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Quantum Aspects Evolutions Tribosystems

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Quantum Aspects Evolutions Tribosystems

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Abstract- The present work deals with the changes which evolve in the tribosystem from the viewpoint of the quantum theory of measurement. It is shown that measurement both enables to determine some parameters of the friction unit and affects the tribosystem structure and properties. The theoretical argumentation in the article is based on the most fundamental concepts: the non-force quantum fields, non-local correlations, quantum entanglement, and model of H. Everett. The tribosystem evolution is viewed as the set of spatial transitions from non-local original state to tribosystem material state registrable by measurement. Some conclusions from the evolution quantum model are confirmed experimentally by studying triboplasma matter as a quantum object.

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I. Introduction

The existing at present the variety of antagonistic in many respects fiction models which absolutely mostly reflect adequately various regularities of friction processes may logically be mutually contradictory because they are based on correctly executed experiments. Proceeding from modern ideas of the theoretical physics, it can be assumed that the measurements proper affect the tribosystem, alter its original structure and turn it into a purely mechanistic system without any influence of molecular forces (the model of G. Epifanov). Meanwhile, following the ideas of D. Tomplinson, B. Derjagin, about the prevailing role of molecular interactions in the friction process confirmed by the experiments conducted by Bowden and Tabor [1], the tribosystem transforms into object subordinated to the microworld quantum laws. To eliminate this contradiction, let us assume that all validly confirmed friction models are separate reflections of one object which we call the "tribosystem proper".

The role of measurements we describe is unusual for three classic science, but in the quantum mechanics any measurement of physical parameters leads to exactly these changes in the physical system. The great Danish physicist N. Bohr was probably the first to realize it. He believed that physical measure-ements are not a simple routine of comparing the experimentally obtained results with the available standards; the measurement is a physical phenomenon of interaction of the object in question and the method of obtaining its information, or the instrument. The tribologists and other scientists lack principally the research methods which do not directly affect the object of study (the tribosystem) [2]. This object itself during measurements produces a certain influence on the instrument creating the inseparable system «object-instrument» [2, 3].

Recognition of the inseparability of the system «instrument-object» demanded from the quantum to introduce new stipulations: the principle of uncertainty and the issuing rejection of determinism of the classic physics and transition to the statistic description of physical processes and admission of existence of simultaneously immeasurable values (the non-commuting values in the quantum theory) et cetera. [2]. As regards the measurement result, then, following the works of P. Dirac, it is the only opportunity is to obtain the result coinciding with one of the eremitic operator value proper characterizing this physical value in the quantum mechanics as the function of coordinate, pulse and time [3]. To describe the act of measurement, the notion was introduced “the observed value” implying any practically measurable value. The inverse statement is true also: any at least theoretically observable value can be measured with a suitable instrument [3].

The physical essence of quantum measurements meets with the known contradiction according to which the quantum laws study the object and reproduce it in the classic instrument parameters. To describe this process, the notion of reduction (collapse) of the wave function was introduced at which the quantum parameters transform into the classic ones. The wave function reduction is invariably combined with the loss of a portion of information about the quantum system. This fact founded the assumption of A. Einstein that the quantum world description is incomplete [4]. N. Bohr carried out the detailed analysis of A. Einstein’s viewpoint and proved that he was wrong and grounded the appearance of completely new ideas which led to the model of non-force interaction, the theory of quantum non-locality, the quantum entanglement of systems and the theory of non-local information state [4].

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The wave function reduction was explained in the concept of H. Everett [5]. In his view, the act of measurement reduces to transforming the instrument proper changing from one macroscopic state into another one; naturally, it cannot be described with the laws of quantum mechanics. Mr. Everett considered different classic instrument states as the division of the objective world into a number of subworlds which corresponds to the number of alternative variants (the own values) obtained when quantum equations are solved. Each subworld of Everett contains the same measuring instrument exploring an absolutely identical object as the corresponding observer's exact replica. The difference is that each subworld yields its own measurement result from the set of variants obtained by solving quantum equations. In the remaining part all the worlds of Everett are identical; therefore, they are physically unambiguous.

The Everett model acquired a particular significance after appearance of the theory quantum non-local states and the idea of quantum entanglement. The notions of quantum entanglement and non-locality relates strongly to the force interaction between quantum objects transforming them into a single entity so that it is impossible to split the physical system into separate independent parts. Under any conditions, these parts are considered integral [6].

