation of Cooper pairs is possible, but it is not described by the standard BCS-theory

One more work [8] also devoted to research of isotopic effect, has not confirmed results of work [7]. They were researched the same polycrystalline compound $Ba_{1-x}K_xFe_2As_2$, and at isotopic replacement of atoms of iron, it was revealed, that though the exponent α and differs from zero, it has a negative sign and consist $\alpha_{Fe} = -0,18$. It means that than more heavily an isotope of iron, that higher value of critical temperature.

Coming from got results, authors [8] believe, that in formation of superconductivity participates and electron-phonon interaction, but character of display of such interaction complex and is not described by standard BCS-model. Possible also variant, when the mechanism of formation of Cooper-pairs is represents a mix of exchange and electron-phonon interactions.

Interesting in this respect is already mentioned work [7]. In it authors investigated not only the influence of isotopic replacements on T_c, but also investigated as thus will changes the temperature of transition of not doped compounds $BaFe_2As_2$ and $SmFeAsO$ in a state of spin density wave T_{SDW}. Appeared, that $\alpha_{SDW} = -\frac{d\ln T_{SDW}}{d\ln m}$ is 0,05 for oxygen and 0,37 for iron. These data directly specify the presence of strong of phonon-magnon interactions. In connection with these results it is necessary to suppose, that isotopic change of value T_c is also caused by phonon-magnon interaction.

For opening the mechanism of superconductivity by an important point is the establishment what mechanisms of behavior electrons in superconducting system of compound is realized, - the mechanism of strong binding according to which electrons can be distinguished, or the mechanism of weak binding, when electrons behave as united integer (so-called strongly correlated the Mott's dielectric).

As follows from review's work [9], the most popular standpoint, that $FeAs$ - systems are weakly correlated systems. However there is also a number of experimental works which results do not agree with such statement. The author [9] in this connection indicates, that though a question on, whether $FeAs$ are - weakly correlated systems or it is strong correlated systems, remains open; electronic correlations play the certain role in these systems.

Researches of properties of iron chalcogenides (FeX) have shown, that, as well as for compounds of the type AFe_2As_2 (where $A = Ca, Sr, Ba$), to transition in a superconducting state for chalcogenides precedes the phase transition to an antiferromagnetic state.

Suppression of an antiferromagnetic state is possible to achieve by doping or compression due to application of the external pressure.

Antiferromagnetic ordering in undoped ferriferous superconductors exists as waves of spin density (SDV), which it is possible, in the simplified approach, to associate with periodic reduction and increasing of electronics spin density. The period of these waves is determined not by the period of a lattice, but properties of magnetic interaction and this state is distinct from variety of magnetic excitation - spin waves.

As SDW-waves arise as result of magnetism in system, which is caused by exchange interaction, the mechanism of formation of Cooper pairs in these compounds also can have an exchange character.

In the works, where investigated the dynamics of spin excitation [10, 11] on not doped $SrFe_2As_2$ and $BaFe_2As_2$ by methods of neutron diffraction analysis, it is informed, that for them at low temperatures antiferromagnetic ordering takes place. For $SrFe_2As_2$ [10] it is revealed, that the spectrum of magnetic exitations has a gap $\Delta \leq 6,5$ meV, above which spin waves are observed. Magnon's spectrum spread up to energe of order 170 meV, essentially exceeding typical frequencies of phonons (40 meV) [11].

Despite of huge quantity of publications on revealing the mechanism of pairing in high-temperature superconductors there are still not solved some questions. As it was noted in the review [9], not clear there are questions: «Whether needs for high-temperature superconductivity the "vicinity" to antiferromagnetism? Whether is antiferromagnetism a competing phase, or it substantially promotes to high-temperature superconductivity, for instance, through replacement of electron-phonon mechanism of pairing by the mechanism, based on spin (antiferromagnetic) fluctuations»? If the author [9] consider, that in ferriferous superconductors «a role of electron-phonon interactions, apparently, can be quite significant (isotope - effect)» the author of other review [12], asserts «the vicinity to antiferromagnetic ordering in cuprates and $FeAs$ - systems stipulates the spin-fluctuating mechanism of the pairing resulting in both cases to high values T_c».

