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Pretreatment of Polymer Melts

Energy Levels in the Hydrogen Atom

Highlights

Normative Model of Global History

Observer on Quantum Measurements

Discovering Thoughts, Inventing Future

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Explaining the Influence of the Observer on Quantum Measurements and the Influence of the Sick Patients on the Doctor

By Prof Maria Kuman
Holistic Research Institute

Abstract- The article explains for the first time the influence of the observer on quantum measurements. 1/ In one set of experiments, it was found that the lifetime of decay of radioactive elements is longer in the presence of spinning liquids or solids. This could only be explained if media between them was present, which was influenced by the spinning. 2/ In another set of experiments, it was found that the lifetime of decay of radioactive elements is longer in the presence of people. Since the Russian scientist Shkatov developed equipment allowing him to measure the spinning of the human's aura, the longer lifetime of radioactive elements in the presence of people could be explained with the influence of their spinning aura (but again the influence could only be explained with the presence of media, which was influenced by the spinning). 3/ In another set of experiments, it was found that without the presence of observer photons and electrons behaved like waves and diffraction pattern was observed when they were passing through two slits. When observer with his spinning aura was present, the photons and electrons behave like particles - diffraction was not observed but only two slits of light. This means that under the influence of observers' spinning aura the photons and electrons behave like particles, which could only be explained if there was a media influenced by the spinning aura of the observer.

Keywords: spinning influence on quantum measurements; observers' influence on quantum measurements; observer influence on diffraction patterns; observer influence on radioactive decay.

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Explaining the Influence of the Observer on Quantum Measurements and the Influence of the Sick Patients on the Doctor

Prof Maria Kuman

Abstract- The article explains for the first time the influence of the observer on quantum measurements. 1/ In one set of experiments, it was found that the lifetime of decay of radioactive elements is longer in the presence of spinning liquids or solids. This could only be explained if media between them was present, which was influenced by the spinning. 2/ In another set of experiments, it was found that the lifetime of decay of radioactive elements is longer in the presence of people. Since the Russian scientist Shkatov developed equipment allowing him to measure the spinning of the human's aura, the longer lifetime of radioactive elements in the presence of people could be explained with the influence of their spinning aura (but again the influence could only be explained with the presence of media, which was influenced by the spinning). 3/ In another set of experiments, it was found that without the presence of observer photons and electrons behaved like waves and diffraction pattern was observed when they were passing through two slits. When observer with his spinning aura was present, the photons and electrons behave like particles - diffraction was not observed but only two slits of light. This means that under the influence of observers' spinning aura the photons and electrons behave like particles, which could only be explained if there was a media influenced by the spinning aura of the observer. We can also expect different type of personalities to influence the quantum measurements differently – positive thinkers (with auras spinning clockwise and sucking energy in) are expected to add energy to the measured quantum system, while negative thinkers (with auras spinning counterclockwise and loosing energy) are expected to suck energy from the measured quantum system. Also neurasthenics with their powerful aura with fluctuating intensity (in the presence of which light bulbs blow up and electronic devices and machines stop functioning) are expected to mess up the measured quantum system. Also, the negative influence of the sick patients on the doctor could explain why the American doctors live in average 58.5 years, while the average American lives 75 years.

Keywords: spinning influence on quantum measurements; observers' influence on quantum measurements; observer influence on diffraction patterns; observer influence on radioactive decay.

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I. Explaining why Two-Slit Diffraction was not Observed when Observer was Present

As far back as in 1906, G. Taylor first performed the double slit experiment. He found that photons passing through two slits were showing diffraction pattern (alternating light and dark lines), which meant that the photons behaved like waves. However, the photons were not showing the normally observed diffraction pattern when observer was present, which meant that in the presence of observer the photons behaved like particles (only two light lines behind the slits were observed). In 1961, Claus Jonson (from the University of Tubingen) observed the same effect with electrons – when passing through two slits, the electrons were showing diffraction pattern, which meant that the electrons behaved like waves. However, the electrons were not showing the normally observed diffraction pattern when observer was present, which meant that in the presence of observer the electrons behaved like particles [1].

Our science (at the present level) cannot explain this, which means that our science needs to be expanded to be able to explain it. Our science presently claims that we are only material body. Based on my almost 40 years of research on the aura, I claim that we are more than just material body [2] – the aura must always be considered. I found that the aura is weak nonlinear electromagnetic field (NEMF) (1,000 times weaker than the field, which the biocurrents of the material body create), but this weak field rules and regulates everything in the body, not with its strength, but with the information it carries. I found that the NEMF (seen as aura) is emotionally sensitive – the aura shines brighter at positive emotions and is dimmer at negative emotions [3].

Since we say that we are in high spirit when we experience positive emotions and we say we are in low spirit when we experience negative emotions, I concluded that the aura must be our emotional Spirit, which is weak informational NEMF. I rejoiced when I found that the ancient Jewish Cabala was teaching to high priest that the aura is our Spirit [2]. The Russian scientist Shkatov developed equipment that allows him

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to measure the spinning of the aura. He found that our aura spins and it spins clockwise at positive emotions and counterclockwise at negative emotions [2]. Since the aura (Spirit) is NEMF and nonlinear physics teaches that vortices spin clockwise and suck energy in, while anti-vortices spin counterclockwise and emit energy, I concluded that at positive emotions our aura (Spirit) is brighter because it spins clockwise and sucks NEMF energy in, while at negative emotions our aura (Spirit) is dimmer because it spins counterclockwise and loses NEMF energy.

However, for this to happen there must be a reservoir of NEMF energy available. Is this reservoir of NEMF energy the Space Matrix (called ether in the past) of which the whole material world was created? I answered this question positively in my article "Explaining the Uneven Earth Growth with Time" [4], which was the only way to explain the observed uneven growth of our Earth with time. So, we are not only a material body – we are a material body and Spirit (seen as aura) and this aura (Spirit) spins [1]. Our aura NEMF has a donut shape (Fig. 1), just like the aura NEMF of our Sun (Fig. 2). While our Sun spins clockwise and sucks NEMF energy from the Space Matrix NEMF to become active every 11 years (in average), our aura NEMF at down starts spinning clockwise and sucking NEMF energy from the Space Matrix NEMF to become active during the day; our aura NEMF at dusk starts spinning counterclockwise and releasing NEMF energy to the Space Matrix NEMF so that we can rest and sleep during the night [1].

Since our donut-shape aura is NEMF and all nonlinear fields have a chain or chains of alternating vortices and anti-vortices, our aura NEMF has a chain of 7 alternating vortices and anti-vortices along the backbone, which can be seen on Fig. 1.

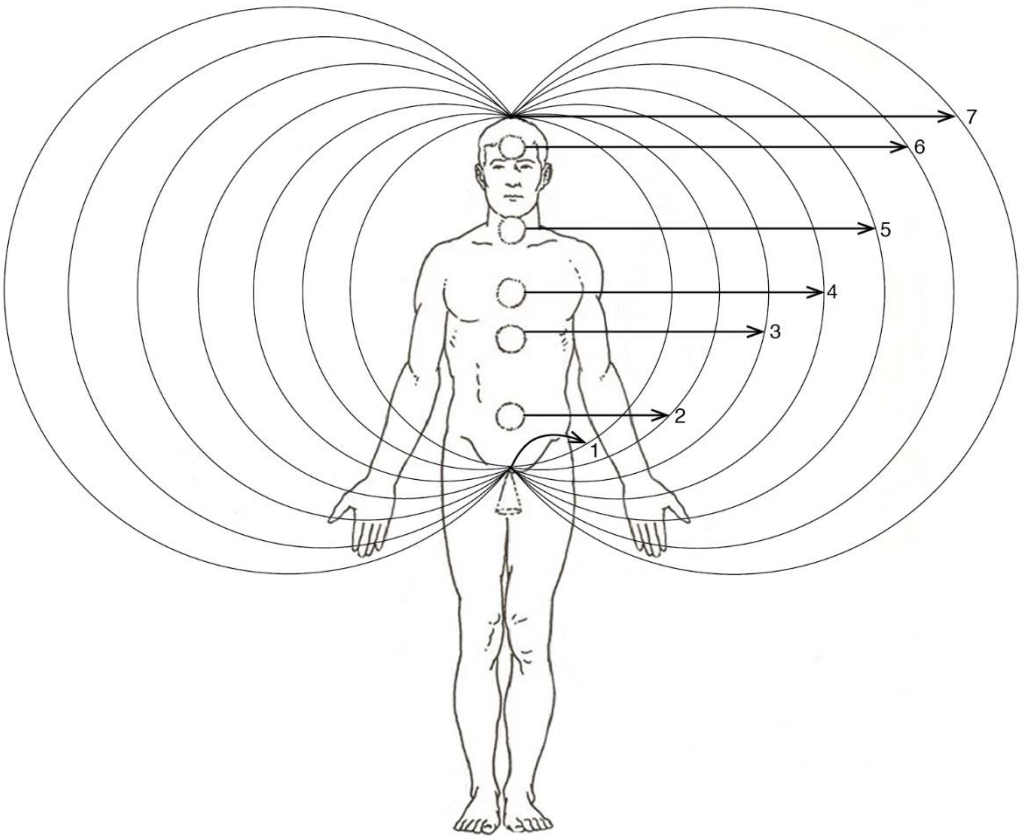


Fig. 1: The chain of alternating vortices and anti-vortices along the backbone of the men's aura NEMF and their corresponding quantum energy levels

These alternating vortices and anti-vortices are numbered with consequent numbers starting with the tailbone and finishing with the top of the head. They are called in ancient Hindu texts "chakras", which mean "spinning wheals" in Sanskrit. To the seven chakras correspond seven discrete (quantum) energy levels of the aura's NEMF (Fig. 1) [2]. Look at the quantum energy levels of our aura (Spirit) NEMF and tell me how the spinning NEMF of the observer with quantum energy levels not to be expected to influence quantum measurements. Of course, it would.

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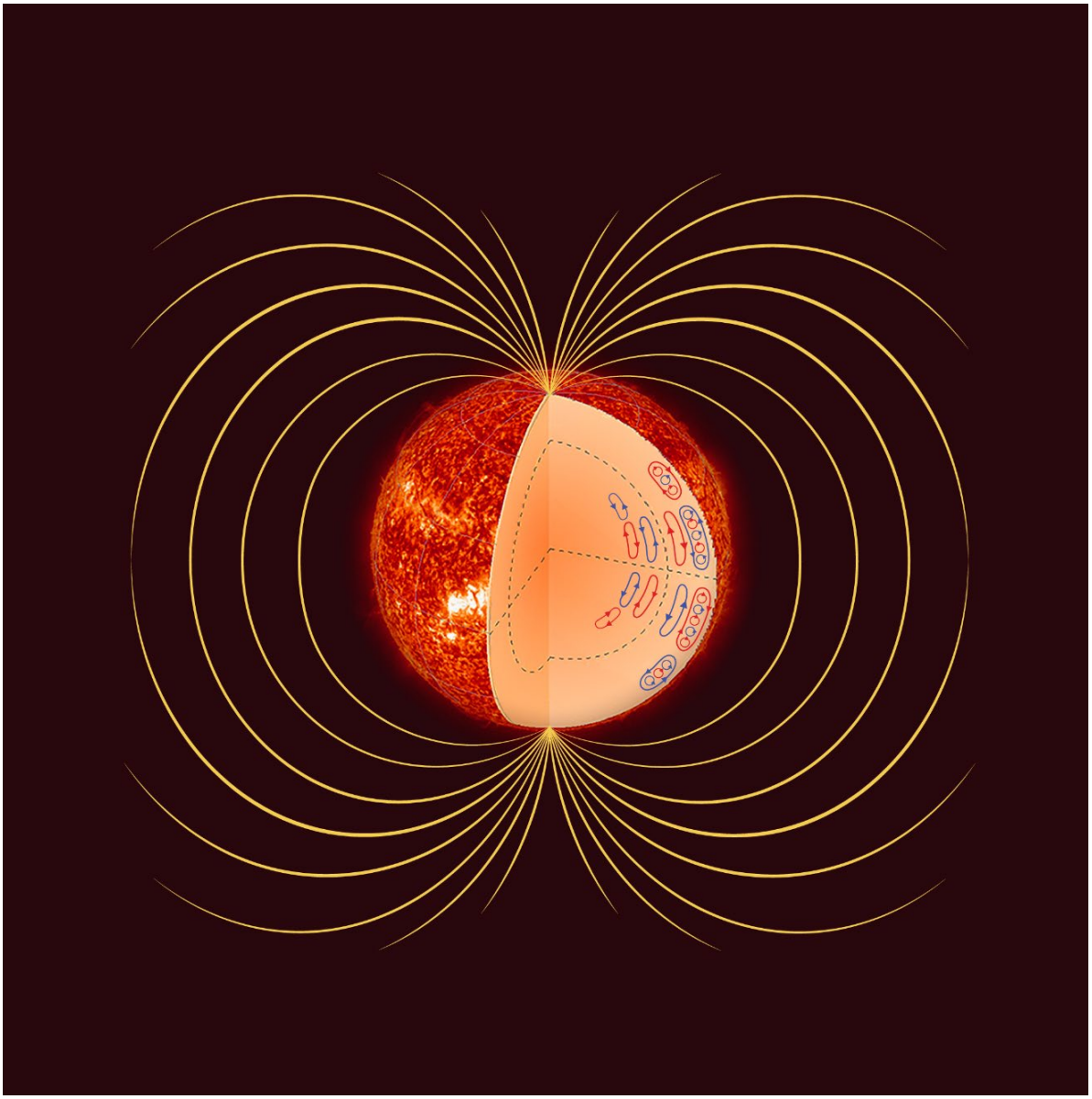


Fig. 2

The Sun has two chains of alternating vortices and anti-vortices running parallel to the equator and the quantum energy levels of the Sun's NEMF.

II. Explaining why the Lifetime Decay of Radioactive Elements is Longer whenObserver is Present

Wolfgang Ketterle from the Massachusetts Institute of Technology reported that the lifetime of decay of radioactive elements is longer when observer is present. The Russian scientist Igor Melnik (Tomsk) did research with spinning liquids and spinning solids in the proximity of decaying radioactive elements and found that the spinning masses were slowing the radioactive decay even from a distance. His results were reported at the International Conference on Torsion Fields and Informational Interactions, held in Sochi in August 2009 [5]. After he studied the influence of spinning liquids and solids on radioactive decay and he found that spinning of both (liquids and solids) slow down the radioactive decay and thus increase the lifetime of the decaying element, he went and studied the Phantom Effect, which is the imprint left on the space after the object has been removed - it allows detection of ex-presence.

However, after all these valuable experiments, Dr. Melnik still couldn't see the presence (existence) of the Space Matrix (called ether in the past) and its role in the observed experiments. He continued to think and to claim that the spinning objects create fields that are not electromagnetic [5], simply because he lacked knowledge in nonlinear physics and could not see that the involved field is nonlinear electromagnetic field (NEMF). In article [6], I showed that everything material

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is a material body and NEMF – it comes from the way the material world was created. If so, spinning liquid and solid masses would have spinning NEMF. If this spinning NEMF slower the decay of radioactive materials, the spinning torus-shape aura NEMF of the observer (Fig. 1) would do the same.

The phantom experiments of Dr. Melnik definitely pointed out that Space Matrix (ether) do exists. Since we said in Section 1 that we are a material body and emotional Spirit seen as aura (which is spinning weak informational NEMF), we can expect the spinning aura of the observer to slow down the decay of radioactive elements just like the spinning NEMF of spinning liquids and solids do. The spinning torus-shape aura NEMF of all living beings is a result of two fields – the NEMF1 of the material body (which Kundalini Yoga presents as an energy spiral running upward along the backbone and the NEMF2 of the Spirit (which Kundalini Yoga presents as an energy spiral running downward along the backbone [7]).

This means that the two fields (NEMF1 of the material body and NEMF2 of the Spirit seen as aura) of all living beings have opposite polarity and they are attracted to each other, as two magnets with opposite polarity would do. In the way the spinning NEMF of spinning liquids (or solids) slower the decay of radioactive elements, so would the spinning aura (Spirit) NEMF of humans. And this is true for all living beings, whose spinning aura NEMF consist of magnetically coupled NEMF1 (body) + NEMF2 (Spirit).

Not only will the spinning aura of the observer influence quantum measurements, we can expect the quantum measurements to be influenced differently by: 1/ positive thinkers, whose bright clockwise spinning aura will bring NEMF energy to the quantum measurements; 2/ negative thinkers, whose dim counterclockwise spinning aura loose NEMF energy to the Space Matrix NEMF - they are expected to suck energy from what they observe and measure; and 3/ by neurasthenic people, whose strong aura (Spirit) NEMF with fluctuating intensity is expected to mess up the energy of the quantum experiments they observe, in the way they burst light bulbs and disable electronic devices and machines [8].

III. Explaining the Shorter Lifespan of Doctors Living in the Presence of the Spinning NEMF of their Sick Patients

It is a fact that the average lifespan of medical doctors is 58.5 years when the lifespan of the average American is 75 years. This fact can be explained only with negative influence of the aura NEMF of the sick patients on the doctors' aura NEMF. My measurements showed that negative thinking leads to a disease of genetically inherited weak organ [9]. If so, the sick people are either negative thinkers or people with dominantly negative life experiences, who have dim aura NEMF, which spins counterclockwise and looses NEMF energy to the Space Matrix NEMF. Such sick people, when trying to survive, would suck life energy from the quantum experiments they observe, as well as from the doctors they go to. The fact that sick people suck energy explains the saying: "You don't look well – are you sick or taking care of a sick person".

IV. Only Preventive Medicine canProlong the Lifespan of the Medical Doctors to Normal

The only way to make the medical doctors live as long as the rest of the people (75 years) is to embrace preventive medicine. Then the medical doctors will deal all the time with healthy people trying to keep them healthy. This will make the doctors healthy and allow them to live as long as the rest of the people. Therefore, it is in the interest of all medical doctors to do their best to introduce preventive medicine. Ancient China had preventive medicine. Everybody was going to a doctor-acupuncturist 4 times a year for regular check up with pulse diagnostics. If the pulse diagnosis were detecting a minor deviation from norm, usually only one acupuncture treatment was enough to restore the balance and bring back the health [10].

V. Conclusion

Everything material is a material body and NEMF. It comes from the way the material world was created [6], and automatically explains the dualism wave particle. Since the experiments of Dr. Melnik proved that spinning liquids or solids (which have spinning NEMF) slow down the decay of radioactive elements, this article explained that the slowed down decay of radioactive elements in the presence of observer is a result of the influence of the spinning torus-shape aura NEMF of the observer. The influence of the observer on any quantum measurement is influence of his spinning torus-shape aura NEMF with discrete quantum energy levels (Fig. 1) on the quantum measurements. If the medical doctors live in average only 58.5 years, it is because they are dealing with sick people, whose dim aura (Spirit) NEMF sucks some of doctors' energy in attempts to survive.

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A Compelling Formula Indicating the Existence of Ultra-low Energy Levels in the Hydrogen Atom

By Koshun Suto

Abstract- Einstein's energy-momentum relationship, which holds in an isolated system in free space, cannot be applied to an electron in a hydrogen atom where potential energy is present.

The author has previously derived an energy-momentum relationship which holds inside a hydrogen atom. Using an argument of Dirac, a solution is obtained for the positive and negative energy levels based on this relationship too. Even if the energy is described on an absolute scale, the electrons at negative energy levels have negative mass. The author has adopted the name "dark hydrogen atom (DHA)" for this type of unknown material composed of an electron with negative mass and a proton (atomic nucleus) with positive mass. The mass of a DHA is almost the same the mass of an ordinary hydrogen atom. However, a DHA is extremely small compared to an ordinary hydrogen atom, and thus can achieve states of ultra-high density. The author has pointed out that these DHAs, and the hydrogen molecules and other materials formed from them, are the true nature of the unknown material known as "dark matter" whose true nature is currently regarded as unknown. Recently, the author has derived a previously unknown formula for the energy levels of the hydrogen atom. According to this formula, physical quantities of DHA are involved in the energy levels of a hydrogen atom. This paper derives this formula for the energy levels of a hydrogen atom using another method. The author believes this formula to be strong evidence of the existence of DHAs.

Keywords: *einstein's energy-momentum relationship, ultra-low energy levels in the hydrogen atom, negative energy specific to the electron, dark matter, dark hydrogen atom.*

GJSFR-A Classification: *DDC Code: 333.794 LCC Code: TP359.H8*



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A Compelling Formula Indicating the Existence of Ultra-low Energy Levels in the Hydrogen Atom

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Abstract- Einstein's energy-momentum relationship, which holds in an isolated system in free space, cannot be applied to an electron in a hydrogen atom where potential energy is present.

The author has previously derived an energy-momentum relationship which holds inside a hydrogen atom. Using an argument of Dirac, a solution is obtained for the positive and negative energy levels based on this relationship too. Even if the energy is described on an absolute scale, the electrons at negative energy levels have negative mass. The author has adopted the name "dark hydrogen atom (DHA)" for this type of unknown material composed of an electron with negative mass and a proton (atomic nucleus) with positive mass. The mass of a DHA is almost the same the mass of an ordinary hydrogen atom. However, a DHA is extremely small compared to an ordinary hydrogen atom, and thus can achieve states of ultra-high density. The author has pointed out that these DHAs, and the hydrogen molecules and other materials formed from them, are the true nature of the unknown material known as "dark matter" whose true nature is currently regarded as unknown. Recently, the author has derived a previously unknown formula for the energy levels of the hydrogen atom. According to this formula, physical quantities of DHA are involved in the energy levels of a hydrogen atom. This paper derives this formula for the energy levels of a hydrogen atom using another method. The author believes this formula to be strong evidence of the existence of DHAs.

Keywords: einstein's energy-momentum relationship, ultra-low energy levels in the hydrogen atom, negative energy specific to the electron, dark matter, dark hydrogen atom.

I. Introduction

About seven years ago, the author published a paper in GJSFR concerning the true nature of dark matter (DM), the gravitational source (mass) existing in the universe whose true nature is unknown [1]. The author showed that energy levels far lower than those derived based on quantum mechanics exist in the hydrogen atom [2]. Electrons at these ultra-low energy levels have negative mass, and exist near the atomic nucleus (proton).

The author has given the name "dark hydrogen atom (DHA)" to this unknown material composed of an electron with negative mass and a proton with positive mass. The name "dark matter" is used for matter consisting of atomic nuclei with positive mass, and multiple electrons with negative mass. DHAs have almost the same mass as ordinary hydrogen atoms, but are extremely small compared to hydrogen atoms. Therefore, they can attain a state of far higher density than ordinary matter. As a result, DHAs can serve as an enormous gravitational source.

Previously, the author has published several papers on DM, but the claims of the author have attracted almost no notice [3][4][5]. However, in the last seven years, the author has acquired new knowledge relating to DM. Thus, by incorporating the latest results into this paper, and paper [1] will be rewritten in a more compelling form.

II. The True Nature of Potential Energy of the Hydrogen Atom

According to the famous virial theorem, if K is taken to be the kinetic energy of the entire system, and V is taken to be the potential energy of the entire system, then the following relation holds between K and V:

$$\langle K \rangle = -\frac{1}{2}\langle V \rangle . \tag{1}$$

The time average of K is equal to $-1/2$ the time average of V. Also, the sum of the time average K of the kinetic energy of the entire system and the time average of the total mechanical energy E of the entire system becomes 0. That is,

$$\langle K \rangle + \langle E \rangle = 0 . \tag{2}$$

Next, if Eqs. (1) and (2) are combined, the result is as follows:

$$\langle E \rangle = -\langle K \rangle = \frac{1}{2}\langle V \rangle . \tag{3}$$

Now, consider the case where an electron at rest in an isolated system in free space absorbs energy and begins to move. Assume that the mass of the electron has increased to m due to absorption of that energy.

Einstein and Sommerfeld defined the relativistic kinetic energy K_{re} as follows [6].

$$K_{\mathrm{re}} = mc^2 - m_0 c^2 . \tag{4}$$

Here, $m_0 c^2$ is the rest mass energy of the body. And mc^2 is the relativistic energy.

The "re" subscript of K_{re} stands for "relativistic."

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If this object is an electron, then Eq. (4) can be written as follows.

$$K_{re} = mc^2 - m_e c^2. \tag{5}$$

Here, $m_e c^2$ is the rest mass energy of the electron.

Eq. (5) holds if the energy absorbed by the electron is all converted into kinetic energy of the electron. This can be regarded as a matter of course, but in the natural world the contrary phenomenon also exists. There are also cases where an electron acquires kinetic energy by releasing energy.

Next, consider the case where an electron at rest in an isolated system in free space is attracted by the electrostatic attraction of the proton (hydrogen atom nucleus), and forms a hydrogen atom. The electron at rest has a rest mass energy of $m_e c^2$. When this electron is taken into the region of the hydrogen atom, it acquires an amount of kinetic energy equivalent to the emitted photon.

Both energy sources must satisfy the law of energy conservation. The energy source here has been thought to be potential energy. However, we did not deeply pursue the true nature of this potential energy. Potential energy is a name, but there is no corresponding real entity.

The only energy an electron has when at rest is rest mass energy. There is no possible source for supplying the photon emitted by the electron, and the acquired kinetic energy, aside from the rest mass energy of the electron.

Thus, the author regarded the decrease in rest mass energy of the electron as corresponding to the potential energy of the electron, and expressed this as follows [7].

$$V(r) = -\Delta m_e c^2. \tag{6}$$

If potential energy is defined in this way, then the reason why the electron is not absorbed into the atomic nucleus can be explained without relying on quantum mechanics.

It has been thought that the stability of the atom cannot be explained in classical physics. According to Maxwell's electromagnetism, an electron attracted by a proton (hydrogen atom nucleus) is captured instantly by the atomic nucleus while emitting electromagnetic waves.

This problem was solved by Bohr. He explained that the energy levels of the hydrogen atom are discontinuous due to the adoption of the quantum condition [8]. At the same time, he pointed out that there is a minimum value to the energy levels of the hydrogen atom, and explained the reason why the electron is not absorbed into the atomic nucleus (proton). However, the viewpoint of this paper differs from Bohr's explanation.

The potential energy of the hydrogen atom is given by the following formula.

$$V(r) = -\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r} = -m_e c^2 \frac{r_e}{r}. \tag{7}$$

Here, r_e is the following classical electron radius.

$$r_e = \frac{e^2}{4\pi\varepsilon_0 m_e c^2}. \tag{8}$$

According to Eq. (7), the rest mass energy of the electron is exhausted by $r = r_e$

Therefore, the formula for potential energy is applicable in the following region.

$$V(r) = -m_e c^2 \frac{r_e}{r}, \tag{9}$$

No rest mass energy to emit another photon remains in an electron which has approached the atomic nucleus up to the position $r = r_e$

In existing theory, this is explained as $V(r) = -\infty$ when $r \to 0$, but this viewpoint must be reexamined [9].

The proton radius is thought to be about $r_e/4$, and therefore based on classical considerations alone, it is possible to explain the reason why the electron is not absorbed into the atomic nucleus. That is, there is the following lower limit on the energy levels of the hydrogen atom.

$$E = -K = \frac{1}{2}V(r) = -\frac{m_e c^2}{2}. \tag{10}$$

However, this paper does not claim that the hydrogen atom has energy levels like those in Eq. (10).

Incidentally, Bohr derived the following formula as the energy levels of the hydrogen atom.

$$E_{BO,n} = -\frac{1}{2}\left(\frac{1}{4\pi\varepsilon_0}\right)^2 \frac{m_e e^4}{\hbar^2}\cdot\frac{1}{n^2} = -\frac{\alpha^2 m_e c^2}{2n^2}, \quad n = 1, 2, \cdots. \tag{11}$$

Here, α is the following fine-structure constant.

$$\alpha = \frac{e^2}{4\pi\varepsilon_0 \hbar c} = 7.2973525664 \times 10^{-3}. \tag{12}$$

The following value is obtained by taking the ratio of Eqs. (10) and (11).

$$\frac{E_{BO,1}}{E} = \alpha^2 \approx 5.325 \times 10^{-5}. \tag{13}$$

It should be recognized that $E_{BO,1}$ is an energy far higher than the lower limit value that is classically predictable.

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III. Enegy-Momentum Relationship Applicable to the Electron in a Hydrogen Atom

Einstein's energy-momentum relationship does not hold in the hydrogen atom, where potential energy is present. However, physicists have not treated this as much of a problem. This is because physicists have thought that the theory describing the behavior of the electron in the hydrogen atom is quantum mechanics rather than the special theory of relativity (STR).

However, Dirac's relativistic wave equation is derived by taking Einstein's relationship as a departure point.

The author will first look for an energy-momentum relationship applicable to the electron in a hydrogen atom, and then later consider that a relativistic wave equation satisfying that relationship should be derived. The author actually derived a relativistic wave equation to replace the Dirac equation [10]. If one wishes to discuss electron spin, that equation must be solved.

This paper first points out physicists' mistakes regarding electrons in the hydrogen atom.

In discussions at the classical quantum theory level, many physicists believe that the mass of the electron in motion within the hydrogen atom increases when the electron's velocity increases, as predicted by the STR.

However, this is completely mistaken. When an electron is taken into a hydrogen atom, the mass of the electron decreases. If m_n is the relativistic mass of an electron whose principal quantum number is in the state n, then $m_n < m_e$

Attention must be paid to the fact that, inside the hydrogen atom, the relativistic mass of the electron m_n is smaller than the rest mass m_e

Care must be given to the fact that the relativistic kinetic energy of the electron in a hydrogen atom, $K_{re,n}$ is given not by $m_n c^2 - m_e c^2$ but by $m_e c^2 - m_n c^2$ [11]. That is,

$$K_{re,n} \neq m_n c^2 - m_e c^2. \tag{14}$$

$$K_{re,n} = -E_{re,n} = m_e c^2 - m_n c^2. \tag{15}$$

Physicists can regard $K_{re,n}$ as completely mistaken. In the discussion in this paper, Eqs. (6) and (15) are decisively important. If Eqs. (6) and (15) are accepted, then the formulas derived later can be easily understood.

According to the STR, the following relation holds between the energy and momentum of a body moving in free space [12].

$$(mc^2)^2 = (m_0 c^2)^2 + c^2 p^2. \tag{16}$$

The relationship of Einstein holds in an isolated system in free space. If the object of concern is an electron, its rest mass energy becomes $m_e c^2$.

The author previously derived an energy-momentum relationship applicable inside the hydrogen atom using three methods. First, this relationship was derived mathematically [13].

With the following method, this relation was derived through considerations using an ellipse [14]. This is a wonderful derivation method, but it is hard to solve. This paper introduces a third method which is comparatively easy to understand [15].

Now, Eq. (16) is rewritten as follows.

$$\left(mc^2\right)^2 = m_0^2 c^4 + \left(m^2 c^4 - m_0^2 c^4\right) = \left(m_0 c^2\right)^2 + c^2 p^2. \tag{17}$$

Comparing Eqs. (16) and (17), the relativistic momentum p_{re} can be defined as follows.

$$p_{re}^2 = m^2 c^2 - m_0^2 c^2. \tag{18}$$

Hence,

$$p_{re}^2 = \left(m + m_0\right)\left(mc^2 - m_0 c^2\right). \tag{19}$$

The following relation holds due to Eqs. (4) and (19).

$$K_{re} = \frac{p_{re}^2}{m + m_0}. \tag{20}$$

In classical physics, the following relation holds between momentum p and kinetic energy K.

$$K = \frac{1}{2} m_0 v^2 = \frac{p^2}{2m_0}. \tag{21}$$

The relativistic kinetic energy of an electron in a hydrogen atom is defined as follows by referring to Eq. (20).

$$K_{re,n} = \frac{p_{re,n}^2}{m_e + m_n}. \tag{22}$$

Here, $m_n c^2$ is the relativistic energy of the electron when the principal quantum number is in the state n. Also, $p_{re,n}$ indicates the relativistic momentum of the electron.

This paper defines $E_{re,n}$ as the relativistic energy levels of the hydrogen atom. (The quantum number used here is just the principal quantum number. Therefore, $E_{re,n}$ is not a formula which predicts all the relativistic energy levels of the hydrogen atom.)

However, the term "relativistic" used here does not mean based on the STR. It means that the expression takes into account the fact that the mass of the electron varies due to velocity.

According to the STR, the electron's mass increases when its velocity increases. However, inside

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the hydrogen atom, the mass of the electron decreases when the velocity of the electron increases.

The following formula can be derived from Eqs. (15) and (22).

$$\frac{p_{\mathrm{re},n}^2}{m_\mathrm{e}+m_n}=m_\mathrm{e}c^2-m_nc^2. \tag{23}$$

Rearranging this, the following relationship can be derived.

$$\left(m_nc^2\right)^2+c^2p_{\mathrm{re},n}^2=\left(m_\mathrm{e}c^2\right)^2. \tag{24}$$

Equation (24) is the energy-momentum relationship applicable to the electron in a hydrogen atom.

