Top-Down and Bottom-Up Hierarchical Processes in the E-Cat Nuclear Reactor. Physics 2

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Abstract:

The base for explanation of physics for the E-Cat (A.Rossi) Cold Fusion (CF) reactor processes is formed of the elements of Polyscale Hierarchical physics that is being in the development itself for already rather a long time - for more than 45 years. We won't argue or pursue the fundamentals of Hierarchical Scaled Physics-Volume Averaging Theory (HSP-VAT is the transitory title) in this material mostly because it is not a new physics. It is part of the 2nd physics and known since 1967 for ~50 years. The problem is that most of conventional physicists cannot learn, understand and embrace the HSP-VAT. Mostly because it demands the new physics for Heterogeneous matter and we know that most of the physical world around of us is Heterogeneous. The scale accepted and the convenience of the theory and simulation are the factors of Conventional One-scale Orthodox Homogeneous Physics (COHP) that is the discipline taught at present worldwide in schools and universities. Meanwhile, the strict physical consideration that is being required in really challenging or very important areas, fields, problem demands the Hierarchical Scaled physics as well as the strict mathematical and physical definitions and tools for that, which mostly are absent in COHP.

They are absent simply because they were missing at the advent of the new physics of sub-atomic and nuclear phenomena at the beginning of XX.

For example, if the sub-atomic particle/particles are investigated - then they should be of particles - volumetric objects, but not the mathematical point-charge-mass-spins with the properties other than the coordinates of that point. With the consecutive following appropriate mathematical procedures that are applied and distributed as the problem's physics. We are using advances in the 3P (Polyphase-Polyscale-Polyphysics) theory and modeling capabilities for the CF processes depiction to develop the script of processes (physical and mathematical) of collapse of Ni nuclei (and not only Ni element) in Rossi's type of CF reactor (RCFR). The physical and

mathematical models consisting of 3P particles and the scale-continua governing equations create a large set of control equations. This approach is different from the usual notations in conventional one-scale Homogeneous chemistry and nuclear physics with the arithmetical equations of chemical or/and nuclear process'. One more feature in this work is that the action-at-a-distance is not allowed without the intermedium as the phase being present in the volume. For that medium is used the aether. Its properties have been at serious physical studies for more than a century, at least.

We employ the structured models of Ni, Cu, H, Fe nuclei and atoms in the vessel of reactor. Structured models of nuclei and electrons, other known particles all have the EM fields of the lower (sub-atomic) scales, while their collective interaction controlled by the introduced EM pulsating fields is the reason and source of collapsing and transmuting of metal elements.

The problem with electrodynamics specifically is that seems nobody; especially of COHP specialists is even talking qualified on the electromagnetic phenomena in RCFR. The examples of COHP electrodynamics in the reactor are not satisfactory for accepting as an explanation of the electrodynamics within the RCFR. The purpose of understanding of EM phenomena in RCFR is that there is the polyphase polyscale electrodynamics within the RCF reactor, with the critical role in activation and for the transmutation and stability of the processes; nevertheless, COH physics is not familiar with the correct polyscale science due to a few reasons, known and published reasons. Also, the Maxwell-Heaviside-Lorentz (MHL) electrodynamics is not suited and has noted with the insufficiencies for application to the polyscale polyphase media.

We demonstrate the features of polyscale polyphase electrodynamics of MHL and Galilean electrodynamics applied to polyscale - from the sub-atomic to meso-scale continuum mechanics environments in RCF reactor. This kind of theory gives the ability to model and simulate the basic polyscale control electromagnetic phenomena within the RCFR. Meanwhile, that is the foundation for the reactor's function, the nuclei collapse, break, and transmutation. Not the activities around of explanation for the temperature, pressure, boiling or not boiling, and phase mobilities in reactor.

We are delivering here the techniques, some fundamentals of theories, and methods applied for the two-four-scale description of the sub-atomic and nano-microsize particle arrays dynamics in electromagnetic fields in hydrogen medium.

That topic is intriguing in a way that it describes the used physical mechanisms for field force acting on particles. The much known and advanced in many sciences force

field method, formula by Lorentz has been shown vividly by Ja.G.Klyushin is experienced with many defects (insufficiencies) in action. Klyushin developed the new electromagnetic force field formula between two point-particles and used to verify it for many situations. We applied this advanced EM force field formula for creation of the governing two-scale dynamic equations for volumetric charged particles aiming this development first of all for the sub-atomic particles movement application.

As long as the collapse or break of nuclei give birth to gamma photons those are still not the heat generating photons - the chain of photon transformations and nuclear debris collision and interaction leads to the spectrum of particles and transmutation in this polyphase polyscale polyphysics environment.

Key words*: Heterogeneous media; Multiscale; Polyscale; Multiscale modeling; Cold Fusion; Low Energy Nuclear Reactions; Electrodynamics; Heterogeneous electrodynamics; Sub-Atomic modeling; Particles modeling; Elementary particles dynamics; Gauss-Ostrogradsky theorem; WSAM theorem; Averaging theories; Collective interaction; HSP-VAT; Scaleportation; Polyscale physics; Electrons; Photons; CMBR; Electrons, Photons in Vacuum*

1. **Introduction**

1.1 Possible Mechanisms of Transduction and Transmutation in the E-Cat Cold Fusion Reactor's Chamber

There are known some theories for explanation of Cold Fusion Reactors (CFR) function. Until recently those were completely based on the Conventional Orthodox Homogeneous Physics (COHP) classification, physical disciplines, and theories that are based on the established at the beginning of XX century homogeneous particle physics with:

1) most of the sub-atomic particles accepted as the point-mass-charge-spin volume-less entities.

Among other deficiencies of academic contemporary physics especially regarding the CFR we can point out to only a few most strong and dramatic in terms of consequences for general physics and education;

2) electrodynamics of Maxwell-Heaviside-Lorentz (MHL) that is the insufficient theory for polyscale-polyphase phenomena or we might say, an approximate one in many respects;

3) inappropriate (Homogeneous) mathematics used for Heterogeneous matter - which is the most widely distributed media in the universe and in physics naturally; one of consequences of homogeneous mathematics is the QM created to tackle the particle physics problems as with the one scale linear homogeneous fields;

4) inappropriate many-body mechanics of XVIII century used habitually for much more complicated matters of particle physics; while this is also the consequence of the one scale homogeneous mathematics - bodies are taken with the some effects of an unknown surrounding medium (aether, of vacuum0, or space vacuum, or some other matter), but there is no participation - modeling, governing equations, etc., of the surrounding media in these physical models; nevertheless, even this mechanics of many-body statements is not resolved to up the all statements fulfillment for naturally possible problems.

It is not surprising, that the CF COHP theories are inadequate and can not explain, model, and simulate possible nuclei collapse and transmutation with the accompanying other processes - nuclear and atomic radiation, electromagnetic phenomena at activation and in the process of energy generation, energy types (including of heat) transformation pathways, electrochemistry inside of the reactor, interscale phenomena and transport specifically, etc.

We've studied as well many years ago that any COHP explanation for nanosize particles dynamics and electrodynamics is non-credible. Any COHP credible theory that can model the polyphase nanomaterial(s) and other processes is not known. None of credible, because the COHP nanophysics is of one medium, one scale - so inadequate, we published on that the substantial explanations.

We firstly generated the 3P (Polyphase-Polyscale-Polyphysics) theory and modeling capabilities for the CF processes including activation of the reactor. All participating media and particles are taken as the Heterogeneous and structured media or entities. All participating physical processes are taken and present as for the polyphase, polyscale, polyphysics developments. We have conceived, specified and originated the 3P models for mass, momentum transport, sub-atomic scales particles and atoms, molecules dynamics and electrodynamics, nuclei collapse and transmutation, nuclear and atomic radiation, energy generation and transformation.

Significant is to mention that the homogeneous one scale theories are not applicable for the CF transmutation breakdown as actually evident from the multi-decade history of COH nuclear and particle physics when nuclei models are just taken as hypothetical fluid like droplets?

And of course, because this is the tremendous amount of phenomena and processes, the simulation of all these models demands huge resources, human and material. Nevertheless, as it is known from the history of critical and complicated just of the recent XX-th century and contemporary technologies the game is worth of effort. The more important is that the control and optimization would be much better off when the model of processes can be correctly simulated. It is still the nuclear device.

We are delivering here the techniques, some fundamentals of theories, and methods applied for the two-four-scale description of the sub-atomic, nano- microsize particle arrays dynamics, and meso-scale in electromagnetic fields in hydrogen medium.

That topic is intriguing in a way that it describes the used physical mechanisms for field force acting on particles. The much known and advanced in many sciences force field method, formula by Lorentz has been shown by Ja.G.Klyushin is loaded with many defects (insufficiencies) in action. Klyushin developed the new electromagnetic force field formula and used to verify it for many situations.

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One more feature in this work is that the action-at-a-distance is not allowed without the medium as the second phase being present in the volume. For that medium is used the aether while its properties have been at serious physical studies for more than a century, at least.

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The physical and mathematical models consisting of 3P particles and the scale-continua governing equations create a large set of control equations. This approach is different from the usual notations in conventional one-scale Homogeneous chemistry and nuclear physics with arithmetical equations for chemical or/and nuclear process'.

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1.2 Historical Notes on Aether, Sub-atomic Particles and Electrodynamics

We would like, for many reasons, to keep referring to the medium that infiltrate all the materials' forms around, in environment, and known to exists and to be believed by physicists in old times as an aether.

We won't address extensively here in this analysis the terms - quantum vacuum, physical vacuum, as long as it could be acquired by many in their modified description and models that are questionable.

For the strictness of exposition of known and coherently explained and modeled within the paradigm of simultaneous Polyscale-Polyphase-Polyphysics (3P) physical entities and modeling them as a set of related concepts, 3P theories has been suggested as the one concept needed of

intermediate medium - an aether. The long range interaction cannot be provided, executed via the real emptiness, real nothing.

That is known for centuries that physicists always considered the presence of some intermediate substance and called it aether.

Then, at the beginning of XXth century the construction of SR forced Einstein to proclaim that the aether does not exist.

Meanwhile, it is known, but really is hidden in the physical literature, especially in the physical textbooks for universities, that while developing the GR theory Einstein was required to proclaim the opposite postulate - that the aether does exist and in need for the GR.

We won't be writing here broadly on long story (falsified also) of Michelson and Morley, then by Dayton Miller experiments regarding the presence of aether. Most of students and professionals do not know due to well organized false physical education in a manner that experiments by Michelson and Morley, and others already in XX century, were performed incorrectly with flawed data reduction. We do this scrutiny in other scientific disciplines.

It should be remembered that the cosmic space, the vacuum of cosmos is never been empty, it is even more populous then the vacuum in the laboratory - because in cosmos there are always CMBR and other radiation providing energetic particles.

So, cosmos never should be considered a vacuum, better to say that cosmic vacuum is filled with the energetic particles.

Then, the flaws in the MHL electrodynamics are based mostly, or in whole, on the still inappropriate physical assumptions (the studies of continental electrodynamics were mostly rejected? The thoughts and experiments of Gauss and Weber were abandoned or shoved on the shelf) while taken at the beginning and because of mathematical improvisations of Heaviside.

The level of conventional physics right now is not sufficient to describe with certainty many long standing issues such as, for example: What is the magnetism and magnetic field (wrong explanation is given to students)? What are the nuclear interactions? What is the gravitation? What are the sub-atomic particles structures? Etc., etc.

That is a partial explanation, also because at the beginning of XX century there was no understanding and no of physics and mathematics for polyphase, heterogeneous methods. So, physicists couldn't even approach that kind of problems. The vision for heterogeneous media physics need had appeared later in the time of WWII for the tasks related to nuclear weaponry and nuclear power.

Returning back to the many centuries fundamental acceptance of aether existence immediately stands the question that physicists of XX century couldn't approach and solve: Any medium with aether recognized is being meant having at least of the two "phase" medium - one is the aether itself and another is what is put in the problem at the beginning of study (at least one medium for even homogeneous medium).

Meanwhile, since the 80th of XX the two-phase problem began started formulation and solution as the two scale two phase statements - that is the real sense of the two-phase physics [1-18].

Among many advancements on this path there were the Two scale HSP-VAT firstly obtained solutions, the exact ones for the most known few common textbooks problems, can be seen in - 1) "Classical Problems in Fluid Mechanics" http://www.travkin-hspt.com/fluid/03.htm; 2) "Classical Problems in Thermal Physics" http://www.travkin-hspt.com/thermph/02.htm; 3) "Globular Morphology Two Scale Electrostatic Exact Solutions" http://www.travkin-hspt.com/eldyn/glob1.htm.

Then were obtained after 2002 the two-scale HSP-VAT even the analytical solutions of the following classical problems: 4) "When the 2x2 is not going to be 4 - What to do?" http://www.travkin-hspt.com/eldyn/WhatToDo2.htm; 5) "Two Scale EM Wave Propagation in Superlattices - 1D Photonic Crystals" http://www.travkin-hspt.com/eldyn/photcrys1.htm; 6) "Two Scale Solution for Acoustic Wave Propagation Through the Multilayer Two-Phase Medium" http://www.travkin-hspt.com/acoustics/supercross.htm; 7) "Effective Coefficients in Electrodynamics" http://www.travkin-hspt.com/eldyn/edeffectivecoeff.htm.

All these cornerstone (and other two-scale) problems have not been solved for Upper (second) Heterogeneous scale since the first half of the XX century by other methods (given in textbooks the Lower Homogeneous scale "solutions" are wrongly attributed to the Upper Heterogeneous scale wrongly averaged fields). These solutions leave no chances for calculations or comparison with experiment of the Upper scale characteristics using the basis of Homogeneous GO (Gauss-Ostrogradsky) theorem. This has no sense, invalid for Heterogeneous problems like the two-phase tasks of rotating “elementary” particles and the aether. The experimental procedures used now are based on the homogeneous medium assumptions.

1.3 Some Definitions of Scaling Related to the Subject of Continuum Physics as Long as and of Atomic and Particle Physics as Scaled Media

Most of these improvements can be referred to the proper, stricter treatment of collective, interactive phenomena while taking heterogeneous matter for study. To this kind of phenomena/changes we can relate almost any action or process more complicated than collision of "mathematical" ball onto the "mathematical" wall, or movement and collisions of two "mathematical" balls, meaning particles, atoms or molecules in MD.

In all other nature prescribed cases the physical matters are of scaled or multiscale character by existence.

There is no substance of physical content in our known universe that is not a heterogeneous one.

The question is at what scale down the matter is still homogeneous? That answer we don't know yet. And taking the scale an Upper or Lower one, then we will have the Heterogeneous matter anyway.

The volume of the earth can be considered as homogeneous at the galaxy mean scale, meanwhile for our human experiences the earth scale object is a huge heterogeneous one.

Another example – is the water which we can obviously consider as a homogeneous matter? While it is not, at an atomic and lower scales.

As always, we need taking into account these physical characteristics of a matter description that always hold and are promoted for future description quality improvements, and sometimes for this quality change.

Also, in physics there is no action or process that we can name a local one, unless we want to. Otherwise, we have to look into the point and what it means more strictly. Obviously, many actions or processes can be separated from their less important, at the moment or case, surroundings or/and forces. But that is always more or less an artificial choice. Also we don't know yet - what is or not the collective influence of the Lower Scale forces, because up to now we connect the scales by approximations with the help of appropriate coefficients. All the laws in physics in the past have been developed in this way.

These issues have to be open for the inquiries and we have the right to inquire.

In this manuscript we assured to be concerned to the multiscale, heterogeneous, nonlocal and nonlinear properties mostly of the atomic and sub-atomic scales group $\sim (10^{-35} \div 10^{-9})$ m.