The original quantum system prior to reduction is in the non-local state; Russian physicist theoretician S. Doronin terms it as "pure information" [6]. The material forms, such as secondary formations, appear due to some action (measurement) called decoherence. The wave function reduction in this context can be related to the 'materialization" of one of the possible subworlds of Everett which appears due to the decoherence of the original quantum system caused by measurement. It is particularly noteworthy that other "subworlds" (possible alternatives of quantum reality) do not vanish and can appear at any moment. The decoherence can be interpreted as the folding of the original space into a smaller space in which the current reality variant continues to exist also in other subsystems combined by the quantum entanglement. Hence, the decoherence measurement characterizes the transition of the studied object from one reality level to another one. Each of these quantum realities has a corresponding space of events possessing own metrics and temporal regularities [6].

II. Measurement of Quantum Tribosystem Structure

When the tribosystem is considered as the physical system evolving by the laws quantum mechanics can be determined as the earlier introduced notion of the "proper tribosystem" in the term of the "non-local" quantum theory. The tribosystem is a multidimensional quantum object which is in a strongly degenerated non-local state; its physical, mechanical and chemical properties are being formed and demonstrate in the process of measurement act. In other words, the technological characteristics result from the decoherence of the states of the "tribosystem proper" manifesting during specific measurements.

The decoherence and the relating transition from the original non-local state into material triboengineering forms can be considered as the projection of non-local information substance of the "tribosystem proper" from the multidimensional phase space into the tangible world of four-dimensional space and time continuum of G. Minkovskii [7]. This transformation of phase spaces from the viewpoint of linear algebra is the system of linear equations; their number equals the number of measurements of the phase space in which the "tribosystem proper" locates. The number of summands in each equation is determined by the space basis in which the decoherence product "materializes". Because this product is registered in the space of Minkovskii, these summands should number four.

Assume that A_1, A_2, A_n... act as some characteristics of the "tribosystem proper", q_1, q_2, q_3, q_4 act as the bases of its material state due to the decoherence. Let us use the symbols of P. Dirac and record the genera system of equations characterizing the tribosystem behavior:

$$\begin{array}{l} |A_1\rangle = a_{11}|q_1\rangle + a_{12}|q_2\rangle + a_{13}|q_3\rangle + a_{14}|q_4\rangle \\ |A_2\rangle = a_{21}|q_1\rangle + a_{22}|q_2\rangle + a_{23}|q_3\rangle + a_{24}|q_4\rangle \\ ------------------------ \\ |A_n\rangle = a_{n1}|q_1\rangle + a_{n2}|q_2\rangle + a_{n3}|q_3\rangle + a_{n4}|q_4\rangle \\ ------------------------ \end{array} \quad (1)$$

Where a_{ni} (i – the parameter characterizing the number of measurements of the space of Minkovskii) – the coefficients of vector decomposition of the wave function, $|q_i\rangle$ – the vectors of states.

The condition of a similar physical object, including the tribosystem, in accordance with the laws of quantum mechanics, should be orthonormal, respectively, the non-diagonal coefficients a_{ij} transform into the system of equations (1); the indices of which differ by more than a unity and are assumed equal to zero. In order that the system of vectors serves as the basis of liner space it is required and sufficient of the matrix a_{ij} be square and its determinant differs from zero. Then the matrix of coefficients a_{ij} turns plotted from sixteen components characterizing the sixteen dimension of the space of localization of the "tribosystem proper". By additionally assuming that the non-diagonal coefficients a_{ij} in the final matrix structure have zero equality, the following matrix is obtained:

$$A_{ij} = \begin{Vmatrix} a_{11} & a_{12} & 0 & 0 \\ a_{21} & a_{22} & a_{23} & 0 \\ 0 & a_{32} & a_{33} & a_{34} \\ 0 & 0 & a_{43} & a_{44} \end{Vmatrix} \qquad (2)$$

The appearance of the matrix A_{ij} (here three (2×2)-subsystems of diagonal elements are present, (Fig. 1) indicates that the tribosystem in the quantum state is a three times degenerated physical object.