Here, we will reconfirm that, in Eqs. (16) and (24), the energy of an electron initially at rest is $m_\mathrm{e}c^2$. (This paper does not discuss the issues of whether an electron can be completely at rest.) Also, it will be confirmed, regarding the fact that Eq. (24) is applicable in the hydrogen atom, that $r_\mathrm{e}\le r$, just like the scope of application of the formula for potential energy. There are limits on the application of Eq. (24). It is not the case that Eq. (24) is applicable in all regions within the hydrogen atom.

IV. Solusion of Equation (24)

In the past, Dirac derived the following negative solution from Eq. (16).

$$E=\pm mc^2=\pm m_0c^2\left(1-\frac{v^2}{c^2}\right)^{-1/2}. \tag{25}$$

If the same logic is applied to Eq. (24), then the following formula can be derived.

$$E_{\mathrm{ab},n}=\pm m_nc^2=\pm m_\mathrm{e}c^2\left(1+\frac{v_n^2}{c^2}\right)^{-1/2}. \tag{26}$$

$E_{\mathrm{ab},n}$ defined here are the energy levels describing the energy possessed by the electron on an absolute scale.

However, Eq. (26) does not incorporate the discontinuity peculiar to the micro world. Therefore, Eq. (26) must be rewritten into a relationship where energy is discontinuous.

Thus, the author derived discontinuous energy levels using the following relationship [16] (Appendix).

$$\frac{v_n}{c}=\frac{\alpha}{n}. \tag{27}$$

Now, using the relationship in Eq. (27),

$$E_{\mathrm{ab},n}^{\pm}=\pm m_nc^2=\pm m_\mathrm{e}c^2\left(1+\frac{\alpha^2}{n^2}\right)^{-1/2} \tag{28a}$$

$$=\pm\, m_\mathrm{e}c^2\left(\frac{n^2}{n^2+\alpha^2}\right)^{1/2}. \tag{28b}$$

$E_{\mathrm{re},n}$ are the energy levels when $m_\mathrm{e}c^2$ is taken to be the energy of an electron at rest at a position infinitely far from a proton. The relationship of $E_{\mathrm{ab},n}$ and $E_{\mathrm{re},n}$ is as follows.

$$E_{\mathrm{re},n}=E_{\mathrm{ab},n}-m_\mathrm{e}c^2=m_nc^2-m_\mathrm{e}c^2<0. \tag{29}$$

Also, the relationship of these energies can be illustrated as follows (see Fig.1).

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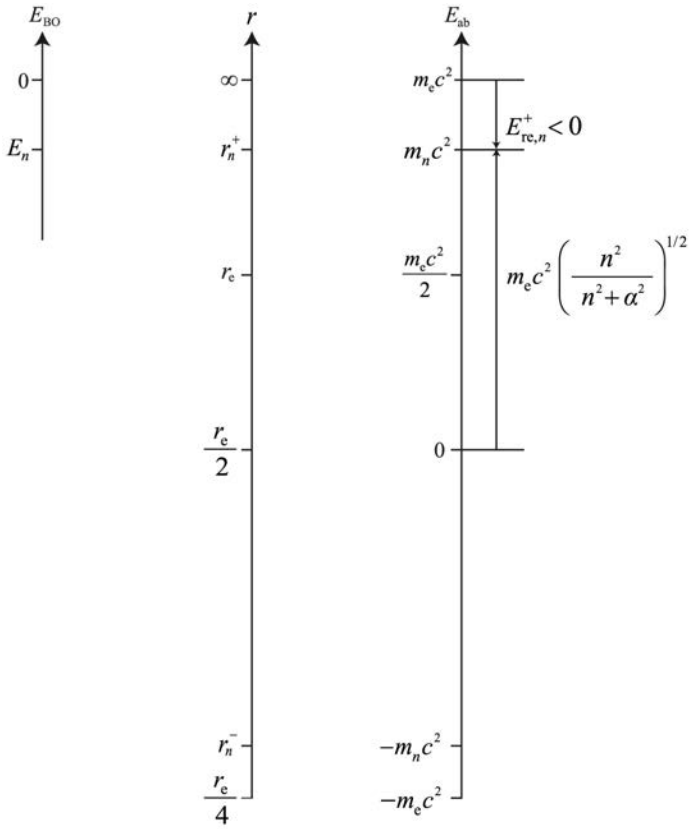


Fig. 1: Relationship of $E_{\mathrm{re},n}$ and $E_{\mathrm{ab},n}$ defined in Eq. (29). $E_{\mathrm{re},n}$ corresponds to the decrease in rest mass energy of the electron, and $E_{\mathrm{ab},n}$ $(m_n c^2)$ corresponds to the remaining part.

Using the definition in Eq. (29), $E_{\mathrm{re},n}$ is as follows.

$$E_{\mathrm{re},n}^{+} = m_e c^2 \left(\frac{n^2}{n^2+\alpha^2}\right)^{1/2} - m_e c^2$$

$$= m_e c^2 \left[\left(\frac{n^2}{n^2+\alpha^2}\right)^{1/2} - 1\right]. \quad (30)$$

$E_{\mathrm{re},n}^{+}$ are the energy levels of an ordinary hydrogen atom, and thus $E_{\mathrm{re},n}$ are omitted unless particularly necessary.

To simplify the discussion in this paper, the only quantum number addressed is n.

Next, when the part of Eq. (30) in parentheses is expressed as a Taylor expansion,

$$E_{\mathrm{re},n} \approx m_e c^2 \left[\left(1 - \frac{\alpha^2}{2n^2} + \frac{3\alpha^4}{8n^4} - \frac{5\alpha^6}{16n^6}\right) - 1\right]$$

$$\approx -\frac{\alpha^2 m_e c^2}{2n^2}. \quad (31)$$

This shows that Eq. (11) for the energy levels of the hydrogen atom derived by Bohr is an approximation of Eq. (30).

Now, the total mechanical energy of the hydrogen atom is given by the following formula.

$$E_{\mathrm{re},n} = K_{\mathrm{re},n} + V(r_n) = -K_{\mathrm{re},n}. \quad (32)$$

Also, if the formula for potential energy is used, then $E_{\mathrm{re},n}$ can be written as follows.

$$E_{\mathrm{re},n} = \frac{1}{2} V(r_n) = -\frac{1}{2}\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r_n} = -\frac{1}{2} m_e c^2 \frac{r_e}{r_n} = -m_e c^2 \left(\frac{r_e/2}{r_n}\right). \quad (33)$$

From Eq. (33), $m_n c^2$ is:

$$m_n c^2 = E_{\mathrm{ab},n} = m_e c^2 + E_{\mathrm{re},n} = m_e c^2 - m_e c^2 \left(\frac{r_e/2}{r_n}\right) = m_e c^2 \left(\frac{r_n - r_e/2}{r_n}\right). \quad (34)$$

Her the following energy is obtai ned if $r_e/2$ and $r_e/4$ are substituted for r_n in Eq. (34).

When $r = \frac{r_e}{2}$, $E_{\mathrm{ab}} = 0$ and when $r = \frac{r_e}{4}$, $E_{\mathrm{ab}} = -m_e c^2$ (35)

How should we think about emission of a photon by an electron that has consumed all its rest mass energy?

In another paper, the author proposed a method of solving that problem. According to the author's hypothesis, for an electron in the state $E_{\mathrm{ab}} = 0$ the photon energy and negative energy cancel out. The absolute

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amount of the respective energies cannot be definitely determined. However, if it is assumed that the electron approaches to a distance of $r = r_e/4$ from the center of the atomic nucleus, then the state with $E_{ab}=0$ can be regarded as the state where the photon energy of $m_e c^2$ and the negative energy of $-m_e c^2$ have canceled each other out. This negative energy can be thought of as the energy the electron latently possesses, and it is predicted that this energy cannot be removed from the electron.

Using this hypothesis, the energy can have a negative mass due to emission of a photon. More detailed explanation will be left to another paper [14].

V. Orbital Radius of an Electron in a Hydrogen Atom

The following equation holds due to Eqs. (28b) and (34).

$$\frac{n^2}{n^2+\alpha^2} = \left(\frac{r_n - r_e/2}{r_n}\right)^2. \tag{36}$$

From this, the following quadratic equation is obtained.

$$r_n^2 - \left(\frac{n^2+\alpha^2}{\alpha^2}\right) r_e r_n + \left(\frac{n^2+\alpha^2}{\alpha^2}\right)\frac{r_e^2}{4} = 0. \tag{37}$$

If this equation is solved for r_n ,

$$r_n^{\pm} = \frac{r_e}{2}\left(1+\frac{n^2}{\alpha^2}\right)\left[1 \pm \left(1+\frac{\alpha^2}{n^2}\right)^{-1/2}\right]. \tag{38}$$

Next, if the electron orbital radii corresponding to the energy levels in Eq. (28b) are taken to be, respectively, r_n^+ and r_n^-,

$$r_n^+ = \frac{r_e}{2}\frac{\left(n^2+\alpha^2\right)^{1/2}}{\left(n^2+\alpha^2\right)^{1/2} - n}. \tag{39}$$

$$r_n^- = \frac{r_e}{2}\frac{\left(n^2+\alpha^2\right)^{1/2}}{\left(n^2+\alpha^2\right)^{1/2} + n}. \tag{40}$$

Also, Eqs. (39) and (40) can be written as follows [3].

$$r_n^+ = \frac{r_e}{2}\left[1 + \frac{n}{\left(n^2+\alpha^2\right)^{1/2} - n}\right]. \tag{41}$$

$$r_n^- = \frac{r_e}{2}\left[1 - \frac{n}{\left(n^2+\alpha^2\right)^{1/2} + n}\right]. \tag{42}$$

In Eq. (42), the electron approaches toward $r_e/4$ as n increases. Therefore,

$$\frac{r_e}{4} < r_n^- \le \frac{r_e}{2}. \tag{43}$$

$$\frac{r_e}{2} \le r_n^+. \tag{44}$$

In this paper, r_n^+ is called the orbital radius, as is customary. However, a picture of the motion of the electron cannot be drawn, even if that motion is discussed at the level of classical quantum theory. The electron in a hydrogen atom is not in orbital motion around the atomic nucleus. The domain of the ordinary hydrogen atom that we all know starts from $r = r_e/2 (E_{ab}=0)$ (The equality sign holds in Eqs. (43) and (44) when $n = 0$).

With the aid of quantum mechanics, r_n^+ and r_n^- can be regarded as the locations (positions) where presence of the electron has maximum probability.

The next compares the orbital radii of an electron in a hydrogen atom r_n^+ and the orbital radii of an electron with a negative mass r_n^-.

The following ratio is obtained from Eqs. (39) and (40).

$$\frac{r_n^-}{r_n^+} = \frac{\left(n^2+\alpha^2\right)^{1/2} - n}{\left(n^2+\alpha^2\right)^{1/2} + n}. \tag{45}$$

Here, if we set $n = 1$,

$$\frac{r_1^-}{r_1^+} = \frac{\left(1+\alpha^2\right)^{1/2} - 1}{\left(1+\alpha^2\right)^{1/2} + 1} = 1.3312484168\times10^{-5} \approx \frac{1}{75120}. \tag{46}$$

The author pointed out that an electron with negative mass forming DHA exists near the atomic nucleus (proton) [4][17].

VI. Evidence of the Existence of Ultra-Low Energy Levels

Is there an experiment demonstrating the existence of electrons at ultra-low energy levels? The author believes that the experiment of triplet production demonstrates the author's hypothesis.

This is a phenomenon where two electrons and one positron are produced from a gamma ray of energy $4m_e c^2$ (2.044MeV). The author has pointed out that one of the electrons produced here is an electron with the negative energy which formed the DHA. However, it was difficult to determine which was better, the author's interpretation or the existing explanation. The author has previously discussed this problem a number of times, so that will not be repeated here. Please refer to the author's other papers [18].

Recently, the author has discovered a new formula which gives the energy levels of the hydrogen atom [19]. The formula previously derived by the author was as follows.

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$$E^{+}_{\mathrm{re},n} = m_n c^2 - m_\mathrm{e} c^2 = m_\mathrm{e} c^2 \left[\left(\frac{n^2}{n^2+\alpha^2} \right)^{1/2} - 1 \right]. \quad (47)$$

However, in recent papers, the author has shown that the energy levels of the hydrogen atom can also be described with the following formula.

$$E^{+}_{\mathrm{re},n} = -K_{\mathrm{re},n} = -cp_{\mathrm{re},n} \left[\frac{\left(n^2+\alpha^2\right)^{1/2} - n}{\left(n^2+\alpha^2\right)^{1/2} + n} \right]^{1/2}. \quad (48)$$

Taking Eqs. (39) and (40) into account, Eq. (48) can be described as follows.

$$E^{+}_{\mathrm{re},n} = -cp_{\mathrm{re},n} \left(\frac{r_n^-}{r_n^+} \right)^{1/2}. \quad (49)$$

In Eq. (49), r_n^- of electrons at ultra-low energy levels contribute to the energy levels of an ordinary hydrogen atom.

In this paper, Eq. (49) is derived using a method different from that in the previous paper.

Now, it is known that Eq. (24) can be written as follows if Eq. (28b) is taken into consideration.

$$\left(m_\mathrm{e} c^2\right)^2 \left(\frac{n^2}{n^2+\alpha^2} \right) + c^2 \left(m_\mathrm{e} c\right)^2 \left(\frac{\alpha^2}{n^2+\alpha^2} \right) = \left(m_\mathrm{e} c^2\right)^2. \quad (50)$$

From this, the following formula can be derived.

$$p_{\mathrm{re},n} = m_\mathrm{e} c \left(\frac{\alpha^2}{n^2+\alpha^2} \right)^{1/2}. \quad (51)$$

Incidentally, the following equation can be derived from Eqs. (24) and (51).

$$\left(m_n c^2\right)^2 = c^2 p^2_{\mathrm{re},n} \left[\frac{m_\mathrm{e}^2 c^2}{p^2_{\mathrm{re},n}} - 1 \right]. \quad (52)$$

Substituting the value of Eq. (51) for $p^2_{\mathrm{re},n}$ in parentheses in Eq. (52),

$$\left(m_n c^2\right)^2 = c^2 p^2_{\mathrm{re},n} \left[\left(\frac{n^2+\alpha^2}{\alpha^2} \right) - 1 \right]$$

$$= c^2 p^2_{\mathrm{re},n} \frac{n^2}{\alpha^2}. \quad (53)$$

Hence,

$$m^{\pm}_n c^2 = \pm cp_{\mathrm{re},n} \frac{n}{\alpha}. \quad (54)$$

Incidentally, according to Maxwell's electromagnetism, there is the following relationship between the energy and momentum of light.

$$E = cp. \quad (55)$$

In light of Eq. (55), Eq. (54) was written as a formula including cp.

Using Eq. (54) the energy levels of an ordinary hydrogen atom can be written as follows.

$$E^{+}_{\mathrm{re},n} = m_n c^2 - m_\mathrm{e} c^2$$

$$= cp_{\mathrm{re},n} \frac{n}{\alpha} - m_\mathrm{e} c^2$$

$$= -cp_{\mathrm{re},n} \left(\frac{m_\mathrm{e} c}{p_{\mathrm{re},n}} - \frac{n}{\alpha} \right). \quad (56)$$

Using Eq. (51) again here,

$$E^{+}_{\mathrm{re},n} = -cp_{\mathrm{re},n} \left[\left(\frac{n^2+\alpha^2}{\alpha^2} \right)^{1/2} - \frac{n}{\alpha} \right]. \quad (57)$$

Incidentally, the author can write the fine-structure constant as follows.

$$\alpha = \left[\left(n^2+\alpha^2\right)^{1/2} + n \right]^{1/2} \left[\left(n^2+\alpha^2\right)^{1/2} - n \right]^{1/2}. \quad (58)$$

Using Eq. (58), Eq. (57) becomes as follows.

$$E^{+}_{\mathrm{re},n} = -cp_{\mathrm{re},n} \cdot \frac{\left[\left(n^2+\alpha^2\right)^{1/2} - n \right]^{1/2} \left[\left(n^2+\alpha^2\right)^{1/2} - n \right]^{1/2}}{\left[\left(n^2+\alpha^2\right)^{1/2} + n \right]^{1/2} \left[\left(n^2+\alpha^2\right)^{1/2} - n \right]^{1/2}}$$

$$= -cp_{\mathrm{re},n} \left[\frac{\left(n^2+\alpha^2\right)^{1/2} - n}{\left(n^2+\alpha^2\right)^{1/2} + n} \right]^{1/2}$$

$$= -cp_{\mathrm{re},n} \left(\frac{r_n^-}{r_n^+} \right)^{1/2}. \quad (59)$$

Actually, Eq. (59) is not used to calculate the energy levels of the hydrogen atom. However, Eq. (59) is an important formula that allows us to have confidence that ultra-low energy levels exist in the hydrogen atom.

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VII. Conclusion

The author has previously pointed out that ultra-low energy levels, not predictable in quantum mechanics, exist in the hydrogen atom. An electron in such a state has negative mass. The author adopted the name DHA for a material formed from such an electron and a proton with positive mass. The thought process whereby the author arrived at this conclusion is summarized below.

1. The reduction in rest mass energy of the electron corresponds to the potential energy of the hydrogen atom. If the reduction in rest mass energy of the electron is expressed as $-\Delta m_e c^2$. then potential energy of the hydrogen atom is given by the following formula.

$$V(r_n) = -\Delta m_e c^2. \tag{60}$$

Also, the relativistic kinetic energy $K_{\mathrm{re},n}$ of the electron in a hydrogen atom is given by the following equation.

$$K_{\mathrm{re},n} = -E_{\mathrm{re},n} = m_e c^2 - m_n c^2. \tag{61}$$

Taking Eqs. (60) and (61) as a departure point, it is possible to derive the various surprising formulas in this paper.

2. The energy-momentum relationship applicable to the electron in a hydrogen atom, where potential energy is present, is not the relationship of Einstein but rather the following relationship.

$$\left(m_n c^2\right)^2 + c^2 p_{\mathrm{re},n}^2 = \left(m_e c^2\right)^2. \tag{62}$$

3. Dirac predicted that there is a negative solution to Einstein's relationship, but using the same argument, it is evident that Eq. (62) has the following positive and negative solutions.

$$E_{\mathrm{ab},n}^{\pm} = \pm m_n c^2 = \pm m_e c^2 \left(\frac{n^2}{n^2+\alpha^2}\right)^{1/2}. \tag{63}$$

E_{ab} is the absolute energy of the electron. E_{ab} becomes zero when the position r of the electron is $r = r_e/2$.

Also, the r's of the electron corresponding to these two energy levels are, respectively, as follows.

$$r_n^+ = \frac{r_e}{2}\left[1 + \frac{n}{\left(n^2+\alpha^2\right)^{1/2} - n}\right]. \tag{64}$$

$$r_n^- = \frac{r_e}{2}\left[1 - \frac{n}{\left(n^2+\alpha^2\right)^{1/2} + n}\right]. \tag{65}$$

This shows that the region in an ordinary hydrogen atom starts not from $r = 0$ but from $r = r_e/2$.

4. The author has previously derived the following formula for the energy levels of a hydrogen atom including only the principal quantum number n.

$$E_{\mathrm{re},n}^+ = m_n c^2 - m_e c^2 = m_e c^2 \left[\left(\frac{n^2}{n^2+\alpha^2}\right)^{1/2} - 1\right]. \tag{66}$$

However, recently the author noticed that the energy levels of the hydrogen atom can also be described with the following formula.

$$E_{\mathrm{re},n}^+ = -cp_{\mathrm{re},n}\left(\frac{r_n^-}{r_n^+}\right)^{1/2}. \tag{67}$$

Furthermore, Eq. (67) was derived by the author using two methods. Eq. (67) is believed to be compelling evidence that ultra-low energy levels exist in the hydrogen atom.

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Appendix

Bohr's orbital radius $r_{\mathrm{BO},n}$ is normally described with the following formula.

$$r_{\mathrm{BO},n} = 4\pi\varepsilon_0 \frac{\hbar^2}{m_e e^2} n^2. \tag{A1}$$

Bohr thought the following quantum condition was necessary to find the energy levels of the hydrogen atom.

$$m_e v_n \cdot 2\pi r_{\mathrm{BO},n} = 2\pi n\hbar. \tag{A2}$$

In Bohr's theory, the energy levels of the hydrogen atom is treated non-relativistically, and thus here the momentum of the electron is taken to be $m_e v$ Also, the Planck constant h can be written as follows [20].

$$\hbar = \frac{h}{2\pi} = \frac{m_e c \lambda_C}{2\pi}. \tag{A3}$$

λ_C is the Compton wavelength of the electron.

When Eq. (A3) is used, the fine-structure constant α can be expressed as follows.

$$\alpha = \frac{e^2}{4\pi\varepsilon_0 \hbar c} = \frac{e^2}{2\varepsilon_0 m_e c^2 \lambda_C}. \tag{A4}$$

Also, the classical electron radius r_e is defined as follows.

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$$r_e = \frac{e^2}{4\pi\varepsilon_0 m_e c^2}. \quad \text{(A5)}$$

If r_e/α is calculated here,

$$\frac{r_e}{\alpha} = \frac{\lambda_C}{2\pi}. \quad \text{(A6)}$$

If Eq. (A1) is written using r_e and α, the result is as follows.

$$r_{BO,n} = 4\pi\varepsilon_0 \frac{\hbar^2}{m_e e^2} n^2 = \frac{e^2}{4\pi\varepsilon_0 m_e c^2}\left(\frac{4\pi\varepsilon_0 \hbar c}{e^2}\right)^2 n^2 = \frac{r_e}{\alpha^2} n^2. \quad \text{(A7)}$$

Equation (A7) containing r_e is superior to Eq. (A1) from a physical standpoint.

Next, if $\hbar$ in Eq. (A3) and $r_{BO,n}$ in Eq. (A7) are substituted into Eq. (A2),

$$m_e v_n \cdot 2\pi \frac{r_e}{\alpha^2} n^2 = 2\pi n \frac{m_e c \lambda_C}{2\pi}. \quad \text{(A8)}$$

If Eq. (A6) is also used, then Eq. (A8) can be written as follows.

$$m_e v_n \cdot 2\pi \frac{r_e}{\alpha^2} n^2 = 2\pi n \frac{m_e c r_e}{\alpha}. \quad \text{(A9)}$$

From this, the following relationship can be derived.

$$\frac{v_n}{c} = \frac{\alpha}{n}. \quad \text{(A10)}$$

Due to Eq. (A10), it is possible to identify discontinuous states that are permissible in terms of quantum mechanics in the continuous motions of classical theory.

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Is the Ability to Feel Magnetic Field Quantum in Nature? Magnetic Field for Anesthesia

By Maria Kuman

Holistic Research Institute

Abstract- In this article, I am going to prove that the ability of all living beings to feel magnetic field is quantum in nature and all living beings feel magnetic fields through their Subconscious. Proof of the relation magnet - Subconscious is the fact that when a hypnotized individual with sleeping Conscious under suggestion was seeing a tridimensional holographic image of a pigeon in his lap (and was petting the pigeon), when a magnet was approached to his head, he said that the pigeon disappeared. If so, we can expect the abilities of all living beings to sense magnetic fields to be subconscious. Since holographic tridimensional images are created with laser light, our aura ("aura" means "light") must be involved in the holographic imaging. I investigated the aura for 40 years and I found it to be weak nonlinear electromagnetic field (NEMF). Being nonlinear, this field can imprint information. I found that this weak informational NEMF from the Subconscious rules and regulates everything in the body, not with its strength, but with the information it carries. Since it relates to the aura (light), it must be Quantum in nature. The quantum nature of the ability to feel magnetic field must be equally true for that: 1/ humans and 2/ migrating birds, which during the migration season were found to have changes in their retina; and 3/ blind mole rats that always built their nests at the southeastern end of their underground tunnels, lost this ability when their eyes were surgically removed, which proves that the sensing of magnetic field is light-related and therefore it is quantum in nature.

Keywords: *sensing magnetic fields; human magnetic sense; birds magnetic sense; mole rats magnetic sense; quantum nature of magnetic sense.*

GJSFR-A Classification: *DDC Code: 538 LCC Code: QC754.2.M3*



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Is the Ability to Feel Magnetic Field Quantum in Nature? Magnetic Field for Anesthesia

Maria Kuman

Abstract- In this article, I am going to prove that the ability of all living beings to feel magnetic field is quantum in nature and all living beings feel magnetic fields through their Subconscious. Proof of the relation magnet - Subconscious is the fact that when a hypnotized individual with sleeping Conscious under suggestion was seeing a tridimensional holographic image of a pigeon in his lap (and was petting the pigeon), when a magnet was approached to his head, he said that the pigeon disappeared. If so, we can expect the abilities of all living beings to sense magnetic fields to be subconscious. Since holographic tridimensional images are created with laser light, our aura ("aura" means "light") must be involved in the holographic imaging. I investigated the aura for 40 years and I found it to be weak nonlinear electromagnetic field (NEMF). Being nonlinear, this field can imprint information. I found that this weak informational NEMF from the Subconscious rules and regulates everything in the body, not with its strength, but with the information it carries. Since it relates to the aura (light), it must be Quantum in nature. The quantum nature of the ability to feel magnetic field must be equally true for that: 1/ humans and 2/ migrating birds, which during the migration season were found to have changes in their retina; and 3/ blind mole rats that always built their nests at the southeastern end of their underground tunnels, lost this ability when their eyes were surgically removed, which proves that the sensing of magnetic field is light-related and therefore it is quantum in nature.

Keywords: sensing magnetic fields; human magnetic sense; birds magnetic sense; mole rats magnetic sense; quantum nature of magnetic sense.

I. The Ability of Humans to Feel Magnetic Fields

Many years ago at European conference, the Russian scientist Cholodov, who studied his entire life the influence of magnets on living beings, said to me in a private conversation that of course humans and all living beings sense the magnetic field, but it is done at subconscious level not to overwhelm our senses. I think he was right because in 1975, when I was a Visiting Professor at the Biophysics Department of Moscow University, the experiment of Dr. Galitzina was going on. An individual in a state of hypnosis (with sleeping Conscious) under suggestion was seeing a pigeon on his lap, and he was patting it. When they approached a magnet to his head, immediate reaction followed: "The pigeon disappeared" the hypnotized person said. Hypnotized individuals have sleeping Conscious, so the image of the pigeon was created by the Subconscious and was probably holographic or tridimensional. The fact that the image disappeared when magnet was approached to his head means that our Subconscious (and everything created by it) is sensitive to changes in the magnetic field.

Let us see what we have in the Subconscious and why would our Subconscious be sensitive to changes in the magnetic field. The hypnotized person was seeing under suggestion a tridimensional holographic image of pigeon on his lap. Holographic (tridimensional) images are created only with laser light. Since "aura" means "light", the aura must be involved in it. My almost 40 years of study of the aura revealed that the aura is weak nonlinear electromagnetic field (NEMF) and if so, it can be expected to be influenced by external magnetic fields.

I hope this explains the disappearance of the image of tridimensional pigeon when magnet was approached to the head of the seeing it hypnotized individual.

Hypnotists discovered with surprise that hypnotized individuals (with sleeping Conscious) can calculate many thousands of times faster. This means that we have a super-computer in the Subconscious, much more powerful than our conscious computer, but we don't have conscious awareness of its existence. Since this supercomputer operates with holographic images and holographic images are created with laser light, obviously the super-computer in our Subconscious operates with the waves of our aura (light) NEMF. And if it operates with light NEMF, it is a Quantum Computer [1], [2], and it can be expected to sense external magnetic fields. This comes to prove that the subconscious sensing of magnetic fields is indeed Quantum in nature.

Joseph Kirschvink and Shin Shimojo, (who measured changes in the brain's alpha waves at magnetic perturbation) found that many people could sense unconsciously magnetic fields. In their article [3] they correctly hypothesize "Quantum Compass of the magnetic sense". However, Kirschvink seems to have changed his mind later on, as he went deeper and deeper into the molecular studies of other authors. However, his primary intuitive envision of the "Quantum nature of the magnetic sense" was right.

About 45 years ago, I was curious how dowsers find underground water with dowsing sticks. Running

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underground water would create changes in the magnetic field of the Earth, so I borrowed magnetometer from the Geophysical Institute and followed dowsers as they search for underground water. At the places where the dowsing sticks in the hands of the dowsers were moving, the arrow of my magnetometer was moving showing changes in the magnetic field of the Earth. This means that the dowsers are individuals sensitive to changes in the magnetic field of the Earth and they are the instruments finding these magnetic changes, their dowsing sticks (just like the arrow of my magnetometer) are just making visible their response to the changes in the earth magnetic field.

II. The Ability of Birds to feel the Earth Magnetic Field, Which Helps when Migrating

In early 2021, scientists from the University of Tokyo published their studies of the birds' ability to sense magnetic field. But let start with the pioneer studies, in 1972 W. Wiltschko and F. Wiltschko published their studies on the magnetic compass of European robins [5]. In 1995, they published a book on magnetic orientation of animals [6]. In 1993, they published an article in Nature that red light disturbed the magnetic orientation of birds [7], which indicated that the magnetic orientation is coupled with colored vision, i.e. it has quantum nature. Independent research on robins of Dr. Mouritsen et al. [8], done at the University of Oldenburg in Germany, showed that the eye protein Cytochrome 4 in the birds' retina is sensitive to changes in the magnetic field of the Earth. (Cytochrome 1 and 2 were found related to birds' daily (circadian) rhythms.

Dr. Henrik Mouritsen did farther research on the night vision of migrating birds [9]. In another article published in PLOS ONE in 2007 Dr. Mouritsen reported that during migration they found increased neuronal connection between the retinal neurons and Cluster N in the forebrain hemisphere and this connection was considered a factor in the increased magnetic sense of the birds during the migration period. Scientists from the Lung University in Sweden studied zebra finches and found that the perception of magnetic field of these birds was also related to the amount of Cytochrome 4 in their eyes [10].

III. The Ability of Mole Rats to Feel Magnetic Field

Mole rats were studied, which lived in dark tunnels and were actually blind. Since they always built their nest in the dark southeast end of the tunnel, it was assumed they must sense the magnetic field. When their eyes were surgically removed, they stopped building their nests on the southeast end of the tunnel. This is another indication that the magnetic orientation must be related to specific chemical changes in the mole rats' eyes [11]. This is in agreement with the finding that the magnetic orientation of birds is related to specific chemical changes in the retina of the migrating birds. This proves that the ability of both birds and mole rats to feel magnetic fields is somehow related to their eyes, which are light sensitive, which makes the sensitivity to magnetic fields quantum in nature.

IV. Conclusion

In conclusion, I need to say that the scientist-researchers got so much immersed in the molecular research that even when some of them, like Kirschvink, started their research with the intuitive envision that the influence of the magnetic field on birds must be quantum in nature, later forgot about this when they became engrossed in the molecular studies of other authors. The influence of magnetic fields on birds must be quantum in nature because it is done through changes in their eyes, which are light sensitive organ. External magnetic fields influence also our aura, which I found to be weak informational nonlinear electromagnetic field (NEMF) [2]. The aura (and the Quantum Computer in the Subconscious operating with the waves of the aura NEMF) is what makes us sensitive even to small changes in external magnetic fields.

I measured the sensitivity of dowsers to changes in the magnetic field by asking them to sense weak magnets covered with a sheet of paper and I found that some of them can sense magnets as weak as 0.001 gauss [4]. Studding the aura for almost 40 years, I found it to be emotionally sensitive – it shines brighter when we experience positive emotions and it is dimmer when we experience negative emotions. Since we say we are in high spirit when we experience positive emotions and we say we are in low spirit when we experience negative emotions, I concluded that the aura must be our Spirit. Then I found that since ancient times the Jewish Cabala was teaching to high priests that the aura (which means light in Hebrew) is our Spirit.

This means that we are a material body, and Spirit (seen as aura) that comes from our Creator. My studies found that the Spirit is weak nonlinear electromagnetic field (NEMF) and being nonlinear it can imprint information. This makes the Spirit weak informational field. To give us freedom of choice, the Creator put the Spirit NEMF and the Quantum Computer working with the waves of the Spirit NEMF in the Subconscious. Being NEMF, our Spirit is expected to be able to sense external magnetic fields and this ability will be Quantum in nature.

Why is it important to know the ability of the humans to sense magnetic fields? It turned out that this has practical application in medicine – magnets can be

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used for anesthesia in the surgical medicine. Anesthesia with magnet [11] is much better than the presently used chemical anesthetics, which cause drowsiness after the surgery and substantially slower the process of recovery because the used chemical anesthetics are poison for the body. When magnet is used for anesthesia, the person is fully conscious after the magnet is removed and the recovery from the surgery is much faster.