We shall note that for high-temperature superconductors the mechanism of transition to superconducting state can appear even more complex, than it was supposed, and have a mixed character. This point of view is confirmed also by work [13], where authors investigated influence of pressure on parameters of transition in a superconducting state of $SrFe_2As_2$ monocrystal. This work is interesting and in that relation, that induction by water of superconductivity in $SrFe_2As_2$, as it mentioned above, explained by compression of a lattice, which occurs and at application the external pressure.

In this work experimentally, by a method of a nuclear magnetic resonance for the first time have found, that for undoped $SrFe_2As_2$ at application to it the external pressure in a diapason 4,2 - 8 ГПа, the simultaneous existence of two phases - antiferromagnetic and superconducting (fig. 3) is found out.

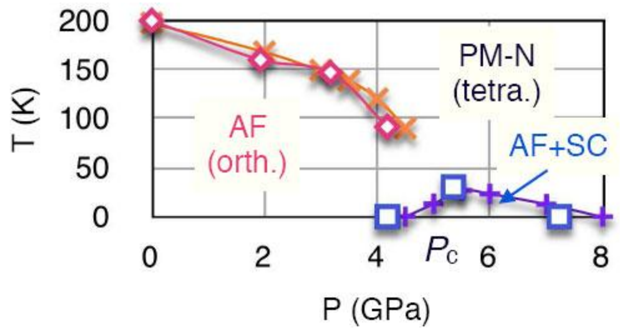

Fig.3. The phase diagram of compound $SrFe_2As_2$ depending on pressure.Upper curve divides areas of an antiferromagnetic and paramagnetic states; the bottom curve outlines area of simultaneous existence of antiferromagnetic and superconducting states. (fig.3 is taken from [13])

As can be seen from fig. 3, in range of 4.2-8 GPa the curves of Neel and phase transition in superconducting state coincide. It means that in this area possible simultaneous existence of superconducting and antiferromagnetic phase.

Such data indicate, that antiferromagnetic state and superconducting state can not only compete one with others, but also coexist. Besides, these data point to significant role of magnetic interaction (having character of exchange interaction) in realization of the mechanism of superconductivity in this compound.

Authors also note, that the effect, observable by them, is appear in consequence of formation of nano-dimensional superconducting /antyferromagnetic hybrid structures and this entangled state is a remarkable example of self-organizing of heterogeneous structures in pure systems.

Let's note also, that this work [13] to some degree approximates us and to comprehension of essence of the mechanism induction by water of superconductivity in films $SrFe_2As_2$.

4. Modern physical views on properties of water

According to the theoretical researches, described in [2, 3, 14 and 15] and other works, usual water in a liquid state is the system consisting of two fractions: the coherent structures, representing individual regions - coherent domains, and not coherent, «classical water», surrounding these regions. Coherent domains are formed owing to resonant interactions of virtual vacuum photons with molecules of water. We shall briefly describe the basic characteristics of these fractions and processes, underlying in basis of their origin, basing on the data of works [3, 14, and 15] where this description is submitted in the simplified variant.

The condensation of a matter from ensemble of not coherent molecules of gas from a position of quantum electrodynamics can be related to electromagnetic interaction of these molecules with a vacuum virtual photon. As it is indicated in [3] with reference to [16], the closely packed ensemble of atoms or molecules, which number N, is able to leak out the virtual photons. We shall assume that molecules have only two states, - the ground states and excited states; energy of excitation $E = h\nu$ is in the order of 10 эВ. The size of a molecule we shall accept about of 1 Å. Then the photon, capable to excite a molecule, should have length of wave $\lambda = c / \nu$, is in the order of about 1000 Å. Let the probability of excitation (according to estimations of the authors [3], which have taken for a basis the size of Lamb's shift [3]) is in the order of about $10^{-4} \div 10^{-5}$. The excited molecule can decay, having let out a photon (through a time corresponding to time of decay), which can excite other molecule, or to be the absorbed by vacuum. The relative probability of these two events will depend on density of the molecules $n = N / \lambda^3$, which are presents inside volume λ^3 of a photon. If the density n will exceed the threshold n_{crit} (Equation 2), the photon will be never returned in vacuum.