For these ~26 orders of decimal magnitude the conventional homogeneous one scale physical theories provide mostly for the approximate or even ad-hoc adjusting mechanisms for the two-scale Bottom-Up scale communication, and that mode is to be re-entered in the current paper from the Bottom-Up and Top-Down interscale transport (communications) point of view. That says the connections of the scale inherited fields are of great significance/importance. We previously studied thoroughly in many sciences (fields) the contemporary homogeneous physics theories for heterogeneous matter and these reviews are referred below.

The strictest definition for the different scale related fields communication - transformation we suggested in 2004 as the ***Scaleportation***.

Scaleportation is the means and procedures of the direct and strict "transformation" of data and processes at one scale to the data and processes of the neighboring Upper or Lower Scale. These interscale communications, scale transformations of data are performed mostly not by formulae using the coefficients as this is customary in homogeneous physics, but via using the interscale governing equations for the phenomena.

Scaleportation has being performed over the all our two-scale solved the HSP problems mentioned in this text and in the website - http://www.travkin-hspt.com, as soon as the

simulation methods that have been based on the algorithms of analytical (exact) or numerical methods created for the direct Bottom-Up (BU) or Top-Down (TD) two-scale solutions.

When more than 2 neighboring scales of physical fields are involved, we have introduced the definition of a ***Scaleleaping*** (or ***Leapscaling***).

At the same time, we involve and describe in some detail the true multiscaling mechanisms stemmed from the heterogeneous analogs of Gauss-Ostrogradsky theorem and scaled exact governing equations and solutions for classical homogeneous physical problems in different physical discipline fields that are under stable development path through the last more than 40 years.

It is the known and exepted in COHP information that all interatomic forces and consequently the upper meso-scale continuum mechanics phenomena can be explained by electromagnetic forces if starting from the lower atomic scale physics.

That means the attractive interactions named as the van der Waal forces (dipole-dipole and London) and hydrogen bonding - that in reality has the quite different physical mechanism, as well as Coulomb long range collective forces, in principle can be evaluated (and will be probably in the near future) via the field generating scaled (two scales [Sc]) governing equations that are much more depicting and are of much more accurate description. Thus, and much more difficult in simulation than use of any kind of potentials, Lennand-Jones forces, for example.

Meanwhile, there are the strong experimental evidences exist that support the new class of mass bodies interaction named as "torsion" Spinning fields interaction. In the present theoretical effort and models regarding the Cold Fusion E-Cat reactor's function we would not engage our studies into this relatively new field of physics.

It might help with the understanding of our approach to the more strict physically and mathematically description of many subjects of Heterogeneous, Scaled, and Hierarchical media and processes in E-Cat reactor, made by nature itself up from the atomic, molecular scale that the some knowledge of HSP-VAT (Hierarchical Scaled Physics - Volume Averaging Theory) can be of assistance for understanding of the E-Cat processes.

To look through, one might browse our previous studies and analytical reports in other areas where the Heterogeneous, multiphase, scaled media and phenomena are in the core of subject matter, while this should help in estimation of the present solid state Heterogeneous Continuum Mechanics field [1-16] and of lower scale physics [17-25].

Some parts from the above mentioned educational materials, texts have been published also in the hard copy literature, see references in the website - http://www.travkin-hspt.com.

So far, in almost all the contemporary physics fields, but Fluid Mechanics and parts of Thermal physics, the tools and math used for Heterogeneous, Scaled, Hierarchical description

are of the 50 years old, from the conventional particle physics, statistical mechanics, and quantum mechanics when the spatial scales used are of (10^{-8} ÷ 10^{-15}) m and less range.

All these tools of the one scale, homogeneous physics and math, just examples, we have found - have been done with the governing equations that were derived with the use of homogeneous Gauss-Ostrogradsky theorem. Or simply do not contain the features and theories that referring to the scale of the particles and of the surrounding media that constitute together the Heterogeneous media.

While this is incorrect.

2. Fundamentals of the HSP-VAT Theory in Application to Particle Physics

2.1 Some principal provisions, conceptual definitions, concepts of scaling matter related to the subject of Particle Physics collective interaction of the arrays of Sub-atomic particles and modeling of Heterogeneous particulate media of two, at least, phase (components) as scaled media with physical and mathematical local and non-local scales strictness.

Principles of the Theory

1) Recognition of the fact - that at any scale the physical substance, particulate media in a volume of interests when the number of particles is substantial and one of interests is the properties of the physical medium (as of a volume), but not of only one single particle which is still the inseparable component of the problem (issues of physical interest), is the Polyphase (at least two phases, one is the interparticle medium that can include the aether) Polyscale (at least two scale) Heterogeneous (Ht) medium. At atomic scale, sub-atomic, or at some of the continuum scales.

2) Recognition of the fact - that the structure and the "phase" content of a volume with particles sample are the fundamental facts controlling the function of the volume fields, substance at given point, material along with the environmental (boundary) conditions.

3) Recognition or knowledge that - in this consideration the polyphase, polyscale studying of the subject - the particulate medium in a volume of interest, medium sample, the material, is the most accurate and revealing way of obtaining the facts, conclusions. This was and is one of the main methods - the reductionism (with inseparable up-scale the holism approach) to study the nature by physical methods so far for many centuries.

4) Recognition or knowledge of the fact - that for studying the polyphase matters, media the only correct way is to use the discovered in 60s - 80s methods, theorems of Hierarchical physics and mathematics: Hierarchical Scaled Physics - Volume Averaging Theory (HSP-VAT), those

specifically were created and tuned throughout the last 40+ years for polyphase polyscale physical, biological matters.

Of many other methods suggested for the Heterogeneous media theorizing, modeling and understanding, up to this time there is no one more fundamental and/or correct.

We won't discuss or comment on numerous schemes suggested for heterogeneous, physical, biological polyphase media in the last ~100 years, as the mixture theory, for example, because they openly use an inadequate or truly simplified physical and mathematical description of the problem. We also published numerous analytical texts in hard copy and the web publications on this issue.

This fact is not objected or disputed by any professional, openly at least, for the last ~(30-35) years. The complexity and educational policies are preventing professionals to acquire and employ the tools of HSP-VAT.

One of the examples is the use of Gauss-Ostrogradsky (GO) theorem for deduction of governing equations for near 200 years in physics and other sciences. This theorem is valid only for a Homogeneous matter that most of professionals even do not know and acknowledge. In hierarchical mathematics there are many like theorems for the same purposes that have been developed and used during the last 40 something years.

5) For the particular area of the particle physics we add the one more physical principle that usually left out in Homogeneous physics. This is the fact that the movement of the particles in the bounding volume can be characterized either by the free transport through the Bounding Surface (BS) (imaginable, mathematical category) or by collision with the matter of BS, not of a smooth Homogeneous imaginable mathematical surface, but of Polyphase Polyscale Heterogeneous matter, material of Bounding substance.

Otherwise the problem would be stated as the unphysical one. Up to now it is stated as with the smooth mathematical bounding surface - but it is the false physical statement. This (5th) physical principle is supporting many times expressed report that there is no really closed system in our physical universe. The Homogeneous (at present it is homogeneous) thermodynamics' concepts are working approximately and mostly for the physics of Homogeneous Continuum Mechanics.

Hierarchical Polyphase Polyscale Concepts for Heterogeneous Media of Particle Physics and for their Modeling

1) There is no physical phenomena, process, act that at the determined scale is not of the Volumetric character or is not consciously or sub-consciously understood and/or modeled with the Averaged phenomena of the sub-scale. Any point-like experiment or method, theory is about for accepting at first the premise that the point is formed by/after somehow averaging of the

forces/movements/reactions etc. of the below scale physics. Mostly it is done implicitly, even in a sub-conscious manner, but this premise is present always. The Top-Down sequence of physical phenomena is more accurate down to the sub-atomic scale particles, the aether in between the particles and some pertained to them phenomena.

What regards to the down scales from an Electron approximate dimension and structure that is covered at our times with the dense fog of the current state particle physics because at the beginning of XX physicists started from the strong postulate - that electron is the point-mass-charge (later with spin) "particle", period, and so physicists did not need to consider it as a physical volumetric (no matter of what volume) particle along with the possible even smaller "particles" (we don't know whether they are particles at all, or just new kind of objects that hardly can be named "particles"? Anyway - down the scale we can not rely on the conclusions of high power accelerators research - and first of all - because they all are based on the MHL electrodynamics. As we know, it is full of insufficiencies.) That is why in conventional (COHP) particle physics are so many "color" and other non-physical definitions (just appropriate mathematics) for the sub-atomic particles.

2) Any Particulate Media in a Volume of Interests (PMVI) is the Heterogeneous media (Ht), material's sample which is in reality the Two scale Two Phase (TSTP), at least, physical entity that have the continuous transport phenomena (as of aether at least, that now is easier and more productive to consider as the Continuous matter, for the lack of knowledge of its properties), the local and the physical field processes of a physical volumetric (averaged at some point) character.

3) It is not correct to study, model and make valuable definitive conclusions about this medium physical functions when using only the one scale one-phase physical phenomenon(a) - as, for example, when the particles presented as the point-mass-charge-spins or as the separate masses without any medium in between apart of "physical" vacuum (without any, but some electrical constant properties), or just vacuum without any properties, or when mixture "theories" for heterogeneous media used, or simple summation of the effects instead of integration are taken into account. Contemporary experimental physics, biology, medical investigations lack ground and fundamental science, while applying the theoretical schemes of one scale physical nature that were suggested in physics (particle physics mostly) many decades ago.

4) We have to declare that the mathematical, first of all they are mathematical, schemes, theories that have been developing and applying in particle physics since the ~1920s, as for the mathematical representation of particles in physics as the mathematical points with physical properties - are inadequate physical methods which brought into an imaginable reality the

numerous inconsistencies in physics so far. And need to be abolished, or at least recognized as the approximate insufficient methods developed in XX century due to the lack or absence of physical and mathematical methods (at the beginning of the XX) that would be appropriate for the sub-atomic particulate media. They need to be taught to graduate students only as the non-major courses. The critique of these unphysical methods we published elsewhere.

5) The scale models for heterogeneous particulate media constitute the separate spatial and temporal physical and mathematical models describing the physical function relationships between the scales and in the scale dependent phenomena in such media.

6) The scale dependent mathematical models are inherently communicative Up-and-Down over the scales in Heterogeneous particulate media. The scale communication of physical properties of Ht medium has been named as a scaleportation of properties and characteristics in HSP-VAT.

7) It is possible to commute the physical models and medium's properties at the neighbouring scales with mathematical strictness using methods developed in HSP-VAT.

8) Each scale developed *Homogeneous (H)* models in a Ht medium based on Homogeneous presentation of this scale physical definitions and the field's governing equations can be connected more or less mathematically strictly to the neighbouring next Up-scale or Down-scale models only (most strictly) via using the interscale mechanisms of HSP-VAT.

9) The polyscale depiction of Ht medium's physical function models is the only correct approach for theoretical modeling and simulation, for experiments data reduction when the subject of analysis, theory, model, experiment is the polyscale physical object(s) with the nature prescribed polyscaling of function.

10) Any *Homogeneous physical substance, medium, materials* sample is in reality also of the two scale, at least, the physical entity that have molecular, atomic, sub-atomic and continuous description of transport, physical field processes of a physical volumetric character. The averaging and scaleportation of molecular (atomic) scale transport and phenomena Up- to the Continuum (one of the continuum) scale phenomena and Down- to the molecular, atomic scale, should be used with application of correct Hierarchical mathematics of discontinuous "broken" physical fields.

11) At present, in the last approximately 27-29 years all the main physical fields, definitions and homogeneous governing equations have been reformulated and upgraded using methods of HSP-VAT for acting in the heterogeneous subject matters, for Heterogeneous media of solids, solids and fluids, polyfluids, particles in fluid, scaled fluids, elasticity of solid and soft solid media, mass, heat, momentum, electromagnetism describing phenomena, wave mechanics, acoustical fields. That is now making available the polyscaling in the description and modeling the most obvious and important transport phenomena in a particulate media.

12) Advancements in the last 25 years in Hierarchical Scaled Physics - Volume Averaging Theory (HSP-VAT) allowed surpassing inadequate, incomplete one scale homogeneous theories for averaging (mixing), "bulk" representing theories in almost every field of physics. Now we can formulate the true polyscale Dynamics theories and models for Ht medium, including and particulate objects and relevant processes, polyscale by nature in a Ht medium.

13) None of the concepts written above (2010) is on the lists of "advanced" programs formulated in the recent and earlier years (and in "new" formulations of disciplines) in academic, university, government programs. And that is a signal of misleading development in the contemporary conventional Homogeneous Particle Physics. Meanwhile the methods of HSP-VAT became explored for atomic, particle and nuclear physics [19-23] based on universal power of the above concepts and advancements throughout the last ~34 years in heterogeneous mathematics and variety of physical disciplines.

2.2. The Local, Non-Local, and Scaled Metrics, Physical Fields, and Their Mathematical Formulation

These few general statements of HSP-VAT below were actually a few times written for other physical disciplines, for other problem fields, etc. We are formulating them again as for the particle physics discipline, where sub-atomic particles are the physical volumetric objects, not as assumed in orthodox particle physics of the XX physics - the point-like, volumeless objects with the assigned properties.

It should be said that in reality the particles, of some small scale or of sub-atomic scales are the volumetric objects with their pertained physical characteristics. And they behave as the particles in another "phase", whether it is the fluid or gas, or aether as with the sub-atomic particles.

The matter of aether was deliberately withdrawn at the beginning of XX century (and we wrote on that):

1) Because the problem of averaging of the array of moving atoms, molecules, free electrons, photons embedded in a medium that can be called vacuum (and is not really empty space - it is what for hundreds years called as aether) or other more complicated media is the problem of scaled heterogeneous physics, it should be treated with the tools of that physics, including first of all the various Volume-Surface integration theorems, developed for Heterogeneous media.

That is why the methods used in homogeneous physics must fail and have been failing for >130 years to develop the correct macroscale medium electrodynamics governing equations.

2) Here we put forward the real reason for the forced desertion (falsified) of the aether in physics just at the beginning of the sub-atomic physics time (among other well spoken, but seems of the secondary significance reasons).

The abandoning of aether was supported by many physicists because of the absence of physical and mathematical theories, tools, methods to treat, theorize, study the polyphase (Heterogeneous, at least two phase) polyscale (at least of two scales) matter as the particulate (poly-particle) media altogether with the continuum medium of aether (at the scales of the sub-atomic value down to $10^{-(10\text{-}18)}$ [m] in between.

Physicists decided to drop the aether existence, as if it does not exist. And study the sub-atomic particles just as a bunch of small point-mass volumeless "particles".

Later on, in the midst of XX, when the nuclear physics, nuclear arms, nuclear power advanced to the state when they could not be studied and advanced further without the polyphase heterogeneous medium being accepted and methods being created for their research and modeling, the commence of the polyphase Heterogeneous physics inevitably emerged.

But physicists up to the time of after the WWII had developed a huge amount of knowledge (approximate) within the regarded particle and atomic physics without an aether, that should lay out the foundation for all these above physical sciences, constructions on the base of particle physics that was the one phase homogeneous one scale physical science at that time and mostly continues to be in this condition now.

In this way leading physicists silently drop the issue of relevance of the polyphase heterogeneous particulate media physics that spread within the nuclear power science and of the base for particle physics that should be of the polyphase nature too.

For that to be the real upgrading in particle physics it just was needed to make a large re-formulation of the particle physics to the polyphase heterogeneous (two phase at least - particles and aether or other medium) polyscale (two scale at least - particle scale and of the bulk, averaged medium properties scale) science.

And that was too complicated task for physicists and physics, with the absence of the most needed methods and heterogeneous mathematics in 1950-60s, that was/is not up to the polyphase heterogeneous science even at nowadays.

That is one of the reasons why we have defective, full of mistakes, mathematical cheating the major body of COHP, particle physics, electrodynamics, etc.