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"Mechanical Pretreatment of Polymer Melts: Critical Aspects and New Rheological Investigations on a Linear and a Long-Chain Branched Polypropylene" by Helmut Münstedt, J.O.R., 65.5(2021): 871-885, DOI: 10.1122/8.0000287

By Jean Pierre Ibar

University of the Basque Country Donostia

Abstract- This paper uses the pretext of commenting on the allegations contained in a paper published by Münstedt regarding this author's work on the "shear-refinement"of linear polymers to explain the difference between his model of polymer interactions (the "new school" paradigm of polymer physics) and the "old school" molecular dynamics paradigm defended by its guardians including Münstedt in this instance. It is true that "shear-refinement" for linear polymers is not explained by the currently accepted models of rheology, whereas it has received a partial explanation for branched polymers. Münstedt concluded that shear-refinement effects can only be observed for long chain branched (LCB) polymers and that linear chain polymers cannot do so. He suggested that the many results showing apparent successful shear-refinement in our work were probably artifacts or due to lacking measurements of the molecular weight before and after our shear-refinement treatments. We show in this paper that Münstedt has not been genuine in his quotations of our work: by incorrectly reporting the results and the procedures, by muting important details, and by making amalgams between different types of experiments he drew wrong conclusions that could possibly misrepresent more than inform the reader about the content of our work on the instability of the entanglement state.

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"Mechanical Pretreatment of Polymer Melts: Critical Aspects and New Rheological Investigations on a Linear and a Long-Chain Branched Polypropylene" by Helmut Münstedt, J.O.R., 65.5(2021): 871-885, DOI: 10.1122/8.0000287

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Abstract- This paper uses the pretext of commenting on the allegations contained in a paper published by Münstedt regarding this author's work on the "shear-refinement"of linear polymers to explain the difference between his model of polymer interactions (the "new school" paradigm of polymer physics) and the "old school" molecular dynamics paradigm defended by its guardians including Münstedt in this instance. It is true that "shear-refinement" for linear polymers is not explained by the currently accepted models of rheology, whereas it has received a partial explanation for branched polymers. Münstedt concluded that shear-refinement effects can only be observed for long chain branched (LCB) polymers and that linear chain polymers cannot do so. He suggested that the many results showing apparent successful shear-refinement in our work were probably artifacts or due to lacking measurements of the molecular weight before and after our shear-refinement treatments. We show in this paper that Münstedt has not been genuine in his quotations of our work: by incorrectly reporting the results and the procedures, by muting important details, and by making amalgams between different types of experiments he drew wrong conclusions that could possibly misrepresent more than inform the reader about the content of our work on the instability of the entanglement state. The experimental reality of the instability of the entanglements should be debated in a straightforward scientific way, without deception of the facts, because its consequences, if validated, require a shift toward a new paradigm in polymer physics, a new understanding of entanglements and of visco-elasticity, nothing less!. We address in this publication the following issues:

- There is no good reason to doubt and attempt to disqualify the results on the shear-induced melt instability of linear polymers (designated "disentanglement" in our work, "shear-refinement" by Munstedt). Münstedt's misquotes were corrected and their implications refuted.
- Münstedt used the classical topological description of long chain branched (LCB) polymers to support his opinion that linear chain polymers cannot qualify to successfully induce shear-refinement effects. We argued that although LCBs and linear chains are architecturally different, the true cause for shear-refinement must be found elsewhere, and we pointed to the dynamic free volume as one of the causes of the melt instability triggering a reduction of viscosity. LCB polymers have inherently more dynamic free volume than the linear polymers, a positive attribute for shear-refinement, but both architectures can support a substantial enhancement of dynamic free volume by melt Rheo-Fluidizing manipulation, not just the LCB type. The dynamic free volume is quantified by the Grain-Field Statistics model of the interactions but not by the molecular dynamic models.
- The reluctance to accept the "melt instability" experimental results by Münstedt was perhaps motivated by the lack of molecular dynamic models' arguments to comprehend them.
- The discovery of the instability of the entanglement network triggers the necessity to understand entanglements differently.
- We briefly introduce the general principles underlying the *Grain-Field Statistical model of interactive coupling of dissipative systems* that we believe could become the basis for a new paradigm in polymer physics beyond the current limitations of the molecular dynamic models (Rouse and reptation) that have dominated our academic interpretation of the deformation of macromolecular chains but fail to construe new experimental evidence (e.g. "Sustained-Orientation", the T_{LL} transition).

I. Introduction

The purpose of Münstedt's paper is clearly stated in his title and in the abstract: taking polypropylene (linear and long chain branched) as the polymer of investigation, and reporting other similar results taken from the literature using different polymers, Münstedt concluded :"*A widerange of linear and nonlinear rheological properties was studied, and it became obvious that long-chain branching is a strong structural precondition for the pronounced pre-treatment effect occurring in processing*". In other words, Münstedt affirms that based on his review of the literature and his own work on polypropylene, there is no substantial effect of a mechanical pre-treatment if one uses a linear polymer, only long chain branched polymers (LCB) will work. This conclusion is contradicting our own experience and publications on this subject [4-40], summarized in Ref. [2], that Münstedt quoted and discussed in his paper.

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"*This* (pre-treatment) *effect is sometimes called "shear modification" or "refining"*", says Münstedt. Other terms have been used more recently: "disentanglement" was used by this author in early experimental work on this subject which started in 1997-1999 [4-13], and continued on for the last 20 years [14-40]. As our critical progress in understanding the origin of this pre-treatment effect on the rheological properties of melts became quantifiable by our model of interactions, the "disentanglement" effect was re-qualified as "the melt shear-induced instability" and we decided to write an introductory book to report the experimental evidence on the instability of entangled melts[2]. The book reviews several aspects of the rheology of polymer melts, showing some of the problems the current theoretical models face in particular with respect to explaining the instability of the melts under non-linear shear stresses. These are the experiments of the book quoted by Münstedt [1]. In particular, it was suggested in that book that the success obtained in producing shear-refinement effects in *linear* polymers raised the issue of re-examining the concepts of entanglement and of visco-elasticity themselves, that is, the foundation of polymer rheology. In the following, "shear-refinement", "disentanglement" and "melt instability" will be used as synonyms, although a subtle difference between these terms exits as explained in [2].

One of the main issues of polymer science has been to balance the benefits of increasing the molecular weight of the macromolecular chains to improve the mechanical properties, and the disastrous impact of increasing the molecular weight on the processing ability, mostly because of the power 3.4 melt viscosity increase with molecular weight [26, 27]. The problems inherent to processing highly viscous melts are worsened by the introduction of additives and other compounds that are added to the resin to further improve the mechanical characteristics of the finished article or are necessary to avoid the chemical degradation of the chains by the high temperatures required to process them because of thehigh viscosity [31-34].

The effect of a "shear-refinement" or "melt disentanglement" mechanical pre-treatment results in a reversible substantial decrease of the melt viscosity and of its elasticity that can be controlled by the parameters of the pre-treatment. This melt pre-treatment may represent, therefore, a key solution to the dilemma of processing high viscous melts [27]. This says how much the question whether shear-refinement can be applied practically to linear polymer is an important issue!

In one hand, the paper by Münstedt [1] stated that the results presented for linear polymers in [2] were probably due to artifacts and not to shear-refinement, concluding that only branched polymers can be shear-refined. In the other hand, Ref. [2] summarized the work of several years that detailed new mechanical shear-pre-treatments of *linear* polymers (LLDPE, PC, PS, PMMA etc.) and concluded that the established molecular dynamic explanations of entanglement and visco-elasticity were challenged by these "disentanglement" results. The new mechanical pre-treatments used a combination of shear-thinning and strain softening means under vibration that produced substantially more shear-refinement effects than any previous method ever did. The clear contradiction between these two publications is examined in this communication.

II. Development

a) The misquotes of Münstedt's to disqualify that shear-refinement does not occur in linear polymers

Münstedt qualifies the important criteria to determine the success of a shear-refinement pre-treatment [1]:

"Two types of information are essential for a deeper understanding of the effects of mechanical pretreatments on the rheological behavior. First is the molecular structure of the polymer in its different states of pretreatment. Molar mass, molar mass distribution and branching architecture are the most important quantities. The second type of information relates to rheological properties. These must be well defined and accurately measured."

One of the criteria of success demonstrated by shear-refinement is specifically claimed by a reduction of the melt viscosity after the pre-treatment. This is the 2ndcriteria referred to by Münstedt, "the rheological properties". Yet, the 1stcriteria, "the molar mass... and branching architecture", is also required to qualify whether shear-refinement is real or is due to the degradation of the chains. It is well known that mechanically processed polymer melts at high temperatures, such as in extrusion, are subject to thermal degradation, inducing a reduction of the molecular weight, hence of the viscosity, especially for entangled polymers.

It is clear, therefore, that if a reader is exposed to shear-refinement results and the information is not given concerning the change of molecular weight, or the MWD was not even carried out, the reader should be inclined to disqualify the conclusions drawn from these results. As will be shown below, Münstedt mentioned such arguments in his paper against the credibility of the shear-refinement results for linear polymers [1]. But such quotes were not genuine.

In reality, great details about the procedures used for the shear-refinement experiments appeared in [2]: the equipment, the possible pitfalls, the shortcomings and how to avoid or get rid of them (p. 116-122 section 4.2, section 4.4.2.6, section 4.16 p.113, p. 216, section 4.4.2 "challenging interpretations, p. 211 of [1]).

Additionally, Refs. [2, 3] were both devoted to describe how the 1st criteria elected by Münstedt was made effective: how two Gel Permeation

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Chromatography instruments (GPC by Waters Instruments Inc.) worked around the clock testing all the samples collected, systematically comparing their MWD with the Virgin reference's, for each batch, how the ratio of (Mw/MwRef.)3.4 was used to correct the viscosity results for that same treated sample. Overall, how more than 13,500 samples of linear polymers were "shear-refine-processed" and tested rheologically and their MWD used to correct the viscosity results [2,3].

Münstedt stated in the abstract of [1], summarizing his conclusions, that when the pre-treatment is real and not due to chain degradation, "it is obvious" that the polymer can only be a long chain branched polymer. He therefore asserted, after reviewing the shear-refinement data on linear polymers presented in [2], that their shear-refinement was not conclusive, i.e. that the apparent reduction of viscosity observed was due to either chain degradation or due to artifacts. This rebuttal is written to confront these statements.

In the following we show that some statements backing Münstedt's assertions misquote or misrepresent the work reported in the book by claiming things which are false or become false by intentional omission of the necessary details required to understand the results. The questionable statements are numbered from 1 to 7 and the objected part are underlined and in bold character.

1. *A commercial LLDPE (ethylene/octene elastomer with Mw=170 kg/mol and Mn=90 kg/mol) was subjected to a strong mechanical pretreatment in the sophisticated device described in [14]. A decrease of Mw was mentioned, but data were not reported.*

   Rebuttal: book Ch. 2, Table 2.1, 3rdrow " LLDPE". The Table parameters regarding molecular degradation are described at p. 26. This table provides the MFI of the untreated and of the pre-treated samples and it is explained that the raw MFI value is corrected for the effect of molecular weight degradation (2 to 5% at p. 26) to obtain the "flow improvement" value, the excess viscosity improvement not due to degradation (the part due to "shear-refinement"). The same type of results are discussed for Polycarbonate at Table 4.1 p. 238 with the note below the Table explaining how GPC measurements before and after the treatment permit to determine the MFI correction due to chain degradation. Additionally, Münstedt was sent by email the GPC curves for LLDPE before and after the pre-treatment [3].
2. In Appendix B of [1]: Polymethylmethacrylate *Modifications of another linear polymer exposed to intensive mechanical pretreatments are described in [14]. For a PMMA random copolymer of 95 % methylmethacrylate and 5 % ethylacrylate with M_w=78 kg/mol and M_n=40 kg/mol, a decrease of the viscosity measured in a dynamic-mechanical experiment after mechanical pretreatment in a special extrusion device was observed. At a first glance, this result might be explained by a thermomechanically induced degradation of the PMMA that would reduce viscosity. It was reported, however, that the initial viscosity curve was approached again when the material was annealed for 24 h at 215°C. This reversibility is taken as an argument for the existence of a pretreatment effect and the absence of a molar mass reduction, which would be, of course, irreversible. However, an analysis of the molecular structure was not carried out.*

   Rebuttal: Ch. 2, Table 2.1 row 5 ("PMMA"): The MFI flow improvement AFTER GPC correction for the change of M_w for this PMMA grade (MFI=17) is 117% . The % degradation of Mw is at p. 26 : "Yet, the molecular weight was hardly changed(~3%) to justify the viscosity reduction(117%)…". Also lines 1-11 at p. 212, for PMMA ("degradation was between 1 -5% depending on the extent of disentanglement obtained).
3. In Appendix B of [1]: Polycarbonate and polystyrene *Polystyrene and polycarbonate are two other linear polymeric materials, which have been discussed in [14]. They were mechanically pretreated in the sophisticated extrusion device described there or by oscillations at high amplitudes in plate-plate geometries. For the two polymers, pretreatment effects have been reported. They were interpreted by a model based on a new theory of polymer physics postulated in [14]. The results have to be considered with some reservation insofar as comparable studies on polycarbonate and polystyrene have not been published in the literature up to now. Furthermore, two questions related to the performance of the experiments would need to be addressed in more detail. The one concerns an undisturbed flow field at the high amplitudes or shear rates used in the plate-plate geometry as discussed in Appendix A. This topic is only tackled indirectly by making use of theoretical considerations from the literature, but direct visual observations of the sample geometry are not shown. The other point is the lack of a convincing molecular analysis in order to demonstrate that the molar mass distribution remained the same during the various steps of pretreatment and recovery of the samples.*

   Rebuttal: For PS and PC, see Table 2.1 p. 27: row 5 for PMMA, row 1 for PC. The MFI flow improvement AFTER GPC correction for the change of M_w is 75% for PC for this PC grade (MFI=12), and 50% for PS. The MWD obtained by GPC before and after treatment is shown in Fig. 4.6 at p. 213 and discussed in p. 212. Table 4.1 at p. 238 gives the % flow increase for several treated PC samples and defines how to calculate the % flow improvement (shear-refinement) from GPC results.

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4. at p. 21 of [1]: *For example, comparing the frequencies and amplitudes chosen in [14] for measurements on PS, which are discussed in Appendix B, with the results in [45], it is evident that edge fracture and its recovery must be considered as sources for the rheological behavior observed, and, thus, any conclusions with respect to effects of mechanical pretreatment and their recovery may be drawn with particular care. No visual observations have been reported to show that geometrical disturbances did not occur during the experiments.*

   Rebuttal: 1. the experiments of [45] by Friedrich are discussed in the book in Ch. 4 (they are refs 60, 61 of ch.4). "Edge fracture explanation" at section 4.4.2.6., p. 216. Also Melt Fracture in parallel plate experiments is covered in section 4.16, at p. 113.

5. at p. 21 of [1] (continued):*These results demonstrate that plate-plate rheometry may not be a suitable method for studies of the effect of a mechanical pretreatment on rheological properties. To exclude geometrical artefacts during oscillatory experiments or measurements at constant shear rates, visual observations are necessary, which are not easy to perform.*

   Rebuttal: All the possible challenging explanations for the shear-refinements results of the book are discussed in section 4.4.2 p. 211 sq.

The best way to prove that artifacts are not involved during oscillatory experiments or measurements at constant shear rate in plate plate geometry is not a visual observation of the surface (which is ,indeed, "not easy to perform" and, besides, turns out to be non conclusive). The best proof is to compare the plate-plate rheological results of viscosity, which are "simulation experiments" results in a rheometer, with the "real" experiments viscosity results on the same sample using the same conditions (with the exception of the extrusion shear rate which is experimentally added but remains constant). This difference between real experiments and simulated experiments in the lab is not acknowledged by Münstedt who does the amalgam, as developed below, and this results in false conclusions. In"real" experiments, the viscosity is measured in the processing chamber designed to separately perform the pre-shearing treatment, and it is measured by an in-line viscometer located at the exit of the melt. In the case of real experiments, the continuous flow of the polymer in a confined gap occurs without edge fracture problems. Additionally, means are added to avoid melt slippage, ensuring a very smooth melt. Therefore, when the effect of frequency and strain amplitude trigger the same rheological response in both the simulated and the real experiments (section 2.2 , p. 22-25, Figs. 2.1 to 2.6 and section 4.1.5.2 p.100 and Fig. 4.5), this is the best proof that the melt instability effect is real. In addition, the pellets obtained by granulation of the frozen strands exiting the die can be measured rheologically under conditions of linear viscoelastic behavior, like for untreated pellets, and the recovery of the viscosity for the treated samples can be spectacularly observed in a plate-plate rheometer, with no possible artifact reasons attributed to the viscosity increase (Figs. 4.33, 4.50, 4.55 etc.)

6. at p. 21 of [1] (continued):*In any case, a broader experimental base of studies by several authors, which should be comparable to each other, is required for answering the question whether a mechanical pretreatment effect may occur for the linear polycarbonate or polystyrene in contrast to the results on the linear polypropylene reported above and those on linear polyethylenes from the literature.*

   Rebuttal: Why compare polycarbonate and polystyrene with polypropylene to validate the results obtained for PC and PS?. Each polymer has its own Rheo-Fluidification specifics. The obvious difference is their polarizability, polyolefins being non polar. The pre-treatment mechanical history parameters must account for the distinct response of different polymers to a shear-deformation to induce the melt instability. This is the know-how of the process.

   Indeed, "*a broader experimental base of studies by several authors…*" is desirable, but this will happen when reviews such as the one by influential scientists will cease denying the reality of the facts. The spread of tendentious opinions does not incite the financing of such important experimental work for the industry. See the section below:"The relunctance to change paradigms".

   Besides, the "disentanglement" experimental work that is summarized in the book has been validated and published by several teams of academics around China, including at the State Key Laboratory of Polymer Materials Engineering, College of Polymer Science and Engineering, Chengdu, Sichuan University [44, 45-48].

b) The confusion generated by amalgamating the different sorts of mechanical pre-treatments

There are several types of "pre-treatments" reported in the book [2], although Münstedt, in his review of the literature [1], does not mention this distinction. Yet, these different procedures to "treat the melt" are of critical importance to conclude whether the results are validating the presence of shear-refinement or are artifacts.

i. *The "real" treatments.*

These are the treatments that are applied via an extruder, a twin-screw, or the machinery that is described in [2] that Münstedt reports in such terms: " *Commercial products were subjected to intensive*

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mechanical deformations combining shear, elongation and even oscillations in an especially designed extrusion device". This device is named a "Rheo-Fluidizer" ([2], Ch. 2, Ch. 4 p. 101, [27]). Another shear-refinement pre-treatment device is the "Rheo-Plast", designed by Agassant and co-workers of CEMEF [41] and applied by Bourrigaud in his thesis [42]. The corresponding paper is quoted by Münstedt (Ref. 39 of [1]). Interestingly, the Rheo-Plast has been used by Agassant [41] to obtain significant shear-refinement improvements for a linear Polyvinyl chloride (PVC), although this result, not discussed by Münstedt, appears to be in contradiction with his own conclusions.

The common feature of all these pre-treatment equipments is that the melt is treated ahead and/or separately of/from the processing unit that exits the melt, allowing to measure the melt viscosity both in the pre-treatment processing unit and via an on-line viscometer positioned at the exit. The meltcan also exit the pre-treatment processing unit through an exit die to create strands that are water quenched and pelletized. Subsequently the pellets can be studied to measure their molecular structure and their rheological properties. In all of these "real" treatments of the melt, the melt is confined in a circular gap with no edge effect. The melt is either extruded while being cross-sheared in the direction perpendicular to the flow axis, or it is simply cross-sheared by rotation of the bob inside the barrel, but not extruded through, alike in a Couette type of rheometer geometry.

The distinctive feature between all the equipment described in the literature as "Shear-Refinement equipment" and the "Rheo-Fluidification" processors reported in [2, 36-40]is the use of melt vibration means to modify the melt rheological properties in addition to the traditional shear and pressure means [27]. This distinctive feature is critical to obtain the melt instability results that are described in the book and in many other communications (Ref. [15] of Ch.2 of [2] provides a list).

ii. *The "simulation" treatments*

These pre-treatments are done in a laboratory rheometer using the plate-plate or the cone-plate configuration. The melt is gently squeezed between the two circular plates but is not confined, presenting an open surface at the rim of the disk. This work is called a "simulation treatment" because it does not reproduce the real treatment conditions of the confined treated melts which don't have edge effects problems. However, even if the variation of the frequency and of the strain amplitude must be restricted to the range whether no melt fracture occurs at the edge, the "simulation experiments" provide important rheological results that are validated when those compare well with the rheological behavior observed for the "real" experiments that they are supposed to simulate.

iii. *The crucial difference between "in-line disentanglement" and "in-pellet disentanglement"*

Ref. [2] emphasizes a great deal the difference between these two types of pre-treatment achievements. The degree of difficulty in achieving one or the other is really crucial for its industrial impact but Münstedt simply ignored this issue.

The conclusions of the "disentanglement" work (Chs. 2,7, 8 of [2]) can be simplified and summarized as follows:

- It is straightforward to achieve for linear polymers huge "disentanglement" benefits (thousand percent decrease of viscosity etc.) when using Rheo-Fluidizers as on-line melt pre-treatment devices. The Rheo-Fluidizer chamber must be positioned ahead of the application requiring the feed of a molten "disentangled" melt. Pressure decrease, temperature decrease, torque decrease are spectacularly lower for all the polymers experimented with (about adozen), as reported in [2]. The optimum conditions are easy to find. Because of the use of much lower temperature to process melt under Rheo-Fluidification condition (e.g. for PC. 235°C instead of 315°C), thermal degradation is also reduced compared to normal extrusion. The results can be understood by considerations of shear-thinning and strain softening expressed in terms of the Dual-Phase model (Ch.5 of [2]).
- To have achieved substantial "in-pellet disentanglement" for at least 5 polymers (Table 2.1 of [2]) was much more challenging to do. Its theoretical implication, as suggested in the book, necessitates a change of paradigm in understanding the physics of interactions in polymers. This is why the "in-pellet disentanglement" results, designated "sustained-Orientation", are exposed in the first chapter of the book after the Preamble: "*Trouble with Polymer Physics: Sustained-Orientation. Ground-Breaking Experimental Research Shakes the Current Understanding of the Liquid State of Polymers*" (p. 21-30).

Münstedt, makes an amagalm of the pre-treatments results, whether produced by a real treatment or a simulated treatment, whether it is an in-line disentanglement or an in-pellet disentanglement achievement, and this confusion is unacceptable to assess (and disqualify) the ability of linear polymers to shear-refine.

7. At p.*23* of [1],: *The ability to reversibly modify LLDPE by a mechanical pretreatment was claimed to be supported by the following experiment using plate-plate geometry [14]. After an oscillation at the angular frequency of* ω*=0.1 rad/s and the strain amplitude of* $\gamma 0$*=1% in the linear regime, the amplitude was stepwise increased up to an amplitude of 25 % at a frequency of 47 rad/s. Due to its frequency*

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dependence, the viscosity decreased by a factor of six and went down further by a factor of two during the 25 min of high amplitude oscillations. Then using the initial linear conditions again, the viscosity rose and regained its starting plateau after about 10 min. This behavior was interpreted as a recoverable shear modification of the LLDPE at the amplitudes and the frequency in the nonlinear regime. These conclusions have to be considered, however, with some reservation in the light of Appendix A, where the results of other authors have been discussed, who performed similar experiments in plate-plate rheometers and reported a decrease of the complex moduli with time at high amplitudes for PP [44] and PS [45] but showed that this behavior was accompanied by sample fracture during the experiment.

8. *Rebuttal:* The plate-plate dynamic experiments reported above on LLDPE (Engage 8180 of Dupont-Dow Elastomers) are taken from Figs. 4.28 and 4.29 of [2]. They are actually repeats done in the laboratory of L.A. Utracki in Montreal (IMI, Boucherville, CA) of tests conducted a few years before that at McGill University with a PhD student of J. Dealy, under his supervision. They represent "simulation" experiments done with a plate-plate dynamic rheometer. Other simulation experiments were done on this LLDPE: pure viscometry tests reported in Fig. 4.2, 4.15 to 4.22 of [2], and viscometry followed by frequency tests in Figs. 4.23 to 4.25 of [2]. All these simulation experiments concur with the triggering of the time dependence of the viscosity but they do not, indeed, say that plate-plate geometry does not influence the results observed. One could say that the level of confidence that the time-dependence of viscosity triggered by a modulated strain increase (Fig. 4.28 b of [2]) was real and not caused by an artifact was around 90% at the time. A few years later, to raise the level of confidence to 100%, the 1st Rheo-Fluidizer processor was designed and built [26, 27, Ch. 2 of [2]]. The same LLDPE resin used earlier at McGill and IMI was treated in the Rheo-Fluidizing processor to produce all kinds of pre-treatments: in-line disentanglement: Figs. 4.6, 4.26 of [2], or in-pellets disentanglement (Ch. 2, Table 2.1 of [2]). These "real" experiments provided rheological results (Figs. 4.7 a and b of [2]) qualitatively identical to those obtained by the plate-plate "simulated" experiments, either by pure viscometry or by dynamic rheometry. In summary, Münstedt draws an objectionable conclusion by comparing the work of others ([44], [45]) who are using different materials than LLDPE, and by not comparing plate-plate "simulations" and "real experiments" reported in dozens of figures for this polymer in the book.

c) Misrepresentation by omission

Something is certain that is not reported by Münstedt, although it is a critical part of the book: the time dependence of viscosity triggered by an increase of the shear strain occurs above a critical strain that is rather small (25% to 50%) and not like the 300% strain quoted by Münstedt that causes the fracture of the melt that is wrongly compared to our results in his Appendix A. Besides, and it is fundamental to say this, the time dependence of viscosity triggered under shear-thinning conditions at low critical strain is observed for both confined melts, even while being extruded, and for melts studied in a plate-plate open edge rheometer. Even if edge effects would induce the time dependence seen in the open edge experiment, this could not be the reason for the shear-induced time dependence when there is no edge! Furthermore, the pellets granulated after the melt viscosity has been reduced by the pre-treatment exhibit a melt flow index that is totally correlated to the pre-treatment viscosity value measured in the Rheo-Fluidizing processing unit (see Figs. 2.6, p.25, 4.9 p. 120, and 4.74 p. 231 in [2]). This was not an anecdotic phenomenon: Ref. [2] reports that 150 lbs lots of "disentangled" polycarbonate and of PMMA were produced and distributed to the large resin manufacturing companies of the world (in Germany, US, Japan and France) who endorsed the results and signed license agreements. Omitting to report this essential evidence appears to insinuate that no one has been able to repeat the work of "disentanglement" described in the book.

By calling "shear-refinement" the "disentanglement" work published in [2], Münstedt omitted to explain, even in a few lines, the basic principles behind "Rheo-Fluidification" and how it differentiated with the prior art, precisely with shear-refinement, making the comparison between the respective results objectable in his paper[1].

In Rheo-Fluidification, unlike in any previous practice of shear-refinement, the shear rate is the vector combination of 3 shear rates that can be controlled independently: a pressure flow shear rate controlled by the extrusion parameters, a cross-lateral shear rate controlled by the RPM of the core shaft inside the treatment chamber, and, superposed onto this cross-lateral shear-rate, a shear rate due to the vibration of the melt in the gap by means that control its frequency and amplitude. The objective of Rheo-Fluidification is to impose to the melt a specific rheological treatment composed of a mix of shear-thinning and strain softening to induce the temporary instability of the rheology of the interactions that create the melt cohesion(from which derive its visco-elastic properties, e.g. the G' and G" components of the modulus).

These specific hybrid shear-thinning/ strain softening mechanical treatments have never been applied by the prior art to polymer melts, neither as pre-

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treatments or during processing. While many problems subsist to improve the efficiency of the Rheo-Fluidizing processes (Ch. 8 of [2]), what has become unquestionable is their ability to substantially reduce the in-line processing parameters when processing those melts, allowing, for instance, to work at either much lower torque (2 to 10 times less), lower temperature (-50 to -100 oC less) or under much lower pressures for the same throughput. Ref. [2] describes these important benefits to processors as the "in-line Rheo-Fluidification benefits". Questioning those results, as it is hinted explicitly or implicitly in Ref. [1], by saying that they should be taken with some caution because they probably are due to degradation, or because the author did not mention or measure the molecular characteristics of the treated melt, is deceptively wrong.

Münstedt omits to mention that the book provides a full assessment of shear-refinement (section 4.1.5.2.3 p. 110-116) and that it addresses the classically admitted argument (revived in his article) that Shear-Refinement only works for branched polymers, being useless for linear polymers, a restriction that has limited the range of applications and the spread of this technology.

Münstedt, omits to mention:

- That Rheo-Fluidification intentionally experimented with a variation of Shear-Refinement because it combines, under vibration, shear-thinning and strain softening effects on the melt to induce a temporary state of rheological instability.
- That this non-equilibrium state of the melt could be controlled by changing the rheological parameters in the Rheo-Fluidizing processor.
- That the Rheo-Fluidified melt could be extruded to provide pellets presenting controlled higher melt flow indexes (MFI) or that it could be placed ahead of a classical processing operation such as an extrusion or an injection molding.
- That the temporary rheological instability of the melt could be obtained with either linear or branched polymers.

d) Münstedt 's Critical Condition that Branching must be Present to Observe Shear-Refinement is Wrong

In the book [2], we introduce new equations to analyze the rheology of melts (shear-thinning, strain-softening) in terms of the Dual-Phase model and show that they also explain the origin of the rheological instability. The long term retention of the lower viscosity in the Rheo-fluidified pellets when re-heated to a melt state, sometimes for times several hundred thousand times greater than the reptation time at that temperature, represents an immense challenge to the currently admitted models of chain dynamics such as reptation. This challenge is not acknowledged by the community of rheologists, except swept away as artifact, such as in the paper by Münstedt. However, how could this be an artifact when we did produce several lots of 150 lbs of sustained-oriented pellets, the product of the "artifact", which could regain in time their original viscosity after re-melting!

The "Sustained Orientation" paradox is linked to a new concept: the instability of the Dual-Phase of the interactions (Ch. 2 of [2]). A first degree instability can be induced by a combination of shear-thinning and strain softening that may result in shear-refinement effects. Sustained-Orientation requires certain conditions in addition to the 1st degree instability criteria to trigger an instability of the 2nd kind: the instability of the entanglement structure.

It is shown that there are two types of sources to trigger the rheological instabilities of polymer melts: one is controlled by the recoverable dynamic free volume variations, the other by the modification of the entanglement network structure, by entropic dissipation (orientation of the network). This dilemma between which mechanism of instability dominates for a given polymer is the true debate to have regarding the shear-refinement results. For instance, the Dual-Phase model of the interactions (Ch. 1 of [2]) explains the dynamic source of the free volume (the F-conformers)which is also influenced by the topology of the chains, in particular whether long chain branching, short chain branching or no branching is present. Both the amount and the structure of the dynamic free volume is influenced by branching. But the dynamic free volume is also influenced by other rheological factors: the orientation of the chains, the frequency and the amplitude of a vibration of the coherent interactive medium, the pressure in the melt, etc. All these parameters influence the local density of the melt and the frequency of the elastic dissipative wave that compensates for the local packing density in-homogeneity between the b and F conformers. In turn, they also influence the melt modulus (the famous $G = \rho RT/M$ correlation), and thus influence shear-thinning and strain softening. Münstedt focuses on the presence of the long chain branches to determine a criteria for shear-refinement [1]. This focus is lacking crucial information which are not given by the molecular models: 1.the determination of the local packing density and of the location of the free volume in the structure, and 2. the influence of branching on these two variables. The Dual-Phase model is easily applicable to this situation because of the cross-duality between the F/b dissipative states and the conformational states (trans, cis, gauche). This [(F/b) ←-→ (c,g,t)] cross-duality also predicts the influence of vibration, shear rate and shear strain on the free volume amount and its distribution, in particular how to increase it, whether the basic polymer is branched or linear. Therefore, the topological criteria by Münstedt that branching must be present to observe the conditions for shear-refinement is simply wrong. The

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correlation must be established with the amount and structure of the dynamic free volume instead.

e) The question and the reluctance of the need to change Paradigms

Admittedly, the apparent disagreement between two scientists on the interpretation of shear-refinement, whether the polymer chains must be branched or can be linear, only touches the visible part of the iceberg. In fact, the real controversy was not about shear-refinement, it was about the need to change paradigm to understand all aspects of visco-elasticity, including shear-refinement. If shear-refinement benefits do apply to linear chain polymers, is our current understanding of the physics of polymers, specifically the concept of entanglement, in default? If the current dynamic molecular models of rheology are incomplete to explain certain linear and non-linear rheological experiments of polymer melts (Chs. 6 and 7 of [2]), should we not change paradigm to explain interactions in polymers?