For such case the next condition should satisfy:

$$P\lambda^3 n_{crit} = 1 , \qquad (2)$$

where P - probability of excitation of one molecule by a virtual photon.

Such process will last until the enough amount of photon will got trapped and a sizeable electromagnetic field will built in this region.

This field:

1) Will create the attraction amongst molecules, producing a large increase of density.

2) Will give a common oscillation of all the trapped atoms with common phase for the whole region, named author of [3] as coherence domain (CD).

In accordance with theoretical estimation of the authors of reference [3], made for water, for CD each molecule is coherent oscillate between the ground state, whose statistical weight 0,87 and where electrons are closely bound; and excitated state, whose weight 0,13 and where they in are found in quasi-free state. For E=12.06 эВ, we have, that λ = hc/E = 1000 Å = 0.1 mc and this value corresponds to the size of CD of water.

At formation of coherent domains there is a reduction of entropy of water system, that results to occurrence of such characteristic as energy of transition (energy gap) from a coherent state to not coherent and, according to [3], it means, that energy of a coherent state is lower, than not coherent. As follows from [3], this size makes 0.26 эВ.

Thermal oscillations in usual water result in that, the both factions: the coherent and non-coherent exist in the non-stationary state, but for them, like as for superfluid helium, the next expression takes place

$$F_c(T) + F_{nc}(T) = 1 \tag{3}$$

According to [3] the equations (3) determine the total number of molecules in each phase for any time interval, but each molecule passes through two phases continuously. This phenomenon generates "flickering" regime for water system. Nevertheless, the situation essentially changed for the water, structured near to solid surfaces (films) [3]; for water, diffused in rocky formation of mountain [17]; for water, bound by biological systems of an alive organism; for natural water and for coherency natural water of left and right polarization (where water is close on some parameters to water of alive organism) [18]; for waters in capillaries and in some other cases. For them the time of existence of the coherent domains is much higher and such domains can form a cluster structures in natural water or whole regions of coherence. Memory of water is defined by such properties of water [19]. We shall notice that any external influence on the water environment is fixed by water through change of its internal structure.

As it was specified above, the excited state include the coherent oscillations with energy 12.06эВ, laying below of energy of the molecule ionization, value of which is at about of 12.60 эВ. Owing to such close disposition of energy of the exited state to energy of ionization in coherent domains, the oscillation of electrons leads to occurrence quasi-free electrons in a coherent state. These electrons can easily be released and can participate in chemical transformations and other processes.

The properties of water in both faction, - coherent and no coherent, greatly differ.

In work [1] is described for the first time opened by its author the SPE-effect and are presented the experimental results on study of water and water-environment of alive organism with using the new methods.

The essence of SPE-effect consists is that the resonance interaction of low intensive (<10 mcWt/cm^2) of millimeter waves (EHF-diapason) with water and biological environments on frequencies, coincident with frequencies of molecular vibrations of water, is taking place. Such frequencies are named by the authors of reference as «resonance».

Experimental results of work [1] have confirmed the existence of two phases in water system.

The water system, as follows from this reference, has in its composition molecular ("ice-like") structures, consisting from cluster's hexagonal formations and the individual water molecules, surrounding these formations. Water molecules in «ice-like» structures are coupling through hydrogen binding. In a solid phase, as authors [1] indicate, oxygen is tetravalent.

The reveal resonant peaks have very high quality factor and correspond to frequency of resonant vibrations of water molecules hexagonal structures. Peaks of these fluctuations is located in region of GHz (there correspond to frequency of 50,3 GHz for radial vibrations and 51,8 GHz for transverse vibrations of chain O-H- hexagonal rings).

Quality factor in region near to 50 GHz of spectrums, which have been taken off from the water environment of alive organisms, is higher than three times, than received at researches of usual water. At treatment of the results authors [12] believe, that «the liquid phase of water is not «the third phase» and represents an associative mix of fragments of molecular structures of its two extreme phases - ice and vapor» though indicated, that water systems of alive organisms are in a resonant state. Thus, «ice-like phase» of waters corresponds in this treatment to a usual solid state.