3) There are two methods used in homogeneous physics for pseudo-averaging of atomic scale Maxwell-Heaviside-Lorentz electrodynamics equations: a) is the expansion in series of the difficult terms that need to be averaged and with the great simplifications (unacceptable) forcefully bring mathematical expressions to the Maxwell-Heaviside-Lorentz conventional continuum mechanics set of equations; b) starting from the one atom averaging of forces the following line of derivation using the mixed methods of unacceptable simplifications along with the recursive use of known Maxwell-Heaviside-Lorentz equations - the same equations that not yet been averaged in an algorithm.

Still, the worst thing in both approaches is that used the incorrect formulae for averaging of differential operators [24-25].

4) Generally, these averaging formulae and pseudo-averaged EM governing equations used up to now in homogeneous microscale electrodynamics, are not correct for atomic scale, for the Upper scales averaging, for Heterogeneous media. That is why the orthodox conventional physics for so many years since 1967 and during the following in the 80-90s developments in the HSP-VAT tried to ignore, suppress, and silence the truthful physics and mathematics of multiphase microscale electrodynamics theory, modeling with averaging and scaleportation, presented in the HSP-VAT methods and math.

Because of this way of homogeneous averaging in atomic and particle physics as said above for averaging of Maxwell-Heaviside-Lorentz equations, the Upper scale (continuum mechanics) equations have been falsified and are incomplete.

All conventional textbooks on electrodynamics and materials science are showing the same type of incorrect mathematical procedures for heterogeneous averaging. While this is actual cheating on the students and general public, professionals in various sciences and technologies [24-25]

Meanwhile, this falsified electrodynamics that is being adjusted for every case, lies in the very core of the Conventional Orthodox Homogeneous physics (COHP) - from particle and atomic physics up to astrophysics.

Claim

It is known that for every physical discipline serious mathematical formulation and modeling should have been used the theorem by Gauss-Ostrogradsky. This theorem formulates the connection in physical and mathematical sense via integration

between the physical features, phenomena on the closing some volume continuous (outlined by us) surface and the phenomena within the embraced volume.

That means, it was already implicitly included the definitions of the two spaces and the two coordinate systems - of the initial integration of volume and over the surface and of the limiting (going to collapse the surrounded volume) mathematical expression between both, in the development of this field mathematical equations and models at each of the spaces agreed for consideration.

One is the scale that we perform the spatial integration - it theoretically can collapse into the point? But what is the point? What this point is representing?

The point in mathematics (that means and in our physical world) is the subject without dimension in any direction, if in Cartesian coordinates, other 3D systems of spatial coordinates.

The lower scale (actually the same scale, but non-local) physics variables and properties in COHP then silently declared as irrelevant, unimportant - hereby we do not use, mention and mean that the point in our mathematical homogeneous formulation is actually the volume used in the GO theorem to obtain the current equation of interest. This approach is justified as soon as the all matters are assumed as of a homogeneous nature, because there are the mathematical theorems showing that the limit transitions when the size of a spatial domain collapses to an infinitely small one are presenting the properties of this domain in the selected internal point into which it collapses.

Meanwhile, we know that physics give us the very small objects - that constitute the body of any material - all these objects consist of atom and molecules.

That means, this conjecture for deduction of governing fundamental equations in physics via using the GO theorem where the volume should collapse to the volumeless point is defective **just at the beginning.**

And this precludes acceptance of the GO theorem for really applying to any physical matter, materials consisting of the atoms and molecules.

Because the GO theorem is mathematically valid for only Homogeneous matter - no atomic and molecular spatial Heterogeneity is accepted.

This surprised(?) "discovery" actually "known" for more than a century, since the XIX-th century, when this approximation was starting to be used in Atomic era physics and chemistry at the beginning of XX century. **But is being successfully ignored.**

There were voices of awareness of this approximation, incorrect for any heterogeneous, polyphase media and materials.

Unfortunately, physicists (leading figures) in the past preferred not to notice this mathematical fact. Chemists followed the path.

Because it was convenient and because this "ignorance" gave the only chance to cover with some mathematical strictness of XIXth century the whole body of physical consideration, more or less strict "proof" of mathematical deductions related to Continuum Media (CM) mechanics.

And most of the media have been accepted as continuum ones, even in chemistry - when it is "known" that any chemical substance, and biological substance and material are discontinuous matters due to existence of their atomic structure.

Then the same approach was adopted and for Atomic and Particle physics.

The absence of corresponding polyphase, heterogeneous theories, mathematics also made its input and continued up to 70th, while first Heterogeneous theorems appeared in 1967.

More correctly is to say that in reality the more precise path for mathematical conventional deductions in physics was and is to consider the discontinuous function of physical substance of interest, when it is no way to do otherwise, because of the atomic structure of a matter.

And at the same time, when any mathematical operations need to be performed for that physical material - the tool of operation is the Continuum conjecture - this matter, material is accepted as a continuous one.

Following that premises physicists use the Homogeneous matter GO theorem and alike up to now in almost any physical theory. While this is incorrect.

The most influential and important forces acting on all sub-atomic, atomic and Upper scales of physical matter, material are the electromagnetic (EM) forces.

We would not accept in this and following papers (editorials) the conventional classical set of Maxwell-Heaviside-Lorentz's (MHL) EM homogeneous matter governing equations and based on them observed results that brought in and were justified for utilizing in the Homogeneous Continuum Mechanics.

We have discussed this issue enough in several publications [13,17-25].

Also we had developed a prove that the electromagnetic phenomena mathematical expression governing equations used and discussed in many research areas of continuum media is an approximation of valid averaged sub-atomic MHL governing equations [24,25].

Meanwhile, at present time a few points of view exist regarding the alternative systems of electromagnetic phenomena developed by different researchers.

There are also the non-local homogeneous media properties. Those also use the basis of integration, or averaging. Integration is taken as for the continuous functions. This legitimate base allows us to approach the variety of media, materials, but only the Homogeneous ones.

For Heterogeneous media and materials there are exist the Heterogeneous Whitaker-Slattery-Anderson-Marle (WSAM) kind of theorems reminding the origin from the GO theorem. And the reason for the definitions of at least two scale spaces and physics became the pivotal one.

This, in turn brings the problem of definitions for the point-like Lower and the point-like Upper scale physical fields. Consecutively, we need to define the non-local, averaged fields for stated Heterogeneous problems at their corresponding scales.

We should obey to this original set of reasoning that was done two centuries ago in Physics and in Mathematics for the homogeneous media and translate it onto the heterogeneous, scaled media.

The great issue in all of this is the connection, communication between the physics and properties of each of the two spaces.

While for the homogeneous medium this question is seems never surfaced and discussed with application of the atomic scale discontinuous matter fields. Meanwhile, for Heterogeneous media we need to specify these definitions with the greater detail.

After all, this is the key issue of scaling heterogeneous physics as it must work. Thus, we start with the definition of a point, a dot used in the mathematical formulation of physical problems.

Definition 1

> At the known and assigned previously system of coordinates the point is the object with no dimension in any of the three coordinates, and this object has the descriptive features, which determine the location of that point in the assigned system of coordinates. The point located physical property of the material has this spatial point determined value.

Following the GO theorem we now know that - if at any point with the coordinates inside of the problem's domain is known the functional dependency for a physical field, which in the most of physical sciences right now is the partial differential or just differential equation(s), then we imply that the domain which served for the derivation of this equation via the GO theorem was the domain of the Lower subspace - because in that theorem we start doing an integration over the finite volume and the finite surface(s).

Now - this principle can be applied to the heterogeneous media, which means - that after the averaging provided according to the one of the WSAM theorems - we get the mathematical equation (dependency) of the higher (another) space. With the corresponding spatial dependencies and the topology of the physical spatial fields.

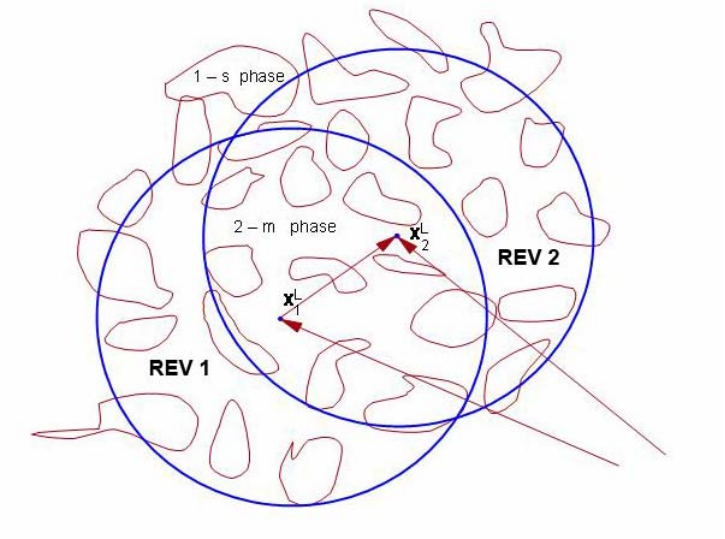

Figure 1. Representative Elementary Volumes (REVs) REV and REV in a heterogeneous medium with the assigned points of representation (x_1, x_2) at the Upper scale physical spatial space. Here presented the two-phase and two scales Heterogeneous medium. The shape of the REVs can be not only a spherical one. Mathematical modeling and simulation are supposed to be performed on both scale spaces with the mathematical statements that complicate formulation and numerical (analytical) calculation of the physical field distributions.

With the one substantial different feature - it cannot infinitely be reducing the size, the volume of this domain - because this volume needs to be kept with the most of descriptive features of the both (or more) phases inside of our spatial integration domain.

Definition 2

The Upper Space point when connected to the Lower Scale Domain might reflect, determine, and establish the features of communications between the both space physics. These features can be of different physical description in accordance to their respected space physics definitions. And vise versa - the Higher Space point physics might control, govern, reflect, and determine in some ways the properties of the Lower Scale physical Domain.

It is easier to discuss and argue about the features of these definitions right now - after the number of problems in various disciplines of physics were solved in the said mode - when the Lower and Upper scale HSP-VAT governing equations were connected directly before and during their respected solutions - it has been shown by means of the two-scale solutions, especially with the exact two-scale solutions of some common textbooks known classical

problems, see in - "Classical Problems in Fluid Mechanics" http://www.travkin-hspt.com/fluid/03.htm; and in the above mentioned other web sub-sections.

2.3 Introductory to Polyphase Description in Particle Physics and Related Technologies

2.3.1 Hierarchical Scaled Volume Averaging Theory (HSVAT) introductory mathematical notions and theorems

The basic idea of hierarchical medium description and modeling is to recognize that the physical phenomena, mathematical presentation of those phenomena, and their models can be very different at even neighboring scales. In most of situations those are different even if phenomena themselves are similar or looking as identical, but the scales are different and the lower scale features should be transported to the upper level of description (or Top-Down) - Figure 1. With that action, the useful information from the lower scale physics would be added to the characteristics on the upper scale level.

The following definitions were used in the 90s in solid state heterogeneous media elasticity theory (HtET) as well as at the earlier times for other sciences dealing with the scaled heterogeneous problems.

The volume average value of one phase in a two phase medium <s (**x**)> in the REV and its fluctuations in various directions, its main physical and mathematical needs, definitions are determined [1,3,5,6] at first looking simple

$$s_1(\vec{x}) = \left\langle s_1(\vec{x}) \right\rangle + \hat{s}_1(\vec{x}), \qquad \langle s_1 \rangle = \frac{\Delta\Omega_1}{\Delta\Omega}.$$

The three types of two-phase medium averaging over the REV (Figure 1) function f are defined by the following averaging operators arranged in the order of seniority

$$\langle f \rangle = \langle f \rangle_1 + \langle f \rangle_2 = \langle s_1 \rangle \widetilde{f}_1 + (1 - \langle s_1 \rangle) \widetilde{f}_2,$$

where the phase averages are given by

$$\langle f \rangle_1 = \langle s_1 \rangle \frac{1}{\Delta\Omega_1} \int\limits_{\Delta\Omega_1} f\left(t, \vec{x}\right) d\omega = \langle s_1 \rangle \widetilde{f}_1,$$

$$\langle f \rangle_2 = \langle s_2 \rangle \frac{1}{\Delta\Omega_2} \int\limits_{\Delta\Omega_2} f\left(t, \vec{x}\right) d\omega = \langle s_2 \rangle \widetilde{f}_2,$$

and the two internal phase averaged functions are given by

$$\{f\}_1 = \widetilde{f}_1 = \frac{1}{\Delta\Omega_1} \int\limits_{\Delta\Omega_1} f\left(t, \vec{x}\right) d\omega,$$

$$\{f\}_2 = \tilde{f}_2 = \frac{1}{\Delta\Omega_2} \int\limits_{\Delta\Omega_2} f\left(t, \vec{x}\right) d\omega,$$

where $\tilde{f}_1$ is an average over the space of phase one $\Delta\Omega_1$ in the REV, $\tilde{f}_2$ is an average over the second phase volume $\Delta\Omega_2 = \Delta\Omega - \Delta\Omega_1$, and <f> is an average over the whole REV. There are also important averaging theorems for averaging of the spatial operator - heterogeneous analogs of Gauss-Ostrogradsky theorem. Those are plenty already since 70-80s [9-18,24,25]. The first few of them needed to average the field equations are the WSAM theorem (after Whitaker-Slattery-Anderson-Marle) and the one is for the intraphase ∇ averaging. The differentiation theorem for the intraphase averaged function reads

$$\{\nabla f\}_1 = \nabla\tilde{f} + \frac{1}{\Delta\Omega_1} \int\limits_{\partial S_w} \hat{f}\, \vec{ds}_1 \ ,$$

$$\hat{f} = f - \tilde{f}, \quad f \forall\ \Delta\Omega_1,$$

where ∂S_w is the inner surface in the REV, $\vec{ds}_1$ is the second-phase, inward-directed differential area in the REV ($\vec{ds}_1 = \vec{n}_1 dS$).

The WSAM theorem sets the averaged operator ∇ in accordance with

$$\langle \nabla f \rangle_1 = \nabla \langle f \rangle_1 + \frac{1}{\Delta\Omega} \int\limits_{\partial S_{12}} f\, \vec{ds}_1 \ .$$

It can be shown that for the invariable morphology (<m>=const) of the medium the operator $\{\nabla f\}_1$ can be presented also as

$$\{\nabla f\}_1 = \nabla \{f\}_1 + \frac{1}{\Delta\Omega_1} \int\limits_{\partial S_w} f\, \vec{ds}_1,$$

when <m>=const. Meanwhile, the foundation for averaging made, for example, by Nemat-Nasser and Hori [26] (and many others) is based on conventional homogeneous Gauss-Ostrogradsky theorem (see pp.59-60 in [26]), not of its heterogeneous analogs as the WSAM theorem.

The following averaging theorem has been found for the **rot** operator

$$\langle \nabla \times \mathbf{f} \rangle_1 = \nabla \times \langle \mathbf{f} \rangle_1 + \frac{1}{\Delta\Omega} \int\limits_{\partial S_{12}} \vec{ds}_1 \times \mathbf{f},$$

and as a consequence, the theorem for the intraphase average of ($\nabla\times\mathbf{f}$) is found to be

$$\{\nabla \times \mathbf{f}\}_1 = \nabla \times \{\mathbf{f}\}_1 + \frac{1}{\Delta\Omega_1} \int\limits_{\partial S_{12}} \vec{ds}_1 \times \hat{\mathbf{f}}.$$

The averaged time derivative according to transport theorem forms in the heterogeneous medium the following mathematical equation for a phase one, for example, is

$$\left\langle \frac{\partial f}{\partial t} \right\rangle_1 = \frac{\partial}{\partial t}\langle f \rangle_1 - \frac{1}{\Delta\Omega} \int\limits_{\partial S_{12}} (\mathbf{V}_s f) \cdot \vec{ds}_1,$$

where vector $\mathbf{V}_s$ is the velocity of the interface surface ∂S_{12}.