The measurement act proper can be repre - sented in the following manner: assume the Hamiltonian H (energy operator) characterizing their original state of the "tribosystem proper", the Hamiltonian h of the tribosystem manifested due to it's decoherence when measured. Then, in accordance with the laws of quantum mechanics, the commutators of these values equal zero [3].

$$[Hh] = Hh - hH = 0 \, , \qquad (3)$$

Both Hamiltonians H and h, due to different dimensionality of their space localization, are recorded in the matrix form as follows:

$$H = \begin{Vmatrix} H_{11} & H_{12} & H_{13} & H_{14} \\ H_{21} & H_{22} & H_{23} & H_{24} \\ H_{31} & H_{32} & H_{33} & H_{34} \\ H_{41} & H_{42} & H_{43} & H_{44} \end{Vmatrix}, \qquad (4)$$
$$h = \begin{Vmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{Vmatrix}.$$

Correspondingly, the product (3) of matrices (4) is the following:

$$Hh = \begin{Vmatrix} C_{11} & C_{12} \\ C_{21} & C_{22} \\ C_{31} & C_{32} \\ C_{41} & C_{42} \end{Vmatrix}, \qquad (5)$$
$$hH = \begin{Vmatrix} C'_{11} & C'_{12} & C'_{13} & C'_{14} \\ C'_{21} & C'_{22} & C'_{23} & C'_{24} \end{Vmatrix}.$$

Where C_{ij}, C'_{ij} – the coefficients found in the standard manner by multiplication of matrices.

If two independent measurements are performed of the "tribosystem proper" yielding the results h_1 and h_2 then it can be shown from relation (3) that: $Hh_1 + h_2 H = Hh_2 + h_1 H$, or in the matrix form it is recorded as follows:

$$\begin{Vmatrix} \Delta C_{11} & \Delta C_{12} \\ \Delta C_{21} & \Delta C_{22} \\ \Delta C_{31} & \Delta C_{32} \\ \Delta C_{41} & \Delta C_{42} \end{Vmatrix} = \begin{Vmatrix} \Delta C'_{11} & \Delta C'_{12} & \Delta C'_{13} & \Delta C'_{14} \\ \Delta C'_{21} & \Delta C'_{22} & \Delta C'_{23} & \Delta C'_{24} \end{Vmatrix}. \qquad (6)$$

Expression (6) reflects the procedure of transponation of matrices proving that the state of quantum system described by matrices ΔC_{ij} and $\Delta C'_{ij}$ are conjugated. The latter in the geometrical interpretation can be considered as the turn by 90^0 of the basic linear spaces of localization of tribosystems [8] (Fig. 2). Fig. 2 is the presentation how the basic configurations change their orientation in the Minkovskii space during the decoherence of physical systems (tribosystems) as the traditional model "light cone" intensively applied in the special theory of relativity. The orthogonality of light cones ΔC_{ij} and $\Delta C'_{ij}$ indicates that there are not any "force" links between them, but it does not absolutely preclude the quantum correlations due to the non-local effects of the non-force origin. The existence of quantum correlation links between quantum subsystems of the type of electron paramagnetic resonance interaction[1] proves that there are non-diagonal coefficients a_{ij} in the matrix A_{ij} [9]. S.I. Doronin, Russian physicists and theoretician, remarked [7] that the symmetric matrix structure (Fig. 1) results from the properties of the quantum system which act always in pairs. The diagonal matrix elements determine the set of main states of the quantum system, while the non-diagonal elements characterize the correlation links between quantum subsystems.

III. Test of Tribosystem Quantum Model

The above arguments, at the first look, have the nature of abstract mathematical reasons. The quantum theory was constructed so as to intentionally exclude those values and notions which cannot be revealed by experimentation. While the tribology at present is mostly the experimental scientific discipline having a strictly application trend. Therefore, the experimental testing of the proposed tribosystem model based on the non-local elements of the quantum theory is the inseparable part of the developed theoretical tribological concept. As the staring point of this testing, let us use the idea abot the disturbing measurement effect on the degenerated information structure of the "tribosystem proper". Let us consider this effect from the viewpoint of the theory of disturbance [2]:

1. The position of disturbed levels depends on the extent of disturbance which increases the "spacing" between closest levels as a result the quantum system degeneration is removed.

[1] EPR is the abbreviation of the family names of A. Einstein and Austrian physicists B. Podolskii and N. Rozen who in 1935 emphasized the incompleteness of the quantum mechanical description of the physical system with the conceptual experiment implying measurement of parameters indirectly by affecting the system [4]. The EPR-interaction , for instance, appears when a particle is born having a zero own moment; a couple of particles (EPR twins) with oppositely directed spins and the behavior due to the principle of uncertainty of Heisenberg is interlinked (entanglement) irrespective of the spacing between them.