What is the «ice-like phase» is possible to find out, in some degree, analyzing behavior of waters in nanosystems.

5. About the reasons of induction by water the superconductivity in compound $SrFe_2As_2$ and $FeTe_{0,8}S_{0,2}$

As follows from [4, 5], at diffusion of water the compounds $SrFe_2As_2$ and $FeTe_{0,8}S_{0,2}$ essentially change properties and the most substantial change is transition to state of superconductivity at low temperatures, which is not found out for just made samples. Besides, as it was indicated above, there are also the structural changes at diffusion of water, one of which is compression of a lattice. Strong anisotropy of properties $SrFe_2As_2$ is found out at application a magnetic field at low temperatures, which arises for the sample, exposited on air, but does not reveal for doped of cobalt compounds [4]. Reduction of resistance [5] for the samples $FeTe_{0,8}S_{0,2}$, exposited on air more of 20 day, testifies on increase of carrier's density at water diffusion.

As satisfactory explanation of processes, occurring in these compounds till now it is not found, researchers suppose that main reason of passing to the superconducting state is a compression of lattice, which is equivalent to application of pressure [4, 5]. But for initial $FeTe_{0,8}S_{0,2}$ the structural transition to a superconducting state is not found out and at application the external pressure, and properties $SrFe_2As_2$ under pressure differ from properties of this compounds at diffusion in their of water.

Thus, any put forward an explanation, constructed from comparison with properties of other high-temperature ferriferous superconductors, is not satisfactory. Remains the other of possibility, - to explain the effect of induction on basis of properties of the water, which are located, as result of diffusion, by single layers, paralleled to basic ferriferous layers.

Unfortunately, it is not known exactly, which one water forms the structures at diffusing in compounds $SrFe_2As_2$ and $FeTe_{0,8}S_{0,2}$, but, nevertheless, the behavior of this two dimension water it is possible to predict, having applied to the description of properties of diffusing waters the positions, advanced by J.Preparata in the theory of condensation of water molecules to a liquid state, created by him on the basis of quantum electrodynamics.

In [16] authors have theoretically shown the possibility of leaking out of photons by closely packed ensemble of atoms or molecules. As it is indicated in this work, it brings to continuous outflow of photons through mirrors of a cavity, even at absence of external influence. So, according to the theoretical estimation, resulted in this work, for 104 atoms ^{85}Ru placed in an optical cavity, emission of photons I = 300 c^{-1} is expected and this settlement value correspond to experimental data.

Authors [16] also indicated on possible processes of self-organization and the processes of outflow of energy, related to them, which can be caused by interaction of system of atoms (molecules) with virtual photons as it occurs in Casimir effect. Pay the attention to a possible version of such system behavior at presence of a dividing barrier and participation of the virtual photons coming from vacuum.

As has shown W.Nernst in 1914, the virtual photon can tune the vibration of identical molecules of system and that provide arising of common phase of such vibrations. This position possible to use and for description of the behavior of water molecules, diffusing in crystalline structure of compound $SrFe_2As_2$ and $FeTe_{0,8}S_{0,2}$. Through the diffusing into compounds molecules of water (in accordance with [16]) also virtual photons can leak from a vacuum. At presence of a sufficient transparency of the basic ferriferous layers of compounds in this energy diapason in area of interaction of molecules with a virtual photon can get and molecules of other layers. For this the probability P of excitation (at enough high degree of a transparency) molecules of water layers, according to the equation (2), should be not less, than:

$$P_f = 1/\lambda^3 n_w, \quad (4)$$

where P_f - average value of probability of excitation by a photon of water molecule in the volume defined by size of a photon (~1000 Å);

n_w - average density of molecules of water in this volume.

If ferriferous layer of the basic material (by virtue of some internal processes) greatly absorb the radiation on frequency of such virtual photon, then in interaction is included the smaller number of the water layers or it occurs in single water layer only. In the latter case it does not lead to those effects which, under our assumption, and are found out in $SrFe_2As_2$ and $FeTe_{0,8}S_{0,2}$ at diffusion in them waters (partly already at a room temperature, - for example, compression of crystalline lattice, the increasing of the concentration of carriers).