2.3.2 Hierarchical Scaled Volume Averaging Theory (HSVAT) Operating Lemmas

When the interface is fixed in space the averaged functions for the first and second phase (as fluid *f* and solid *s*, for example, or two-phase solid) within the REV and over the entire REV fulfill the following conditions, namely

$$\{f+g\}_f = \{f\}_f + \{g\}_f, \qquad \{a\}_f = a,$$

for the conditions of steady state phases

$$\left\{ \frac{\partial f}{\partial t} \right\}_f = \frac{\partial \{f\}_f}{\partial t}, \qquad \{\tilde{f}\, g\}_f = \tilde{f}_f \tilde{g}_f,$$

where *a* - a constant, except for the differentiation condition $\{\nabla f\}_1$ and $\langle \nabla f \rangle_1$, that is as written above in the two forms.

There is an important difference in the definitions of averaged and fluctuation values in regards of their meaning and values in the REV comparing to definitions supported by Whitaker and co-authors see, for example, in [27,28]. The treatment and interpretation of the averaged values inside of the REV are supported in the classical interpretation when a value, considered as an averaged inside of the Lower scale REV volume, is still the constant value within the same initial ground scale REV the assigned representation point $\mathbf{x}^u$ for the Upper scale description space. The more detail on that problem are given in [6,9-12,29]. These methods are supported and verified by the exact two-scale solutions that have been able for performing because of that.

Some clearance to this difficult issue brings the concepts and formulation of the scaled problems in the two or more scales.

The **intrinsic type** of averaging $\{f\}_f$ fulfill all four of the above conditions as well as the following four consequences

$$\{\tilde{f}\}_f = \tilde{f}, \quad \{\hat{f}\}_f = \{f - \tilde{f}\}_f = 0,$$
$$\{\tilde{f}\,\tilde{g}\}_f = \tilde{f}_f \tilde{g}_f, \quad \{\tilde{f}\,\hat{g}\}_f = \tilde{f}_f \hat{\tilde{g}}_f = 0.$$

At the same time, $\langle f \rangle_f$ and $\langle f \rangle$ do not fulfill neither the second of the averaging conditions for $\{f\}_f$, with equalities

$$\langle f+g \rangle_f = \langle f \rangle_f + \langle g \rangle_f, \qquad \langle a \rangle_f \neq a, \quad \langle a \rangle_f = \langle m \rangle a,$$

while for the stationary morphology spatial volumes

$$\left\langle \frac{\partial f}{\partial t} \right\rangle_f = \frac{\partial \langle f \rangle_f}{\partial t}, \qquad \left\langle \tilde{f}\, g \right\rangle_f = \tilde{f}_f \langle g \rangle_f,$$

nor the consequences of the other averaging conditions

$$\left\langle \tilde{f} \right\rangle_f = \langle m \rangle \tilde{f}, \Rightarrow \left\langle \tilde{f} \right\rangle_f \neq \tilde{f}, \quad \left\langle \hat{f} \right\rangle_f = \left\langle f - \tilde{f} \right\rangle_f = 0,$$

$$\left\langle \tilde{f}\, \tilde{g} \right\rangle_f = \langle m \rangle \tilde{f}_f \tilde{g}_f, \Rightarrow \left\langle \tilde{f}\, \tilde{g} \right\rangle_f \neq \tilde{f}_f \tilde{g}_f,$$

$$\left\langle \tilde{f}\, \hat{g} \right\rangle_f = \tilde{f}_f \langle \hat{g} \rangle_f = 0.$$

At present, the models of transport phenomena in heterogeneous media when using the HSP-VAT allow to treat media with the following features: 1) multi-scaled media; 2) media with non-linear physical characteristics; 3) polydisperse morphologies; 4) materials with phase anisotropy; 5) media with non-constant or field dependent phase properties; 6) transient problems; 7) presence of imperfect interface surfaces; 8) presence of internal (mostly at the interface) physical-chemical phenomena, etc.

More detail on the non-local VAT procedures and governing equations for different physical problems modeled in homogeneous media by linear mathematical physics equations can be found in publications [1-5,7,8,30] and many other. Meanwhile, features depicting closure, nonlinear theory, polyphysics applications, polyscale developments, exact solutions, etc. can be found only in the works like [6,9-13,16,18,24,25,29] and in the website http://www.travkin-hspt.com.

3. Some Undisputed and Silent Inappropriate Definitions and Concepts of COHP That Preclude Trustworthy Theory of Cold Fusion Within the COHP

3.1 Description of Matter in COHP

As it is known from the history of civilizations and science the ancient advanced societies (Greek, for example) at their times considered that all substances consist of four main components - an aether, flame, air, and solid (soil) parts.

Throughout the centuries humans advanced to a much more accurate physical picture regarding the substances presented on the earth and in cosmos.

In his 1984 work [31] (" Ethical Probe of Einstein's Followers in the USA: An Insider's View," http://www.scientificethics.org/IlGrandeGrido.htm, 354 pages, 1984) on ethics in the US physics R.Santilli wrote:

"According to a rather widespread view in contemporary physics, the entire universe can be reduced to a collection of points (resulting into the so-called local theories), with only action-at-a-distance interactions (resulting into theories of potential type).

According to this view, the entire universe can be described by only one quantity, the Lagrangian or the Hamiltonian, defined locally, at a collection of distinct points. In fact, all known interactions are totally reduced to local-differential and potential treatments. I am referring to electromagnetic, weak, strong, and gravitational interactions.....

However, the existence of interactions which are structurally beyond local-differential and potential techniques is equally unquestionable. This is typically the case for the strong interactions whose range is exactly of the order of magnitude of the size of all hadrons, 10^{13} cm. The diagram above therefore depicts the conditions of mutual penetration of the wave-packets of particles which are necessary to activate the strong interactions.

It is then evident to all that wave-packets in conditions of mutual penetration cannot be effectively reduced to isolated, dimensionless points, unless extremely crude descriptions are desired.

The diagram above therefore identifies the insufficiency of the contemporary reduction of the universe to a collection of isolated points (locality) with only action-at-a-distance interactions (potentiality), in a favor of suitable, non-local/integro-differential generalizations...."

We would like to continue with this great excerpt from R.Santilli's work with the statement: Because the problem of averaging ("non-local/integro-differential generalizations") of the array of moving atoms, molecules, free electrons, photons embedded in a medium that can be called vacuum (and is not really empty space - it is what for hundreds years called as aether) or other more complicated media is the problem of scaled heterogeneous physics, it should be treated with the tools of that physics, including first of all the various Volume-Surface integration theorems, developed for Heterogeneous media.

That is why the methods used in homogeneous physics must fail and have been failing for >130 years to develop the correct interscale medium electrodynamics governing equations.

We considered and refuted the "unquestionable" postulates of COH particle and atomic physics [20,32-34] that are intended to prove the claims of QM and "virtual" mathematical atomic physics proponents that everything is good apart of the points when the classical physics "seems" cannot overcome the difficulties of the theory of sub-atomic physics.

Among these methods and definitions we randomly selected just a few that are well acknowledged and used in COHP.

Neglecting the real physical phenomena followed from the existance of particle-mass-charge presence and spatial distribution - with exact locations, of sub-atomic particles and atoms themselves such things and definitions and assumptions as:

1) the "free-electron" model where crystal is considered as a Homogeneous medium with the electrons embedded in a homogeneous constant positive charge space.

2) the opposite assumption model - when electrons are tightly bound in the space, while electron itself is the "wavefunctions".

3) many body effects are taken care of within the self-consisted field. Because no heterogeneous methods that are existing have known.

4) space average of the microscopic fields over a certain region is defined as

$$\langle \mathbf{E}(\mathbf{r},t)\rangle = \mathbf{E}(\mathbf{q};\omega)exp(i(\mathbf{qr}-\omega t)).$$

What is the base for that apart of imaginable mathematical decomposition for assigned governing equations?

5) Field theories, where calculated the perturbation series in powers of electron-electron interaction. Well, this would be the homogeneous mathematical scheme for interaction that is even incorrectly assigned.

6) Electron-phonon interaction? What is this ? In terms of physical particles - not the synthetic objects that are used for mathematical convenience?

What is the phonon? Pure mathematical character imagination.

7) A single electron moving in the periodic potential of the crystal lattice in imaginable Fermi liquid theory allowing to consider only one electron in the substance (matter crystal lattice), as the substitute of the Heterogeneous matter consisting of electrons, photons if we have to take into account the electron's energy (mass) change, atoms and aether (yes, aether) at least.

8) The concept of semi-classical theory of electron transport when the external forces (fields) considered as in classical physics - as acting on a body; while the internal properties of a substance (crystal) treated in a quantum mechanics sence.

This is the consequence of inability of COHP to treat the collective forces (physical effects) correctly on the lower atomic-sub-atomic scale and on the Upper scale of kind of continuum scale that is named in COHP as "classical way" and finally on the two scales of the problem at least.

Another great incapability in COHP is that the dynamics equations for particles within the presence of matrix of another phase local-non-local particles, atoms just cannot be formulated in COHP.

9) Pseudopotential ? What is that? In terms of physics not mathematics? Because in COHP there is no structural models for physical objects and of mathematics for them ?

10) Many authors write about atoms something as:

"probability of penetration through the potential Coulomb barrier for the collision of atoms....."

Again we see here absolutely no Electrodynamics in an atom or/and between of atoms because for this exist the reasons since ~1920s: in COH physics there is no Heterogeneous electrodynamics - so, the treatment of arrays of atoms is not available. The MD is of the same group of illegitimate physics and math methods. All of this due to unwillingness to face the facts regarding the electromagnetism at the sub-atomic scales.

11) It is not a surprise that COHP workers can write that - "To date, there is no distinct quantum--mechanical theory of solids, even for the case of such highly ordered systems as crystals."

While actually it is better than a “progress” on this topic than if that happened using the COHP instruments.

It is easily noticed that all of the above shortcomings, deficiences are the result of neglecting, abandoning the real physical picture of Heterogeneity of atomic and sub-atomic world in substances, materials.

These just mathematical concepts are freely accepted and included in physics now as the "classical" ones.

Meanwhile, they are all the consequences of point-mass one phase Homogeneous treatment of polyphase Heterogeneous media no matter what physical effect and scale are considered. In nuclear physics that was understood (not properly treated) already in 1940s during the atomic bomb research. In chemical engineering and thermal physics this was apprehended after 1967.

3.2 Three Important Assumptions That Have Destroyed Conventional Orthodox Homogeneous Physics

Going back into history of physics and considering the great innovations in it at the beginning of XX century we should accept (each of these statements has been thoroughly studied in the past ~30 years) that the three main concepts that appeared to be the postulates, for Conventional Orthodox physics and particle physics (PP) indeed had been ruling in physics.

1) One is that the sub-atomic ("elementary") particles are the mythical just mathematical points with mass and charge, but not the real Physical objects of volumetric character.

Because the point in mathematics has No Volume, No Surface, nothing - just the location coordinates. Physicists probably did not realize this at that time?

Meanwhile, the subatomic particles have volumes, surfaces, structures, and other properties.

2) Number two wrong issue that is habitual in particle physics is the inadequate description of Electromagnetic phenomena related to sub-atomic particles when the Maxwell-Heaviside-Lorentz (MHL) electrodynamics theory applied with the system of equations that used for explanations for more than a hundred years in Continuum Mechanics. In spite that even in the XIX century there were noticed imbalances in initial set up and conceptual approach to the MHL system of equations with the lack of experimental verification. During the XX century and the beginning of this XXI many scrupulous scientists found imbalances, and inadequacies in applications of MHL electrodynamics to technical, practical problems. And started questioning and advancements. More of that, the substantial and well-founded GEK (Galilean Electrodynamics by Klyushin) theory had been moved forward. Not only the one new theory is known now, but the best right now (we have been analyzing other suggested upgrades of MHL electrodynamics theories as well and critique has been laid out and known elsewhere) and we put forward many arguments supporting the new Galilean Electrodynamics now.

3) The third area of inadequate reasoning in particle and general physics is the wrong mathematics for Heterogeneous media used for centuries, but for and with another goal. We are talking about the wrong Homogeneous mathematics used in particle physics as well as in all physics for everything on this planet and for astrophysics as if all media are Homogeneous. At the beginning of XX, and in the earlier times in XIX, in the midst of XX there were no correct tools to use for Heterogeneous problems so, mathematicians and physicists used and continue to use in their research what they knew - the Homogeneous Calculus and related disciplines for that.

These three areas, among others, had brought in many inadequacies and problems in descriptions for particle physics phenomena that continued and in general physics.

3.3 Postulates Introduced in Physics During Beginning of Quantum Mechanics and Particle Physics Times

1) All particles are accepted and assumed to be viewed and treated as the "point-like," point-mass (with the mass that is being attached to this object?) or having no extended body in space. That was done because there were tremendous difficulties in treatment of many-body problems in general physics and mathematics in XVIII - XIX and even in XX centuries. There were no

mathematical methods for that treatment and even now these problems having approximate simulating solutions.

2) All particles and surrounding media as, for example, an air or the vacuum were treated as the one-phase Homogeneous medium with either the space indistinguishable locations of point-particles or with use of the Dirac's δ -function.

3) Because at that time there were also no concepts and theories of multi-phase media and their methods of interaction, modeling and solution. Those were developed much later in continuum mechanics of fluids and gases (with later on the wide applications to other sciences and engineering) while supported by the corresponding newly developed mathematical tools.

4) There were no boundaries, bounding surfaces for point-particles. No need to have those. That postulate brought in the great problems.

5) So, with introduction by Dirac the theory of electron simultaneously with the theory of δ -function in 1929 there were solved two and even three tasks in atomic, sub-atomic physics:

a) physical and mathematical fields could be continually considered as the homogeneous ones and all powerful existing at the time mathematical mechanisms and tools for solution of those homogeneous problems could be applied;

b) the location and movements of particles and atoms could be assigned as for the Homogeneous fields source functions in mathematical formulation of the tasks;

c) the powerful methods of statistics were free to apply to the point-particles in space behavior, advantageous for their assigned interaction collective movements and characteristics. That was the beginning of statistical mechanics shining.

That also created the problem of near particle field's description, that became the statistical qualities of a field.

This vision of particles as point-mass particles and fields as the Homogeneous ones, was accepted in 1920s - 1930s because physicists couldn't solve correctly the particulate problems as is. With particles as small, but still physically volumetric particles and the physical fields as of Polyphase media of different phases with distributed spatial fields. Now we can do this.

Since then, the electron and photon are the Point-mass objects in COHP with no volume and volumetric characteristics.

Since then, the huge body of mathematics, let alone physics, has been developed just to support this artificial picture.

While physics became a metaphysical science, because of false point-particles, MHL electrodynamics, SR and GR following from this short-hand electrodynamics, and QM that became the compounding original theory for everything small enough to not study it within.

6) With these above assumptions (1-4) that was not surprising that Quantum Mechanics was introduced and advanced in this fantastic mathematical formulation as we know it now. Little

later Dirac's δ-function added greatly to the functionality of the hard solid rock of QM that is laying on the road to further progress in physics for many decades.

People started to find inconsistencies, flaws in QM in the earlier years of QM appearance. And that was not too hard.

At present situation, when those statements of 1920-1930s can be solved for the real physical polyscale media at atomic and sub-atomic scales and many issues had been resolved, because the HSP-VAT theories for that solution during the last 20-30 years have been advanced far enough.

3.4 Hidden, Concealed and/or Incorrectly Interpreted Phenomena in the Sub-atomic Electrodynamics and Particle Physics in Conventional Orthodox Homogeneous Physics – COHP

In many (most) parts of physics we can not refer and consider the Homogeneous physics "theories" where there are no physical objects present and where the theoretical (physical) and mathematical constructions (often wrong simply by the use of homogeneous tools) are placed in the field as the pure imaginable objects that are free for conjectural developments.