During the ten years of persistent and systematic experimental validation of the evidence regarding "sustained-orientation" that was revealed through publications at annual APS and SPE meetings [4-25] and in patent letters [26-34], it became apparent that these results appeared to conflict with the established models of melt deformation. This made this author decide to endorse a full academic career to concentrate on the understanding of "sustained-orientation" and "entanglements". The book in Ref. [2] is the first result from that effort (Ch. 8). More publications are in the works ([51. 52]).

f) A few words about the new Paradigm

In our view, "conformers", the constituents of the macromolecules, gather into statistical systems which go beyond belonging to individual macromolecules. A conformer is shown in Figure 1.1 of Ch. 1 of [2]. The macromolecules themselves represent a chain of "covalent conformers" put together as an entity. The problem is to determine whether the chain properties, derived from its statistics, control entirely the dynamics of the collection of chains making up a polymer. This is what has been assumed by all the other theories, and this is what the Dual-Split kinetics and the Grain-Field statistics challenge.

Also in our model of interactions, the Free energy of the collection of chains assembled as a polymer is not equal to the scaled-up Free energy of a macromolecule embedded in a mean field created by the influence of the other macromolecules. This is particularly true below the temperature T_{LL} (see below), which itself is function of the dynamics of the experiment and the chain characteristics. In fact, for many experimental conditions, depending on temperature and other factors, our model of polymer interactions does not require, in its hypotheses and derivations, a description of the changes which occur to the individual macromolecules (like its rms end-to-end distance). The dynamic statistical systems dealt with to determine the Free energy and its structure (Enthalpy and Entropy), are not the macromolecules in our approach. However, the fact that macromolecules compose the basic structure is essential, for instance to understand the basis of our new Dual-Phase statistics and to explain "entanglements", for which our model provides a completely different interpretation than the ones offered by the conventional spaghetti bowl or tube models [Ch.1 of [2]].

A "covalent conformer" is not the same as a "free conformer", often seen as the three-bond element constituting the mer in the polymerization process. Its interaction to other conformers by covalent bonding modifies the conformational potential energyof a free conformer, and this governs the statistical properties of a "free chain". Here we are still "classical", yet when dealing with a collection of chains put together, our approach differs from the classical one. Conformers belong to two types of sets: they belong to macromolecules, which link them via covalent forces, as we just said, and they belong to the grand ensemble of conformers which are linked by inter-intra molecular forces, van der Waals, dipole-dipole, and electrostatic interactions which affect and define the viscous medium. That duality is intrinsic to conformers, which are thus called "the dual-conformers" to mark this specificity. The potential energy of a dual-conformer is different from the potential energy of a conformer part of a free chain.

To simplify, one could view the difference between our statistical model and the classical model to describe the properties of polymers as follows: according to the classical views, the statistical systems are the macromolecules, i.e. a network of chains; the properties of the chains are disturbed by the presence of other chains and by the external conditions (temperature, stress tensor, electrical field, etc.). The classical definition of the statistical system contrasts with our approach whereby the statistical systems are the "dual-conformers", not the macromolecules. The interactive coupling between the dual-conformers is defined by a new statistics, the Grain-Field Statistics, that explores the correlation between the local conformational property of the dual-conformers and their collective behavior as a dissipative network (we designate below the dual-conformers "conformers", to simplify).

The statistics that are used by the classical models and by our model to describe the RIS (rotational isomeric states) of the conformers are fundamentally different: the classical molecular dynamic statistics is the Boltzmann statistics, famous for its kinetic formulation of the properties of gases. The Dual-Split or Dual-Phase statistics, leading to the Grain-Field Statistics, is inspired by the classical Boltzmann concept

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but departs from it by defining a dissipative term in the RIS equations and assuming that the Free Energy remains always equal to its minimum value, that of the equilibrium state, even for transient states. The dynamics created by such changes in the fundamental equations result in the formation of a collective modulation responsible in rheology for the "the elastic dissipative wave" to compensate for the local dynamic free volume difference between the F and b conformers (Ch. 1 of [2]).

In our analytical formulation of the dynamics of these "open dissipative systems of interactions" generated by our two modifications of the classical formula, we realized that essentially two mechanisms of structuration of the Free Energy prevailed and competed: a "vertical structuring" and a "horizontal" structuring", each specifically applying its own version of the basic equations. This distinction increased the complexity of the analytical solution but was, in our opinion, a fundamental aspect of the way interactions worked. The vertical structuring refered to a split of the units (collectively interacting in the system) into 2 compensating sub-systems having each a different statistical partition. The horizontal structuring, also called "cloning", offered a different split of the collective set, via the generation of Ns identical sub-systems, each with the same statistical partition. Each split mechanism generated a dissipative function. The total dissipative function ought to be minimized (it is 0 at stable equilibrium), a condition that created their mode of compensation, i.e. whether they worked independently, in sequence or simultaneously.

These general principles can be applied to describe the rheology (linear and non-linear) of polymer melts, define the entanglement network and quantify its stability.

g) The T_{LL} transition

The details of the simulations performed using the Grain-Field model of polymer interactions shows the existence of a temperature, that we associate with T_{LL}, where the collective modulation of the local interactions between conformers by the open dissipative network collapses. A recent two-parts article [43] explores the properties of T_{LL} when it is defined in such a manner. It is shown that T_{LL} plays a crucial role in deciding whether and when the Boltzmann's statistical theory is allowed to be used to determine the status of the interactions when a stress or a voltage field is applied [43]. T_{LL} appears as the temperature of transition between these two assessments of the interactions: below T_{LL}, the collective dissipative aspect of the interactions dominates, i.e. the statistical systems of interactions are open dynamic systems that are not the macromolecules, and the energy of the interactions as a whole modulates the local conformational states: the Boltzmann's statistics does not apply. Above T_{LL}, however, the collective modulation collapses, the statistical systems are no longer dissipative and the Grain-Field statistics becomes the Boltzmann's statistics. The macromolecular chains could now be considered as Boltzmann's statistical interacting systems, as an alternative option to the Grain-Field statistics (that continues to be valid, though, even if it is no longer dissipative).

In our conclusions, this is a key issue: the currently established theoretical models of the interactions in polymers are based on "chain dynamics" statistics. In rheology, for instance, the Rouse and reptation models explain most of the behavior for $M < Mc$ and $M > Mc$, respectively. But these models fail to explain "Sustained-Orientation" and "T_{LL}" and other non-linear properties of polymers (Chs. 6 and 7 of [2]). The reason for this partial success of the classical models can be explained by the Grain-Field Statistics of the interactions which, as we just said, remains valid at all temperatures across T_{LL}, yet stops being dissipative and becomes coherent with the classical statistics used by the molecular dynamic models when $T > T_{LL}$. Consequently, the application of macromolecular (chain) dynamic models can only be justified for conditions of use of the material that position its temperature above the T_{LL} transition ($T > T_{LL}$). The problem is that the existence of T_{LL} is not even recognized by these molecular dynamic models. Below T_{LL}, the free energy of the collection of chains assembled as a polymer is not equal to the scaled-up free energy of a macromolecule embedded in a mean field created by the influence of the other macromolecules. Besides, the temperature T_{LL} is itself a function of the dynamics of the experiment and the chain characteristics.

If one tests the predictions of the classical approach under conditions that bring its state above T_{LL}, one may conclude that those data validate the classical views since they provide correct answers in the range tested. This is not an easy task, because T_{LL} is rate dependent, pressure and shear dependent and molecular weight dependent [43]. Thus, although one will find in the literature convincing experimental evidence of success for the classical models, which is the reason for their acceptance, we claim that these successes are due to the use of conditions that bring the state of the polymer above its T_{LL} transition. We have suggested abandoning the molecular dynamic interpretations of the behavior of polymer melts because of their lack of general applicability (Ch. 8 of [2], [51, 52]).

III. Conclusion

We show in this paper that Münstedt[1] has not been genuine in his quotations of our work [2] by incorrectly reporting the results and the procedures, by

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muting important details, and by making amalgams between different types of experiments to draw wrong conclusions that mislead more than inform the reader about the content of the work and its importance for polymer science and technology. The excuse that no one else has been carrying out similar experiments to be able to prove it or disprove it is wrong: many reputable academic institutions in China have duplicated our entanglement instability work reported in [2] and elsewhere [4-40], validating our results in recent publications [44-50].

We have addressed the following subjects and reported their importance in our publications:

- There is no good reason to doubt and attempt to disqualify the results on the shear-induced melt instability of linear polymers (designated "disentanglement" in Ch. 4 of [2]). Münstedt misquotes were corrected and their implications refuted.
- Münstedt used the classical topological description of long chain branched (LCB) polymers to support his opinion that linear chain polymers cannot qualify to successfully induce shear-refinement effects. We argued that although LCBs and linear chains are architecturally different, the true cause for shear-refinement must be found elsewhere, and we pointed to the dynamic free volume as one of the causes of the melt instability triggering a reduction of viscosity. LCB polymers have inherently more dynamic free volume than the linear polymers, but both architectures can support a substantial enhancement by melt Rheo-Fluidizing manipulation, not just the LCB type. The dynamic free volume is quantified by the Grain-Field Statistics model of the interactions but not by the molecular dynamic models.
- The reluctance to accept the "melt instability" experimental results by Münstedt was perhaps motivated by the lack of molecular dynamic models' arguments to comprehend these results (Chs. 6, 7 of [2]).
- The discovery of the instability of the entanglement network triggers the necessity to understand entanglements differently (Ch. 1, 2 of [2]).
- The debate brought by Münstedt whether linear polymers can trigger shear-refinement or not was the tip of the iceberg. The real debate concerns the validation of the Sustained-Orientation experiments and its impact to understand interactions in polymers, whether the macromolecules are themselves the statistical systems of interaction, the current view, or the source of a modification of a new statistics that renders dissipative the classical Boltzmann's formalism.

A recent review of our introductory book on the physics of polymer interactions has just been published by T. J. Hutley [53].This reviewer ends his review as follows:

"*The broader and more extensive industrial implementation of disentanglement technology might be hindered by the complete paradigm shift introduced here. It requires a re-boot of the thinking of polymer engineering and the design of polymer processing equipment, which have all developed based upon an earlier rigid paradigm that polymers are necessarily high viscosity fluids.*

The reviewer believes that achieving disentangled polymer melts is a new disruptive technology that could reconfigure the polymer industry value chain, and bring brand new economic and environmental (lower energy consumption) benefits. Bold engineers who can imagine the potential of what is described in this book will be on a path, along which few have travelled….."

While it is, indeed, crucial that scientists doubt the results of others and it is, of course, acceptable to disagree with someone else 's conclusions, the practice of deception, even subtly introduced, to refute what one disagrees with should remain a red line that is never crossed.

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Normative Model of Global History

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Abstract- The global (geo)political system is determined. The first, elementary interpretation of the concept of freedom and its calculus is introduced. Two global metahistorical goals of the realms of freedom and necessity have been identified. The basic aspects of modeling history, right and left in politics, tradition, innovation, progress are determined. The concept of an “actor” (a player, a decision-maker) is formulated. The formulation of the moral code of actors is given. The inevitability of actors' awareness of the choice between the realms of freedom and necessity is discussed, which leads to a second, deeper interpretation of the concept of freedom. The space and time of actors are discussed, and the relevant aspects of the transition between two target sets of actors are listed. The content of ethics is determined, providing a return to the realm of freedom and necessity. Metaethics of the outcome of choice — the third interpretation of the category of freedom.

Keywords: global political system, patom, geopatom, actor, freedom, functionality of freedom, realm of freedom and necessity, actor ethics, choice, rational discourse, irrational intuition.

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- ✓ History teaches one thing — it teaches nothing.
- ✓ Everything is possible. Everything is allowed.
- ✓ There is no time, nothing happens.

I. Introduction

By the term "normative" we mean the existence of some external, fully informed and disinterested observer in the historical process. The normative model of history is built from the point of view of just such an observer. Note that this is not only some methodological preset. Looking ahead, we note that the presence of an external observer, from the point of view of which history is modeled, makes it possible to build a single, global historical space and time. If we follow Hegel [1], then, in essence, the external observer is an "absolute idea" or "world spirit". Previously, this mathematical model of global history was published in Russian [2,3].

Consider the global political system, a schematic view of which is shown in Figure 1. Let's formally represent it as a set of some atoms, which we will further call patoms (short for Political ATOM). We need a patom only to the extent that it is indivisible and indestructible.

Let's give the concept of "patom" a concrete content. Since we are interested in describing phenomena of a global scale, it is natural to consider under the patom, first of all, large political and territorial formations. This approach is typical in general for such disciplines as political geography and geopolitics. In connection with the chosen interpretation, it is natural to call a patom a "geopatom" (short for GEO Political ATOM). It should be noted that the choice of a geopatom as a patom makes it possible to maximize the scope of the studied historical interval, during which the patom can be considered indivisible and indestructible.

Depending on the goals of modeling certain aspects of history, it may turn out that the set of patoms is not limited to geopatoms. In this case, nothing prevents us from identifying other patoms comparable in importance and scale to geopatoms and also responsible for world political dynamics. For example, religious, ethnic, ideological and other factors can be "atomized" and introduced into the general set of patoms of the global political system. In this regard, one of the main tasks of modeling will be to identify the necessary and sufficient set of patoms to describe the world historical dynamics. In the future, we proceed from the hypothesis that this set is limited to geopatoms. At the same time, the state structure of the political system is considered secondary in relation to geopatoms, which are primary.

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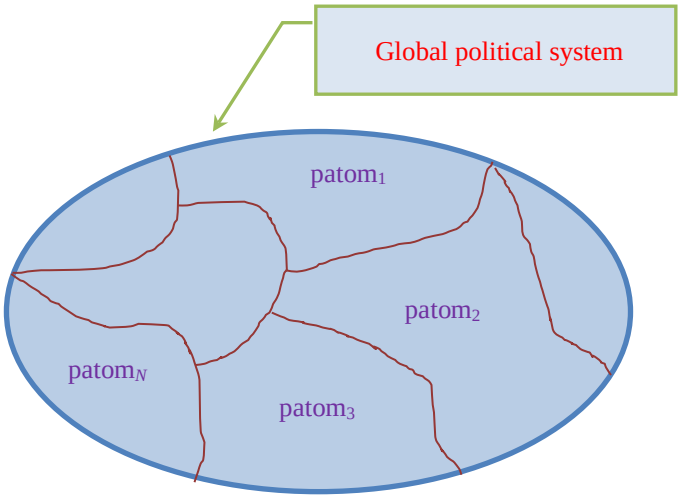


Figure 1: Abstract image of the global political system, consisting of a set of patoms

Figure 2 shows the modern global political system from the point of view of a set of individual states acting as geopatoms. Due to the fact that states can arise (for example, modern Israel was formed in 1948) and disintegrate (for example, the collapse of the USSR occurred in 1991), their dynamics sets the time dimensions during which geopatoms-states can be considered indivisible and indestructible.

What can we say about the number of geopatoms? What is their internal difference? Some of the answers to these questions are given by political geography [4] and geopolitics [5,6]. For us at this stage, it is only important that there is some finite number of them *N*. So, let the political system contain *N* geopatoms. We assign them the number 1,2,…, *N* and introduce the set $I = \{1,2,\ldots,N\}$. We will assume that geopatoms can enter into various alliances: bi-, tripartite, etc.

An arbitrary union s is a subset of the set I, i.e. $s \in I$, $s = (i_1,\ldots,i_n)$, where $i_1,\ldots,i_n$ — numbers of geopatoms, while they are pairwise different and their order is not significant. An arbitrary union *s* is also an element of the set 2^I, which is the set of all subsets of the set *I*, i.e. $s \in 2^I$. Let us define the rank of an arbitrary union *s* in the following form: rank(*s*) = *n*, when $s = (i_1,\ldots,i_n)$, i.e. the function rank(*s*) is simply the number of geopatoms participating in its formation. The rank(*s*) value can vary from 1 to *N*, while rank(*s*) = 1 for those unions that consist of one geopatoms. Thus, by definition, a geopatom is considered to enter into a one-sided alliance with himself.

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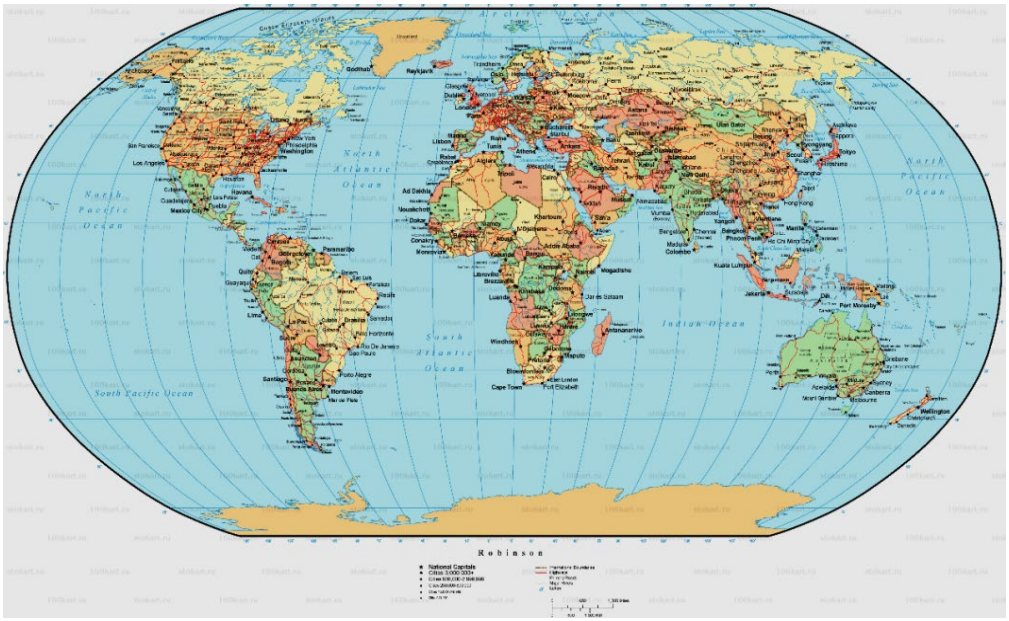


Figure 2: A specific image of the global geopolitical system, consisting of set of geopatoms-states

The set of all possible unions of rank *n* is denoted by S_n, i.e., $S_n = \{s \in 2^I : \mathrm{rank}(s) = n\}$. The cardinality of a set, or the number of elements included in it, will be denoted by the symbol $||\ldots||$. Thus, the cardinality of the set S_n is C_N^n, i.e. $\| S_n \| = C_N^n$, where C_N^n is the number of combinations from *N* to *n* ($C_N^n = \frac{N!}{n!(N-n)!}$, $n! = 1 \cdot 2 \cdot \ldots \cdot n$). The set of unions of rank $n \geq 2$ will be denoted by the symbol *S*, i.e. $S = \{s \in 2^I : \mathrm{rank}(s) \geq 2\}$. Since $S = \bigcup_{n=2}^{N} S_n$, one can find that $\| S \| = \sum_{n=2}^{N} C_N^n = 2^N - N - 1$.

Let us introduce the concept of *geopolitical configuration* and denote it by the symbol *u*. The geopolitical configuration is the totality of all geopatoms S_1 (or alliances of rank one) and some set of their alliances *w*, i.e. $u = S_1 \cup w$, where $w \in 2^S$ (2^S the set of all subsets of the set of unions of rank $n \geq 2$). The entire set of geopolitical configurations $\{u\}$ will be denoted by the symbol *U* and we will call this set the *(geo)political*, *historical universe* or *configuration space*. It is easy to estimate the size of the configuration space: it is equal to $\| U \| = 2^{2^N - N - 1}$.

Figure 3 shows an example of a geopolitical configuration with *N* = 4. The configuration in Figure 3 consists of four one-way unions (1),…,(4), two- and three-way unions (12) and (134), respectively. The configuration in Figure 3 can be represented as *u* = {(1),(2),(3),(4),(12),(134)}. Total configurations in the geopolitical system with four geopatoms $U = \{u_1, \ldots, u_{2048}\}$, because $\| U \| = 2^{2^4 - 4 - 1} = 2048$. Note that each of the configurations $u_i, i = 1, \ldots, 2048$ includes four geopatoms, which are considered indivisible and indestructible.

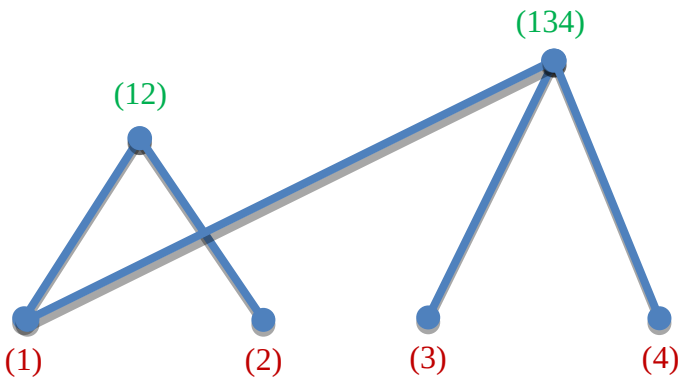


Figure 3: An example of a geopolitical configuration *u* = {(1),(2),(3),(4),(12), (134)}

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The constructed historical universe *U* contains the initial material from which the historical process is "assembled". For this model, the global historical process is a chain of changes in configurations, or, in other words, the dynamics of the formation and disintegration of unions, and subsequent sections will be devoted to studying the mechanism of transition from the current configuration to the next one.

From the point of view of politics, the main interest is the answer to the question: what patoms and their unions are actors (player; the term actor is widely used in sociology and political science) of the political system? This means that this patom or union has objective and subjective conditions to be a participant in the global political game. Objective conditions are reduced to the availability of resources (energy, minerals, etc.), subjective conditions — to will and freedom, and more briefly — to free will (these attributes are studied in more detail in the model of psiphysics [2,3]). The concept of an actor is central to the history model. These or those actors are the main acting figures of history, the subjects of history, while the actors can not always be personified.

In the following sections, the concept of freedom will be formalized in the sense of freedom of political choice for an individual actor and the world as a whole. Freedom, along with resources, is the main regulator of the relations of actors with each other. Freedom for the world as a whole will lead us to the formulation of two global metahistorical goals: the realm of freedom and the realm of necessity.

The next section is devoted to the study of the question of the grounds for preference by certain actors of either the realm of freedom or the realm of necessity in their global goals and aspirations. This question is the subject of the ethics of actors, and it will be reduced to the definition of a key state in global history, which will be called Choice. What is the Choice, and what is its meaning in the context of World history, we will discuss further.

II. Political Characteristics of the Actor

Regarding the actor, let us formulate the question of the extent to which he is a political subject. Let us define the concepts of *political subject* and *political object*, as well as the subject-object measure of an arbitrary actor. This measure will be interpreted as *sovereignty*. To the extent that an actor has sovereignty, to that extent he is a political subject. The less sovereignty, the closer the actor is to the state of a political object. Since the state of sovereignty is transient, in some cases an actor, being a subject, can become an object and vice versa. Thus, the concepts of a political subject and a political object are mutually complementary.

First, for simplicity, we will assume that *N* geopatoms are actors and there are no other actors. Later this restriction will be lifted. On the elements of the configuration space, we define the function $\mu_{i,n}(u), u \in U$, which denotes the number of unions of rank *n* with the participation of the *i*-th geopatom in this geopolitical configuration *u*. By definition, we assume that $\mu_{i,1}(u) = 1$, $i = 1,...,N$ for any configuration *u*, $u \in U$, i.e. a geopatom is indecomposable in itself and enters into a one-sided union with itself one and only time. Little is known about the relationship between the numbers $\mu_{i,n}(u)$, $i = 1,...,N$, $n = 2,...,N$. It is easy to see that for any configuration from *U* the following formula is true:

$$\sum_{i=1}^{N} \mu_{i,n}(u) = n\nu_n(u) \qquad (1)$$

where $\nu_n(u)$ is the number of different unions of the *n*-th rank in *u*, while they can take the values $0,1,...,C_N^n$. The values $\mu_{i,n}(u)$ take the values $0,1,...,C_{N-1}^{n-1}$ and already, according to (1), they are not independent. For example, for $n = N$ and $\nu_n = 1$ it follows from formula (1) that $\mu_{1,N} = \mu_{2,N} = ... = \mu_{N,N} = 1$.

To characterize the *i*-th geopatome-actor as right or left in the political sense of the word, we introduce the *political function* $\chi_{i,n}$, $n = 1,...,N$. Its meaning is simple. It is positive, i.e. a geopatom is right oriented when he enters into a small number of alliances of the *n*-th rank with other geopatoms. Conversely, the political function is negative, i.e. a geopatom is left-oriented when he enters into a large number of unions of the *n*-th rank with other geopatoms. It is this interpretation of the signs of the political function (plus — right, minus — left) that takes into account well-known political science traditions.

Since the total number of unions of the *n*-th rank that a geopath can join is equal to C_{N-1}^{n-1}, then we will choose the value $\frac{1}{2}C_{N-1}^{n-1}$ as a separator between a small and a large number of unions. Normalizing the range of changes in the values of the political function for the interval from -0.5 to $+0.5$, we introduce an auxiliary function $\varphi = \varphi(a,\xi)$, which is defined for non-negative integers *a* and ξ, and $\xi = 0,1,...,a$. In this case $\chi_{i,n} = \varphi(C_{N-1}^{n-1}, \mu_{i,n})$, $n = 2,...,N-1$. For $n = 1$, we assume that $\chi_{i,1} = -0.5$, i.e. geopaths are always left oriented. This is natural, because geopatomes are, by definition, indecomposable. Finally, for $n = N$ we assume that $\chi_{i,N} = 0.5 - \mu_{i,N}$. As a result, we write

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$$\chi_{i,n} = \begin{cases} -0.5, n = 1; \\ \varphi(C_{N-1}^{n-1}, \mu_{i,n}), n = 2,\ldots, N-1; \\ 0.5 - \mu_{i,n}, n = N. \end{cases} \quad (2)$$

A typical form of the function $\varphi(a,\xi)$ in two different cases, when $a = 2k$ is even and $a = 2k-1$ odd (k is an integer), respectively, is shown in Figure 4. The analytical expression of the function φ has the following form:

$$\varphi(a,\xi) = \begin{cases} \frac{k-\xi}{2k}, a = 2k; \\ \frac{k-1-\xi}{2k-1}, (a = 2k-1) \wedge (\xi \le k-1); \\ \frac{k-\xi}{2k-1}, (a = 2k-1) \wedge (\xi \ge k); \end{cases}$$

where ∧ is the logical "and" symbol.

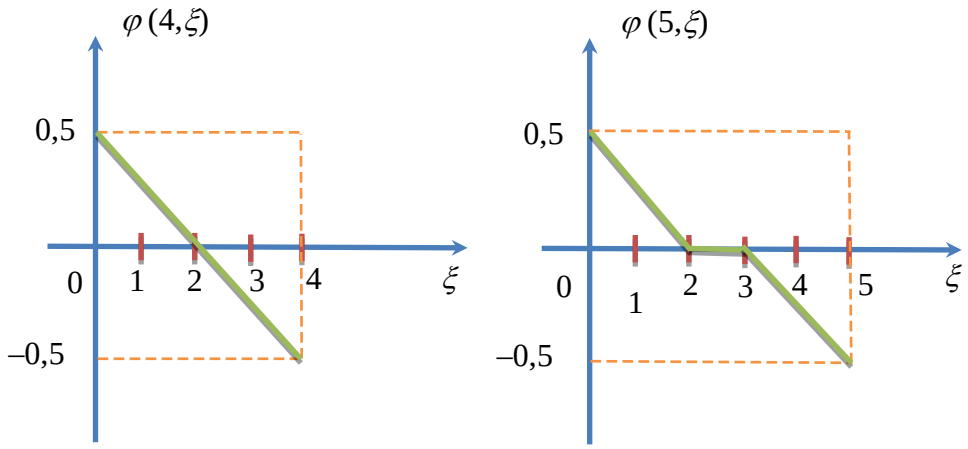


Figure 4: Typical form of functions $\varphi(a,\xi)$ in two different cases, when $a = 2k$ is even and $a = 2k-1$ is odd, respectively

The political function $\chi_{i,n}(n \ge 2)$ varies from – 0.5 at $\mu_{i,n} = C_{N-1}^{n-1}$ to + 0.5 at $\mu_{i,n} = 0$. When $\chi_{i,n} = -0.5$, the *i*-th geopatom enters into all possible unions of rank *n* ($n \ge 2$), and this state will be called the state of *lacing* of the *n*-th rank. When $\chi_{i,n} = 0.5$, the *i*-th geopatom does not enter into any of the unions of rank *n*, and this state will be called the state of *self-identification* of the *n*-th rank.

For the *i*-th geopatom-actor, we define a non-negative *sovereignty function* ρ_i, or simply *sovereignty*, using the following simple formula:

$$\rho_i = [\tfrac{1}{4}(N-2) - \sum_{n=2}^{N-1} \chi_{i,n}^2]^{1/2}. \quad (3)$$

According to definition (3), sovereignty varies from 0 to its maximum value $\frac{1}{2}(N-2)^{1/2}$, i.e. $0 \le \rho_i \le \frac{1}{2}(N-2)^{1/2}$, $i = 1,\ldots,N$.

Let's define the meaning of the terms lacing and self-identification. To do this, we note that if a geopatom is going (or not going) to enter into any alliances, then he must have some doctrine that approves or disapproves of certain alliances. Assume that a geopatom approves and enters into all alliances. Then, naturally, he does not have a non-trivial doctrine, just as in the opposite case, when he is self-identified and rejects all unions. If in the first case he is completely conditioned in his choice, then in the second he is completely unconditioned, i.e. self-identified, falling out of the context of world relations.

A geopatom who enters into all unions will also be called a *super-left*. In this case, each political function from the corresponding set takes on a value of – 0.5, i.e. $\chi_{i,n} = -0.5$, $n = 2,\ldots,N$. The minus sign emphasizes the "leftness" of the laced geopatom, whose location on the segment [– 0.5; + 0.5] is extremely left. A geopatom who does not enter into alliances can also be called a *super-right*. In this case, each political function takes the value + 0.5, $\chi_{i,n} = +0.5$, $n = 2,\ldots,N$. The plus sign

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emphasizes the "rightness" of the self-identified geopatom, whose location on the segment [– 0.5;+ 0.5] is extremely right.

It is clear that the over-left laced and over-right self-identified geopatoms are degenerate cases. In general, the geopatom has some doctrine of selecting alliances favorable to him. At the same time, not all $|\chi_{i,n}|=0.5$, $n=2,...,N$, are equal to 0.5. In the language of the sovereignty function, this means that $\rho_i>0$. In the limiting case of a laced and self-identified geopatoms, there is no sovereignty, i.e. $\rho_i=0$.

Note that the lack of sovereignty is characteristic not only for the laced and self-identified geopatoms. The equation $\rho_i(u)=0,\ u\in U$ allows 2^{N-1} configurations that differ in the choice of signs for the values of political functions of different ranks, i.e. $\chi_{i,n}=\pm 0.5$, $n=2,...,N$. Thus, when some geopatom acts according to the rule of joining or not joining all unions of one rank or another, then he, like a laced and self-identified geopatom, has no sovereignty. In this regard, we note that, by virtue of the definition in (3), the sovereignty function is invariant under the operation of replacing all unions with non-unions and, vice versa, all non-unions with unions, i.e. $\rho_i(u)$ is invariant under the transformation $\mu_{i,n}\to C_{N-1}^{n-1}-\mu_{i,n}$ or $\chi_{i,n}\to-\chi_{i,n}$.

Considering that, according to (3), the maximum value of sovereignty is $\frac{1}{2}(N-2)^{1/2}$, we can estimate the extent to which the *i*-th geopatom-actor is a political subject (object). It is clear that when $\rho_i=0$ sovereignty is minimal or, otherwise, it is absent. In this case, the *i*-th geopatom does not have a nontrivial doctrine of selecting favorable unions for him, and he, of course, is a *super object*. We will consider the maximum possible value of the sovereignty $\frac{1}{2}(N-2)^{1/2}$ of an individual geopatom-actor as a sign of such a doctrine, the possession of which puts the geopatom into the state of a *super subject*. Thus, from the superobject at $\rho_i=0$ we come to the supersubject at $\rho_i=\frac{1}{2}(N-2)^{1/2}$. The values of ρ_i are between $\rho_i=0$ and $\rho_i=\frac{1}{2}(N-2)^{1/2}$ characterize the *i*-th geopatom as a subject and an object in different proportions. Figure 5 contains the nomenclature used to describe the gradations of sovereignty of the *i*-th geopatom-actor.