Interaction of water molecules with the virtual photon, coming out from vacuum, can lead to synchronization of vibrations of water molecules and formation of the coherence regions, similar to coherent domains. According to positions of quantum electrodynamics it will lead to an attraction between a molecules of water and, accordingly, between the layers of the molecules which have appeared in the field of interaction. Result will be the compression of a crystal lattice of compound.

Any other mechanisms of a lattice compression of compounds at diffusion in them waters, except the specified by us here (connected with the tune of vibrations of water molecules in a uniform by vacuum virtual photon), it has not been put forward till now.

It is interesting to indicate one more publication [20] where it is informed, that the effect of induction of superconductivity is found out and at contact of compound $FeTe_{0,8}S_{0,2}$ with the alcohol-containing water solution. At heating the $FeTe_{0,8}S_{0,2}$ compound in the various alcoholic beverages, with compound there are the same changes, as well as at an exposition on air, in particular, the compression of lattice. We shall note in this connection, that according to [1] the resonant spectra of EHF-diapason, which have been taken off from water and alcohol-containing water solution, have a very close location of a resonant peaks though the intensity of these peaks are different. Such distinction in [1] explained that for water, containing spirit, typically the higher delaminating of hexagonal planes, than for pure water.

Ethanol spirit, as well as usual water, is an associated liquid, i.e. contains hydrogen bindings. It means [3], that positions quantum electrodynamics, advanced by G.Preparata for water, are suitable and for the description of this substance. Probably, exactly these characteristic also cause the possibility by molecules of an ethanol spirit to interact with virtual photon and induce the super-conductivity in crystalline structure either as water molecule.

Though the unique reason of induction, in opinion of authors of the works, which for the first time have fixed the effect, is the compression of a lattice (that equivalently as they consider, to application of external pressure), such explanation as, authors specify, is not sufficient.

Really, the influence of diffusing waters is not reduced to compression only.

As follows from above mentioned works, to induce the transition to superconductivity it is possible two ways: firstly, compression and, second, doping. Doping can bring to next result: to reduce the interaction between layers, to suppress the transition in an antiferromagnetic state and to increase the concentration of carriers.

Properties of two-dimensional water, being situated between the basic layers, by virtue of features of its formation on some parameters are similar to so-called EZ-water (exclusion zones, EZs), - to water, a thin layer adjoining to any hydrophilic surface.

An adjoining surface shields an EZ-layer from the destroying influence of thermal vibrations of external environment, in consequence of which the regions of CD appear substantially anymore. It is typical, that for near-surface waters, adjoining to surfaces of alive, viscosity is lower, than usual water and EZ-water. The reasons of such difference are in detail discussed in [3] and authors connect them with an opportunity of coherent domains to resonate among themselves in alive.

Enumerate some differences of EZ-water from usual water according to [3].

1. EZ-water considerably more viscous, than normal water (on the order)
2. EZ-water has negative electric potential (up to 150 mV)
3. On border between EZ-water and usual water protons are concentrated.
4. EZ-water blocks penetration of impurity molecules.

In opinion of authors [3] EZ-water is formed, basically, from the molecules residing in a coherent state and vibration with a united phase (in area of coherent) between the basic and excited states. The attraction among molecules vibrates in one phase, according to positions of quantum electrodynamics causes the higher viscosity, than for not coherent molecules of water. Besides, such water easily gives electrons, since the difference between energy of ionization (12,60эВ) and energy excitation (12,06 эВ) is insignificant. Ability of easy giving of electron leads to occurrence of negative electric potential and concentration of protons on border, as it is specified in points 1.and 2.

Let's consider in more detail, what occurs with the molecules of water, diffusing in compounds $SrFe_2As_2$ and $FeTe_{0,8}S_{0,2}$.

Water molecules, diffusing in these compounds, in consequence of interaction with a virtual photon and the subsequent passing to coherence, get such quantum characteristic, as a phase, unique for each area of coherence. The further interaction between separate areas can lead to their merging, as well as for EZ-water, especially at the decrease of temperature.