While the physical ground is also of conjectural nature as:

1) At the sub-atomic scales the electrodynamic phenomena are completely for and by the point-mass, point-charge structureless particles.

2) Particle physics is based on QM (and similar) concepts and tools and in this capacity genially has only point-mass structureless particles to work with.

That is no wonder that in a time frame of more than hundred years we don't know for sure and don't seen even an electron - because it was accepted just from the beginning as a point with mass and charge, and spin; nothing more.

3) That is why it is "flying" (curling) over the nucleus, but nobody seen that how? Contrary, there are already images of stable location of electrons over the nuclei.

4) All these countless particle physics methods using the Lagrangians and Hamiltonians (LH) are the XVIII-th century tools, developed for the point-mass volumeless particles (bodies).

5) Because of this in all these LH assessments there is no spatial or correct statistical averaging, even in the atom's volume. The technique of statistical averaging of point-mass particles and/or their properties can not include the structure of particles by the definition of those. The point is a point - no structure in it, it is a volumeless object.

Lagrangian mechanics is used in particle physics because it gives the simplified point-mass particle systems behavior and assessments of the issues, functions.

Not a phase-related continuum homogeneous or heterogeneous media. So, all the parts of the "system" are the point-mass (PM) particles that are connected (coupled) in some system of interacting in some way via the vacuum-aether the PM particles.

In this way one can freely avoid the volumetric and surficial consideration of particles, and of averaging difficulties regarding the heterogeneous media.

The methods explored, used in particle and atomic physics can be traced back to the XVIII century, when mechanics of Newton can not been used for many problems that were appeared, created with the formidable thrust in advancements of mechanics itself as well as of astronomy.

There was a burst in classical mechanics and astronomy with the many body formulated problems. All of them were considered as a one phase many body tasks. For the point-mass bodies.

3.5 Scale, Interscale and Bulk Theories in Continuum Mechanics Physics Disciplines

In our [6,9-16,18,35-40] (other publications) we kept in mind the desire and base while considering the tedious comparing and analysis of those homogeneous GO studies for Continuum Mechanics when on the other hand using the point of view as of the presence and force of the Heterogeneous WSAM theorem and other theorems of this kind for heterogeneous media along with the other HSP-VAT advancements, found throughout the last 47 something years.

One of the main objections to the heterogeneous and would be "scaled" publications, research in COHP and to the ones specific statements on Continuum Mechanics in the referred studies, papers in [6,9-16,18,35-40], is that in these simulation techniques authors can not describe properly the - "coupling," "multiscaling," "connection of scales," "scale bridging," etc., because they can not properly address and formalize the collective behavior, collective physical subjects phenomena at the neighboring physical scales as well as the surficial phenomena for all the said simultaneously in Modeling Governing Equations.

For example, the missed points are the descriptions and properties of the two scales and how the REV and the Lower scale medium are corresponding one to another? What is written and presented is not enough with regard of these issues. Then - How the two-scale equations are corresponding one to another?

That is not understood and is not treated as for the scaled problems, but those are indeed the polyscale ones.

One of characteristic examples as in [26] we have mentioned that the issues of:

a) "effective mechanical properties measured in experiments are relations between the volume

average of the strain and stress of microscopically heterogeneous samples," - these properties are the result of experimental set-up made for Homogeneous medium, and as such bearing the features of GO homogeneous medium theorem based experimental set-up.

Not a Heterogeneous Medium Experiment (HtME) on Elasticity (as of the physical field in this example) properties. This is the experiment (HtME) where the dependency of stress on a displacement field as of an averaged field usually established, thus this dependency would consist also within the HtME provided with the surficial integrals for the displacement fields over the interfaces within the measured volume, within the REV or one of possible REVs taken as for this curtain experiment. Means, This should not be the Homogeneous experiment, if we are determined to deal with the our Heterogeneous medium. Well, in this case we have to obtain the the Heterogeneous dependence between the average displacements and average stress in the whole Heterogeneous medium, in the separate phase(s) of the medium.

b) the Upper scale elasticity (as of the physical field in this example, but also for other physical phenomena as well) model fields are determined throughout not only the Lower scale microelasticity fields, but also and that is the major constitutive part of Upper scale physics, by the Upper scale Ht Governing equations solution for the problem's domain Heterogeneous medium. Otherwise, if the Upper scale GE would be accepted as of Homogeneous medium, then the Upper scale Effective Coefficients (EC) and Boundary Conditions (BC) would not the conventional Homogeneous medium EC and BC.

c) in most situations, central question in the problems the Upper scale statement conditions are of the prevailing importance for the Heterogeneous problem (elasticity in this case) and as such the Upper scale mathematical statement must be stated rigorously, as much strict as the theory allows. That means - the Lower and the Upper scale GEs must be constructed so directly mathematically tied, as they are in physical nature of the problem, usually. That means also - that the Top-Down as well as the Bottom-Up sequances should be used for mathematical formulation of the Two Scale Problem. Also, the Upper scale GEs formulated as the conventional homogeneous statement are incorrect if taken separately from the correct Lower and Upper scale Heterogeneous GEs as in this paper, for example. As in a whole one can find that in spite the careful construction of the Representative Elementary Volume (REV) in all the Homogeneous studies over the Heterogeneous medium problems the analysis derived regarding the averaged stress, strain, and other functions, fields is done as for the homogeneous medium and finally, of course, the governing equations have been done as for homogeneous statements usually performed and known from textbooks. That did not add any value to the program of such a scale as developing the multiphysics, multiphase transient continuum mechanics problems theory.

4. Particle Physics and Sub-Atomic Scales Electrodynamics

We prefer to cite some known remarks as of Wallace [41], others who wrote critically and cited the words of W.Heisenberg [42,43]: "New experimental results are always valuable, even if they only enlarge the data table; but they are especially interesting if they answer critical questions of the theory. In the theory one should try to make precise assumptions concerning the dynamics of matter, without any philosophical prejudices. The dynamics must be taken seriously, and we should not be content with vaguely defined hypotheses that leave essential points open. Everything outside of the dynamics is just a verbal description of the table of data, and even then the data table probably yields more information than the verbal description can. The particle spectrum can be understood only if the underlying dynamics of matter is known; dynamics is the central problem." (Underlined by us).

It is our turn to notice that the dynamics of "elementary" particles **can not** be ascribed with the COHP understanding and profiling of these particles as the point-mass-charge-spin objects - with properties.

It is the mathematical construction – the point-mass-charge-spins are not of physics first of all.

4.1 The Aether Phase in the Sub-Atomic Scales Electrodynamics

Continuing the introductory part on aether in 1.2 we make some formal remarks on the essence that researchers imbed into the structure of the aether, of course, the imaginable features - because the aether's structure so far is defying description of details. Nevertheless, some features can be accepted as via the experiments.

Many, if not any researcher on aether conclude that the aether has a structure and that it has to be with - "one feature of the aether, one overlooked by Clerk Maxwell and all those who did pursue their 19th century models of aether. The aether conveys electromagnetic waves. Those waves might have a lateral oscillation, meaning that they wriggle sideways in their forward progress as does a snake." (Insisted by Aspden, in his "The Heresy of the Aether" [44]).

Meanwhile, what is not known to any devoted educated and even highly qualified researcher of aether is that the structure features of aether demanding the recognition that aether is the Heterogeneous medium, and as such needs to have rather different treatment as a physical medium than Homogeneous medium that these researchers are able to employ for the purpose at the current moment.

The pretty important is the fact that electromagnetic "waves" is actually rather mathematical, but not physical characteristic of electrodynamics in any medium. Electromagnetism is the feature and quality belonging to electromagnetic particles and a medium in which those particles are distributed and/or moving through. There is no so called "electromagnetic" field without charges and a media. Media itself cannot create the "electromagnetic" field.

That means when researchers are saying or treating the "electromagnetic" field - they treat the mathematical implementations of charges that are moving within the media [45-53]. What kind of charges and how they create the "electromagnetic" field, we will discuss below in the text of this manuscript.

Aether medium by Atsukovskiy [54] is the viscous, compressible fluid-like medium. In the studies [55,56] profoundly shown inconsistencies in electrical engineering (conventional MHL electrodynamics) without existence of aether. That is, even in practical usage of electrical engineering when experimentally verified rules (laws) - it is obvious need in aether as intermediating medium.

Nevertheless, other researcher [57] does not agree with this and considers that "....Ether is presented as an all-pervading medium consisting of particles of two equal but opposite in sign, species. Ether has a certain electromagnetic density and elasticity."

"Established facts and phenomena suggest that the ether is a specific medium, fundamentally different from the liquid and solid media."

"One of the most remarkable properties of ether is that it has no resistance to a uniform movement."

"Otherwise, the ether has no density or mass of the same kind, which have a physical body, that is, one that has a dimension, for example, (kg/m^3)."

Summarizing the above results to general properties of ether (vacuum) author [57] includes among others the following characteristics of aether:

"...the ability to penetrate into all physical bodies, while possessing the qualities of the medium, does not reveal the effects of friction;"

"1. Ether (ether medium) consists of two particles with opposite , species. Opposite sign are attracted to each other, forming a homogeneous a space in which, in an undisturbed state, each of adjacent particles opposite in sign to the particle. Opposite in sign particles attracted to each other with great force.

2. Opposite in sign the particles constituting the ethereal medium move relative to each other without friction . Ethereal medium consisting of these particles is a medium of some kind. It can exist indefinitely Linear, circular and other physical movement, shear deformation, etc. This medium has a density in the conventional sense. It has certain electromagnetic properties.

3. Any physical, having a mass (density), substance (a substance molecules, atoms) permeable to the ethereal medium. Any physical substance can move in the ethereal medium without friction."

"4. Inertial forces arise in any physical substance interacts with ethereal medium only when accelerating or decelerating motion. Uniform local physical body movement deforms the ethereal medium, changing the distance between the oppositely charged, conjunct with great force particles of the ethereal medium, which close up again after his passage."

We rest in the description of current theory for Cold Fusion technical needs with the unspecified mechanical structure of aether and take it as a still medium with electromagnetic and some of continuum mechanics known properties. Nevertheless, we do not support the simplistic definition of electron, other sub-atomic particles as the swirls of aether itself. We don't have evidences of that, otherwise it's just one of frivolous conjectures.

4.2 Electron and Photon as Volumetric particles

There are many, not only of COHP authorship, theories of sub-atomic particles. In this text we are first of all interested in theories where the sub-atomic "elementary" particles are treated as the volumetric objects with the substantiated properties, with their models where the established in physics doubtless features are present in the volumetric particle models.

We found those also. Among them we mostly are interested in theories that have some connection to faultless other areas of physics. For example, when person develops the volumetric theory for an electron and at the same time talking about QM and/or QFT or QED - it is the clear sign that this person is of not enough qualifications in physics, because he supports obsolete or simply approximate or wrong theories in COHP. At the same time he contradicts to the same opinion that volumetric particles stand for.

We will add here some text and basics for including that in models for electron and photon specifically into the details of particle physics. We just want to have ability to simulate our most unusual terms in governing equations on the Upper scales where the continuum electrodynamics is being formulated.

The great reason for seeking the volumetric models of sub-atomic particles is that in this way the tight connection of sub-atomic electrodynamics with the dynamics of particles themselves and with the overall collective Bottom-Up and Top-Down scaleportation of some properties, may be the substantial part of all characteristics that are clearly on the table.

The problem with the dynamics of sub-atomic particle is that their momentum equations are insufficient in COHP with the short-handed Lorentz force model that is working for more than a century and brought in during this period many problems in particle and general physics. While it is known the COH physics can not average any equation of the sub-atomic phenomena by its own internal inability.

We would start in the current theory with the theory of structured electron, proton, nucleus, (Fig. 2-4) hydrogen atom, and molecule mostly following the developments by Ph.M. Kanarev in particle and atomic physics those we have found as the most advanced at this time in physics.

Then we proceed to physics of electron arrays based on the HSP-VAT methods for Maxwell-Heaviside-Lorentz and Galilean electrodynamics where the electron arrays dynamics (not the molecular dynamics (MD) of homogeneous physics) ***can be explored with a mathematical rigor***, while we accept the ideas and vision of the nature of one and numerous electrons (atoms) in the determined volume. Those issues are different than in COHP explained hydrogen physics, for example, phenomena, while the hierarchical scaled approach allows contemplating the known phenomena at present at each scale of considered physics, homogeneous and/or heterogeneous.

For example, if in scaled physics the electron arrays (Fig. 5) should be and can be undoubtedly considered as the number of electrons (other sub-atomic particles), not a cloud of mathematical mass-points, in the aether, in the medium, not in the vacuum that has, nevertheless, the electrodynamics properties? If a medium is empty - means nothing inside of a volume, it should not have any properties by the logical and philosophical definitions. How the nothing can have internal properties?

Figure 2. Electron in 3D - shown without the surficial movements and magnetic momentum and a spin, that is following

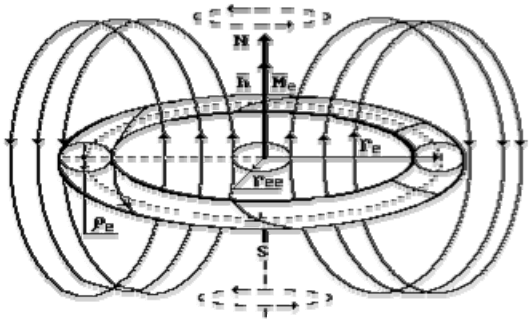

Figure 3. Electron in an aether - Kanarev, Ph.M. [52,53]

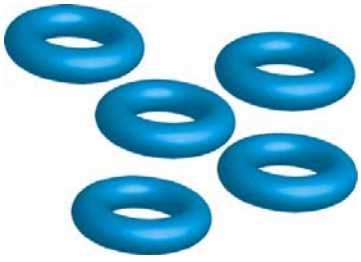

Figure 4. Protons in 3D - without its magnetic momentum and surface dynamics. It is one of imaginable simplified, but anyway the 3D volumetric structures of a particle.

Then, we are concerned to the never correctly considered problem - Fig. 5,6 (well, it was considered either simplistically or bluntly incorrect regarding the mathematics and physics statement), of what are the properties of such an array if it is still or moving in space (aether) while particles (electrons, protons) explicitly have dynamics or due to initial impulse or due to external electromagnetic fields (while this definition of electromagnetic field needs to be specified additionally to get to more strictly and openly stated meanings), when even the governing equations are written incorrectly, with unrecognizable simplifications.

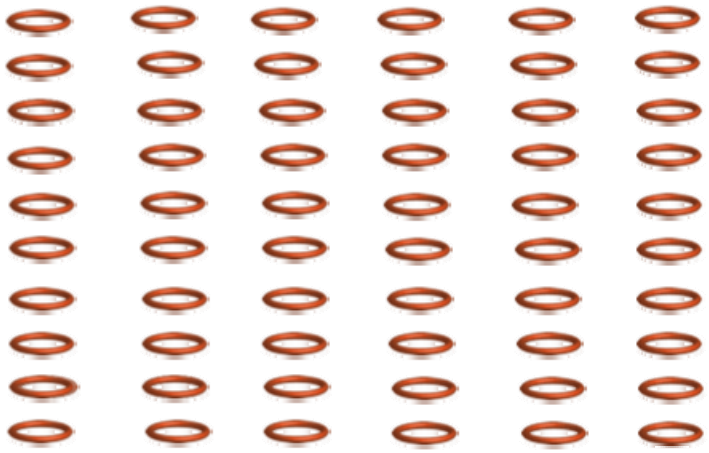

Figure 5. An array of ordered electrons in space. To theorize and model this array the COHP methods are artificial, so the modeling of particles swarm in particle accelerators, for example, is pretty simplified because can not be Upscale averaged, while dynamics equations are incorrect themselves.