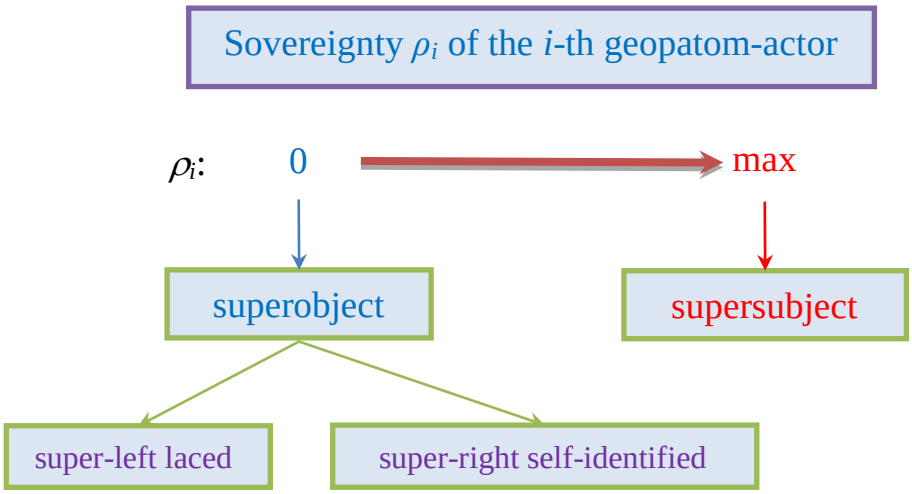


Figure 5: Nomenclature used to describe the sovereignty gradations of the *i*-th geopatom-actor

The sovereignty function is a measure that allows one to rank geopatoms-actors according to their power. In particular, it is possible to formulate the concept of world domination. One or another geopatom-actor has world domination in a weak sense, if his function of sovereignty is greater than the others. And, finally, this or that geopatom has world domination in a strong sense, when his sovereignty is maximum, and the sovereignty of all others is minimum.

Let's consider the general situation, when the actors can be both individual geopatoms and some of their unions. Denote by $S_0=S_1\cup S$ the set of all unions, including one-sided ones. The symbol *A* denotes a non-empty set of actors of the geopolitical system. It is clear that *A* is a subset of S_0, i.e., $A\subseteq S_0$.

One of the main attributes of an actor is that he is. This means that any geopolitical configuration must contain the entire set of actors *A*. Such a set of configurations does not coincide with the original configuration space *U*. We introduce the symbol U_A to denote those configurations that are possible for a given set of actors *A*. We construct the set U_A, based on the fact that *A* is given.

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Let us define the operation of combining a pair of unions $a=(i_1,...,i_n)$ and $b=(j_1,...,j_m)$ into a third $c=(k_1,...,k_l)$, i.e. $a\cup b=c$ according to the rule of set-theoretic union of elements of the set of geopatoms numbers *I*. Let us construct the set S_A of those unions that are formed by the union of an arbitrary set of unions-actors from *A* and those that differ from *A*, i.e.

$$S_A=\{s\in S_0: s=a_1\cup...\cup a_k; k=1,...,\|A\|; a_1,...,a_k\in A\}\setminus A.$$

Taking into account that the set of actors *A* is present in all configurations from U_A and that only actors are responsible for the formation and dissolution of unions, we have

$$U_A=\{u\in U: u=S_1\cup A\cup w, w\in 2^{S_A}\}. \quad (4)$$

According to the definition in (4), $U_A\subseteq U$ for any *A*, $A\subseteq S_0$, while $U_{S_1}=U$. Thus, the truncated configuretion space U_A coincides with the original one only if the actors are all geopatoms and there are no other actors, i.e. when $A=S_1$.

Consider an example. Let *N* = 4, $S_1=\{(1),(2),(3),(4)\}$, *A* = {(12), (134)}, then $S_A=\{(1234)\}$,

$$U_A=\{(1),(2),(3),(4),(12),(134);(1),(2),(3),(4),(12),(134),(1234)\},$$

wherein $\|U_A\|=2$. Figure 6 shows both valid configurations from U_A, asterisks here and below denote the property to be an actor.

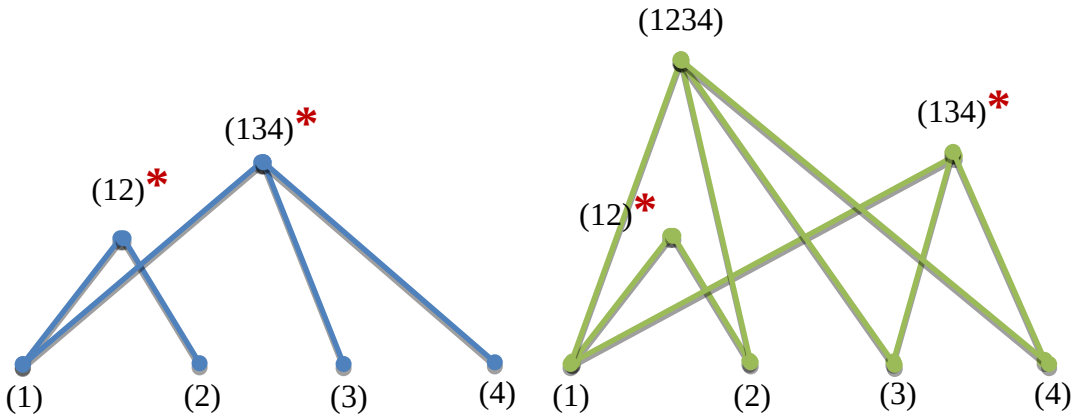


Figure 6: Examples of geopolitical configurations with two actors

Let the symbol $S_{a,n}$ denote the set of unions of the *n*-th rank with the participation of the *a*-th actor ($a\in A$), i.e.

$$S_{a,n}=\{s\in S_A: a\subset s, n=\mathrm{rank}(s)>\mathrm{rank}(a)\}.$$

Let $\mu_{a,n}(u)$, where $u\in U_A$ is an integer function of the number of unions of the *n*-th rank with the participation of the *a*-th actor, while it can take values from 0 to $\|S_{a,n}\|$, i.e. $\mu_{a,n}(u)=0,1,...,\|S_{a,n}\|$. By analogy with the case when $A=S_1$, i.e. when the actors were geopatoms, we define the political function and the function of sovereignty in the general case of an arbitrary set of actors *A*. Taking into account (2), (3), by analogy we have

$$\chi_{a,n}=\begin{cases}-0.5, n=\mathrm{rank}(a);\\ \varphi(\|S_{a,n}\|,\mu_{a,n}), n=\mathrm{rank}(a)+1,...,N-1;\\ 0.5-\mu_{a,n}, n=N;\end{cases}$$

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$$\rho_a = [\tfrac{1}{4}(N - \mathrm{rank}(a) - 1) - \sum_{n=rank(a)+1}^{N-1} \chi_{a,n}^2]^{1/2}.$$

The functions $\mu_{a,n}, \chi_{a,n}$, and ρ_a are constructed in such a way that they coincide with $\mu_{i,n}, \chi_{i,n}$, and ρ_i for $A = S_1$.

III. Choice of Doctrine

As above, we first consider the case $A = S_1$, i.e., all geopatoms are actors and there are no other actors. Let us dwell on the choice of two types: the choice of doctrine by an individual geopatom against the background of others and by the world as a whole. Note that the world as a whole is not an actor and cannot choose directly. However, determining the doctrine of choice by the world as a whole and the number of such doctrines is important when choosing doctrines by individual geopatoms. Here we mean that the world as a whole chooses indirectly through the choice of individual geopatoms in the aggregate. We will not be interested in the specific content of this or that doctrine, that is, which alliances are preferred by certain actors. It is important to determine the power of the class of doctrines from which the choice is made. This power of the class of doctrines, which can be understood as the number of choice alternatives, will be called freedom in the sense of freedom of political choice both for an individual actor and for the world as a whole.

As stated above, the *i*-th geopatom is a supersubject when $\rho_i = \frac{1}{2}(N-2)^{1/2}$. At the level of *n*-party unions $(2 \le n \le N-1)$, this means that the doctrine of the *i*-th geopatom approves and disapproves of an approximately equal number of alliances from the set of allowed ones. Indeed, the *i*-th geopatom can join $\mu_{i,n}$ and not join $C_{N-1}^{n-1} - \mu_{i,n}$ unions of the *n*-th rank. A specific set of $\mu_{i,n}$ alliances and $C_{N-1}^{n-1} - \mu_{i,n}$ non-unions defines some doctrine of the *n*-th rank of the *i*-th geopatom. The total number of doctrines is $C_{C_{N-1}^{n-1}}^{\mu_{i,n}} (n \ge 2)$, it is maximum at $\mu_{i,n} \cong \frac{1}{2} C_{N-1}^{n-1}$ or more precisely at $\mu_{i,n} = \lambda(C_{N-1}^{n-1})$, where $\lambda(\xi) = \xi / 2$ when ξ is even and $\lambda(\xi) = (\xi - 1)/2$ or $\lambda(\xi) = (\xi + 1)/2$, when ξ is odd. Thus, the *i*-th supersubject selects its doctrine from the class containing the maximum number of doctrines of the *n*-th rank. This class of doctrines is characterized by $\lambda(C_{N-1}^{n-1})$ alliances and $C_{N-1}^{n-1} - \lambda(C_{N-1}^{n-1})$ non-alliances.

So, the *i*-th geopatom-actor, striving to become a supersubject, is interested in the class of doctrines in which their maximum number, i.e. it maximizes the functional

$$f_i(u) = \prod_{n=2}^{N} C_{C_{N-1}^{n-1}}^{\mu_{i,n}}, \quad (5)$$

which in what follows will be called the *freedom functional*, or simply *freedom*.

For the world as a whole, the doctrine of choice is simply some configuration $u \in U$, and the number of doctrines *D*, or the freedom of the geopolitical system as a whole, is the power of the configuration space *U*, i.e. $D = \| U \|$. Freedom for the world as a whole can be calculated differently, it is a deuce raised to the power of the number $\| S \|$ of possible unions. The deuce takes into account two options: there is a union or it is not, i.e.

$$D = \| U \| = 2^{\|S\|} = 2^{2^N - N - 1}. \quad (6)$$

Let's return to section 2 in the part where the political function $\chi_{i,n}$ was defined. According to its definition in (2), it is equal to zero at $\mu_{i,n} = \lambda(C_{N-1}^{n-1})$. Thus, the *i*-th geopatom is neither right nor left at the level of unions of rank *n*, when he is a supersubject, i.e. has maximum freedom. Any deviation both to the right and to the left leads to a decrease in freedom. This also means that the most free geopatom-actor is located in the exact center of the political spectrum, if by spectrum we mean the range of values [– 0.5; + 0.5] of the political function.

The totality of the doctrines of the supersubject can be characterized as follows. Let some geopatom can enter into the maximum possible number of unions. At the same time, at the level of unions of rank *n*, he acts according to the rule of "tossing a coin": if "heads" falls out, he enters an alliance, if "tails" falls out, he does not join this union. In this case, he, with a probability close to one, will become a supersubject and will have maximum freedom.

Any geopatom-actor striving to become a subject is concerned with increasing his freedom, freedom in the sense of choosing from the maximum number of doctrines. At the same time, freedom can be maximum for a supersubject. Given the fact that everyone is connected to everyone, it seems impossible for all geopatoms to become supersubjects at the same time. If any geopatom or a group of geopatoms become supersubjects, then at the expense of the freedom of the others. The statement about the impossibility of all geopatoms being simultaneously supersubjects is not proven, however, the analysis of particular cases confirms this conclusion.

Let's make a brief digression in connection with how the freedom of the geopatom-actor was defined in

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(5). The definition of freedom in (5) is not unique. It can be assumed, for example, that geopatoms do not distinguish between the ranks of unions. In this case, given that the total number of alliances with a fixed geopatom is $\sum_{n=2}^{N} C_{N-1}^{n-1} = 2^{N-1} - 1$, we have

$$f_i = C_{2^{N-1}-1}^{\mu_i}, \qquad (7)$$

where μ_i is the number of unions of rank greater than two, with the participation of the *i*-th geopatom. As the study of particular cases in determining freedom according to formula (7) shows, geopatoms can become supersubjects at the same time. Thus, when each geopatom-actor does not distinguish between ranks when counting the number of doctrines, he and every other geopatom-actor can become supersubjects in the aggregate. In this case, freedom is not "scarce" for them. The latter circumstance seems to be uncharacteristic of the behavior of the geopatom-actor. That is why we tend to count the number of doctrines of the geopatom according to formula (5), based on the criterion: the individual freedom of the supersubject of the geopatom-actor should be as "scarce" as possible.

The relationship between formulas (5), (7) can be illustrated as follows. Let us unite the sets of unions of the same rank, i.e. $S_2,...,S_N$ in *L* groups, *L* can take the values 1,…, $N-1$, so that $\bigcup_{n=2}^{N} S_n = \bigcup_{l=1}^{L} Z_l^{(L)}$, where the index (L) denotes some partition into *L* groups $Z_1^{(L)},...,Z_L^{(L)}$. So, for $L = 1$ we have $Z_1^{(1)} = \bigcup_{n=2}^{N} S_n$, and for $L = N-1$ we consider $Z_1^{(N-1)} = S_2,...,Z_{N-1}^{(N-1)} = S_N$.

We will assume that within a group of some division geopatoms do not distinguish between ranks when counting the number of doctrines. Let the maximum number of unions $Z_l^{(L)}$ with the participation of some geopatom within the group be $q_l^{(L)}$, and the number of unions with the participation of the *i*-th geopatom in the *l*-th group is $\mu_{i,l}^{(L)}$. In this case, the number of doctrines of the *i*-thgeopatom is calculated by the formula

$$f_i^{(L)} = \prod_{l=1}^{L} C_{q_l^{(L)}}^{\mu_{i,l}^{(L)}}.$$

It can be proved that the supersubject has maximum freedom at $L = 1$ and minimum at $L = N-1$, i.e.

$$\max_L \max_{u \in U} f_i^{(L)} = \max_{u \in U} f_i^{(1)} = \max_{u \in U} C_{2^{N-1}-1}^{\mu_i},$$

$$\min_L \max_{u \in U} f_i^{(L)} = \max_{u \in U} f_i^{(N-1)} = \max_{u \in U} \prod_{n=2}^{N} C_{C_{N-1}^{n-1}}^{\mu_{i,n}}.$$

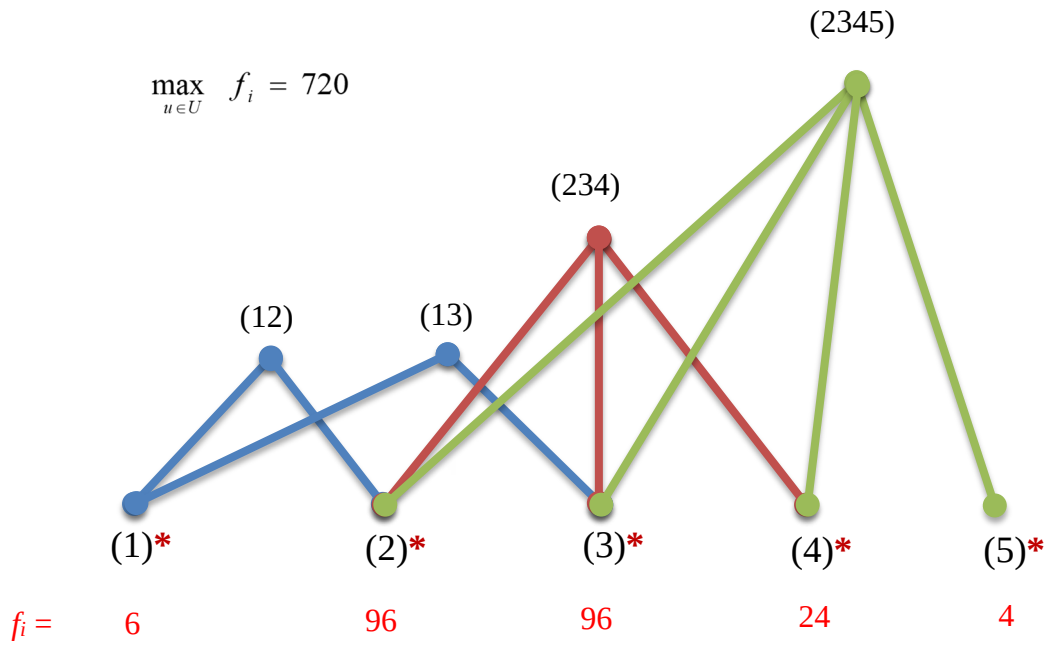


Figure 7: An example of a geopolitical configuration in which the individual freedoms of geopatoms-actors are calculated

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Figure 7 shows an example of a configuration for $N = 5$, in which freedom is calculated using formula (5). For each of the geopatom-actors, the freedom was {6,96,96,24,4} respectively, and, in addition, the maximum possible individual freedom (720) was found. Geopatoms in Figure 7 as actors are marked with stars "*".

Let us introduce a notation for the maximum value of the number of doctrines of the *i*-th supersubject D_i in the general case, i.e. $D_i = \max_{u \in U} f_i(u)$. Let us estimate in order of magnitude the amount of information for the *i*-th geopatom-supersubject according to the well-known formula $Q_i = \log_2 D_i$ and the world as a whole $Q = \log_2 D$. We assume that for the *i*-th supersubject $\mu_{i,n} \approx \frac{1}{2} C_{N-1}^{n-1}$, then, taking into account (5), (6), we find

$$Q_i \approx 2^{N-1} - 2 + (\tfrac{1}{2}N - 1)\log_2 \tfrac{2}{\pi} - \tfrac{1}{2}\sum_{n=2}^{N} \log_2 C_{N-1}^{n-1},$$

$$Q = 2^N - N - 1. \qquad (8)$$

Assuming that the number of states and territories with a different status on Earth is 261, we put $N = 261$. Noteworthy in (8) is the term $\sim 2^N$, which at $N = 261$ is an astronomically large number $\sim 2^{261} \cong 3.7 \cdot 10^{78}$. Thus, according to the most conservative estimates, each of the supersubjects-states needs to process information in the amount of about $3.7 \cdot 10^{78}$ bits for the correct choice of the doctrine of behavior.

The values given in (8) can be given a different, entropy interpretation. The entropy interpretation of the values Q_i and *Q* is that they characterize the maximum degree of uncertainty in the choice of doctrines of behavior by the supersubject and the world as a whole.

In addition, the value of *D* can also be interpreted as a measure of the complexity of the geopolitical system as a whole. Below we will return to the concept of "complexity" in connection with stability and historical time.

Summarizing the list of interpretations of the value *D*, we can say the following:

- ✓ *D* — is the amount of freedom for the world as a whole,
- ✓ $\log_2 D$ — is the volume of processed information necessary to select the doctrine of the behavior of the actor-supersubject,
- ✓ $\log_2 D$ — entropy as a measure of uncertainty when choosing the doctrine of the behavior of an actor-supersubject,
- ✓ *D* — is a measure of the complexity of the global geopolitical system.

Very briefly, the interpretation of the value of *D* is reduced to the following metaphorical equality:

"*D* = freedom = information = entropy = measure of complexity"

Now let's remove the initial restriction that the set of actors is limited only by geopatoms, i.e. we assume that *A* — an arbitrary subset of the set S_0. In this case, the analogues of formulas (5), (6) are the following:

$$f_a^{(A)} = \prod_{n=\mathrm{rank}(a)+1}^{N} C_{\|S_{a,n}\|}^{\mu_{a,n}}, \mathrm{rank}(a) < N, \qquad (5')$$

$$D_A = \| U_A \| = 2^{\|S_A\|}, \qquad (6')$$

where $f_a^{(A)} = 1$, when rank(*a*) = *N*, $\| S_A \|$ — is the cardinality of the set of unions that are not actors and are formed by the union of an arbitrary number of actors. Formulas (5´), (6´) coincide with (5), (6) for $A = S_1$, i.e. $f_i^{(S_1)} = f_i, D_{S1} = D$. The functional $f_a^{(A)} = f_a^{(A)}(u), u \in U_A$ defines the freedom of the actor *a*, $a \in A$, and D_A — the freedom for the world as a whole for a given set of actors *A*.

From the point of view of thermodynamics, when freedom D_A is interpreted as entropy, one can speak of a regular increase in entropy-freedom in the event that the global geopolitical system is closed. However, it is essentially open, primarily through resources. There are a number of factors (strength, will and power, which are determined in the model of psiphysics [2,3]), through which the geopolitical system is also open.

Freedom for the world as a whole is maximum at $A = S_1$, i.e.

$$\max_{A \subseteq S_0} D_A = D_{S_1} = D.$$

Thus, maximum freedom for the world as a whole is possible only where and when the actors are geopatoms and there are no other actors. The world in which maximum freedom is possible, we will call the *realm of freedom*. In contrast to the realm of freedom, we define the *realm of necessity* by the condition $D_A = 1$. The realm of necessity is not unique. For example, for $A = S_N, S_N \cup S_{N-1}, \ldots, S_0$, we have $D_A = 1$, which can be verified directly.

Figure 8 shows examples of configurations from the realms of freedom and necessity, when the number of geopatoms is 4, i.e. *N* = 4. The realm of necessity is limited to a single configuration, which is shown in Figure 8.

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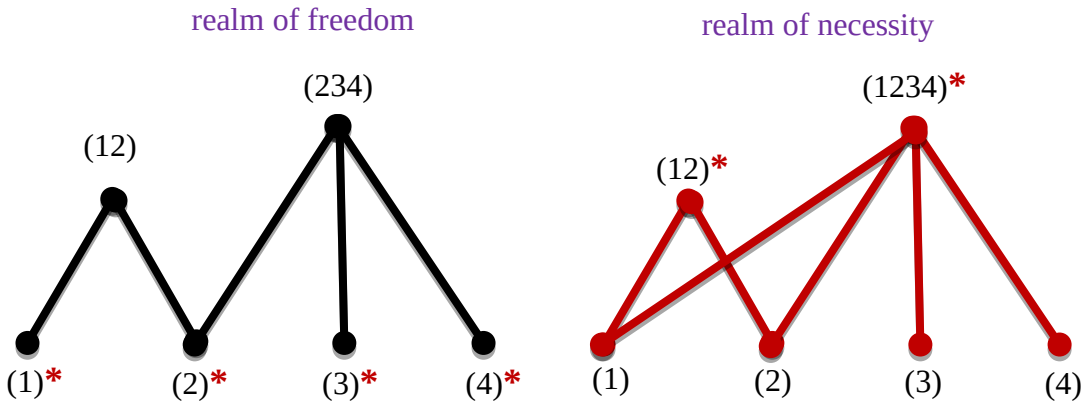


Figure 8: Examples of configurations from the realms of freedom and necessity

IV. Resource Limits

Consider the resource constraints in our model. Let the number of such resources be *M*. Each of the geopatoms is a direct producer of one or another group of resources. Denote by $R_i^{(\alpha)}$ the intensity with which the *i*-th geopatom produces the α-th resource. These resources, after distribution, are consumed both by the geopatoms themselves and by all unions. The intensity is understood as the amount of resources produced per unit of physical time. This circumstance stands out due to the fact that the concept of "historical time" will be formulated below, which has little in common with its physical counterpart. The connection between the intensity of resource production and physical time characterizes the natural rootedness of the geopolitical system in the physical world surrounding it.

Denote by g_i the set of alliances involving the *i*-th geopatom, including himself. The cardinality of the set g_i is $\sum_{n=1}^{N}\mu_{i,n}$. The set g_i is determined by a specific configuration, i.e. $g_i = g_i(u)$, $u \in U$. Let us define *NM* non-negative value-functions $r_{g_i}^{(\alpha)}$, *i* = 1,…,*N*, α=1,…,*M*. The value $r_{g_i}^{(\alpha)}$ characterizes the distribution of the α-th resource of the *i*-th geopatom within the set g_i, while proceeding from the fact that

$$\sum_{s\in g_i} r_{g_i}^{(\alpha)} = 1. \qquad (9)$$

If the sum in (9) is normalized not by one, but by 100%, then the values acquire the meaning of taxation rates for the *i*-th geopatom as a direct producer of the α-th resource from those unions in which the *i*-th geopatom takes part.

Let us determine the consumption of the α-th resource by the *s*-th union ($s \in u$) by the formula:

$$\sum_{i\in s} r_{g_i}^{(\alpha)}(s) R_i^{(\alpha)},$$

that is, the consumption of the *s*-th union consists of the shares of the α-th resource transferred by each of the geopatoms included in *s*. In order for the union *s* to exist, it must consume the α-th resource not less than some threshold value $R^{(0,\alpha)}$, i.e.

$$\sum_{i\in s} r_{g_i}^{(\alpha)}(s) R_i^{(\alpha)} \geq R^{(0,\alpha)}, \qquad (10)$$

while for simplicity it is assumed that $R^{(0,\alpha)}$, $\alpha = 1,\ldots,M$ are constants, although they can also be functions of the *s*-th union, i.e. $R^{(0,\alpha)} = R^{(0,\alpha)}(s), s \in u$.

Taking into account (10), we determine the resource constraints in our model by the formula:

$$R(u) = \bigwedge_{s\in u}\bigwedge_{\alpha=1}^{M}\left(\sum_{i\in s} r_{g_i}^{(\alpha)}(s) R_i^{(\alpha)} \geq R^{(0,\alpha)}\right), \qquad (11)$$

where $\wedge$ — sign of conjunction (logical multiplication). According to (11), the configuration *u* satisfies the resource constraints when *R*(*u*) = true and *R*(*u*) = false otherwise. Recall that the terms *true* and *false* in Boole algebra mean true and false. In other words, some configuration *u* can exist in reality if *R*(*u*) = true and cannot exist when *R*(*u*) = false.

We note the following circumstance. In the general case, it is necessary to proceed from the assumption that a particular configuration *u* has an inverse effect on the intensity of resource production (the global situation affects the local production of certain resources), i.e. $R_i^{(\alpha)} = R_i^{(\alpha)}(u)$, $u \in U$, which in general is the subject of political economy. Accounting for this factor makes the task of describing global historical dynamics even more difficult.

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Only the actors of the political system know (naturally, within certain limits) how to spend the produced resources. They, in the final analysis, carry out the distribution of consumption as they see fit, i.e. they control the form of quantities $r_{g_i}^{(\alpha)}$, $i = 1,\ldots,N$, $\alpha = 1,\ldots,M$, responsible for taxation. At the same time, the actors, being intertwined within the framework of a certain geopolitical configuration, enter into various kinds of relations with each other regarding resources. These include relations of competition, cooperation, etc.

Each of the actors of the set *A* is characterized by the possession of a certain plan of its existence in the context of the world as a whole. In the general case, there can be as many plans as there are actors. If there are fewer of them, then we can talk about coalitions of actors adhering to the same plan. Since we have already singled out two special states in history, which are called the realms of freedom and necessity, let us consider what is the attitude towards them from the side of the individual plans of the actors. If a group of actors adheres to the same metahistorical goal — the construction of the realm of freedom (the realm of necessity), then each of the actors in this group has a special unified plan, which we will call *progressive*(*traditionalist*). The first plan is characterized by a strategy for increasing the freedom of the world as a whole, i.e. orientation towards the progressive crushing of large scale actors, when, in the limit, the set of actors is exhausted by geopatoms. The second plan is characterized by an orientation towards traditional ideas about actors as unions of a fairly high rank.

Both plans have a huge number of adherents. Let's give some examples. L. Mises [7] and F.A. Hayek [8], defending liberal democratic values, connects them with the right to freedom in the sense of freedom of political choice. Plato in his theory of the ideal state left no room for freedom of choice. The largest traditionalist of our time is R. Guenon [9].

Let us formulate the following question: on what basis does this or that actor adhere to either progressive or traditionalist plans in achieving a global metahistorical goal — the realm of freedom, the realm of necessity? We will refer this question to the group of questions: “How should it?”, “On the basis of what should it be?” etc., i.e. we will refer it to the field of ethics.

V. Modeling of History

From the point of view of an external observer, the historical process is presented as a chain of configuration changes, i.e.

$$\ldots \to u_{-1} \to u_0 \to u_1 \to \ldots, u_k \in U, k = 0, \pm 1, \ldots$$

What are the reasons for the arbitrary transition $u_k \to u_{k+1}, k = 0, \pm 1, \ldots$? While these causes can be extremely varied, there is some typology among them. Let us present such a typology in the form of four aspects of the historical process. Let's call them

- *resource*,
- *psychodynamic*,
- *information* and
- *gaming*.

The allocation of the resource aspect is due to the fact that, in general, resources are given to us from the outside. The psychodynamic aspect is studied within the framework of the model of psiphysics [2,3]. The information aspect of the historical process is characterized by the desire of actors to gain maximum freedom. Finally, the game aspect includes everything related to the mutual struggle of actors for resources.

The transition from the current geopolitical configuration to the next, i.e. the transition $u_k \to u_{k+1}$, ($k = 0, \pm 1, \ldots$), let's call it an *elementary historical event*, an *elementary dynamic act* of history. It seems that the reasons for such a transition, i.e. the mechanism of historical dynamics, can be exhaustively described within the framework of one of the four aspects of the historical process (resource, psychodynamic, informational and gaming) or from some combination of them.

Let's look at all four aspects in more detail. First of all, it is necessary to divide them into two groups. The first group includes resource and psychodynamic, the second — information and play. The division into two groups is due to the fact that the resource and psychodynamic aspects, in contrast to the informational and game ones, cannot be fully controlled by the actors. In other words, aspects of world history from the first group can be attributed to objective conditions, and those from the second — to subjective ones.

Figure 9 shows the methodology for studying the historical process from the point of view of analyzing the contribution of one or another aspect of the four listed to a given historical event.

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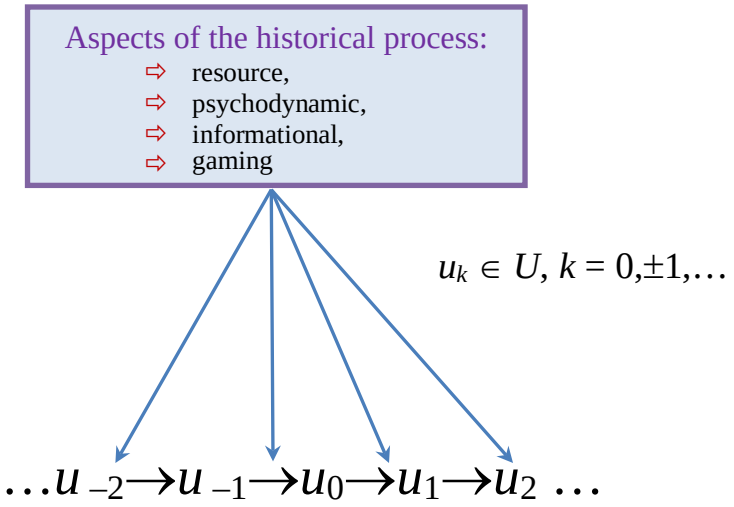


Figure 9: Scheme of the methodology for studying the historical process in terms of analyzing the contribution of one or another aspect to a given historical event

Further, we will dwell in more detail on the second group of aspects of history, considering that the resource and psychodynamic aspects are fixed.

A characteristic feature of the informational aspect of the historical process is the striving of actors for maximum freedom. Since gaining maximum freedom requires maximum information, the quantitative assessment of which is given in (7) on the example of the realm of freedom, the informational aspect of history is directly related to the information industry. The confirmation of the reality of the information aspect is the goal of building an "information civilization" proclaimed for the first time in the West [10]. Let us present the mathematical formulation of the informational aspect of the historical process. Considering (5′), (11), we have

$$f_a^{(A)}(u) \to \max,\ a \in A; \qquad R(u) = \text{true},\ u \in U_A. \tag{12}$$

According to (12), each of the actors tends to the state of maximum freedom under given resource constraints. Aiming for the maximum in (12) means that the *a*-th actor, before entering into a new union or before leaving the old one, calculates the freedom functional $f_a^{(A)}$. If a new state leads to an increase in freedom and it is acceptable due to resource constraints, the actor tries to update it. Of course, it must be taken into account that these assessment procedures are carried out by all actors from *A* in the aggregate.

Along with the psychodynamic, the game aspect of the historical process seems to be the most loaded with mathematics, since it is reduced to a well-known section of mathematics — the theory of games of many persons in its most complex version — coalition games of many persons [11].