Let's note, that in area of interaction with the virtual photon, having the energy E = 10эВ (which length of a wave, accordingly, makes about 1000 Å), gets enough amount of layers of the water, which are settling down between the basic ferriferous layers. Thus, the condensation of diffusing water molecules in a state, on its properties reminding "ice-like" state, is carried out.

Let's emphasize here, that the coherent water in a formations of water layers, as well as usual water in coherent domains, not is the water, which properties correspond to frozen crystallize water, where absent coherent domains. Here we have superposition of the ground state, where molecules are closely bonded among themselves and the excited, where electrons are "handling" in an electronic cloud and are collectivized for all region of coherence, i.e. are as unit.

The most essential difference of water in two-dimensional layers from «ice-like state» is that: these layers do not coupled in a transversal direction by hydrogen banding and has two "external" electrons on one atom of oxygen, because oxygen in «ice-like state» is tetravalent.

The second difference will be, that in the field of interaction with a virtual photon for all water layers the regime of coherence is established, i.e. all processes occur in a uniform and with unique phase. In consequence are the changes of polycrystalline structure, since layers of water at coherencies tend to approaching, in the result of which can change the parameters of a lattice, its compression. It also is observed experimentally.

Let's note, that at the usual freezing of water there is, as is known, a process of expansion, instead of compression.

The third difference is that the polycrystal lattice stabilizes processes in water layers in accordance with their own internal process and can appear the resonance transitions (and it is possible also the processes, similar to some extent to effect of affinity, - when superconductivity in one substance induces superconductivity in the other substance).

From EZ-water, diffusing water differs, as well as from usual water, by two-dimensional character, the absence of hydrogen binding between layers. At the same time inherent to it, as well as for EZ-water, higher degree of coherence, ability easily to give of electrons and, probably, number of other properties.

From the enumerated particularities of water in single layers follows, that such layer:

1. Can shield interaction between layers of the basic material (it is expressed in occurrence of anisotropy of properties, which it was mentioned above for $SrFe_2As_2$).

2. To be suppliers of electrons to the basic ferriferous layers (it is found out for $FeTe_{0,8}S_{0,2}$).

3. To be factors of approaching of ferriferous layers (change of geometrical parameters [4, 5]).

4. Can influence on the processes of ordering, than to suppress antiferromagnetic ordering, as compete with a superconducting phase (transition to superconductivity).

All these four listed factors are the factors of promoting the transition in a superconducting state.

However there is also one more factor, related to that at low temperatures the water can be only in the pair-state. For this state, as against from ortho-state, molecules of water can not rotate and, consequently, to form the binding structures, - the type of hexagonal [21].

As for such structures are available of two "external" electrons [1], the opportunity is not excluded, that these electrons also can participate in formation of Cooper pairs: or with others electrons of water layers, or with electrons from the basic ferriferous layers (taking into account, that the processes in individual water layers occur synchronously). We shall note, that interaction of water molecules with atoms of iron can lead to conversion of water protons and transition of water molecules from a pair–state in an ortho-state [21] and thereby to promote occurrence of processes of electrons pairing.

The synchronization of vibration of the water structures (for usual water is hexagonal structures) and of magnon processes of the basic ferriferous layers are possible also. Really, in [7] the presence of strong pfonon-magnon interactions for compound $BaFe_2As_2$, similar to compound $SrFe_2As_2$, is revealed, and authors [1] find out the resonant vibrations of hexagonal water structures in a gigahertz-range. Frequency of vibrations of a coherence water structures, located by a single layers, can be synchronized at low temperatures with the processes, caused by exchange interaction in iron-containing layers.

As there are no reliable literary data on finding of correlation interactions of superconducting type for electrons in layers of near-surface waters, (some indications on such opportunity for the water, bound by alive structures, are available in [22]), that the most probable mechanism of stimulation, besides possible processes of pairing electrons from layers of water and the basic ferriferous layers, apparently, will be complex manifestation of the factors listed in points 1-4.