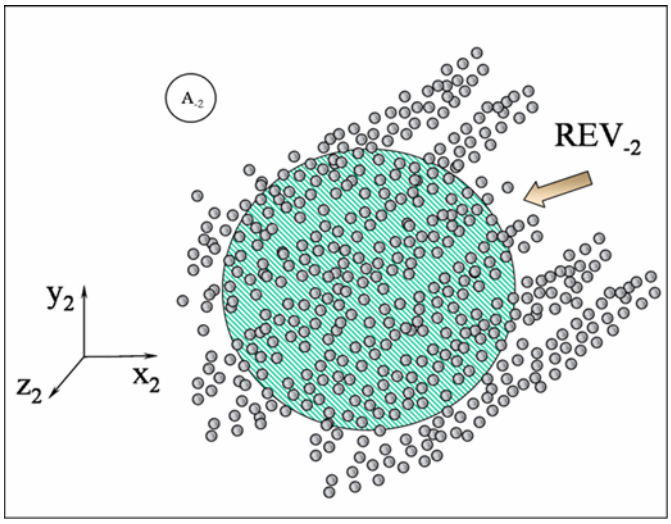

Figure 6. An array of photons in space dynamics - two-scale modeling reveals the wave character of some dynamics regimes.

4.3 Lower Sub-Atomic Scale Maxwell-Heaviside-Lorentz (MHL) GE in SI

Now we provide the set of Maxwell-Heaviside-Lorentz (MHL) GE in SI with $\mathbf{j} \neq 0$, $\rho \neq 0$ for a vacuum (aether) and moving charge point-like particles as for the homogenized mixture with sources (electrons, for example) as it is described in GOHP textbooks when $\mathbf{j} \neq 0$, $\rho \neq 0$:

in the (**e** - **b**) pair before averaging (real) for the upper scale governing EM equations

$$\nabla \cdot (\mathbf{e}) = \frac{\rho_{ch}}{\varepsilon_0}, \ \nabla \cdot \mathbf{b} = 0,$$

$$\nabla \times \mathbf{b} = \mu_0 \varepsilon_0 \frac{\partial \mathbf{e}}{\partial t} + \mu_0 \mathbf{j}, \quad \mathbf{j} = (\rho_{free} \mathbf{v}_{free} + \rho_{bound} \mathbf{v}_{bound}),$$

$$\mu_0 \varepsilon_0 = \frac{1}{c_0^2}, \quad \mathbf{b} = \mu_0 (\mathbf{h} + \mathbf{m}), \ with \quad \mathbf{m} = \mathbf{0},$$

where **m** is the magnetization

$$\nabla \times (\mathbf{e}) = -\frac{\partial}{\partial t} (\mathbf{b}),$$

These might be also compared to the pure vacuum0 Maxwell equations in (**e** - **b**)

$$\nabla \cdot \mathbf{e} = 0, \qquad \nabla \cdot \mathbf{b} = 0,$$

$$\nabla \times \mathbf{b} = \left(\frac{1}{c_0^2} \right) \frac{\partial}{\partial t} (\mathbf{e}), \quad \nabla \times \mathbf{e} = - \frac{\partial}{\partial t} (\mathbf{b}).$$

4.4 Galilean Electromagnetism Governing Equations by Klyushin (GEK)

As J.Klyushin [58-60] wrote - the "modern theory of electrodynamics possesses some drawbacks among which perhaps the most unpleasant is that Lorentz force does not satisfy the third Newton Law."

Also, "many experiments in many countries which cannot be explained in traditional ways were produced."

That were among a few motivations behind the development of the Galilean Electrodynamics by Klyushin (GEK) we named it.

Among many outstanding features of this electrodynamics theory might be mentioned the list of fundamental benefits (not complete) that J.Klyushin considers as the main advantages:

1) the new GEK electrodynamics generalizations bring the following gains:

"a) divergence of Magnetic field is assumed to be non zero, i.e. existence of magnetic charge is accepted. But such charge does not coincide with Dirac monopole in many aspects. It is closely connected with magnetic moment of the electrically charged particles and in this sense it may be considered as an another incarnation of the electric charge. But in contrast to electric charges a force similar to Coulomb one does not appear between two magnetic charges. They begin interact only in movement;

b) total time derivatives are used instead of the partial ones in the equations. Physically this means that we can take into account the aether, i.e. media in which electric wave propagates. For this, the direct current which is introduced into traditional Maxwell equations "by hands" turns to be one of the two items forming convective part of the total time derivative. The second part of it is a curl expression which appears when electric wave is described and which was not a subject of investigation in the Maxwell system explicitly.

Mathematically this means that generalized GEK system is Galileo invariant and we do not need to use Lorentz transformation: total time derivative takes it into consideration automatically. Generalized MHL equations have a good mathematical peculiarity in addition: they have solution in the case of separate charge in contrast to traditional MHL equations.

2) The last mathematical peculiarity of the Generalized MHL equations enables us to propose some new approaches to the concepts of the fields and their interaction.

a) Fields are defined not as a force acting on a charge but just as a solution of the GEK system. It is shown in appendix one that electric field has mechanic dimension of velocity and magnetic field is non-dimensional one and means rotational angle.

b) ***Thus we turn to be able to describe interaction between charges with the help of interaction between fields induced by these charges***. Interaction energy and interact ion impulse are constructed with the help of the fields. Interaction energy gradient supplies us with the

Huygens part of the force and the time derivative of the interaction impulse gives us Newton part of it. The obtained formula describes all the experimental results known to the author.

3) Some examples are investigated.

a) A case nowadays investigated usually in the framework of Relativity theory examined. An alternative formula is proposed.

b) Peculiarity of interaction between two electrically charged beams is investigated. Existence of cluster effect is predicted.

c) It is shown that electric constant ε_0 means the free aether mass density and magnetic constant μ_0 means the free aether compressibility. They are different in different substances. Examples are proposed to show that many qualities of capacitors, solenoids, diamagnetics and paramagnetics are determined by ε_a and μ_a in these bodies."

We will set up the explanatory text of substantial character in another work, but here the only pure notions of physical and mathematical character will be allowed.

Generalized formula for EM Two-Particles Interaction force

At the beginning of GEK formulation as for a one scale homogeneous theory Klyushin presents, first of all, the model for the two charges interaction while taking into account of both electric and magnetic fields.

Taking from Klyushin [58,59] we set up the rectangular right hand coordinate triple to be defined in three-dimensional Euclidian space. Where $\mathbf{x} = \mathbf{x}(x_1,x_2,x_3)$ to be a point in this space, t is the time dimension, and **i,j,k** are the unit vectors. Designate q_1, q_2 to be the electric charges 1 and 2, $\mathbf{v}_1$, $\mathbf{v}_2$ and $\mathbf{a}_1$, $\mathbf{a}_2$ are their velocities and accelerations. For simplicity the charges are assumed to be evenly distributed in a ball of radius r_1.

Let $\mathbf{E}_1$, $\mathbf{E}_2$, $\mathbf{B}_1$, $\mathbf{B}_2$ be electric and magnetic induction field intensities generated by the charges in a space (aether).

"In the development below, a double index means field intensity created by the charge whose index goes first evaluated at the point where the charge whose index goes second is situated. For instance $\mathbf{E}_{21}$ means the electric field intensity created by the second charge at the point where the first charge is located. Let $\mathbf{r}_{21}$ be the radius-vector from charge 2 to charge 1, r is its modulus, $r >> r_0$ and ε_0 is the dielectric constant" in an aether."

Note, that we have two spherical charges of radius r_0 that placed in an aether environment.

The model (formula) for the charge 2 producing the following force on charge 1 Klyushin [58,59]

$$\mathbf{F}_{21} = -\nabla[4\pi\varepsilon_0 cr^3(\mathbf{B}_{12} \cdot \mathbf{E}_{21})] + \frac{d}{dt}[4\pi\varepsilon_0 cr^3(\mathbf{B}_{12} \times \mathbf{B}_{21})]. \quad (4.1)$$

Here $c = c_0\,(\mathbf{i}\times\mathbf{j})\cdot\mathbf{k}$, where c_0 is light velocity. This quantity is called pseudo-scalar light velocity.

Klyushin [58,59] writes that each of the two charges moves creating electromagnetic fields in the surrounding space (aether) while these fields $\mathbf{E}_1$, $\mathbf{E}_2$, $\mathbf{B}_1$, $\mathbf{B}_2$ depend on the charge's value, its velocity and radius-vector. The fields may be found as solutions of some equations as of Maxwell-Heaviside-Lorentz or other systems.

Now we bring in the homogeneous GEK statement when the electric charge q somehow distributed in the space (where it is an aether and charges) with density ρ, originates electric and magnetic fields which are the solutions of the following system in SI:

the Gauss's law GEK equation

$$\mathrm{div}\mathbf{E} = \frac{\rho}{\varepsilon_0}, \quad (4.2)$$

the Faraday's law of induction GEK equation

$$\mathrm{rot}\mathbf{E} = -\frac{d\mathbf{B}}{dt}, \quad (4.3)$$

the conservation of magnetic induction **B** GEK equation

$$\mathrm{div}\mathbf{B} = -\frac{\rho}{c_0\varepsilon_0}, \quad (4.4)$$

and the Ampere-Maxwell law GEK equation (in an aether (vacuum0))

$$\mathrm{rot}\mathbf{B} = \left(\frac{1}{c_0^2}\right)\frac{d\mathbf{E}}{dt}. \quad (4.5)$$

In equation (4.4) is present the "magnetic charge" term $(-(\rho/(c_0\,\varepsilon_0)))$ which is (Klyushin [59]):

"1) Such a "magnetic charge" is a pseudo-scalar, i.e. its sign changes when a right handed coordinate triple is changed for a left handed one.

2) It is c_0 times less than an electric charge; correspondingly, its dimension differs from the electric charge dimension.

3) And last but not the least, the force equation (4.1) implies that two static "magnetic charges" do not interact, because the second term in (4.1) responsible for magnetic interaction is zero in this case. I ask the reader to pay attention to this fact because "ordinary physical mentality" usually identifies field and force, two charges and their inevitable static interaction. We shall see that Newtonian (second) part in (4.1) does not contain static item."

When all the arguments that were produced in a favor of this Homogeneous presentation of the medium with charges have been sounded in monographs by Klyushin [59,60] - we must add:

that the total time derivatives in two equations of GEK are needed because of long time standing confidence of that only the aether can connect interaction of the charges in any case, for

example in a aether (vacuum0)), but and in any other phase while being in between the other phase atoms (molecules), or in the problems of an aether with the charges.

We now provide the arguments that the charges, volumes occupied by charges, should be considered as "phases", yes, special volumetrically designating themselves as the spatial "phases."

It is one of the prime statements in the polyphase medium that presents the best and the most rigorous mathematical description of polyphase medium while is showing the processes in each homogeneous phase separately. This gives ability to model and simulate processes (physics of processes) in the most accurate mathematical procedure ways. At the same time, it is the only approach at this time - end of the XX and beginning of XXI centuries, when the solution of these Two-scale physical problems can be achieved taking into account all the physical features of phenomena happened in both scales - some of them cannot be described and seen in the One scale homogeneous mathematical physics statements.

4.5 Averaging of the MHL Governing equations at the Sub-Atomic Scale in SI

The common view pseudo-averaged matter in an aether (vacuum0) linear Maxwell-Heaviside-Lorentz (MHL) Homogeneous Electrodynamics Governing Equations are:

the Gauss's law equation

$$\nabla \cdot \mathbf{E} = \frac{\rho}{\varepsilon_0},$$

Faraday's law of induction equation

$$\mathrm{rot}\mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t},$$

conservation of magnetic induction B equation

$$\nabla \cdot \mathbf{B} = 0,$$

and the Ampere-Maxwell law equation

$$\mathrm{rot}\mathbf{B} = \frac{1}{c_0^2}\left[\frac{\mathbf{j}}{\varepsilon_0} + \frac{\partial \mathbf{E}}{\partial t}\right], \quad c_0^2 = \frac{1}{\mu_0 \varepsilon_0},$$

then we can write that

$$\nabla \times \mathbf{B} = \mu_0 \mathbf{j} + \frac{1}{c_0^2}\frac{\partial \mathbf{E}}{\partial t}.$$

As soon as conventional homogeneous physics states that this set of equations is the most accurate we can use it for writing the 3-phase MHL equations for aether-electrons-photons in a volume - as the MHL EM sub-atomic media (Lower scale) GEs in SI:

where in the aether phase EM MHL GE (Lorentz style) in the (**e - b**) pair

$$\nabla \cdot (\varepsilon_0 \mathbf{e}_0) = 0, \quad \nabla \cdot (\mathbf{b}_0) = 0,$$
$$\nabla \times (\mathbf{b}_0) = \frac{1}{c_0^2}\frac{\partial}{\partial t}(\mathbf{e}_0),$$
$$\nabla \times (\mathbf{e}_0) = -\frac{\partial}{\partial t}(\mathbf{b}_0),$$
$$\mu_0 \varepsilon_0 = \frac{1}{c_0^2}, \quad \mathbf{b}_0 = \mu_0(\mathbf{h} + \mathbf{m}), \text{ with } \mathbf{m} = \mathbf{0},$$

plus the electrons phase - for a one electron the MHL similar GEs (the coefficients are taken just by analogy - no real physics at present time can be provided regarding the internal properties and function of electron, apart of some surface of electron properties and some sizes)

$$\nabla \cdot [\varepsilon_1 \mathbf{e}_1] = \langle \rho \rangle_1 = e,$$
$$\nabla \cdot (\mathbf{b}_1) = 0,$$
$$\nabla \times (\mathbf{b}_1) = \frac{1}{c_1^2} \frac{\partial}{\partial t} (\mathbf{e}_1),$$
$$\nabla \times (\mathbf{e}_1) = -\frac{\partial}{\partial t} (\mathbf{b}_1),$$

plus the photons phase, the great number of photons with their local scale ($10^{-15} \div 10^{-10}$) m fields (the coefficients are taken just by analogy - no confirmed real physics now can be provided about the internal properties of photons, but physical models by Kanarev [45-53], Klushin [58-60], and some other researchers, apart of some surface of photon properties (hypothetical and some sizes) advanced by Kanarev [52-53]

$$\nabla \cdot [\varepsilon_2 \mathbf{e}_2] = 0, \quad \nabla \cdot (\mathbf{b}_2) = 0,$$

$$\nabla \times (\mathbf{b}_2) = \frac{1}{c_2^2} \frac{\partial}{\partial t} (\mathbf{e}_2),$$
$$\nabla \times (\mathbf{e}_2) = -\frac{\partial}{\partial t} (\mathbf{b}_2).$$

These equations according to COHP are the best for the aether (vacuum0) description of sub-atomic scales electrodynamics, but not for the interior of electrons and photons that considered in COHP as the point-like particles - so, no volume for "phase" equations.

Meanwhile, many characteristics of electron and photon's "exterior" surfaces are actually assessed and known even at current moment [52-53].

Notes, that the whole litany regarding the "speculative" like formulation of electrodynamics for the phases of electron and photon is not worthwhile the piece of paper for its placement - because it is of the much better justification then numerous artificial constructions of QM and QF theories. As of, for example, particle is the wave - wave-particle famous "duality." That is not of physical reality.

That is of experiments wrong interpretation. Interpretation that is based on the point-like volumeless nature of particles, wrong their collective effects interpretation, and other forced imaginable features, while methods of HSP-VAT allows to have the data reduction on the two-scale base - that is the essence of experiments.

Pretty important is that the equations of particles momentum should be assessed and taken into the whole set of governing equations.