Let us consider equations (9) more carefully. Their political meaning is twofold. On the one hand, they mean how many shares of a particular resource are transferred to various unions. In this case, the special preferences of each geopatom in relation to various unions may affect. On the other hand, it is necessary to take into account that the actors are primarily responsible for the distribution of resources. This duality can be removed in the following way. We will assume that the actors take into account both their own interests and those preferences that are characteristic of individual geopatoms. The state structure of the geopolitical system can act as special preferences of geopatoms.

Let some political configuration *u* be given. It satisfies the resource constraint, i.e. *R*(*u*) = true and contains some set of actors *A*. Denote by symbol h_a the set of alliances involving the *a*-th actor, including himself. The set of sets h_a, $a \in A$ does not exhaust all unions from the configuration *u*, since some geopatoms may not be actors, although they are always contained in *u* by definition. Let the numbers of geopatoms that are not actors be $i_1,\ldots,i_l$, respectively, while *l* can take values from 0 to *N*. In this case,

$$u = (i_1) \cup (i_2) \cup \ldots \cup (i_l) \cup \bigcup_{a \in A} h_a .$$

Consider an arbitrary union *s* from the configuration *u*, formed with the participation of at least one actor. Let us define *M* non-negative value-functions $p_s^{(\alpha)}$, $\alpha = 1,\ldots,M$, such that

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$$\sum_{a\subseteq s, a\in A} p_s^{(\alpha)} = 1, \quad (13)$$

where $\alpha = 1,\ldots,M$. These values characterize the distribution of the degree of control of the α-th resource between those actors that entered the s-th alliance during its formation. The total amount of the α-th resource $K_a^{(\alpha)}$ controlled by the a-th actor can be determined by the formula:

$$K_a^{(\alpha)} = \sum_{s\in h_a} p_s^{(\alpha)}(a) \sum_{i\in s} r_{g_i}^{(\alpha)}(s) R_i^{(\alpha)}. \quad (14)$$

If we sum $K_a^{(\alpha)}$ over all actors, we can find

$$\sum_{a\in A} K_a^{(\alpha)} = \sum_{i=1}^{N} R_i^{(\alpha)} - lR^{(0,\alpha)}. \quad (15)$$

The meaning of formula (15) is as follows. The set $K_a^{(\alpha)}$, $a \in A$ is simply some distribution of control over the α-th resource among all actors minus the minimum necessary to support non-actor geopatoms.

Now we have everything to formulate the game aspect of the historical process. As part of the game aspect of the historical process, each of the actors, making changes to the global configuration, is concerned about the following. First, he must be, since the rules of the game allow for his death. Second, assuming the first is true; he needs to maximize the amount of resources he controls. Thus, taking into account (14), (15), we have the following M game-theoretic problems:

$$K_a^{(\alpha)} \to \max, a \in A;$$

$$\sum_{a\in A} K_a^{(\alpha)} = \sum_{i=1}^{N} R_i^{(\alpha)} - lR^{(0,\alpha)}, \alpha = 1,\ldots,M. \quad (16)$$

Each of the M tasks in (16) is represented by a game of a variable number of persons with payoff functions $K_a^{(\alpha)}$, $a \in A$. The control parameters on the part of the players are the function quantities $r_{g_i}^{(\alpha)}$, $p_s^{(\alpha)}$, $i = 1,\ldots,N$, $\alpha = 1,\ldots,M$, $s \in u$, satisfying equations (9), (13).

Problem (16) should be considered, generally speaking, as a coalition game, but unlike the classical theory, the number of players is variable. Note that if the number of resources is more than one, uncertainty may arise between the game tasks for each of the resources. Removing this uncertainty assumes that the utility of each of the resources can be recalculated in units of any other resource. In other words, to remove uncertainty, it is necessary to assume that the utility of each resource is transferable.

Comparing the informational and game aspects of the historical process, one can see that the actors adhere to different values in them. If in the first case the value is freedom, then in the second — resources.

Speaking of history, there was no mention of time anywhere. This circumstance is not accidental, because it is necessary to clarify what time it is. The number of the configuration in the chain $\ldots \to u_{-1} \to u_0 \to u_1 \to \ldots$ is called *historical time*, then the historical time interval is simply the number of configuration changes between two arbitrary fixed configurations. Historical time is thus an integer. Time in the usual, physical sense, i.e. *physical time* arises only when there is a single measure of all historical events. Such a measure can be the dating of changes in historical configurations in units of astronomical time, i.e. t_k, $k = 0,\pm1,\ldots$, where t_k, $k = \ldots,-2,-1$ — past, t_0 — current, t_k, $k = 1,2,\ldots$ — future events. What can be said about the times t_k, $k = 0,\pm1,\ldots$? Their specific meanings depend on all four aspects of the historical process, i.e. on what are the characteristic times of each of the aspects. Both historical and physical time are secondary to the dynamics of the geopolitical system, which is the dynamics of the formation and dissolution of alliances.

Considering that actors can be born and die, from the point of view of an external observer, we can talk about a chain of changes in the sets of actors:

$$\ldots \to A_{-1} \to A_0 \to A_1 \to \ldots, A_l \subseteq S_0, l = 0,\pm1,\ldots$$

and the corresponding *time of the actors* $l = 0,\pm1,\ldots$ From the standpoint of actors' time, the historical process is the dynamics of the birth and death of actors. The transition mechanism from the current set A_l to the next A_{l+1} ($l = 0,\pm1,\ldots$) will be studied further. Let us also define the space of actors by the formula $W = \{A : A \in 2^{S_0} \setminus \varnothing\}$, i.e. the set of actors can be any non-empty subset of the set of all unions of all ranks. It is easy to estimate the cardinality of the set W, namely $\|W\| = 2^{2^N-1} - 1$.

Let us return to the interpretation of the freedom of the actor and the world as a whole as a measure of complexity. In cybernetics, there is an idea that a system is more stable the more complex it is. In relation to the global geopolitical system, it should be clarified with respect to what time stability is estimated. If this time is historical time, then yes, indeed, the geopolitical system is the more stable the more complex it is. From the standpoint of physical time, this is not so. The difference in the assessment of stability in terms of historical and physical time is especially pronounced in the interpretation of natural or social cataclysms on a global scale. Thus, a military conflict with the unlimited use of

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nuclear weapons is the “end of history” from the point of view of physical time and the “triumph” of history from the standpoint of historical time. The last statement is deciphered simply: at the moment of conflict, the intensity of the dynamics of the formation and disintegration of unions increases sharply. Thus, despite the fact that the complexity-freedom of the world as a whole is growing, the “fragility” of society as a single biogeophysical body within the bounds of its enclosing biosphere does not necessarily decrease.

Note that neither historical time nor the time of actors play such an essential role as time plays in physics. If in physics, time is substantial and directly woven into the physical-dynamic reality, then in history historical time is mediated by an external observer and is only a statement of events by an external observer. The real historical dynamics is concentrated in the existence of actors who are born, die and make certain decisions about the formation and disintegration of unions. In other words, in this model of history, time seems to be absent, but the historical process takes place.

VI. The Moral Code of the Actor

The normative model of global history built in the previous sections is not closed conceptually, because does not answer the following question: on what basis does this or that actor adhere to either a progressive or traditionalist plan in achieving a global historical goal — the realm of freedom, the realm of necessity, respectively? We will refer this question to the group of questions: “How should it be?”, “On the basis of what should?” etc., i.e. we will refer to the field of ethics. Since in the model the actors (geopatoms and their unions) are chosen as the subjects of historical dynamics, it is necessary to build something in the spirit of the ethics of actors, or, in other words, to formulate the moral code of the actor.

The actor's moral code is not an “anthropomorphic” ethics. Indeed, if actors are understood as geopatoms and their unions, ethnic groups, states, etc., then it is extremely difficult to bring their behavior under the ethics of human relations, because they “live” according to other laws and, if you like, in other “spatio-temporal dimensions”. So the logic of general humanistic morality [12] cannot be used as an adequate tool in planning and predicting the behavior of certain actors. Due to the fact that the ethics of actors is global in nature, in the general case it may have nothing to do with individual moral systems developed within the framework of one or another actor or taken from one or another religious denomination.

Taking into account the results of modeling in the previous sections, we list the attributive properties of the actors. First, there must be an actor, because the rules of the game allow for his death. Now let life be secured. In this case, the second attributive property of the actor is his striving for a state of maximum freedom. It was stated above how he does this by forming (disintegrating) alliances with other actors (see formula (5′)), which also constitutes the essence of the informational aspect of the historical process. And, finally, the third attributive property is the desire of the actor to control more and more resource(s) (see formulas (14), (16)). This intention of the actor is realized in the competition for resources with other actors and constitutes the essence of the game aspect of the historical process.

All three attributes, intentions, each actor implements in interaction and in conjunction with other actors. At the same time, regardless of whether or not some actor(s) are considered with others in the implementation of their attributive properties, an ideal, universal scheme of the actor's behavior is developed, which we will call the *moral code of the actor*. The latter can be formulated in several ways. So, following I. Kant [13], let's use his categorical imperative, giving it a specific content.

The categorical imperative of the actor.

Actor:

1) must be, (17)
2) must be free,
3) must be rich.

Note that all three duties are subordinated (with some reservations, which are set out below) in importance from top to bottom and outline the main intentions of the actor. All three duties considered in universality, i.e. in relation to each of the actors, are the categorical imperative implemented in three requirements. So, the actor should not just be, be free and be rich, but in such a way that these intentions are realized not to the detriment of other actors. It was in this that I. Kant saw the formal realization of the moral law and virtuous behavior. Thus, the actor acts morally, well, i.e. does a good deed when his actions in accordance with the three main motives (17) do not conflict with other similarly motivated actions of other actors.

Taking into account (17), we will give a more detailed expression in the form of the moral law of the actor.

Actor:

1) must be — not to the detriment of other actors;
2) must strive for maximum freedom — not to the detriment of others; (17′)
3) must strive to control the maximum amount of resource(s) — not to the detriment of others.

The actor's moral code can be taken either in the form of a categorical imperative (17) or in the form of a moral law (17′). There is no difference between them, except that the first is formulated more concisely than

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the second, and the maximization of freedom and resources in (17) is understood implicitly.

So, since actors have a moral law, they become moral subjects, they can evaluate their actions within the framework of the dichotomy: "good — bad", "good — evil", etc. The experience of the dichotomy "good — bad" act is the central existential, the existence of the actor as a moral subject. Let's talk about this existence as a burden. Let's ask ourselves the following question. Can an actor get rid of moral existence as a burden? Yes, it can be in the one and only case when the number of actors is reduced to one. There are many single-actor configurations. Of these, we choose one and only one on the basis of the following considerations. Since in the modern world the intensity of communication is so great that it cannot be said that any of the regions on Earth is not covered by them, we arrive at the following global geopolitical configuration with one actor:

$$\{(1),\ldots,(N),(12\ldots N)^*\}. \qquad (18)$$

Figure 10 shows a graphical representation of the geopolitical configuration (18) with one actor.

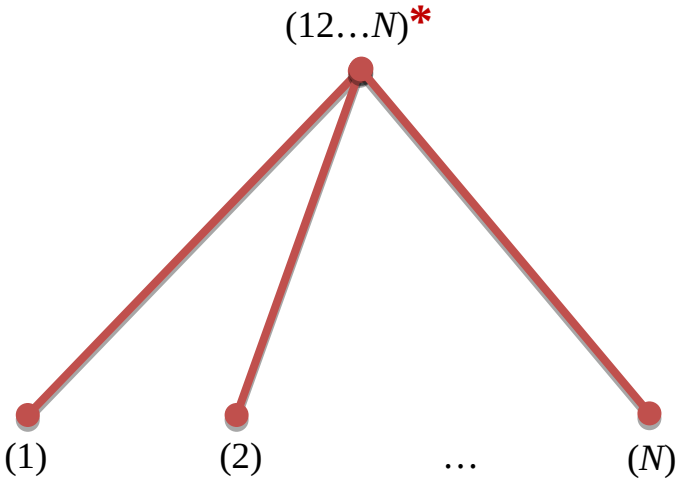


Figure 10: Geopolitical configuration with one actor

Why did you have to pay attention to this circumstance? This is due to the fact that the basis of freedom in the sense of freedom of political choice is transcendental freedom, which is confirmed by all world religions that see the root of any ethical systems in the sense of mystical experience of the transcendental world as absolute freedom [16]. From these positions it is natural to interpret the existence of the moral actor as (his) burden. Thus, according to Scripture, man separated from the Creator after the fall, taking upon himself the burden of knowing good and evil. Rising to an independent life, he became like God, but only became like him, since this gift (of freedom) is too heavy, and it is and will always remain a burden, since man himself, due to his short-sightedness, has made a substitution of otherworldly freedom on thise-worldly.

Consideration, on the basis of which the configuration (18) was chosen, we will call the *compression of space*, or the *communication limit*. Modern means of communication bring closer the moment when the geopolitical space (more precisely, the space of actors) will become super-compressed and accessible everywhere, shrinking to the limit into a "point".

Configuration (18) (Fig. 10) is nothing but the realms of necessity. A single actor has the ultimate freedom in a world with one actor, which is equal to the ultimate lack of freedom, i.e. necessity. It is in this world that the "good — evil" dichotomy is removed. The actor becomes on the other side of good and evil, i.e. becomes transcendentally free. Thus, we need to distinguish between this-worldly freedom in the sense of freedom of political choice and otherworldly freedom — transcendental freedom, and the first can be realized in a world with at least two actors, and the second (in full) — with one actor. The burden of existence of the moral actor is completely removed with the experience of transcendental freedom, which from this worldly point of view is nothing [14,15].

VII. Violations of the Moral Code by Actors

Having clarified the meaning of this and otherworldly freedom, let us return to the subordination of freedom and wealth in the moral code of the actor. If freedom is interpreted as otherworldly, then it certainly comes to the forefront (after being) as a more ancient and deeper motive for the existence of an actor. If freedom is seen as this-worldly, then freedom and wealth may not be mutually subordinated. In this case, both freedom and wealth are simply components of the actor's this-worldly existence.

The splitting of freedom into this and the other world lies at the basis of the dichotomy "progressism — traditionalism", i.e. in the preferences of the actors either

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the realm of freedom or the realm of necessity. At the same time, from the otherworldly point of view, the meaning of the terms "the realm of freedom" and "the realm of necessity" is directly opposite, i.e. from the transcendent point of view, the this-world realm of freedom is the realm of necessity, and the realm of necessity is the realm of freedom. Given the entropy interpretation of this-worldly freedom, one could say that the realm of freedom is the "realm of chaos", and the realm of necessity is the "realm of cosmos". Based on the foregoing, instead of the terms "progressism", "traditionalism" one can also use Becker's terminology — "secular", "sacred" [17].

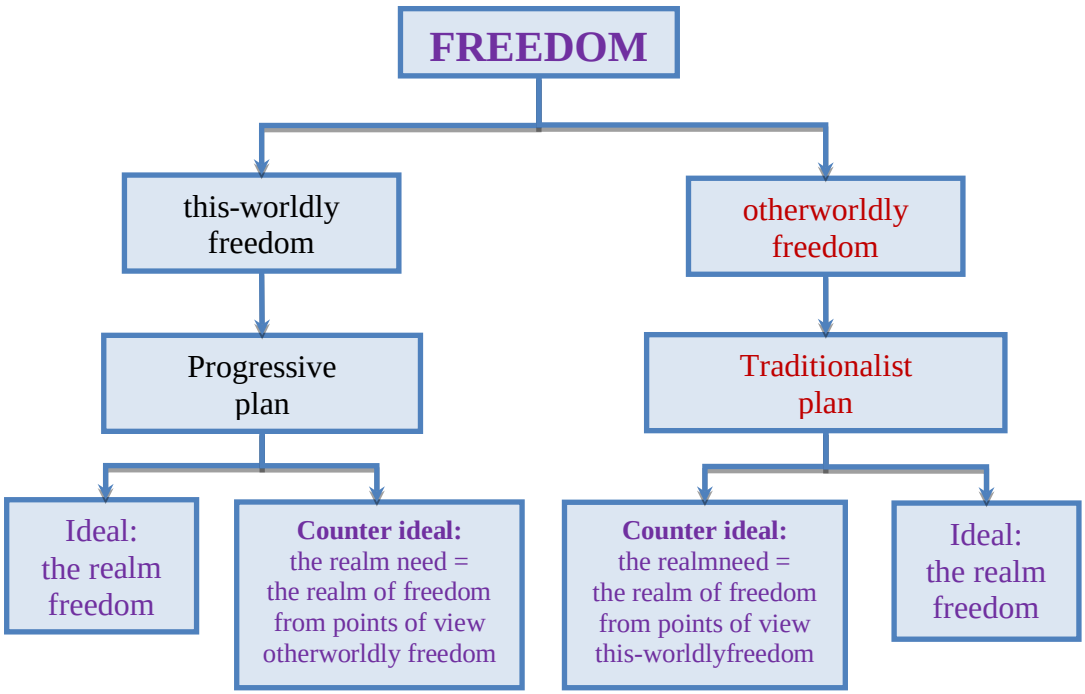


Figure 11: A flowchart representing how freedom is interpreted in terms of two global metahistorical goals: the realm of freedom and the realm of necessity

Let us answer the question: why was it necessary to invoke a religious interpretation of the realm of necessity? This is due to the fact that neither scientific nor actually desacralized ethics can give grounds for choosing between the realms of freedom and necessity. From the last two points of view, a person, through his free will, can will both without any reason (provided that space is compressed), which completely removes the ultimate historical goals from the control of a person, since their choice becomes absolutely random. Such a situation can be qualified as the horror of a completely secularized world before global history. From this point of view, science, acting as a fighter against religion, is terrible, because it gives two equally unacceptable answers to the choice between the realms of freedom and necessity. So, if it proves that free will does not exist, then we build an "anthill". If it proves that free will exists, then the choice between two global metahistorical goals is taken out of our control. Within theology, the (non)existence of free will has been discussed for a long time [18], in our time, discussions on this issue periodically arise in connection with the ambitions of science for a monopoly in the field of worldview. In the model of psychophysics [2,3], the issue of free will is solved in the sense that without will and without freedom it is impossible to formulate and, in a certain sense, solve the psychophysical problem in relation not only to the operator, but also to an arbitrary actor of the global political system.

Figure 11 shows a block diagram showing how freedom is interpreted from the point of view of two global metahistorical goals: the realm of freedom and the realm of necessity.

What is the meaning of the moral code of actors in connection with global history? He appears in two roles. Firstly, it gives a moral assessment to all the historical actions of actors, and secondly, it acts as a global *status quo*. Let's discuss these two interpretations in more detail.

The moral code exhausts the ethical experiences of actors in evaluating their actions as "good — bad", "good — evil", and so on. Is it really that important to stick to a code of ethics? In our time, its importance is becoming extreme, because it has a real material content in the form of means of mass destruction. The presence of the latter deters actors from unilateral

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actions that conflict with the interests of others. Thus, the presence of means of mass destruction leaves a very small "range" for the actor, where he can get a new ethical experience of knowing good and evil. Or, in other words, any attempts by the actor, if not to get out of, then to weaken the action of the ethical code are fraught with the loss of the actor's being. Despite this, a number of actors violate the ethical code. What are the reasons for these phenomena?

There may be two such reasons. The first is associated with drastic changes in the environment, the second — with the pressure of the will to power. The second reason is characterized in terms of the philosophy of F. Nietzsche [16].

Possible catastrophic changes in the human environment have long been discussed and modeled not only by the scientific community, but also by the general public, primarily by the "green" movement [19]. The main problem is that the "man + biosphere" system cannot be reproduced more or less self-identically. The growth of mankind is carried out due to the destruction and degradation of the biosphere. The unrestrained growth of population and the unlimited consumption of irreplaceable resources leaves no hope that humanity can stop its expansion on its own. Mankind can stop only by responding to the already thrown challenge from the biosphere. This will require a global restructuring of the geopolitical configuration, which will take place under the sign of environmental protection and will consist in the transfer of additional powers to the central body. Restructuring itself will be "evil", because a number of actors may not agree to the voluntary transfer of their powers to the central body. Humanity's response to the challenge of the biosphere (hereinafter, we will use the terminology of A. Toynbee [20]) creates the prerequisites for a new rethinking of the traditionalist metahistorical plan.

The second factor leading to the violation of the moral code is determined by the desire, the will to power. The actor does evil deeds not because he seeks power, but because this passion becomes excessive. On the one hand, the desire for power is woven into the power-volitional infrastructure of the world, and on the other hand, its overabundance tears this structure. Moral condemnation receives not the desire for power itself, but its overabundance. In the model of psiphysics [2,3], the power-volitional infrastructure and dynamic principles of the formation and decay of the actor(s) will be determined and investigated.

From a religious point of view, the desire for power is rooted in the transcendent. Excessive desire for power can be interpreted as an invasion of the transcendent world into the this-world. The intrusion of the transcendent is rooted in our experience of absolute freedom, which is nothing or absolute evil from the thise-world. The intrusion of the transcendent is rooted in our experience of absolute freedom, which is nothing or absolute evil from the point of view thise-world [21]. Insofar as man has separated himself from the Creator, he has created his own "human" ethical code, from the standpoint of which the transcendent world is the source of absolute evil. This expresses the God-fighting character of the moral code of the actor, for whom the freedom of this world is not just a value, but a value in itself. In irreconcilability to otherworldly, transcendental freedom lies the danger, which S. Huntington speaks of as "God's revenge" [22]. N.A. Berdyaev [23] and K. Jaspers [24] warned about the same danger.

Speaking of politics as "the art of the possible", we generally stand for the observance of the moral code of actors. From the point of view of an overly power-hungry actor, one might say of politics as "storming the impossible". Terror as a phenomenon of modern times is an illustration of the thesis that politics can be "storming the impossible" [25].

So, the global political system as an ensemble of actors lives in accordance with the moral code (17) or (17′). The principles of violation of the latter are listed above. The question arises: is it possible, being within the framework of the ethical code, to come both to the realm of freedom and to the realm of necessity from the current configuration? As will be seen below, the last question should be answered in the negative. In particular, this means that the actor's moral code serves only to fix the status quo between actors and acts as a mechanism for grasping and curbing history. Since the observance of the moral code prevents the possible construction of other historical configurations, the historical process from the point of view of the code is immoral and evil, because it goes independently and against the pressure of the code. Thus, the moral code of the actor acts as an instrument of total control not only over man, but also over nature. The emancipation of the actor from the code is identical with his death. In accordance with these assessments, the moral code acquires a special ontological status. He strives to exhaust and replace the existence of actors, which is in fact rooted in absolute freedom.

Let us return once more to the clarification of the term "traditionalism" ("sacred"). According to the definition of the realm of necessity, it was noted that it is not unique. Figure 12 with $N = 4$ shows examples of the realm of necessity in four cases: a) there is space compression and a moral code; b) there is no compression, there is a code; c) there is compression, there is no code; d) there is no compression and no code. The traditionalist plan of history implies the realization not of an arbitrary realm of necessity, but only one in which there is a contraction of space and the moral code of the actor is absent, i.e. case c) in Figure 12 or configuration (18) in the general case.

The moral code of the actors, in the sense in which it was formulated above, is the ethics of the *status quo*. As will become clear later, the ethics of the *status*

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quo does not extend to the two target sets of actors of the realms of freedom and necessity. For them, their own ethical principles will be formulated, which, in contrast to the ethics of the *status quo*, have the universal properties of global metahistorical goals.

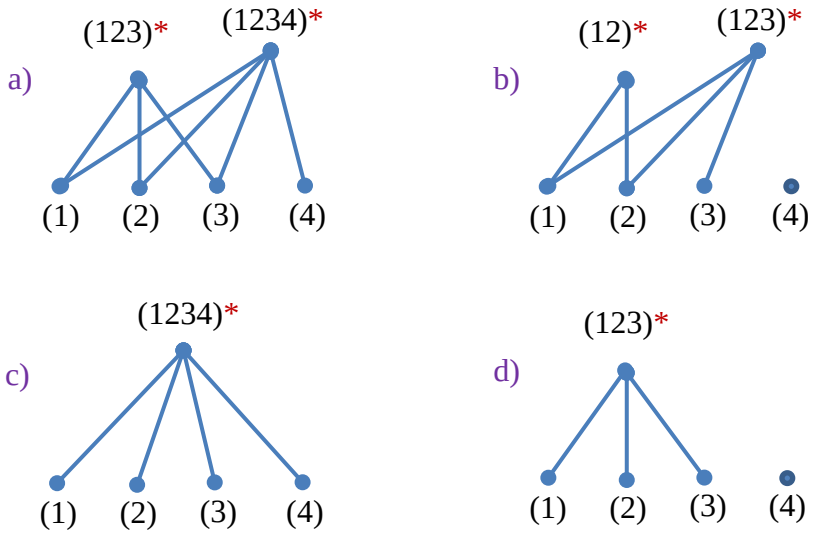


Figure 12: Examples of realms of necessity

VIII. The Choice between the Realms of Freedom and Necessity

Let us discuss the choice between the realms of freedom and necessity. Let's start with the geopolitical reasons for the choice. Imagine mentally two limiting geographic locations of land and sea on the surface of the Earth. The first geography is as follows: islands, more or less the same in area, are scattered evenly over the surface of the Earth. In the second geography there is one large island-continent (for example, in the past, according to some specialists in geophysics, the pro-continent was Pangea). Most of the actors of the first geography are characterized by an orientation towards a progressive metahistorical plan of development, while for the majority of actors of the second geography they are oriented toward a traditionalist metahistorical plan. On the site [26], from the point of view of the theory of plate tectonics, there is a multiplication of the movement of continents on the surface of the Earth in time, where both extreme forms of geography are clearly visible.

Now we can comprehend from the geopolitical point of view the geography in which we live. It is clear that the configuration of land and sea is such that it is neither island nor continental, while it has both components. During the period of space contraction, it is not clear *a priori* what choice will be made. Space compression is the culminating point of confrontation between insular and continental geopolitical devices. The confrontation itself is understood and formulated primarily in the works of the largest geopoliticians, such as F. Ratzel, J.R. Kjellén, H.J. Mackinder, K. Haushofer and some others. More details about geopolitics in terms of climate, relief and traffic can be found in the work of the author [6].

Let's imagine a confrontation scheme. Let the geopolitical system have the following simple structure $\{(1)^*, (2)^*, \ldots, (n)^*, (n+1,\ldots, N)^*$ and other unions are not actors$\}$, (19)

where $1 << n << N$. In (19) $(1)^*,\ldots,(n)^*$ are one-rank actors oriented towards the realm of freedom; $(n+1,\ldots,N)^*$ is a high-ranking actor oriented towards the realm of necessity. The confrontation between them will consist in mutual challenge and response. Thus, a high-ranking actor can respond to a challenge from one-rank actors by disintegration, for example, in the following way:

$$(n+1,\ldots,N)^* \rightarrow (n+1,\ldots,m)^*, (m+1,\ldots,N)^*, \quad (20)$$

where $n+1 < m < N$. To a challenge from a large-ranked actor, single-ranked actors can respond by combining, for example, according to the following scheme:

$$(1)^*,\ldots,(n)^* \rightarrow (1\ldots n)^*. \quad (21)$$

If according to scheme (20) the realm of freedom is approaching, then according to scheme (21) — the realm of necessity. Which of the schemes (20), (21) will work depends on what exactly these or those actors will offer each other, i.e. what exactly will be their challenge to each other. It is clear that both schemes (20), (21) do not fit into the moral code of the actor, because the existence of the original actor(s) after the collapse (combination) ceases. Thus, the mutual actions of actors according to the challenge-response scheme in

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the "island-continent" confrontation are, generally speaking, morally evil.

Let us take into account the grounds for choosing from the side of possible catastrophic changes in the biosphere. It has already been noted above that the answer to the challenge from the biosphere will be such a restructuring of the global geopolitical system, which is deliberately oriented towards the traditionalist metahistorical plan, i.e. towards the realm of necessity. By itself, this restructuring does not mean the coming of the realm of necessity, but its trace may play an important role in the moment of space compression.

Let us take into account the power component of choice. From the foregoing, it is clear that the invasion of the transcendent can occur anywhere, but this breakthrough is most likely in continental regions. The superpower gap in the power-volitional infrastructure of the world can have a decisive impact on the choice at the moment of space compression. However, the outcome of the choice is unclear, and there may be several such gaps. If there is only one such gap, then in the period of the communication limit it can definitely push the choice towards the realm of necessity.

Let's sum up the intermediate result. It became clear that it was necessary to speak not just about choice, but about Choice with a capital letter. It lasts a finite time, during which space is compressed and the communication limit is reached. At the same time, the Choice cannot occur without space compression, and the space compression is primarily due to the Choice. At the moment of the Choice, the space is drawn into a "point", both metahistorical goals of the realms of freedom and necessity become available for realization simultaneously. There is a final presentation by actors to each other of arguments for and against ultimate metahistorical goals. Next comes the most important thing — the Choice itself. Its outcome is a mystery, it is fatal and irreversible. The person after the Choice will become different irrevocably. All previous history is a preparation for the outcome of the Choice, while the actors will solve not just some ethical problem, but the Metaethical problem of the whole history.

So, in addition to the moral code of the actor, outlined above, there is the Metaethical problem of the outcome of the Choice. Each of the actors at the time of the Choice must decide on its outcome and present those arguments that he considers decisive for this. We do not know all these arguments, but some of them are already obvious. These are such dilemmas of choice as "liberalism – autocracy", "science – religion", "secular – sacred", "harmony – disharmony" with the biosphere, "good – evil" within the actor's moral code, present and future weapons of mass destruction, genetic engineering, eugenics, parapsychology, drugs, and some others.

IX. Space and Time of Actors

Let's move on to a deeper study of the space and time of actors. Figure 13 schematically shows the space of all sets of actors *W*, the number of elements in which is $2^{2^N-1}-1$. Two special points are singled out: the realm of freedom and the realm of necessity (hereinafter we will use the abbreviated names "r.f." and "r.n.", respectively). It is believed that for r.f. $A=S_1$, i.e. all geopatoms are actors and there are no other actors, for r.n. $A=S_N$, i.e. in r.n. one and only actor embracing all geopatoms.

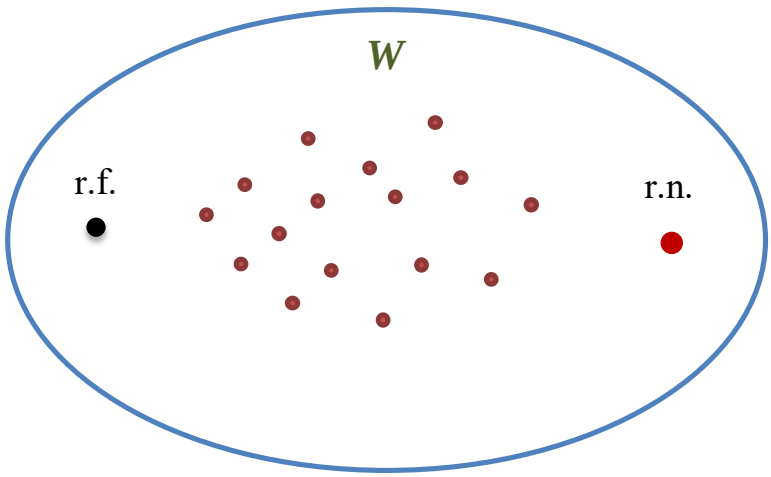


Figure 13: Actor space *W*

Since actors are born and die, from the point of view of an external observer, one can speak of a chain of changes in the sets of actors, i.e.

$$\ldots \to A_{-1} \to A_0 \to A_1 \to \ldots, A_l \in W, l = 0, \pm 1, \ldots$$

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In this case, $l = 0, \pm 1, \ldots$ is the time of the actors, $A_l, l = \ldots, -2, -1$ are the past; A_0 is the current one, $A_l, l = 1, 2, \ldots$ are the future sets of actors.

Let us discuss what are the reasons for the arbitrary transition $A_l \to A_{l+1}$, $l = 0, \pm 1, \ldots$? By analogy with how the reasons for the transition from one configuration to the next were analyzed within the framework of the historical process, we will define a certain typology of the reasons for changing the sets of actors. Let us present such a typology in the form of four aspects of the historical dynamics of actors. Let's call them

- *resource*,
- *psychodynamic*,
- *target* and
- *gaming*.

The resource and psychodynamic aspects are related to the objective conditions for the existence of actors. The game aspect is entirely responsible for the struggle of actors among themselves in their competition for resources. And, finally, the target aspect describes the desire to implement the global goals of the community of actors, i.e. striving to build either the realm of freedom (r.f.) or the realm of necessity (r.n.).

Now we can understand that the point depicting a certain set of actors A_l ($l = 0, \pm 1, \ldots$) in Figure 13 does not just randomly drift on the set *W*, but has some attracting and repulsive ones — in the face of r.f. and r.n. — goals. Consider the r.f. and r.n. as what they are, i.e. already implemented as goals. Their implementation as goals implies that they must be there. The necessity of goals is the essence of the progressive and traditionalist metahistorical plans.