6. Properties of one-dimensional water chains in carbon nanotube.

In works [1, 3] two models of a structure of water are stated. Though experimental results of work [1] confirm the theoretical concepts presented in [3], nevertheless, the treatment of experimental results, received by authors [1], does not coincide with positions [3].

If, in opinion of authors [1], "ice-like" the phase of water represents a certain crystalline-like structure, in the theory G.Preparata it is the «coherent domain»!

What takes place indeed can show only experiment. It is very important to investigate behavior of water in such systems, where water steadily keeps the structure, instead of flickering regime.

Such states arise for water, bounded by alive systems, for which very narrow coherent peaks in spectra of resonant interaction with SHF-radiation are fixed [1], which specifies a high degree coherence of such water.

Now there are not enough the publications, concerning to research of two-dimensional water properties, though it plays the important role in realization of biological processes in alive organisms. Such water is quality similar to near-surface water of alive organisms, forms the layers in a few hundred molecules thickness, enveloping molecular structures and surfaces of fabrics of alive organisms. All vital processes occur in near-surface water environment. For such water, except of high degree coherence, it is typical also delaminating of water planes, because of what such planes are poorly bound between itself. [23].

For this reason the big interest for physics of water represents the research of effect of induction by water of superconductivity, where diffused water located by single layers, which have not bound by hydrogen bonds between itself.

Essentially is and that, the compounds, in which the effect of induction was showed, are found at a low temperatures in a state, close to superconductivity [4, 5].

As follows from carried out above analysis of mechanism of effect inducing displaying in $SrFe_2As_2$ and $FeTe_{0,8}S_{0,2}$, for the description of diffused waters properties, as well as the mechanism of inducing by water of superconductivity, more acceptable is the treatment of G.Preparation. According to it water in the single layers, which are settling down in parallel to the basic ferriferous layers of compounds, represents the coherent system, having some characteristics of EZ-water. It does not show properties of usual ice, as it was necessary to expect on the basis of work [1] conclusions.

The further researches of water properties in nanosystems, carried out for last decade, also have confirmed validity of theoretical treatments by G.Preparata.

The most interesting, from our point of view, are the results of researches of water properties in carbon nanotubes, carried out by A.I. Kolesnikov and his colleagues from Argonne National Laboratory [23]. Nanotubes, which were used for researches, had length up to several tens nanometers and have consisted of one or several rolled up in a tube hexagonal graphite planes (graphene); their diameter made from 1,35 up to 1,90 nanometers. Water in such nanotube, practically, did not interacted with a wall of nanotube and represented one-dimensional structure.

Authors measured elastic dispersion of neutrons in such system and compared the received data with results of the same measurements on usual ice. On fig. 4 the temperature dependences of root-mean-square fluctuations $\langle u_H^2 \rangle$ of water protons are resulted.

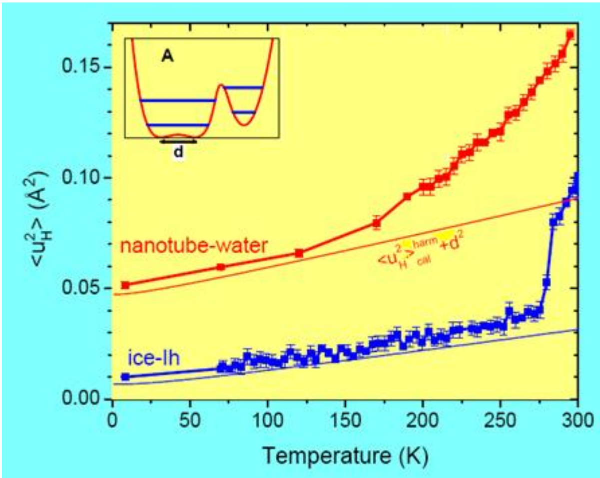

Fig. 4. The temperature dependence of amplitude of root-mean-square fluctuations of water protons in nanotube and in ice (from experiments on elastic dispersion of neutrons). (The Fig. is taken from [23])

As it is visible from the figure, that root-mean-square fluctuations of water protons in nanotubes in 4 times exceed those for ice throughout the 8-273 K temperature range.