Averaged equations of aether, electrons and photons combined electrical fields

$$\nabla \cdot [\varepsilon_0 \langle m_0 \rangle \tilde{\mathbf{e}}_0] + \nabla \cdot [\langle s_1 \rangle \varepsilon_1 \tilde{\mathbf{e}}_1] + \nabla \cdot [\langle s_2 \rangle \varepsilon_2 \tilde{\mathbf{e}}_2] +$$

$$+\varepsilon_0 \tfrac{1}{\Delta\Omega} \int\limits_{\partial S_{0p}} (\mathbf{e}_0) \cdot \vec{ds}_0 + \varepsilon_1 \tfrac{1}{\Delta\Omega} \int\limits_{\partial S_{p1}} (\mathbf{e}_1) \cdot \vec{ds}_1 + \varepsilon_2 \tfrac{1}{\Delta\Omega} \int\limits_{\partial S_{p2}} (\mathbf{e}_2) \cdot \vec{ds}_2 = \langle s_1 \rangle ne,$$

when

$$\langle \mathbf{E} \rangle = [\langle m_0 \rangle \varepsilon_0 \tilde{\mathbf{e}}_0 + \langle s_1 \rangle \varepsilon_1 \tilde{\mathbf{e}}_1 + \langle s_2 \rangle \varepsilon_2 \tilde{\mathbf{e}}_2], \mathbf{E} = (\varepsilon_0 \mathbf{e}_0 + \varepsilon_1 \mathbf{e}_1 + \varepsilon_2 \mathbf{e}_2),$$

where n is the mean assessed quantity of electrons in the $\Delta\Omega_e$

Finally

$$\nabla \cdot (\langle \mathbf{E} \rangle) + \tfrac{1}{\Delta\Omega} \int\limits_{\partial S_w} (\mathbf{E}) \cdot \vec{ds} = \langle s_1 \rangle ne = \langle \rho \rangle_1.$$

Further for the averaged magnetic induction equation combined when

$$\langle \mathbf{B} \rangle = \left[\langle m_0 \rangle (c_0 \varepsilon_0) \tilde{\mathbf{b}}_0 + (c_1 \varepsilon_1) \langle s_1 \rangle \tilde{\mathbf{b}}_1 + (c_2 \varepsilon_2) \langle s_2 \rangle \tilde{\mathbf{b}}_2 \right],$$
$$\mathbf{B} = ((c_0 \varepsilon_0) \mathbf{b}_0 + (c_1 \varepsilon_1) \mathbf{b}_1 + (c_2 \varepsilon_2) \mathbf{b}_2),$$

then finally (symbolically)

$$\nabla \cdot (\langle \mathbf{B} \rangle) + \tfrac{1}{\Delta\Omega} \int\limits_{\partial S_w} (\mathbf{B}) \cdot \vec{ds} = 0.$$

Further is the averaging of other two ($\nabla \times$) the Lower sub-atomic scale homogeneous MHL equations. Ampere-Maxwell law equation for aether

$$\nabla \times \mathbf{b}_0 = \left(\tfrac{1}{c_0^2} \right) \tfrac{\partial}{\partial t} (\mathbf{e}_0),$$

note - no homogeneous source of current (charges) is present in this equation.

Now averaged over the domain of an aether, for example, is the Ampere-Maxwell equation for aether with moving inside particles (electrons and photons)

$$\nabla \times \left(\langle m_0 \rangle \tilde{\mathbf{b}}_0 \right) + \tfrac{1}{\Delta\Omega} \int\limits_{\partial S_{0p}} \vec{ds}_0 \times \mathbf{b}_0 = \left(\tfrac{1}{c_0^2} \right) \left[\tfrac{\partial}{\partial t} \langle \mathbf{e}_0 \rangle_0 - \tfrac{1}{\Delta\Omega} \int\limits_{\partial S_{0p}} (\mathbf{V}_{sp}(\mathbf{e}_0)) \cdot \vec{ds}_0 \right],$$

where accounting for both type of particles (electrons, photons) we would have

$$\tfrac{1}{\Delta\Omega} \int\limits_{\partial S_{0p}} (\mathbf{V}_{sp} \mathbf{e}_0) \cdot \vec{ds}_0 = \tfrac{1}{\Delta\Omega} \int\limits_{\partial S_{0p1}} (\mathbf{V}_{sp1} \mathbf{e}_0) \cdot \vec{ds}_0 + \tfrac{1}{\Delta\Omega} \int\limits_{\partial S_{0p2}} (\mathbf{V}_{sp2} \mathbf{e}_0) \cdot \vec{ds}_0,$$

and the Faraday kind of equation based the induction equation for a still aether, but with moving particles is

$$\nabla \times (\langle m_0 \rangle \tilde{\mathbf{e}}_0) + \tfrac{1}{\Delta\Omega} \int\limits_{\partial S_{0p}} \vec{ds}_0 \times \mathbf{e}_0 = -\tfrac{\partial}{\partial t} \langle \mathbf{b}_0 \rangle_0 + \tfrac{1}{\Delta\Omega} \int\limits_{\partial S_{0p}} (\mathbf{V}_{sp}(\mathbf{b}_0)) \cdot \vec{ds}_0.$$

Then we should arrange at first the averaged $\nabla \times$ two equations from the MHL like as the set of combined (full) EM GE: in (aether + electrons + photons) which is if averaged

$$\langle \mathbf{B} \rangle = \left[\langle m_0 \rangle (c_0 \varepsilon_0) \tilde{\mathbf{b}}_0 + (c_1 \varepsilon_1) \langle s_1 \rangle \tilde{\mathbf{b}}_1 + (c_2 \varepsilon_2) \langle s_2 \rangle \tilde{\mathbf{b}}_2 \right]$$

with

$$\mathbf{B} = ((c_0 \varepsilon_0) \mathbf{b}_0 + (c_1 \varepsilon_1) \mathbf{b}_1 + (c_2 \varepsilon_2) \mathbf{b}_2), \ (c_0 \varepsilon_0) = \sqrt{\tfrac{\varepsilon_0}{\mu_0}},$$

then finally the Upper scale charged particles plus aether combined Ampere-Maxwell like equation is formed as

$$\nabla \times \langle \mathbf{B} \rangle + \tfrac{1}{\Delta\Omega} \int\limits_{\partial S_w} \vec{ds} \times \mathbf{B} = \tfrac{\partial}{\partial t} \langle \mathbf{E}_{K3} \rangle - \tfrac{1}{\Delta\Omega} \int\limits_{\partial S_w} (\mathbf{V}_s \mathbf{E}_{K3}) \cdot \vec{ds},$$

where

$$\langle \mathbf{E}_{K3} \rangle = [\langle m_0 \rangle \tilde{\mathbf{e}}_0 + \langle s_1 \rangle \tilde{\mathbf{e}}_1 + \langle s_2 \rangle \tilde{\mathbf{e}}_2], \quad \mathbf{E}_{K3} = (\mathbf{e}_0 + \mathbf{e}_1 + \mathbf{e}_2).$$

The last Upper scale charged particles plus aether the Faraday like induction combined equation for the three-phase medium mean (averaged) fields finally appears as this

$$\nabla \times \langle \mathbf{E}_{K3} \rangle + \tfrac{1}{\Delta\Omega} \int\limits_{\partial S_w} \vec{ds} \times \mathbf{E}_{K3} = -\tfrac{\partial}{\partial t} \langle \mathbf{B}_{K2} \rangle + \tfrac{1}{\Delta\Omega} \int\limits_{\partial S_w} (\mathbf{V}_s \mathbf{B}_{K2}) \cdot \vec{ds},$$

where

$$\tfrac{1}{\Delta\Omega} \int\limits_{\partial S_w} (\mathbf{V}_s \mathbf{B}_{K2}) \cdot \vec{ds} = \tfrac{1}{\Delta\Omega} \int\limits_{\partial S_{0p}} (\mathbf{V}_{sp}(\mathbf{b}_0)) \cdot \vec{ds}_0 +$$
$$+ \tfrac{1}{\Delta\Omega} \int\limits_{\partial S_{p1}} (\mathbf{V}_{sp}(\mathbf{b}_1)) \cdot \vec{ds}_1 + \tfrac{1}{\Delta\Omega} \int\limits_{\partial S_{p2}} (\mathbf{V}_{sp}(\mathbf{b}_2)) \cdot \vec{ds}_2.$$

if for this taken

$$\langle \mathbf{B}_{K2} \rangle = \left[\langle m_0 \rangle \tilde{\mathbf{b}}_0 + \langle s_1 \rangle \tilde{\mathbf{b}}_1 + \langle s_2 \rangle \tilde{\mathbf{b}}_2 \right]$$
$$\mathbf{B}_{K2} = (\mathbf{b}_0 + \mathbf{b}_1 + \mathbf{b}_2).$$

4.6 Particles Momentum Equations in the Aether (vacuum0)

Now - when the charged and magnetic moment particles (photons, electrons, nuclei, ions, atoms) are moving in an aether (vacuum0) and one might be willing to use the Lorentz force formula for the two (or more) charged particles where the fields $\mathbf{e}_2$, $\mathbf{b}_2$ are symbolizing (affecting) the force onto the charged test particle q_1

$$\mathbf{F}_{21} = q_1(\mathbf{e}_2 + \mathbf{w}_1 \times \mathbf{b}_2), \tag{4.6}$$

where both particles are the moving charges. Note, the issue of charge q_1 effecting the moving another charge q_2 even does not sound? We guess that it is because at that time Lorentz did not know - How to do this?

The equation of motion of particle with mass m_1 in the present "inviscid" framework" of aether while the second particle having the fields $\mathbf{e}_2$, $\mathbf{b}_2$ is

$$m_1 \dot{\mathbf{w}}_1 = m_1 \tfrac{d\mathbf{w}_1}{dt} = \mathbf{F}_{21} = q_1(\mathbf{e}_2 + \mathbf{w}_1 \times \mathbf{b}_2),$$

or commonly in the general fields "averaged" **E** and **B** the Lorentz force formula in the equation looks as

$$m_1 \tfrac{d\mathbf{w}_1(\mathbf{r}_1,t)}{dt} = \mathbf{F}_{int}(\mathbf{r}_1,t) = q_1(\mathbf{r}_1,t)(\mathbf{E}(\mathbf{r}_1,t) + \mathbf{w}_1(\mathbf{r}_1,t) \times \mathbf{B}(\mathbf{r}_1,t)), \tag{4.7}$$

where **E** and **B** should be here taken or known as "averaged" already field variables? Or assigned or known "averaged" functions.

4.6.1 Averaging of the Force formulae Equations in the REV

Then we should phase average $< >_p$ this equation with the Lorentz's (Heaviside) force field formula over the phase of particle(s) (any particle or combined arrays) (p) as

$$\left\langle m_1 \frac{d\mathbf{w}_1(\mathbf{r}_1,t)}{dt} \right\rangle_p = \langle \mathbf{F}_{int}(\mathbf{r}_1,t) \rangle_p = \langle q_1(\mathbf{r}_1,t)(\mathbf{E}(\mathbf{r}_1,t) + \mathbf{w}_1(\mathbf{r}_1,t) \times \mathbf{B}(\mathbf{r}_1,t)) \rangle_p,$$

where we get the averaged equation of momentum of collective array (field) of interacting particles - particle phase, electrons, for example, as (with the simplified for start electron mass $m_1 = m_e$ =const), while the total time derivative

$$\frac{d\mathbf{w}_1(\mathbf{r}_1,t)}{dt} = \frac{\partial \mathbf{w}_1(\mathbf{r}_1,t)}{\partial t} + (\mathbf{w}_1 \cdot \nabla \mathbf{w}_1),$$

the averaged particle phase 1 (electrons) equation will be

$$m_e \left[\langle s_1 \rangle \frac{\partial(\widetilde{\mathbf{w}}_e)}{\partial t} - \frac{1}{\Delta\Omega} \int\limits_{\partial S_{p1}} (\mathbf{V}_{sp}(\mathbf{w}_e)) \cdot \vec{ds}_1 \right] + m_e \langle s_1 \rangle \widetilde{\mathbf{w}}_e \cdot \nabla\left(\widetilde{\mathbf{w}}_e\right) +$$

$$+ m_e \widetilde{\mathbf{w}}_e \cdot \left(\frac{1}{\Delta\Omega} \int\limits_{\partial S_{p1}} \mathbf{w}_e \, \vec{ds}_1 \right) + m_e < \widehat{\mathbf{w}}_e \cdot \nabla\left(\widehat{\mathbf{w}}_e\right) >_{p1} =< \mathbf{F}_e >_{p1} , \tag{4.8}$$

where the averaging of a convective part over the phase one <w w> is provided as in [9,10,12,13].

This Upper scale governing equation (4.8) COHP is not even able to obtain, to derive. The methods of COHP don't allow doing this. Here we observe the 3 unknown in COHP terms included in this equation.

Comparing this upper scale momentum equation for the particulate phase (medium) with the COHP standard scaleless momentum equation with the Lorentz force formula

$$m_e \frac{d\mathbf{w}_e(\mathbf{r}_e,t)}{dt} = \mathbf{F}_{int}(\mathbf{r}_e,t) = e(\mathbf{r}_e,t)(\mathbf{E}(\mathbf{r}_e,t) + \mathbf{w}_e(\mathbf{r}_e,t) \times \mathbf{B}(\mathbf{r}_e,t)),$$

used, for example, in [61] (in chapter 6 and in other use of electron's momentum) and in million of such textbooks on COHP electrodynamics (and other disciplines) further as already the well done momentum equation for "generalized" electrons field (by the way, the focus is shifted at once from the velocity field to other functions), everyone can observe a striking difference in mathematics and physics therein.

Well, this kind of mathematics-physics used in COHP everywhere. Because conventional university physics cannot do the averaging of this even simple kind of governing equation.

The force field should be averaged as over the phase of particles (we remember that the particles are the volumetric objects with our some knowledge about their properties), so the field of external influence on the particle when using the Lorentz force $\mathbf{F}(\mathbf{r},t)$ can be seen as

$$< \mathbf{F}_{int}(\mathbf{r},t) >_p =< q_p(\mathbf{r},t)(\mathbf{E}(\mathbf{r},t) + \mathbf{w}_p(\mathbf{r},t) \times \mathbf{B}(\mathbf{r},t)) >_p =$$

$$=< q_p(\mathbf{r},t)\mathbf{E}(\mathbf{r},t) >_p + < q_p(\mathbf{r},t)(\mathbf{w}_p(\mathbf{r},t) \times \mathbf{B}(\mathbf{r},t)) >_p ,$$

where $\mathbf{E}(\mathbf{r},t)$ and $\mathbf{B}(\mathbf{r},t)$ are supposed to be already averaged external functions in the problem, in the space. Those could be and External fields also, but now we are talking about only of

internal collective fields as a result of numerous dynamic charges that are present in the volume of space.

While taking the charge at first as the constant value $q(\mathbf{r},t) = e = const$ for a separate electron and for a photon; we can write this averaged equation as, for example, for electrons force field

$$< \mathbf{F}_{int}(\mathbf{r},t) >_1 =< q_1(t)\mathbf{E}(\mathbf{r},t) >_1 + q_1(t) < (\mathbf{w}_1(\mathbf{r},t)\times\mathbf{B}(\mathbf{r},t)) >_1 =$$
$$= \langle s_1\rangle n q_1(t)\{\mathbf{E}(\mathbf{r},t)\}_1 + n q_1(t)\langle s_1\rangle\left[\widetilde{W}_{1i}\times\widetilde{B}_i + \left\{\widehat{w}_{1i}\times\widehat{B}_i\right\}_1\right],$$
$$\mathbf{w}_1(\mathbf{r},t) = w_{1i}(\mathbf{r},t), \quad \mathbf{B}(\mathbf{r},t) = B_i(\mathbf{r},t).$$

We should point out here that in homogeneous physics for more than 100 years COHP physicists just do the substitution in this formula as in Schwinger et al. [61] formula (4.62) and not only in that textbook, we described this with interest in [24,25]

$$\mathbf{F} = \iiint d\mathbf{r}(\rho\mathbf{E} + \tfrac{1}{c}\mathbf{J}\times\mathbf{B}), \quad (4.62)$$

while they cannot average (integrate mathematically correct) this kind of equations and processes. Physicists in conventional physics also use the equation (6.1) of motion for charge particle as in [61] in p. 63

$$m_1\tfrac{d\mathbf{w}_1}{dt} = \mathbf{F}_{21} = q_1(\mathbf{e}_2 + \mathbf{w}_1\times\mathbf{b}_2) = e_e(\mathbf{E} + \mathbf{w}_1\times\mathbf{B}), \quad (6.1)$$

where used the already somehow "averaged" fields **E** and **B**, while they should be averaged along the whole equation of motion and MHL set of equations. Professionals in COHP - they do not make the averaging of the right hand side, they cannot do this.