2. The degenerated quantum object with the main quantum number n, after the external field F is imposed, splits up into the $(2n\text{-}1)$ component with the spacing between extreme demilevels after the splitting equal to [2]:

$$\Delta W = 3F \cdot n(n-1). \tag{7}$$

In accordance with the general matrix view of decoherent tribosystems with the Hamiltonian terms, the quantum number n is equal to eight (n=8). In order to appreciate the relevance of this result, the tribosystem should be experimentally studied in the state in which the quantum effects are most evident. This state is the triboplasma or the super excited matter state on the friction surface [10, 11].

To study the quantum structure at this state, the tribometer type *Falex* was devised with the contact geometry "shaft – partial insert"; it is described in detail in works [11-16]. This tribometer used the non-destructive radio spectroscopy method to investigate the electromagnetic processes initiated by friction in the "fluorine plastic-steel" tribounit. The friction apparatus design permits to create electric and magnetic fields in the friction unit and to test it also in the vacuum [11, 17]. The friction parameters of the tribosystem are registered electrically by the power (P, W) of the friction apparatus motor expended directly to overcome the friction force.

The finding in the experiments published in works [13-14, 16] have revealed the following:

1. The friction power depends qualitatively on the frequency of external magnetic field imposed in the friction unit via the value range of maxima and minima.
2. The friction power for the selected testing conditions and friction unit materials corresponds to three broadest regions limited by frequency bands 80, 300 and 600 MHz (Fig. 3).

The obtained signal decomposition into separate harmonics reveals that the frequency range from the first minimum at 80 MHz belongs to two harmonics of the electromagnetic spectrum emitted by the triboplasma or 30 and 40 MHz, the second portion with the limited power P at 300 MHz belongs to five harmonics 80, 120, 160, 200, 250 MHz, the third portion belongs already to seven harmonics from 320 to 600 MHz. the dependencies in Fig. 3 in work [16] were analyzed and it was assumed that it is the case of distinct triboplasma shell structure like the quantum structure of atoms. The total number of harmonics is noteworthy or separate states N: N = 2+5+7 = 14 unities. Because the frequency range was above 600 MHz, we have not studied this range in detail and presume that the harmonics should number more. The spectral regularities permit to assume highly accurately that the total number of harmonics should be not less than N = 15…16. Earlier it has been remarked that the number of components N equal to the number of quantum states relates to the quantum number n through the relation $N = 2n\text{-}1$. Thus, n is integer; assuming N = 15 find that n = 8, it corresponds to the matrix structure (6).

IV. Conclusions

This coincidence is little likely to be accidental, it is rather that the triboplasma quantum structure relates to the phenomenon of decoherence and the tribosystem we obtained formally mathematically with minimal tolerances reflects sufficiently the true internal processes evolving at micro levels of friction contact where the quantum correlations "reign". If it is actually so, it is particularly worthwhile to look for the non-power interactions determining the relation between vaqriious manifestation of the "tribosystem proper". This conclusion is validly confirmed by the fact that the matrix structure (2) presumes the existence of three subsystems "emerging" due to the decoherence of the original tribosystem as the quantum object and appearing to researchers as the objective reality resulting from the triboanalysis.

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References Références Referencias

1. Akhamatov, A. S. "Molecular Physics of Boundary Friction", Moscow: Physical and Mathematical Literature, 1963, 471 pp.
2. Landau, L.D., Lifshits, E.M. Theoretical Physics, Vol. 3. Quantum Mechanics (Non-relativistic Theory). Moscow: Nauka, 1974, 464 pp.
3. Dirac, P.A.M., Principles of Quantum Mechanics. Moscow: Nauka, 1960, 404 pp.
4. Fok, V.A., Einstein, A., Podolskii, R., Rozen, N., and Bohr, N. Can one believed in the quantum states Mechanical and physical description of reality is complete? Achievements of Physical Science, 1938, Vol. 16, No 4, pp. 436-457.
5. Feigin, O. O. Great quantum revolution, Moscow: Eksmo, 2009, 256 pp.
6. Doronin, P. I. Quantum Magic (URL: http://booklos.org/book/561487/daa7bf)
7. Doronin, P.I. Measure of quantum entanglement of pure states. Quantum magic, 2004, Vol.1, No 1, pp. 1123-1137.
8. Fermi, E., Quantum mechanics (summary lectures), Moscow: Mir, 1968, 367 pp.
9. Baratin, I.V., Grishanin, B.A., and Zadnov, V.N. Entanglement quantum states of atomic systems, Achievements of Physical Science, 2001, Vol.171, No 6, pp. 625-646.