The need for r.f. suggests that the actors "insist" that there are exactly as many of them as there are geopatoms, so that they are geopatoms. This means that in the event of a violation of this state of affairs, there must be an effective mechanism for returning to the r.f. Under violation of r.f. is understood as any event caused by the resource, psychodynamic or game aspect of the historical dynamics of actors. Since the return mechanism can be applied to any element of the set *W*, it must have universal properties. What are these properties? In general, we will characterize such properties, following J. Habermas [27] and other sociologists, by the term "rational discourse" in contrast to the opposite term "irrational intuition". The meaning of the terms "rational discourse" and "irrational intuition" is manifested in the nature of the unions that geopatoms make among themselves. Figure 14 shows examples of unions of rank *N*, which were formed on the basis of rational discourse and irrational intuition, respectively.

In Figure 14,a, geopatoms-actors voluntarily enter into an alliance (12…*N*), rationally agreeing on the appropriate deductions of the resource to ensure the existence of the alliance. In Figure 14,b, the existence of the union-actor (12…*N*)* from the point of view of geopatoms is absolutely irrational, because they a priori proceed from the fact that the union-actor already exists, and it is not they (geopatoms) who transmit the corresponding resource, but the union-actor transfers their own resource to them, based on their goals. Irrational intuition is characterized by sensory experience of such concepts as "homeland", "nation", "faith", "state", etc.

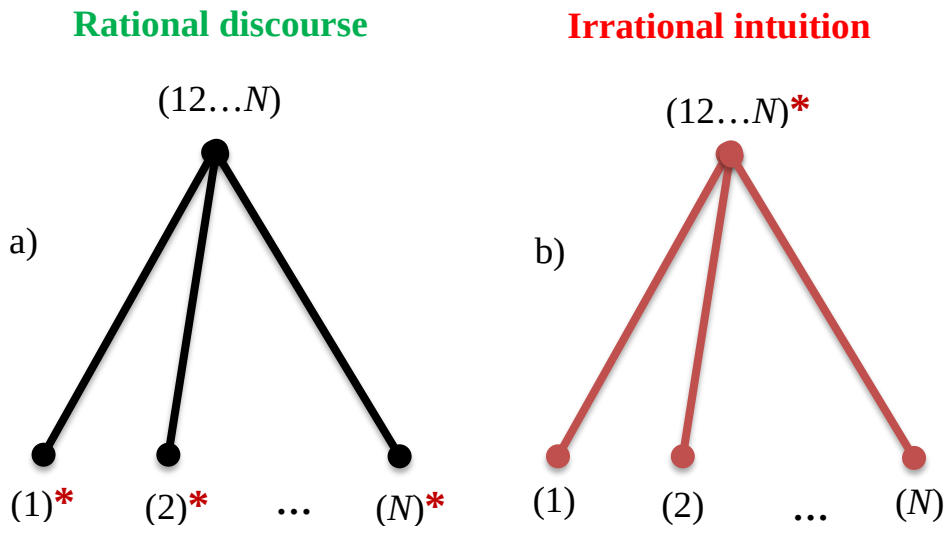


Figure 14: Two geopolitical configurations illustrating two ways of communication

The mechanism of return to the r.f. with various kinds of violations is a universal methodology of rational discourse, which calls into question the existence of any non-geopatoms actors. The mechanism of return to the

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r.f. with various kinds of violations is a universal methodology of rational discourse, which calls into question the existence of any non-geopatoms actors. The procedure of rational discourse cannot be applied only to geopatoms-actors, because they are by definition indivisible and indestructible. The application of the methodology of rational discourse cannot be considered as a kind of ideology in itself, automatically working. It requires from its participants, i.e. from geopatoms - actors, constant vigilance. Vigilance in the sense that this methodology remains authentic, and not alienated from its bearers — geopatoms - actors. In general, the mechanism of alienation is associated with the dual nature of man, both this- and otherworldly creatures. Options for weakening vigilance were discussed by J. Habermas [27] in the critique of "functional reason", as well as by M. Horkheimer [28] in the critique of "instrumental reason" and some others. We can say that rational discourse is a method of declaring a permanent choice in favor of the r.f. for various kinds of disorders.

It would be naive to think that rational discourse is a natural tool of communication. It is highly unnatural and requires constant support for itself. In particular, rational discourse receives this support in ethics, in which an appeal is made to the duty of a person to be reasonable, i.e. to the ethics of "Homo sapiens". Figure 15 shows a diagram of the mechanism for returning to the r.f. for various kinds of disorders.

The need for a target setting of the traditionalist plan presupposes that the central and only union-actor "insists" that the it (union-actor) exists. This means that there is a mechanism for returning to the r.n. for various kinds of disorders. Under violation of r.n. any event caused by the resource or psychodynamic aspect of the historical process is understood. As in the case of the r.f., the mechanism for returning to the r.n. must be universal, because it can be applied to any element of *W*. The basis of the mechanism of return to r.n. is an irrational intuition, the action of which is expressed in the merger of all those actors that, for one reason or another, were formed as a result of a violation of the previous r.n. Irrational intuition is a way of declaring a constant choice in favor of the r.n. for various disorders.

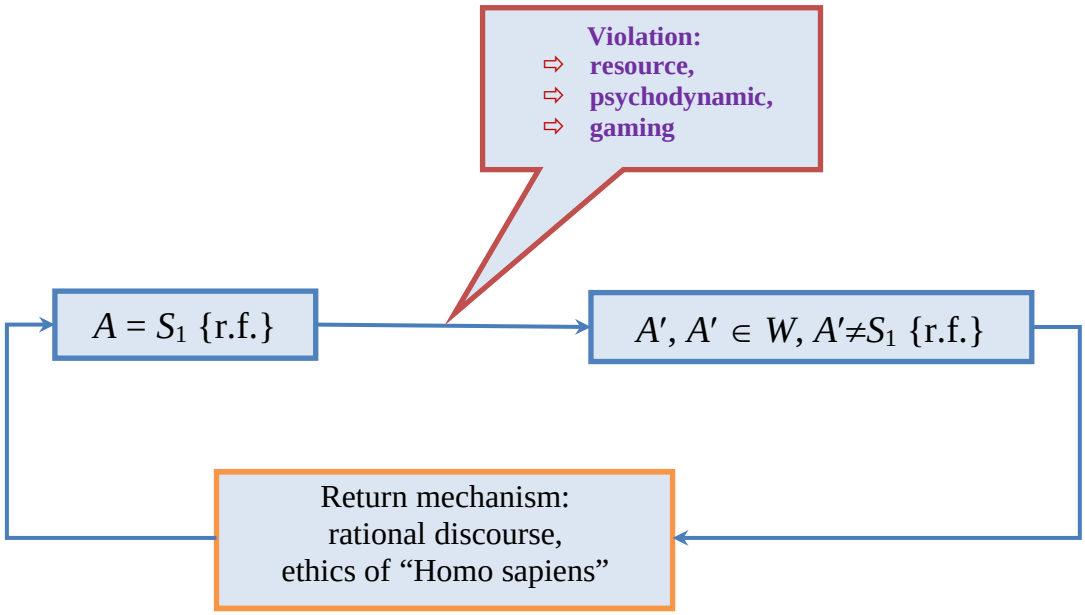


Figure 15: Scheme of the mechanism for returning to the r.f. for various types of disorders

Irrational intuition is not natural, it, like rational discourse, is subject to alienation, which is expressed in its support from the sacralized ethics of the duty of faith in the "Supreme Being". Figure 16 shows a diagram of the mechanism for returning to the r.n. for various kinds of disorders.

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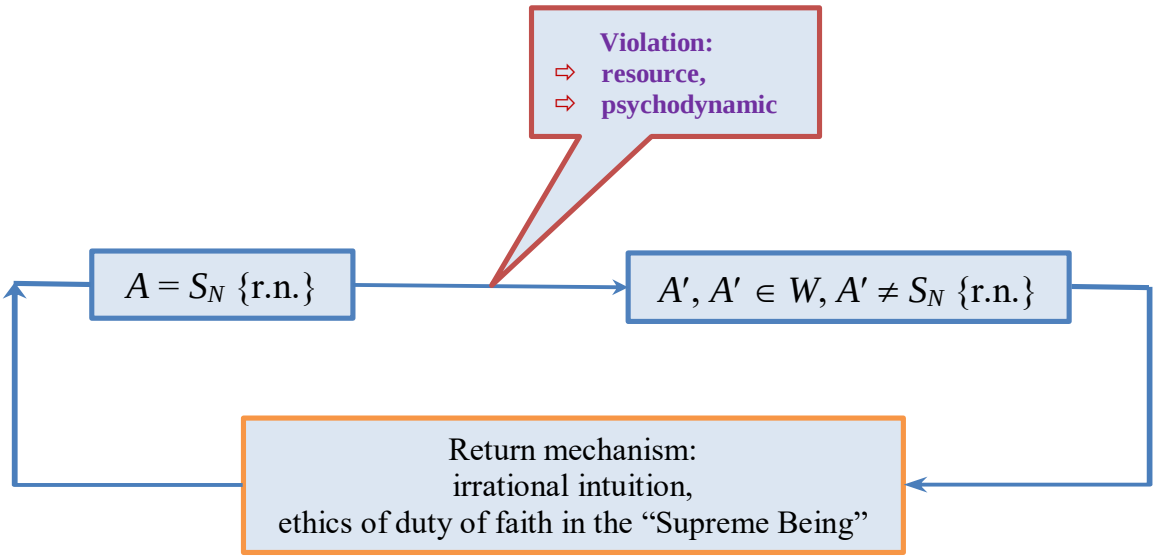


Figure 16: Scheme of the return mechanism in the r.n. for various types of disorders

Earlier, we found out that for any set of actors *A* from the space *W*, a certain effort is required in order to be. This is expressed in the fact that any non-target set of actors has its own *status quo* ethics, and the target sets of r.f. and r.n. — the ethics of "Homo sapiens" and the ethics of belief in the "Supreme Being", respectively. Thus, each non-target element of the set *W* persists, according to Vl.S. Solovyov [29], in its separateness and independence. Since there are two target elements in the space *W*, any other elements can persist in their separateness, representing the *status quo* or the dynamic balance of two forces directed towards the r.f. and r.n. respectively.

Figure 17 shows a diagram of the field of forces acting from the r.f. and r.n. to other non-target elements of the set *W*.

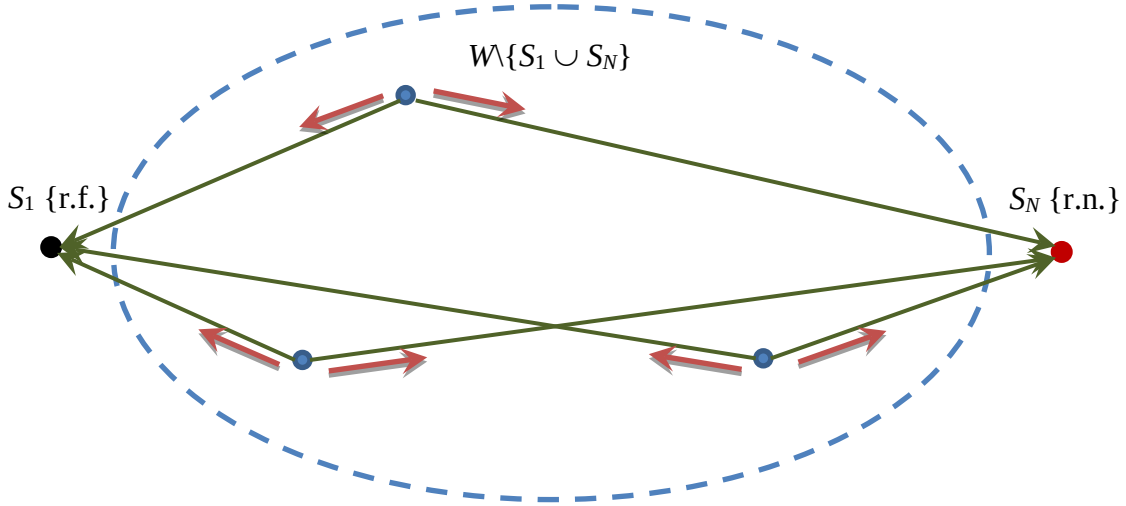


Figure 17: Scheme of the field of forces acting from the side of the r.f. and r.n.to other non-target elements of the set *W*

Let us now mentally assume that one of the target elements of the set *W* is fully realized. This means that any other elements of the set *W* cannot rely on the *status quo*, i.e. cannot persist in their independence and separateness. They are rather virtual to the extent that the target state has not recovered itself from the violation. In this case, the power tension comes from a single center — r.f. and r.n. respectively. Figure 18 shows the diagram of the force field in these two cases. In each of them, the space and time of the actors, as it were, cease to exist, converging to one of the target elements.

Comparing Figure 17,18, one can see that history as a chain of changes of sets of actors is possible, since both metahistorical goals are actualized, and the choice did not occur. And vice versa, since there is a

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chain of changes of sets of actors independent in their status quo, both metahistorical goals exist, and the choice has not occurred.

Let's pay attention to Figure 17. It can be seen that a non-target point, representing a certain set of actors, in its drift can come either to the r.f. or to the r.n. However, as noted above, due to the mechanism of alienation and under the influence of various kinds of violations, the state of the realized goal is not eternal. Sooner or later, the representative point will leave the past target state and go to the opposite one. As a result, up to non-target elements of the set *W*, the inversion mode will be supported: $\ldots \to \text{r.f.} \to \text{r.n.} \to \text{r.f.} \to \ldots$ In this mode, the selection is permanent. In the inversion mode, the rule of many (r.f.) is replaced by the rule of one (r.n.) and vice versa. At the regional level, the inversion scheme reproduces the historical cycle of various forms of government considered by Aristotle [30].

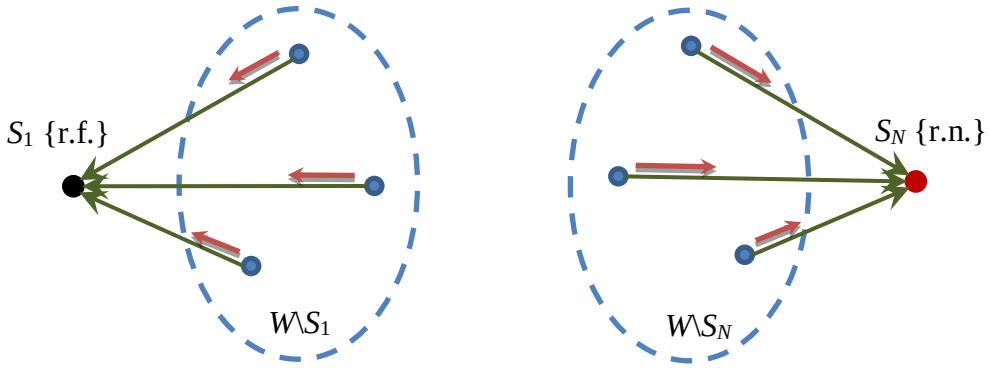


Figure 18: Scheme of the field of forces in the case when the choice is either r.f. or r.n. took place

The choice that has been discussed so far does not serve as the desired one, since it is not irreversible. The possibility of the inversion mode completely discredits the choice, because it loses any eschatological meaning. In this case history is an endless series of transitions: $\ldots \to \text{r.f.} \to \text{r.n.} \to \text{r.f.} \to \ldots$, and choice is only the moment of switching from one target state to another. Since it is possible to overcome the "bad" infinity (Hegel's term) of the inversion regime, sooner or later it will be realized. Let's call this opportunity Choice with a capital letter. So, a person can face a Choice that is irrevocable and irreversible. It is the Choice that makes it possible to overcome the bad infinity of the inversion mode and stop history forever. Is Choice fatal? Both yes and no. Choice is rather the limit of human freedom. A person is free to cross the border, but he is also free not to transgress. If a person refuses to Choice, then he is in the inversion mode from one target state to another, and history, as you know, can wait and wait for a person to decide on a Choice. It is the last decision that is of particular interest and the subject of the Metaethics of the outcome of Choice, formulated in the previous section.

X. Metaethics of Choice Outcome

The essence of the Metaethics of the outcome of the Choice is to completely equalize the chances of winning each of the two target states. Both the realm of freedom and the realm of necessity must persist in their opposition as long as possible, increasing the tension of the struggle without limit. It is in this tension that the hope of overcoming and consummating World history is hidden. And in this lies the Secret of World History. No one knows to what extent the struggle must be brought to bear in order for the Choice to take place. As a result, the Choice is extremely difficult, because it can always end with a banal choice of one of the target states. From this point of view, Choice is a gift, something that is extremely difficult to acquire, but also extremely desirable. Choice, because it is a gift, can be interpreted as a temptation. Since Choice is both a gift and a temptation, it is also a "trap".

We have come to the most important thing — to the removal, to the completion of the Choice. What is Choice? Choice as a confrontation between two can only be realized with the help of a third. This third is the external observer, from whose positions the model has been built so far. The essence of the Choice is that the external observer, as it were, enters the actors of the r.f. and r.n. and, conversely, the actors of the r.f. and r.n. acquire an external observer in themselves. The Choice is reminiscent of the return of the Hegelian absolute idea to itself after its otherness, when the external observer is interpreted as an absolute idea. Figure 19 shows the states of the target sets of actors and the external observer before and after the Choice.

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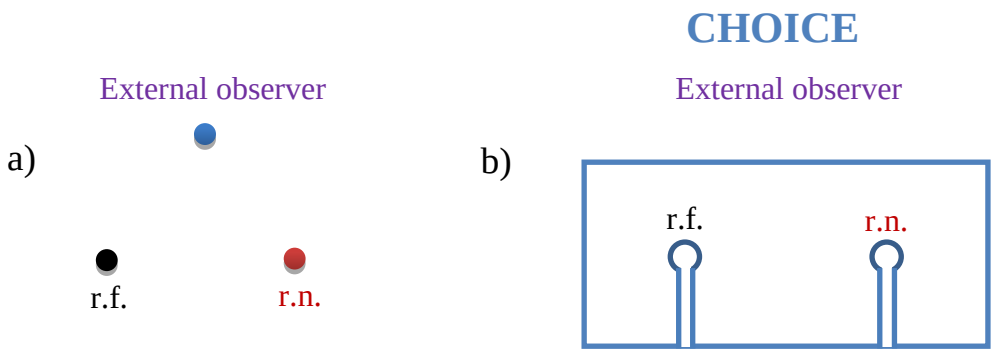


Figure 19: Two target sets of actors and an external observer before and after the Choice

If before the Choice (Figure 19,a) the target states and the external observer oppose each other in mutual alienation, then at the moment of the Choice (Figure 19,b) they acquire each other and become one. Not only target states become a whole, but also all other elements of the space of actors *W*. Thus, an external observer, penetrating all elements of the set *W*, makes them one. But they are united only insofar as they are permeated by an external observer, and as elements of the set *W* they are different.

Here is a symbolic interpretation of the Choice in a mechanistic language. Everyone is well aware of the symbol of the pendulum, which deviates either to the right or to the left. Under the deviation to the left we mean the choice of r.f., by the deviation to the right — the choice of r.n. The endless oscillations of the pendulum symbolize the mode of inversion in global history. Let's turn now to the mechanics. Consider a pendulum that can rotate 360^0 around its fulcrum in the gravitational field. Figure 20 shows an image of an ideal pendulum fixed at the fulcrum *O* and consisting of a weightless rod of length *l*, at the end of which a load of mass *m* is placed.

According to mechanics, the pendulum has its own oscillation frequency $\omega = \sqrt{g/l}$ (*g* — free fall acceleration in the gravity field). Oscillations (or rotations by 360^0) always take place, with the exception of two cases. The trivial case is when the pendulum is at rest and is at point *P*. The non-trivial case of the absence of an oscillatory regime in the dynamics of a pendulum corresponds to a well-defined selection of initial conditions. Let us give the pendulum initially resting at point *P* an angular velocity of either $+2\omega$ or -2ω, where plus corresponds to rotation to the right, and minus to rotation to the left. In these two special cases, the pendulum will indefinitely approach the position of the exact vertical *Z* either from the right or from the left. The formula for the dependence on time *t* of the angle φ of the position of the pendulum relative to the vertical axis is as follows:

$$\varphi = 2\arcsin\left[\frac{\exp(\pm 2\omega t)-1}{\exp(\pm 2\omega t)+1}\right], \qquad (22)$$

where *t* — time.

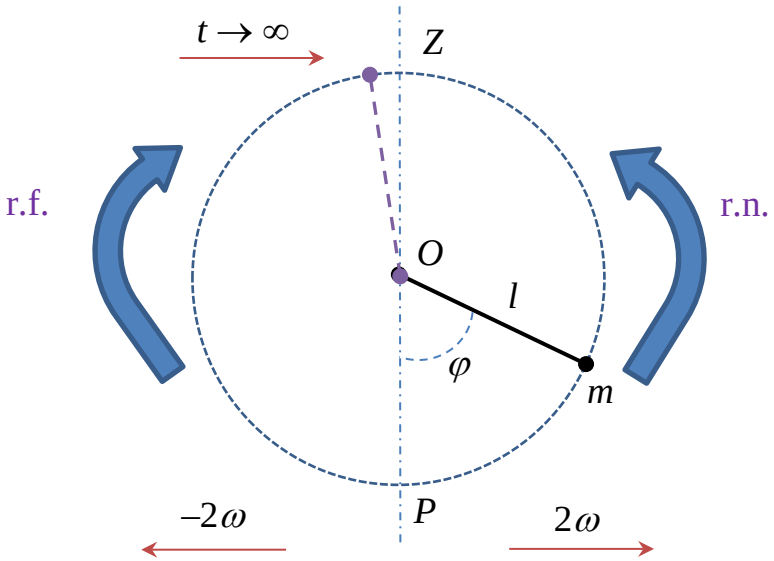


Figure 20: The image of an ideal pendulum fixed at the fulcrum *O*

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Expression (22) is the solution of the pendulum equation $\varphi'' + \omega^2 \sin\varphi = 0$ under the initial conditions $\varphi'(0) = \pm 2\omega$, $\varphi(0) = 0$, which corresponds to the motion along the separatrix. Considering (22) and tending *t* to infinity, we find that $\varphi \to \pm 180^0$. As a result, we have that in such a well-known image as a pendulum, there is an unoscillating mode of motion, which by analogy corresponds to the Choice in our model, and a well-defined selection of initial conditions that provide a non-oscillatory mode of motion — the Metaethics of the outcome of the Choice.

XI. Conclusion

With the onset of the Choice, all actors of the geopolitical system acquire the vision of an external observer of themselves and acquire the attributes of an external observer of complete awareness and disinterest in the historical process. It is in this sense that the End of history comes, which before the Choice was the history of the struggle of a pair of metahistorical goals: the realms of freedom and necessity. The end of history does not mean that the world ceases its physical existence, it only means that the space and time of the actors *W* become one, shrinking into a point. In this case, questions like: what and how many actors are in the geopolitical system are meaningless? Are they born or do they die? The Choice removes the dualism of this-worldly and otherworldly freedom and carries out their synthesis.

The normative model of global history developed in the previous sections was built around the concept of "freedom" and its calculus. The analysis showed that the freedom calculated above is this-worldly freedom. Precisely insofar as it is this-worldly freedom can be equated with information, entropy, and the degree of complexity of an individual actor and the world as a whole. This-worldly freedom is significant for actors because they do not realize their inner relationship, their unity with each other through the experience of otherworldly freedom. The latter will be the subject of study of the model of psiphysics, where a typical actor will be "designed" and the internal unity of an arbitrary number of actors will be shown.

Choice is at the same time a communication limit. But communication is not in the sense in which it was defined above, i.e. type of rational discourse or irrational intuition. So, from the point of view of the Russian philosophical school, the Choice leads to the transformation of logic, it becomes the logic of unity, which, starting with V.S. Solovyov, was also developed in the works of E.N. Trubetskoy, S.N. Bulgakov, P.A. Florensky, S.L. Frank, L.P. Karsavin and a number of other authors. Speaking, for example, in the words of S.L. Frank [31], Choice as a communication limit is "antinomic monodualism — the unity of separateness and interpenetration, transrational hovering over opposites".

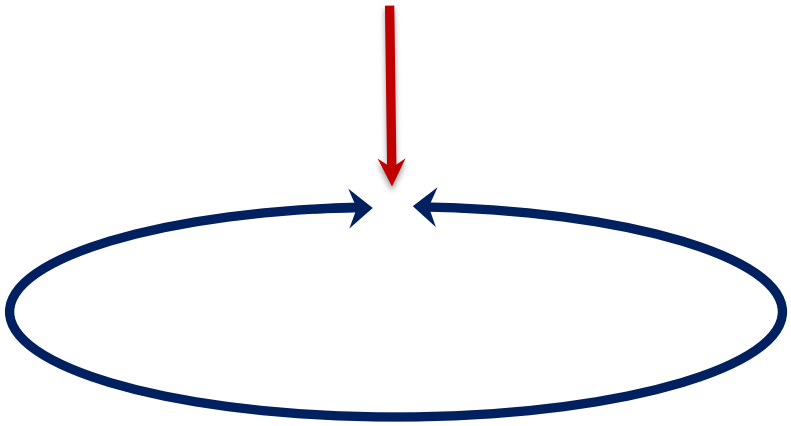


Figure 21: Symbol of the normative model of global history

Figure 21 shows the symbol of the normative model of global history, which illustrates the central event of World history — the Choice, presented as a meeting of three — actors of r.f., r.n. and an external observer.

It is clear that the problem of completing the history does not depend on what and who is understood by the subjects of history, called actors in the model. All conceivable interpretations of actors become unified from the point of view of an external observer entering them at the moment of completion of the historical process. If we follow the philosophy of history of Hegel, then, in essence, the external observer acts as an "absolute idea", or "world spirit", and Choice is the return of the world spirit to itself.

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New Spectro-Electrochemical Setup for Determining the Rate Change of Oxide Film Growth of Aluminum by White Light-Optical Interferometry

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University of Dayton

Abstract- White light interferometry was applied to obtain the rate change of an oxide film growth of aluminum samples during the anodization in aqueous solutions. The thickness (d) of the oxide film was determined by Fabry-Perot, i.e., white light, interferometry. In other words, for the first time, an electromagnetic, i.e., Fabry-Perot, method was utilized to obtain the rate change of the oxide film growth of aluminum samples rather than the electronic, i.e., direct current (DC) or alternating current (AC), methods, as a function of the time (t) of the anodization processes. Therefore, the abrupt rate change of the d(d)/dt was called anodization-emission spectroscopy. The anodization process of the aluminum samples was carried out by the DC method in different sulphuric acid concentrations (0.0,2,4,6,8,10% H2SO4) at room temperature. In the meantime, the Fabry-Perot interferometry was used to determine the difference between d of two subsequent values, d(d), as a function of the elapsed time, dt, of the DC experiment for the aluminum samples in H2SO4 solutions. The Fabry-Perot interferometry was based on a fiber-optic sensor to make real time-white light interferometry possible at the aluminum surfaces in the acid solutions.

Keywords: *fabry-perot interferometry, white light interferometry, oxide film growth, aluminum, sulphuric acid, anodization, fiber-optics sensor, DC method, and SEM.*

GJSFR-A Classification: *DDC Code: 791.4309 LCC Code: PN1993.5.A1*



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New Spectro-Electrochemical Setup for Determining the Rate Change of Oxide Film Growth of Aluminum by White Light-Optical Interferometry

Khaled Habib [α], Waleed Mohammad [σ], Farzia Karim [ρ], Joydeep Dutta [ω] & Partha Banerjee [¥]

Abstract- White light interferometry was applied to obtain the rate change of an oxide film growth of aluminum samples during the anodization in aqueous solutions. The thickness (d) of the oxide film was determined by Fabry-Perot, i.e., white light, interferometry. In other words, for the first time, an electromagnetic, i.e., Fabry-Perot, method was utilized to obtain the rate change of the oxide film growth of aluminum samples rather than the electronic, i.e., direct current (DC) or alternating current (AC), methods, as a function of the time (t) of the anodization processes. Therefore, the abrupt rate change of the d(d)/dt was called anodization-emission spectroscopy. The anodization process of the aluminum samples was carried out by the DC method in different sulphuric acid concentrations (0.0,2,4,6,8,10% H_2SO_4) at room temperature. In the meantime, the Fabry-Perot interferometry was used to determine the difference between d of two subsequent values, d(d), as a function of the elapsed time, dt, of the DC experiment for the aluminum samples in H_2SO_4 solutions. The Fabry-Perot interferometry was based on a fiber-optic sensor to make real time-white light interferometry possible at the aluminum surfaces in the acid solutions. Also, an abrupt rate change of the d(d)/dt of the oxide film of the aluminum in 2.0,4.0,6.0,8.8,10.0% H_2SO_4 and in deionized water (0.0% H_2SO_4) was observed to occur once between 10 to 20 minutes. Then, the d(d)/dt of the oxide film was recorded around zero between 20 to 30 minutes. Eventually, the d(d)/dt of the oxide film was gradually increased during the remaining elapsed time of the experiment.

Keywords: fabry-perot interferometry, white light interferometry, oxide film growth, aluminum, sulphuric acid, anodization, fiber-optics sensor, DC method, and SEM.

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I. Introduction

Several opto-electrochemical spectrometers were developed by the author [1 & 2] for materials evaluation of pure aluminum in aqueous solutions. The spectrometers were developed based on incorporating a phase shift sensor-dependent on coherent (laser) light methods for measuring microscopic deformations and alternating current (AC) methods like electrochemical impedance spectroscopy (EIS) for determining electrochemical parameters of samples in aqueous solutions. Furthermore, the combination of the coherent light methods and the electrochemical techniques was applied not only as opto-electrochemical spectrometers for materials evaluation of pure aluminum in aqueous solutions but also for a surface detection of different 3D-micro-alterations at a spatial resolution equivalent to one half of the wavelength of the laser light used, 0.3mm [1&2]. The developed spectrometers were a double layer (DL) capacitance-emission spectroscopy [1], and a resistance-emission spectroscopy [2], for determining the electrochemical behavior of anodized aluminum in aqueous solution. In the first spectrometer [1], the anodization process of the aluminum samples was carried out by chemical oxidation in different sulphuric acid concentration (0.5-3.125% H_2SO_4) at room temperature. In contrast, the second spectrometer [2], the anodization process of the aluminum samples was carried out by the electrochemical impedance spectroscopy (EIS) in different sulphuric acid concentrations (1.0–2.5% H_2SO_4) at room temperature.

Other investigators have studied the anodic dissolution processes of aluminum alloys by using the coherent light methods [3-8]. Only Qualitative results were reported from those investigators [3-8]. In contrast, the opto-electrochemical spectrometers [1&2] of the author were the first attempt to mathematically interpret interferometric patters of the coherent light methods of aluminum samples under the anodic dissolution processes, thus far.

On the contrary, in a recent study, the authors have managed to monitor the growth rate of the aluminum oxide and its corresponding current density

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films during the anodization process by non-coherent (white) light methods, like Fabry-Perot interferometry, i.e., spectral optical-sensor [9-10].

A detection of anodization emission-spectra of oxide films of aluminum samples by non-coherent light methods was the focus of the present investigation. The detection was possible by using a simultaneously combination of non-coherent(white) light method, i.e., Fabry-Perot interferometry, and electrochemical DC methods. More specifically, the combination of Fabry-Perot interferometry and electrochemical DC methods was used as an emission spectrometer for determining the rate change of the growth of oxide films [d(d)/dt] of the aluminum samples in aqueous solution. In this study, an externally applied potential, during the DC test, was applied to produce a thicker oxide layer than the layer that aluminum normally has in the air [11-13]. Also, by detecting the emission spectra of the anodized films of aluminum samples [d(d)/dt versus time of the anodization(t)], one can determine the growth rate [d(d)/dt] behavior of the oxide film of aluminum in real-time, in the solution by white light interferometry.

II. Theoretical Analysis

It is well known that the formation of the oxide film (d) on a metal sample can be measured by Fabry-Perot interferometry as follows [9-10].,.

$$d=[\phi(\omega)\lambda]/[2\pi n_A \cos\theta_2] \quad (1)$$

Where,

$\phi(\omega)$ is the phase difference between the oxide/electrolyte interface.

λ is the wavelength of the incident light.

ν_A is the refractive index of the oxide film.

θ_2 is the reflected angle of the incident light.