Authors [23] have shown also, that water molecules in nanotubes are found in wide two-well potential (shown on an insert). A low-barrier double-well potential with flattened bottom is presents for hydrogen (as be obvious from an insert). Delocalization of protons makes approximately 0,2Å.

Authors [23] explain such high values of size by that, that, according to their results, the average amount of the hydrogen bounds, which bind a molecule of water with its two nearest neighbours (so-called coordinate number), was reduced from 3,8 up to 1,86. In consequence of that, the mobility of molecules has increased. "New water" did not freeze even at temperature, even on eight degrees differing from absolute zero.

In later work [24] carried out by. A.I. Kolesnikov with colleges too, is presented the additional data on properties of nanotubes waters. They are informed the next: «We find that at 5 K the kinetic energy of the protons is 35 meV less than that in ice Ih at the same temperature, and the high momentum tail of the distribution, characteristic of the molecular covalent bond, is not present … Our data reveal that the protons in the hydrogen bonds are coherently delocalized and that the low temperature phase is a qualitatively new phase of ice».

These works are direct confirmation that the water in nanosistems is shown the unusual properties and is not the same substance, as usual ice.

Unusual properties of water should be shown as in alive systems, which the high degree of coherence is peculiar, so and in the some nano objects of the lifeless nature that confirms experiments. Apparently, the positions, advanced

J.Preparata, most approach for the description of characteristics of such water systems

The characteristics of nanowater in layered compounds $SrFe_2As_2$ and $FeTe_{0,8}S_{0,2}$ can appear are close to properties of near-surfaces water of alive organisms.

Conclusions

Now there are two approaches to the description of properties of usual water. According to usual views, - water presents a homogeneous medium. However theoretical and the experimental researches, which have been carried out especially for last decades, have not confirmed such point of view. The most significant of last achievements in field of water physics are discovery the effect СПЕ [1] and theoretical development by G.Preparata [2], which predicted for usual water the existence of separate regions of coherency - coherent domains. Authors of discovery of СПЕ-effect, on the basis of the results received by them, have drawn a conclusion that water will consist of two extreme phases - vapor and ice. As against them, G.Preparata has shown that processes of condensation of water molecules in a liquid state occur owing to interaction of water molecules with vacuum virtual photon and the water medium will consist from the separate coherent regions surrounded by individual molecules of water.

As follows from works of the authors, who have opened effect of the inducing by water of superconductivity in $SrFe_2As_2$ and $FeTe_{0,8}S_{0,2}$ [3, 4], it is not possible to explain neither the reason of compression of a lattice of compounds, nor the factors, resulting to superconductivity at diffusion in compounds of water, proceeding from properties of compounds.

For finding such reason in the present work the analysis of possible behavior of diffusing waters, situated by single layers parallel to the basic ferriferous layers of compounds, from a position of development, advanced G.Preparata, is carried out for usual water. It is shown, that such water can have some properties of EZ-water, by virtue of what, layers of diffusing waters:

1. Can shield interaction between layers of the basic material.
2. To be effective suppliers of electrons to the basic ferriferous layers.
3. To be factors of approaching of ferriferous layers.
4. To influence on processes of ordering, than to suppress antiferromagnetic ordering as competitive with superconducting phase.

As all these four points are factors of induction of the transition to superconductivity, the most probable mechanism of effect of induction, besides arising of the possible processes of pairing of electrons from layers of water and of the basic ferriferous layers, apparently, will be the complex realizing of these factors.

Thus, it appears, that the positions, developed by J.Preparata, most befit for the description of characteristics of water nanosystems, to which belongs and diffused in $SrFe_2As_2$ and $FeTe_{0,8}S_{0,2}$ water; such water on the properties differs from usual water.

The experimental confirmation that the water in nanosystems can behave in the unusual way is the data of researches on properties of water in nanotubes, where such water does not freeze at temperature up to 8 K.

Thus, nanowater at low temperatures is not usual ice and its properties it is expedient to describe from a position of the statement of quantum electrodynamics, advanced by G.Preparata at creation of the theory of a water molecules condensation in a liquid state.

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