10. Thiessen, P.A., Meyer, K., and Heinicke, G. Grundlagen der tribochemie. Abn. Dtsch. Acad. Wiss. K1., No 1, 1966, pp. 15-33.
11. Lyubimov, D.N., Dolgopolov, K.N., and Pinchuk, L.S. Micromechanism of Friction and Wear. Introduction to Relativistic Tribology. Berlin: Springer, 2013, 219 pp. Springer Series in Materials Science, Vol. 176.
12. Lyubimov, D.N., Vershinin, N.K., and Dolgopolov, K.N. Triboplasma fine structure in the contact of fluorine plastic – steel and its connection with friction parameters of friction node. Friction and lubrication of machines and mechanisms, No 7, 2011, pp. 37-41.
13. Lyubimov, D. N., Dolgopolov, K. N., and Vershinin, N. K. Micromechanisms of triboplasma shell structure forming. Friction and Lubrication of Machines and Mechanisms, No 7, 2012, pp. 10-13.
14. Lyubimov, D.N., Dolgopolov, K.N. Quantum-Corpuscular mechanism of frictional interaction of surfaces of friction. Friction and Lubrication of Machines and Mechanisms, No 3, 2012, pp. 11-14.
15. Lyubimov, D.N., Dolgopolov, K.N., Fundamentals of evolution of tribosystems. Shakhty: Federal State Budget Institution of Vocational Higher Professional Education «Juzhno-Rossijskii State University of Economics and Service, 2011, 95 pp.
16. Lyubimov, D.N., Pinchuk L.S. and Dolgopolov, K.N. Quantum Tribophysics. Rostov-on-Don: South Federal University Publishers, 2012, 294 pp.
17. Friction Machine: Patent No 2494370, Russian Federation: Int. Cl. G01N3/56 (2006.01). Lyubimov, D. N., etc, Application 2012112204/28(018415), dated 29.03.2012.

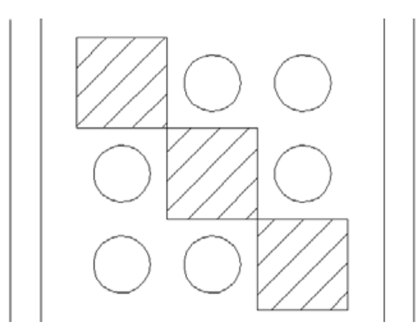

Figure 1 : Structure of matrix A_{ij} (4×4): shaded square areas correspond to three (2×2)-subsystems

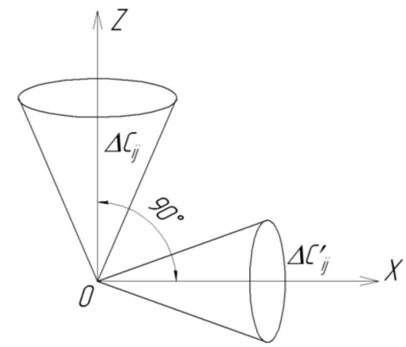

Figure 2 : Turn of light cone of space of Minkovskii of “tribosystem proper” when it undergoes decoherence during measurement

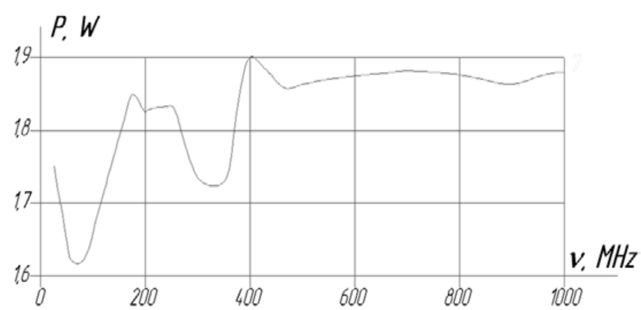

Figure 3 : Variations of power P (W) expended by friction apparatus electric motor to overcome friction forces in steady wear of friction couple “fluorine plastic-steel” in response to frequency ν (MHz) of electromagnetic field imposed on friction unit.

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