So, d can be determined (via Equation (1)) by measuring the reflection parameters of the white light, i.e., $\phi(\omega)$, θ_2, of the oxide film in aqueous solution. Consequently, the emission spectroscopy of the oxide film can be detected by plotting d(d)/dt versus the elapsed time of the DC experiment, where $d(d)=d(t_1)-d(t_0)$ is the difference between d of two subsequent values at t_1 and t_0, respectively. Therefore, a plot of d(d)/dt versus time, will reflect the abrupt rate change, emission spectroscopy, of the growth of the oxide film as a function time.

It is worth mentioning that the reflection of the white light of the oxide film in aqueous solution has been not affected by the porosity nucleation and porosity expansion in the oxide film as the film thickens. In general, the pore sizes were much lower than the white light resolution,0.35mm, in order to the pores to affect the reflection parameters of the white light, i.e., $\phi(\omega)$, θ_2, of the oxide film in aqueous solution.

III. Experimental Procedures

Aluminum samples were cut from a pure aluminum (99.7%) sheets with a specification of 5 cm x 5 cm x 0.15 cm. Then, the aluminum samples were surface treated by a procedure called chemical mechanical polishing (CMP) [14]. The CMP's procedure involves annealing and electropolishing of the samples to smoothen the surface roughness to a mirror-like surface. Details on the CMP's procedure are given elsewhere [14-16]. A range of a potential value was applied during the CMP's procedure. The potential range was selected based to the requirement of current density on the specific area of the samples to produce a mirror-finished surface of aluminum samples during the CMP's procedure. Thereafter, one side and all edges of the samples were coated with a coal tar (black) epoxy (polyamide cured) in order to shield those sides from anodization. Then, the bared side of the sample, i.e., working electrode, was anodized in the presence of 0 (0% is deionized water only), 2, 4, 5, 6, 8, and 10% H_2SO_4 (vol%) solutions at room temperature (about 20°C). The other electrodes of the electrochemical cell were a graphite electrode, i.e., as a counter electrode, and a Saturated Calomel Electrode (SCE), as a reference electrode [9-10]. A potentiostat (EG&G Princeton applied research model 363) was used as a DC power source. The corrosion potential (open circuit potential (OCP)) was monitored, as soon as the sample immersed in the solution, with respect to the SCE. Then, the potentiostat. was used as an external DC power source to apply a 9 V potential with respect to the recorded OCP of the sample in solutions, for 90 minutes. Subsequently, the anodic current was recorded during the anodization process [9-10].

The growth of aluminum oxide film during the anodization of the aluminum samples in solutions was monitored by a combination of a fiber optics-based sensor, for a simultaneous application of the real-time Fabry–Pe´rot interferometry, and the DC electrochemical method [9-10]. The fiber optics-based sensor consists of a fiber set and a collimator, i.e., a collimating lens, that were inserted in a glass tube. The fiber set and the collimator were used not only to reduce the distance of incident light from the sample, but also to transverse the white light to reach the immersed aluminum sample in the electrochemical cell, as shown in Figure 1 [10]. The phenomenon of multiple reflections normally occurs inside the aluminum oxide film as soon as the white light reaches the sample, causing Fabry–Pe´rot effect [17]. A chromium coated-glass slide was used as a three-port beam splitter to split the white light beam into two beams, as shown in Figure 1. The white light source was a 20W Halogen lamp (spectral range from 500 to 900 nm). Besides, the Ocean Optics USB4000 spectrometer was used for analyzing the reflected light from the samples.

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The light was guided and collected in a large core, 1 mm diameter, multimode optical fiber [9-10].

Since the resolution of the high-density spectrometer is 0.2 nm, therefore the sensitivity of the thickness change given by $\Delta\delta/\delta = \Delta\lambda/\lambda$ will yield a sensitivity of approximately 3 $x10^4$ at the central wavelength of (700 nm) the white light source. So, one light beam is transverse to the aluminum sample in the electrochemical cell and the other beam is transverse to a high-density spectrometer, Fig.1. Meanwhile, a reflection spectrum obtained from Fabry–Perot interferometry was recorded by the high-density spectrometer after a specific time interval (every 10 minutes) [9-10]. Subsequently, the thickness (d) of the aluminum oxide film was obtained during the formation of the oxide film [9-10].

Eventually, the abrupt rate change of the growth [d(d)] of the aluminum samples in H_2SO_4 solutions was determined. In addition, a scanning electron microscopy (SEM) was used to determine the final d values of the oxide film of the aluminum samples in H_2SO_4 solutions. It is worth noting that the total bare-surface area of the aluminum samples was 5 cmx 5 cm=25 cm^2. On the contrary, the exposed surface area of the aluminum samples to the H_2SO_4 solution was 22.5 cm^2 9.,. In other words, the unexposed surface area of the aluminum samples to the H_2SO_4 solution was 2.5 cm^2. Therefore, the final d values of the oxide film of the aluminum samples was determined by the SEM at the interface between the exposed surface area and the unexposed surface area of the aluminum samples in 0, 2, 4, 6, 8,10% H_2SO_4 solutions. Figure 2a is an example of a SEM of the final thickness of the aluminum oxide film in 8% H_2SO_4 solution. The diagonal line in the SEM images (Fig.2) represents the interface line between the exposed surface area and the unexposed surface area of the aluminum samples in 8% H_2SO_4 solution. The approach of the SEM measurement of the final thickness of the aluminum oxide film was adopted in the present work to precisely match the d measurement by Fabry-Perot interferometry with respect to the unexposed surface area of the aluminum samples to the acid solutions.

It is worth mentioning that the novelty of the present work lies in the fact that for the first time, spectral interferometry of forming an oxide film was converted to anodization-emission spectroscopy by obtaining the rate change[d(d)/dt] of the forming oxide film of aluminum samples under applied DC potential by white light. In other words, a new electrochemical-emission spectrometer was developed for studying in situ the growth rate [d(d)/dt] of the oxide film of the aluminum in H_2SO_4 solutions. In contrast, the early work of the authors [9]was about the anodization process, i.e., measuring only the oxide film growth, of aluminum sample in 4% sulfuric acid (H_2SO_4) solution by the combination of Fabry-Perot, i.e., white light, interferometry and DC methods at room temperature. Likewise, the measurement of the corresponding current density of the forming oxide film was demonstrated by the authors[10] in 0,2,4,6,8, and 10% sulfuric acid (H_2SO_4) solution by the combination of Fabry-Perot, i.e., white light, interferometry and DC methods at room temperature.

On the contrary, the thickness of cadmium sulfide (CdS) thin films during the growth film was determined [18] by precipitation of the film at a glass substrate. in an aqueous solution of, 30 mM cadmium acetate and thioacetamide solution, at 60°C temperature by only Fabry-Perot, i.e., white light, interferometry.

IV. Results and Discussion

Figure 2 illustrates an example of the thickness of the oxide film of the aluminum samples (anodized in 8% H_2SO_4 respectively) observed by SEM closely correspond to the thickness obtained from optical fiber based electrochemical sensor. Therefore, the proposed sensor based on Fabry-Pérot interferometric technique with the combination DC electrochemical method can successfully measure the thickness of anodic alumina (AAO) film during the anodization process. However, some variation could happen between real time measured thicknesses of AAO compared to SEM measurements since DC electrochemical anodization takes place in a highly resistive environment. The measurement error in case of in-situ measurement of thickness of anodic alumina is ±0.02μm and SEM measurement is ±0.03μm.

Figure. 3. shows plotted data of the thickness of the oxide film (d) versus the elapsed time of the aluminum samples in H_2SO_4 solutions. It is obvious from Fig.3 that the growth of the oxide films has been triggered from the beginning of the anodization time of the aluminum samples by the applied potential of 9 V potential with respect to the recorded OCP of the sample in solutions, for 90 minutes. The growth of the oxide films (d) was observed to increase with increasing the acid concentration in a stepwise manner for all aluminum samples during the elapsed time of the experiment. In other words, the growth of the oxide films (d), in Fig.3, is basically an accumulation of optical waves, i.e., spectra, of the Fabry-Perot interferometry as indicated in Equ.1.

In general, that the final thickness of the Al_2O_3 films (d) in 0.0% H_2SO_4, (0.925μm), 2.0% H_2SO_4, (2.135 μm), 4.0% H_2SO_4, (2.34 μm), 6% H_2SO_4, (2.1 μm), 8.0% H_2SO_4, (2.661 μm), and 10% H_2SO_4, (3.8 μm) was recorded to increase as the concentration of the H_2SO_4 increased. The final thickness of the Al_2O_3 films (d) by Fabry-Perot interferometry was found in a good agreement with those measured by SEM, in 0.0% H_2SO_4,(0.925□m), 2.0% H_2SO_4, (2.14 μm), 4.0% H_2SO_4, (2.34 μm), 6% H_2SO_4, (2.07 μm), 8.0% H_2SO_4, (2.7 μm),and 10% H_2SO_4,(3.81 μm). It seems that the final thickness of the Al_2O_3 films (d) by Fabry-Perot

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interferometry and SEM in 2.0,4.0,6.0,8.0,10% H_2SO_4, is ranged from 100 to 300% higher than that in 0.0% deionized water. This is because of the high resistance of the water in comparison to the acid solutions.

The final growth rate[d(d)/dt] of the Al_2O_3 films in 2.0% H_2SO_4 (20.1 nm/min.), 4.0% H_2SO_4, (24.3 nm/min.), 6% H_2SO_4 (19.8 nm/min.),8.0% H_2SO_4 (30.1 nm/min.),and 10% H_2SO_4 (38.7 nm/min.) was recorded to increase as the concentration of the H_2SO_4 increased, except for the Al_2O_3 films [d(d)/dt] in 6.0% H_2SO_4,(19.8 nm/min),in which the entire d(d)/dt was found lower than the rest of the obtained d(d)/dt. This abnormality can be explained due to the final thickness values of the Al_2O_3 films (d) in 6% H_2SO_4 by Fabry-Perot interferometry (2.1□□m), and in 6% H_2SO_4,(2.07 μm) by SEM were lower than the rest of the obtained d by Fabry-Perot interferometry and SEM, respectively.

In contrast, Figure. 4. shows plotted data of the d(d)/dt versus the elapsed time of the aluminum samples in H_2SO_4 solutions. From Fig. 4, one can determine the abrupt rate change of the growth rate of the oxide film of the aluminum samples in different solutions as a result of the anodization process. In other words, the rate change of the growth of the oxide films (d(d)/dt), in Fig.4, is basically the first derivative of the optical waves, i.e., spectra, with respect to time. Therefore, any abrupt rate change of emitted spectra was called emission-spectroscopy as a result of the anodization processes.

In general, the rate change of the d(d)/dt was observed, from Fig.4, to increase in responding to the increase of the acid concentration for all aluminum samples during the elapsed time of the experiment. On the contrary, an abrupt rate change of the d(d)/dt of the oxide film of the aluminum in 2.0-10.0% H_2SO_4 and in deionized water (0.0% H_2SO_4) was recorded in one occasion. The abrupt rate change was observed only to occur between 10 to 20 minutes. The observation of the abrupt rate change in Fig.4 could happen as a result of an unstable transient condition during the Al_2O_3 formation, i.e., crazing of Al_2O_3 film [11 &12]. Then, the d(d)/dt of the oxide film was recorded around zero, [d(nearly constant value=18 nm/min)/dt], between 20 to 30 minutes. Eventually, the d(d)/dt of the oxide film was gradually increased during the remaining elapsed time of the experiment.

V. Conclusions

1. For the first time, the combination of the Fabry-Perot, white light, interferometry and DC techniques was used to develop a new spectrometer for studying in situ the growth rate [d(d)/dt] of the oxide film of the aluminum in H_2SO_4 solutions.
2. The abrupt rate change of the d(d)/dt of the oxide film represents the anodization–emission spectroscopy, during the simultaneous recordings of Fabry-Perot interferometry and the DC tests, of the aluminum samples in different H_2SO_4 solutions.
3. In general, the rate change of the d(d)/dt was observed to increase with increasing the acid concentration in a stepwise manner for all aluminum samples during the elapsed time of the experiment.
4. On the contrary, the abrupt rate change, d(d)/dt, of the oxide film of the aluminum in 2.0-10.0% H_2SO_4 and in deionized water (0.0% H_2SO_4) was recorded once.
5. The abrupt rate change was observed to occur between 10 to 20 minutes. Then, the d(d)/dt of the oxide film was recorded around zero [d(nearly constant value=18 nm/min)/dt], between 20 to 30 minutes. Eventually, the d(d)/dt of the oxide film was gradually increased during the remaining elapsed time of the experiment.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Compliance with Ethical Standards

The authors have no objection of the following issues:

1. To “disclosure of potential conflicts of interest”.
2. To declare “research involving human participants and/or Animals”.
3. To take any action concerning the submitted article by “informed consent “.

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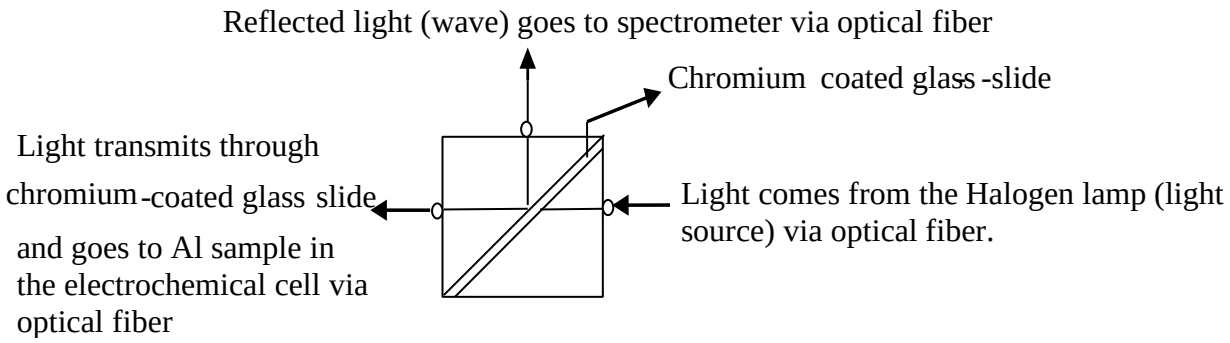


Fig. 1: The optical fiber setup of transverse light from the Halogen lamp to the spectrometer and the Al sample through a beam splitter

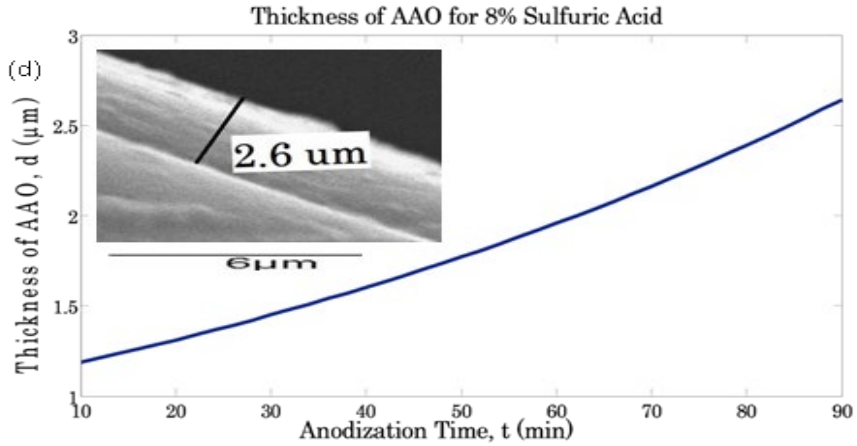


Fig. 2: An image of SEM of the final Al_2O_3 film thickness of aluminum in 8% H_2SO_4 solution, respectively

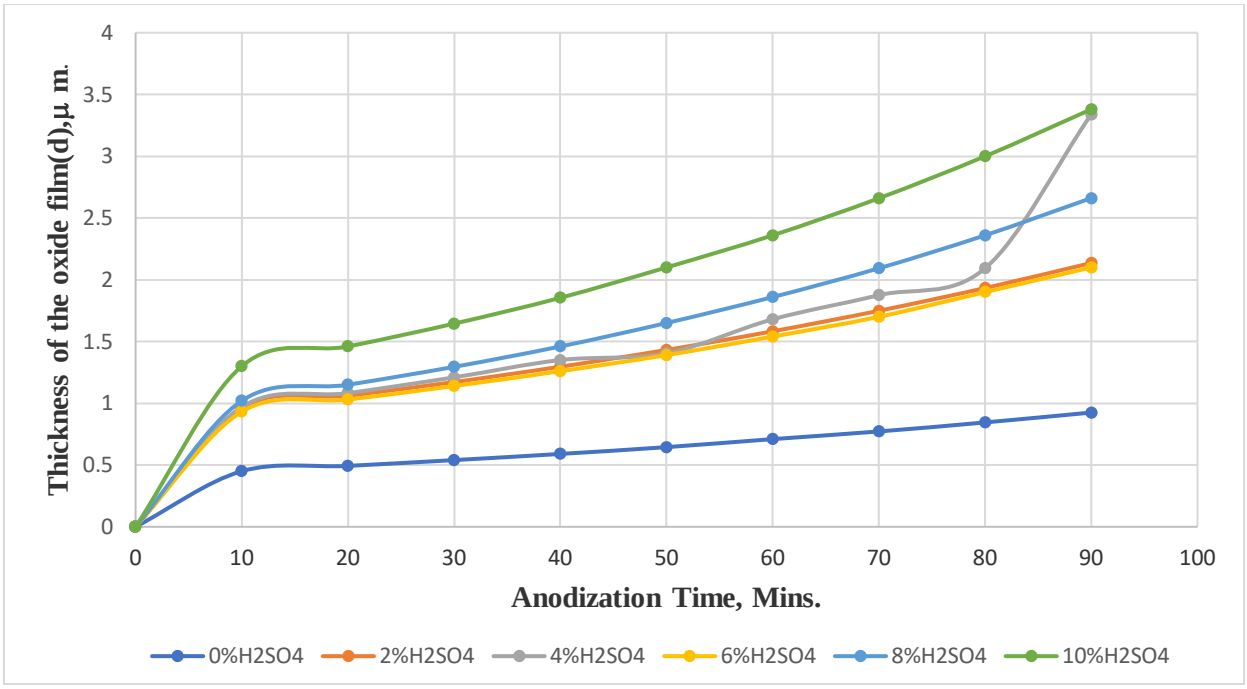


Fig. 3: Growth of the Al_2O_3 films (d) during the anodization time of Al sample in 0.0,2.0,4.0,6.0,8.0, and 10% H_2SO_4 solutions

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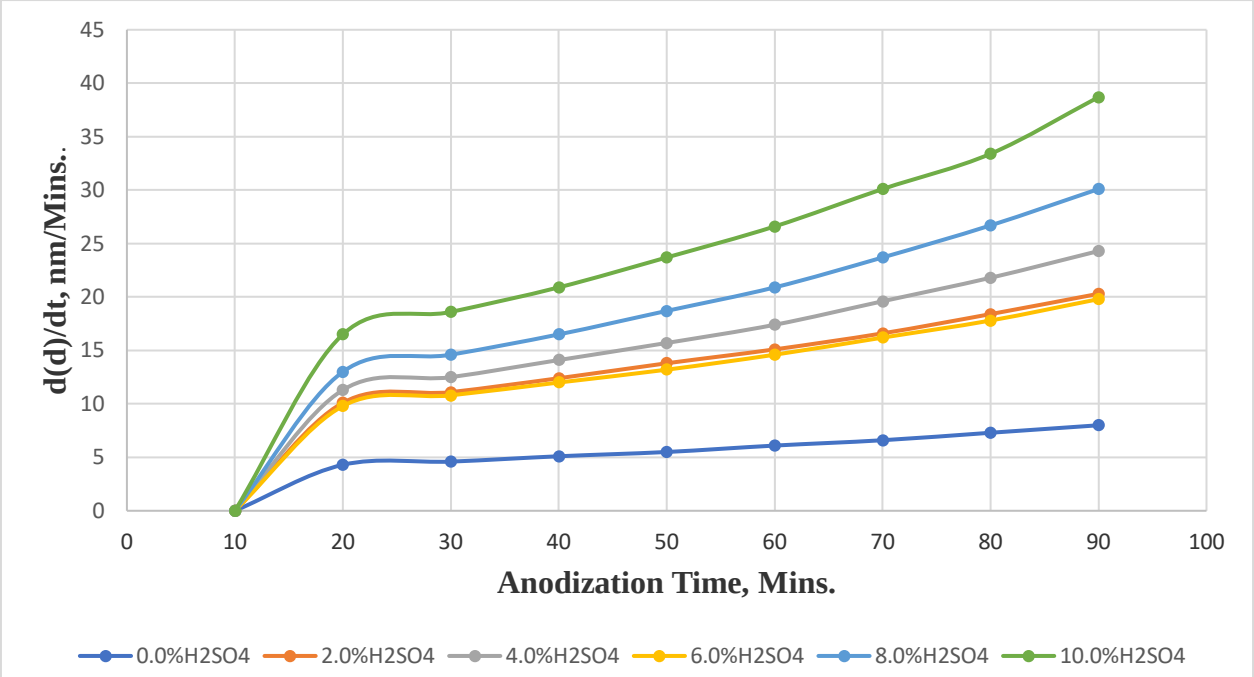


Fig. 4: Growth rate (d(d)/dt) of Al_2O_3 films during the anodization time of Al sample in 0.0,2.0,4.0,6.0,8.0, and 10% H_2SO_4 solutions

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Zeeq Un Nafas (Asthma) and their Understanding in the Past: *Unani* Concept

By Rahat Raza, Farah Ahmad, Yasmeen Ansari & Danish K Chishti

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Abstract- The Unani System of Medicine pioneered in Greece and was developed by Arabs into an elaborate medical science based on the frame work of the teaching of Buqrat (Hippocrates) and Jalinoos (Galen). Since that time Unani Medicine has been known as Greco-Arab Medicine. This system is based on Hippocratic theory of four humours viz. blood, phlegm, yellow bile and black bile, and the four qualities of states of living human body like hot, cold, moist and dry. They are represented as earth, water, fire and air, the Greek ideas were put by Arabian physician as seven principles (Umoor-e-Tabbiya) and included, element (Arkan), temperament (Mizaj), humours (Akhlat), organs (Aaza), sprit (Arwah), faculties (Qowa) and functions (Afaal). In this system is it believed that, these principles are responsible for the body constitution and its health, as well as, diseased conditions (Ishtiyaq, 1983) The term 'ZeequnNafas' is composed of two words 'Zeeq' and 'Nafas' meaning 'narrowing' and 'breathing', respectively. In other words, it means difficulty in breathing. ZeequnNafas is mentioned by the ancient physicians and philosophers like Buqrat (Hippocrates - 460 – 377 BC) and Jalinus (Galen - 129–210 AD). Buqrat described this disease as breathlessness. (khan, 2003) In unani classics, Ta'deel- Mizaj (correction of temperament) is required and TanqiaMawad (cleansing of viscous humour), Mulattif, MunaffisBalgham and MukhrijBalgham drugs are recommended.

Keywords: *asthma; unani; unani medicine; greco-roman medicine; prevention, diet.*

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Zeeq Un Nafas (Asthma) and their Understanding in the Past: *Unani* Concept

Rahat Raza [α], Farah Ahmad [σ], Yasmeen Ansari [ρ] & Danish K Chishti [ω]

Abstract- The Unani System of Medicine pioneered in Greece and was developed by Arabs into an elaborate medical science based on the frame work of the teaching of Buqrat (Hippocrates) and Jalinoos (Galen). Since that time Unani Medicine has been known as Greco-Arab Medicine. This system is based on Hippocratic theory of four humours viz. blood, phlegm, yellow bile and black bile, and the four qualities of states of living human body like hot, cold, moist and dry. They are represented as earth, water, fire and air, the Greek ideas were put by Arabian physician as seven principles (Umoor-e-Tabbiya) and included, element (Arkan), temperament (Mizaj), humours (Akhlat), organs (Aaza), sprit (Arwah), faculties (Qowa) and functions (Afaal). In this system is it believed that, these principles are responsible for the body constitution and its health, as well as, diseased conditions (Ishtiyaq, 1983) The term 'ZeequnNafas' is composed of two words 'Zeeq' and 'Nafas' meaning 'narrowing' and 'breathing', respectively. In other words, it means difficulty in breathing. ZeequnNafas is mentioned by the ancient physicians and philosophers like Buqrat (Hippocrates - 460 – 377 BC) and Jalinus (Galen - 129–210 AD). Buqrat described this disease as breathlessness. (khan, 2003) In unani classics, Ta'deel-Mizaj (correction of temperament) is required and TanqiaMawad (cleansing of viscous humour), Mulattif, MunaffisBalgham and MukhrijBalgham drugs are recommended. Sometimes Muqi (emetics) are recommended for evacuation of Balgham.Mohallil-e-Auram and Daf-Tashannuj are also recommended. (sena, 1411) In this article authors describe about the concept, risk factors,causes, pathophysiology and classification of Asthma.

Keywords: asthma; unani; unani medicine; greco-roman medicine; prevention, diet.

I. Aetiology

In Unani system of medicine treatment of the diseases of known etiology is based on administration of drugs having actions contrary to etiological changes i.e. known as Ilaj-Bil- Zid. According to this principal of treatment, Unani scholars have designed various formulations comprising of drugs with hot and dry temperament for asthma which temperament is cold and moist.) (SENA, 1957).

- The patient should be kept in clean, calm and airy room free from air pollution during attack of the disease.
- Ta'deel-e-Mizaj (correction of temperament).
- TanqiaMawad (cleansing of viscous humour), Mulattif, MunaffisBalgham and MukhrijBalgham drugs are recommended.
- Sometimes Muqi (emetics) are recommended for evacuation of Balgham.
- Mohallil-e-Auram and Daf- e-Tashannuja real so recommended.
- Treat the underlying cause in case of ZeequnNafasShirki.
- Avoid exposure to excessive heat and cold.
- Avoid constipation.
- Avoid mental and physical stress.
- Avoid use of citrus fruits, oily food and red chilies.
- Avoid use of diuretics because it may increase the consistency of Balgham

a) Dietary recommendations

Recommended Diet Ghiza-e-Lateef (easily digestible), Musakhkhin (heat producing) were recommended to the patients, such as Maa-ush-Shaeer (barley water), Maa-ul-Asl (honey water), Chuqandar (Beet root) chicken soup; almond oil, spinach, Kaddu (pumpkin), Saib (apple), Behi (quince), Hareera, mutton soup, etc. (sena, 1411)

b) Dietary restrictions

The patients were advised to avoid cold and phlegm producing flatulent food items, such as lemon, chilled water, grapes, orange, oily foods and red chili.

Tahaffuz (Prevention/Precaution):

Indigestion, Fikr (mental stress), Kasrat-iJimā' (Excessive coitus), Ta'b(exertion), Gham o Alam (Grief & Sorrow), AfkārMushawwisha (Apprehensions)and factors causing Yubūsat (dryness) to be avoided. (Ishtiyaq, 1983)

II. Risk Factors

As people with asthma have inflamed airways which are sensitive to things which may not bother other people. These things are "triggers." These triggers vary from person to person. Some people react to only a few things while others react to many.

It can be triggered by allergens (things people can get allergic to), irritants (things that irritate the airways), and certain other situations (which cause asthma through quite complicated means). Commonest are:

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1) Exposure to some of the outdoor factors like pollens from plants, trees and grasses, including freshly cut grass and mould etc.
2) Exposure to some of the indoor factors like animal dander from pets with fur or feathers, dust and dust mites specially in carpeting and pillows etc., Cockroach droppings, Indoor mould etc.
3) Exercise: like running or playing hard, especially in cold weather
4) Upper respiratory tract infections (URTI): It commonly includes tonsillitis, pharyngitis, laryngitis, sinusitis, otitis media, and the common cold or flu
5) Emotional upset: the commonest are anger, sadness or fear
6) Irritants: like strong smells and chemical sprays; perfumes, paint and cleaning solutions, cold air. Lawn and turf treatments, Chalk dust, weather changes, cigarette and other tobacco smoke.

III. Pathophysiology

"Asthma" is a Greek word derived from the verb "aazein" which means to exhale with open mouth and to pant. Buqraat (Hippocrates- a Greek physician) was the first to name this disease as 'panting' which means breathlessness. Later on many Unani scholars keenly studied about Asthma and mentioned it in their books.

Zeeq-un- nafas (Bronchial Asthma) is a chronic lung disease characterized by episodes of acute broncho constriction causing shortness of breath, cough, chest tightness, rapid respirations and wheezing (appreciated on auscultation of the chest is the most common physical finding). In other words it is chronic inflammation of the bronchial tubes (airways) that cause swelling and narrowing (constriction) of the airways. It is a disease that affects the lungs by allergies or infections resulting in narrowing of airways which causes difficulty in breathing and cough. It is a well-known hypersensitivity disorder characterized by ventilator insufficiency.

In many asthma patients, timing of the symptoms of disease is closely related to physical activity. Even, some healthy people can develop asthma like symptoms only when exercising. This is called exercise-induced asthma (EIA) or exercise-induced bronchoconstriction (EIB).

The disease is influenced by multiple genetic developmental and environmental factors. It affects over 300 million people around the world. One in every four urban children is asthmatic. Current estimates suggest that 300 million people worldwide suffer from Bronchial Asthma and in addition 100 million may be diagnosed with Bronchial Asthma by 2025. An increasing prevalence and severity of asthma has been reported worldwide.

Unani scholars are well known about it since last 3500 years, where asthma like symptoms were recorded in an Egyptian Manuscript called "Eberus Papyrus". At present asthma has spread globally. It affects approximately 4% of the total world population.

The affected people belong to various age groups, but children and elders are more prone. (nafees, 1324).

IV. Classification

Rabban Tabari (838–923 AD) has described various types of ZeequnNafas: 1. ZeequnNafasQasir (caused by weakness of the respiratory muscles) 2. ZeequnNafasMutatabae (caused by inflammation of the diaphragm or excessive heat) 3. Zeequn Nafas Mustaqeem (caused by weakness or atony of the respiratory muscles) 4. ZeequnNafasQawi (caused by Iltihab and Hararat) 5. ZeequnNafas Zaeef (caused by Burudat) 6. ZeequnNafasAseer (caused by accumulation of viscid secretions in the bronchial tree or gaseous collection in the chest putting pressure on the bronchial tree externally). Hakim Ajmal Khan (1868-1927) has described following two types of ZeequnNafas: 1. ZeequnNafasYabis (Bronchial asthma without expectoration caused due to spasm in the bronchial tree and the respiratory muscles) Clinical Study of A Polyherbal Unani Formulation in ZeequnNafas (Bronchial Asthma) 2. Zeequn-NafasMartoob (Bronchial asthma with expectoration that is caused due to spasm along with accumulations of phlegm in the bronchial tree) Eminent physician Hakim Azam Khan (1815-1902 AD) has described following eight types of the disease: 1. RabwNazli (Allergic Asthma) 2. RabwBalghami (Catarrhal Asthma) 3. RabwDukhani (Asthma due to pulmonary insufficiency 4. Rabwlstarkhai (Asthma due to paresis of respiratory muscles 5. RabwYabus (Asthma due to fibrosis of lungs) 6. RabwBarid (Asthma due to cold) 7. RabwWarmi (Potter's Asthma) 8. RabwHaar (Hot type Asthma) (arzani, 1988)

V. Material & Methods

Literature and claims in support of this article has been taken fromClassic books of Unani system of medicine. For the search of these books author visited following four libraries, namely (a) Library of Central Council for Research in Unani Medicine (CCRUM), Regional Research Research Institute of Unani Medicine (RRIUM).

VI. Conclusion

As far as Unani medicine is concerned, it is very well versed with understanding and management of Asthma. Bronchial asthma is one of the most common diseases in general population which is the main ailment of the respiratory disorders. Inspite of the incidence of bronchial asthma is increasing in many countries of world with advancement of treatment modalities and

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India is not an exception for this. It is one of the commonest illnesses of western world, attesting 8-10% of children and 3-5% of adult populations. It has been estimated that the incidence of bronchial asthma is increased by approximately 50% over the last 10 years (Pal R, 2009) In India prevalence of bronchial asthma is 6% on the majority of surveys.

Asthma changes the quality of life of patients, whatever may be their age group it is an important cause of school absenteeism and loss of working days. The costs due to asthma, which currently represents approximately 1% of direct and indirect health care costs, are also steadily mounting. Unani Medicines has best results in treatment of Asthma.

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Unless specified in the notification, the Editorial Board's decision on publication of the paper is final and cannot be appealed before making the major change in the manuscript.

Acknowledgments

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

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The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.

Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11'", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.



Format Structure

It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

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The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, “What words would a source have to include to be truly valuable in a research paper?” Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

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Tips for Writing a Good Quality Science Frontier Research Paper

Techniques for writing a good quality Science Frontier Research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of science frontier then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.



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7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

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To make a paper clear: Adhere to recommended page limits.



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- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

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This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.



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Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

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Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
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Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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