At the left hand side we have the one particle velocity term, while at the right we have the already averaged fields $<\mathbf{e}_2> = \mathbf{E}$ and $<\mathbf{b}_2> = \mathbf{B}$?

These kinds of tricks one can often find in the homogeneous one-scale atomic, particle physics. They use instead of separate functions of charge $q_1(t)$ or $q_1(\mathbf{r},t)$ the multiplication

$$\mathbf{J} = \left[\tfrac{q_1(\mathbf{r},t)}{\Delta\Omega}\mathbf{w}_1(\mathbf{r},t)\right]$$

that would involve the one more equation to the set - the charge conservation equation. That is the complicating thing for charged particle transport as soon as we need to account with the accuracy on the transformation and collisions of the particles - so to speak of the "elementary" particles transformations. Which is the complicated by itself phenomenon.

Then, in COHP workers substitute the pair ($\mathbf{e}_2$, $\mathbf{b}_2$) by the pair of “already” Upper scale (averaged) fields (**E**,**B**) which is the false mathematics. Because in COHP there are no Heterogeneous procedures for physics and mathematics and it cannot be done the correct averaging, as we say on this everywhere. Do we need this **J** involvement, unaveraged? Of course not.

At least we need to do

$$< \mathbf{F}_{int}(\mathbf{r},t) >_1 + < \mathbf{F}_{int}(\mathbf{r},t) >_0 =< \mathbf{F}_{int}(\mathbf{r},t) >_1 =$$
$$= \langle s_1\rangle n q_1(t)\{\mathbf{E}(\mathbf{r},t)\}_1 + n q_1(t)\langle s_1\rangle\left[\widetilde{W}_{1i}\times\widetilde{B}_i + \left\{\widehat{w}_{1i}\times\widehat{b}_i\right\}_1\right],$$

as soon as for the aether (vacuum0) $<\mathbf{F}_{int}(\mathbf{r},t)>_0=0$. At least for a weak exchange with the aether.

4.6.2 J.Klyushin the Upper scale Averaged Force Fields equation for distributed in space arrays of charges in an aether (vacuum0).

Let's take the charged particle acceleration equation as generally in the fields **e** and **b** (not averaged yet) as when the equation is written for the force on particle q_1 at $\mathbf{r}_1$ by the particle q_2 at $\mathbf{r}_2$ applied via the Klyushin's force formula

$$m_1 \frac{d\mathbf{w}_1(\mathbf{r}_1,t)}{dt} = \mathbf{F}_{int}(\mathbf{r}_1,\mathbf{r}_2,t) = -\nabla[4\pi\varepsilon_0 c_0 r^3(\mathbf{b}_1(\mathbf{r}_2,t)\cdot\mathbf{e}_2(\mathbf{r}_1,t))] +$$

$$+\frac{d}{dt}[4\pi\varepsilon_0 c_0 r^3(\mathbf{b}_1(\mathbf{r}_2,t)\times\mathbf{b}_2(\mathbf{r}_1,t))], \quad r=|(\mathbf{r}_2-\mathbf{r}_1)|, \tag{4.9}$$

where one of possible modeling mathematics can be through the averaging of the left hand side over the variable $\mathbf{r}_1$ while the right hand side over the variable $\mathbf{r}_2$ at first.

We should phase average $<>_p$ this equation with the Klyushin's force field formula over the phase of particles (p) as, for example, electrons. The dynamics equation for a single electron when averaged has the form

$$\left\langle m_1 \frac{d\mathbf{w}_1(\mathbf{r}_1,t)}{dt}\right\rangle_{p1} = \langle \mathbf{F}_{int}(\mathbf{r}_1,\mathbf{r}_2,t)\rangle_{p1} = \langle -\nabla[4\pi\varepsilon_0 c_0 r^3(\mathbf{r}_2,\mathbf{r}_1,t)(\mathbf{b}_1(\mathbf{r}_2,t)\cdot\mathbf{e}_2(\mathbf{r}_1,t))]\rangle_{p1} +$$

$$+\left\langle \frac{d}{dt}[4\pi\varepsilon_0 c_0 r^3(\mathbf{b}_1(\mathbf{r}_2,t)\times\mathbf{b}_2(\mathbf{r}_1,t))]\right\rangle_{p1}, \quad \mathbf{r}_2=\mathbf{r}_1+\mathbf{r}_{21}, \quad r^3(\mathbf{r}_2,\mathbf{r}_1,t), \tag{4.10}$$

where $\mathbf{r}_{21}$ is being calculated via the corresponding equation for particle at $\mathbf{r}_2$ at the current moment of calculation.

Here the force field should be averaged over the phase of particles (remember, the particles are the volumetric objects with some inflicted from outside knowledge about their properties), so the field of external influence on the particle when using the Klyushin's fields force $\mathbf{F}(\mathbf{r},t)$ (4.9) can be seen as following

$$\begin{aligned} <\mathbf{F}_{int}(\mathbf{r}_1,t)>_p &= \langle -\nabla[4\pi\varepsilon_0 c_0 r^3(\mathbf{b}_1(\mathbf{r}_2,t)\cdot\mathbf{e}_2(\mathbf{r}_1,t))]\rangle_p + \\ &+\left\langle \frac{d}{dt}[4\pi\varepsilon_0 c_0 r^3(\mathbf{r}_2,\mathbf{r}_1,t)(\mathbf{b}_1(\mathbf{r}_2,t)\times\mathbf{b}_2(\mathbf{r}_1,t))]\right\rangle_p = \\ &= 4\pi\varepsilon_0 c_0\langle -\nabla[r^3(\mathbf{r}_2,\mathbf{r}_1,t)(\mathbf{b}_1(\mathbf{r}_2,t)\cdot\mathbf{e}_2(\mathbf{r}_1,t))]\rangle_p + \\ &+4\pi\varepsilon_0 c_0\left\langle \frac{d}{dt}[r^3(\mathbf{b}_1(\mathbf{r}_2,t)\times\mathbf{b}_2(\mathbf{r}_1,t))]\right\rangle_p. \end{aligned}$$

As soon as in this development was used the pair-wise interaction formula in the right hand side, the averaged mathematics, simulation algorithms should be tuned for the nonlinear simulation techniques. And these are ordinary methods.

4.7 Averaging of the GEK Governing Equations at the Sub-Atomic Scale in SI

Among the sufficiently numerous versions of possible formulations of GEK Upper meso-scale governing equations we take the following. At first we write down the **scaleless** pseudo-averaged homogeneous version of equations:

the Gauss's law GEK equation

$$\nabla \cdot \mathbf{E} = \frac{\rho}{\varepsilon_0},$$

the Faraday's law of induction GEK equation

$$\nabla \times \mathbf{E} = -\frac{d\mathbf{B}}{dt},$$

$$\nabla \times \mathbf{E} = -\left[\frac{\partial \mathbf{B}}{\partial t} + (\mathbf{v} \cdot \nabla)\mathbf{B}\right],$$

the conservation of magnetic induction **B** GEK equation

$$\nabla \cdot \mathbf{B} = -\frac{\rho}{c_0 \varepsilon_0},$$

and the Ampere-Maxwell law GEK equation (in an aether (vacuum0))

$$\nabla \times \mathbf{B} = \left(\frac{1}{c_0^2}\right)\frac{d\mathbf{E}}{dt},$$

$$\nabla \times \mathbf{B} = \left(\frac{1}{c_0^2}\right)\left[\frac{\partial \mathbf{E}}{\partial t} + (\mathbf{v} \cdot \nabla)\mathbf{E}\right], \quad \mu_0 \varepsilon_0 = \frac{1}{c_0^2}.$$

4.7.1 GEK EM Sub-atomic Particles (Lower Scale) and Media (Aether First) GEs (full time derivative)

Taking the approach that for all we have the three phase electrodynamics phenomena - when the three phase interacting in a known in particle physics way, we write down the GEK governing equations.

Aether phase EM GEK (Lorentz style) in the (**e - b**) pair:

$$\nabla \cdot (\varepsilon_0 \mathbf{e}_0) = 0,$$

$$\nabla \cdot ((c_0 \varepsilon_0)\mathbf{b}_0) = 0,$$

$$\nabla \times (\mathbf{b}_0) = \frac{1}{c_0^2}\frac{d}{dt}(\mathbf{e}_0), \quad \nabla \times (\mathbf{b}_0) = [\mu_0 \varepsilon_0]\frac{d}{dt}(\mathbf{e}_0),$$

$$\nabla \times (\mathbf{e}_0) = -\frac{d}{dt}(\mathbf{b}_0),$$

$$\mu_0 \varepsilon_0 = \frac{1}{c_0^2}, \quad \mathbf{b}_0 = \mu_0(\mathbf{h}_0 + \mathbf{m}_0), \; with \quad \mathbf{m}_0 = 0; \; \sqrt{\mu_0 \varepsilon_0} = \frac{1}{c_0},$$

Now we can draw the GEK equations for an electron. The Gauss's law GEK equation and the conservation of magnetic induction $\mathbf{b}_1$ GEK equation

$$\nabla \cdot [\varepsilon_1 \mathbf{e}_1] = \langle \rho \rangle_1 = e,$$

$$\nabla \cdot [(c_1\varepsilon_1)\mathbf{b}_1] = -e,$$

along with Ampere-Maxwell like GEK equation

$$\nabla \times (\mathbf{b}_1) = \tfrac{1}{c_1^2}\tfrac{d}{dt}(\mathbf{e}_1), \quad \nabla \times (\mathbf{b}_1) = (\mu_1\varepsilon_1)\tfrac{d}{dt}(\mathbf{e}_1),$$

and analogue of Faraday's law of induction GEK equation

$$\nabla \times (\mathbf{e}_1) = -\tfrac{d}{dt}(\mathbf{b}_1),$$

$$\mu_1\varepsilon_1 = \tfrac{1}{c_1^2}, \quad \mathbf{b}_1=\mu_1(\mathbf{h}_1 + \mathbf{m}_1), \; with \quad \mathbf{m}_1\neq 0; \; \sqrt{\mu_1\varepsilon_1} = \tfrac{1}{c_1}.$$

Plus the photons phase (the coefficients are taken just by analogy - no confirmed real physics now can be provided about the internal properties of photons, but by Kanarev [45-53], Klushin [58-60], other workers

$$\nabla \cdot [\varepsilon_2\mathbf{e}_2] = 0,$$

$$\nabla \cdot [(c_2\varepsilon_2\mathbf{b}_2)] = 0,$$

$$\nabla \times (\mathbf{b}_2) = \tfrac{1}{c_2^2}\tfrac{d}{dt}(\mathbf{e}_2), \quad \nabla \times (\mathbf{b}_2) = (\mu_2\varepsilon_2)\tfrac{d}{dt}(\mathbf{e}_2),$$

$$\nabla \times (\mathbf{e}_2) = -\tfrac{d}{dt}(\mathbf{b}_2), \quad \mathbf{h}_2 \quad \mathbf{m}_2 \quad \nabla \times (\mathbf{e}_2) = -\tfrac{d}{dt}(\mathbf{b}_2),$$

$$\mu_2\varepsilon_2 = \tfrac{1}{c_2^2}, \quad \mathbf{b}_2=\mu_2(\mathbf{h}_2 + \mathbf{m}_2), \; with \quad \mathbf{m}_2\neq 0; \; \sqrt{\mu_2\varepsilon_2} = \tfrac{1}{c_2}.$$

Of course, the sets of electrodynamics governing equations for the "interior" of "elementary" sub-atomic particles are of conjectural nature. Meanwhile, it is the legitimate mathematical method for description with further intent to apply the reverse problem research for determination the versions of equations that might be suitable for interior of these particles.

We do know too little about these particles nature and interior. We have to state also that the conjectural methods in physics and mathematics are the valuable methods for studying phenomena. All mechanics, theoretical mechanics that used up to now in conventional particle physics was grown on the conjectural mathematical schemes in XVIII. And up to now is in use.

The problem with this method is that often instead of further advancement of the conjectural scheme it is being transformed into a dogma, postulate without the good ground.

The set of governing equations for the two kinds of sub-atomic particles in the aether includes the equations of particles movement, momentum.

4.7.2 GEK EM Sub-Atomic-Meso-Scale Averaged GEs in SI

The first two divergence GEs

$$\nabla \cdot (\langle \mathbf{E}_{K3} \rangle) + \tfrac{1}{\Delta\Omega} \int\limits_{\partial S_w} (\mathbf{E}_{K3}) \cdot \vec{ds} = \tfrac{\langle s_1 \rangle ne}{\varepsilon_1} = \tfrac{\langle \rho \rangle_1}{\varepsilon_1},$$

$$\nabla \cdot (\langle \mathbf{B}_{K2} \rangle) + \tfrac{1}{\Delta\Omega} \int\limits_{\partial S_w} (\mathbf{B}_{K2}) \cdot \vec{ds} = -\langle s_1 \rangle \left(\sqrt{\tfrac{\mu_1}{\varepsilon_1}} \right) ne = -\tfrac{\langle s_1 \rangle ne}{(c_1\varepsilon_1)}.$$

only if we accept here that

$$\langle \mathbf{E}_{K3} \rangle = [\langle m_0 \rangle \mathbf{e}_0 + \langle s_1 \rangle \mathbf{e}_1 + \langle s_2 \rangle \mathbf{e}_2] \text{ and } \mathbf{E}_{K3}=(\mathbf{e}_0 + \mathbf{e}_1 + \mathbf{e}_2)$$

$$\langle \mathbf{B}_{K2} \rangle = \left[\langle m_0 \rangle \tilde{\mathbf{b}}_0 + \langle s_1 \rangle \tilde{\mathbf{b}}_1 + \langle s_2 \rangle \tilde{\mathbf{b}}_2 \right] \text{ and } \mathbf{B}_{K2} = (\mathbf{b}_0 + \mathbf{b}_1 + \mathbf{b}_2).$$

Or if to take the averaged electric strength

$$\langle \mathbf{E} \rangle = \langle \mathbf{E}_K \rangle = [\langle m_0 \rangle \varepsilon_0 \tilde{\mathbf{e}}_0 + \langle s_1 \rangle \varepsilon_1 \tilde{\mathbf{e}}_1 + \langle s_2 \rangle \varepsilon_2 \tilde{\mathbf{e}}_2],$$

while the hypothetical local **E** is the one that is not existing because it is only virtually the "local" field

$$\mathbf{E} = \mathbf{E}_K = (\varepsilon_0 \mathbf{e}_0 + \varepsilon_1 \mathbf{e}_1 + \varepsilon_2 \mathbf{e}_2),$$

still for the Upper scale it is the real field with its actions, then

$$\nabla \cdot (\langle \mathbf{E} \rangle) + \frac{1}{\Delta\Omega} \int\limits_{\partial S_w} (\mathbf{E}) \cdot \vec{ds} = \langle s_1 \rangle ne = \langle \rho \rangle_1.$$

and if the three phase averaged magnetic induction

$$\langle \mathbf{B} \rangle = \langle \mathbf{B}_K \rangle = \left[\langle m_0 \rangle (c_0 \varepsilon_0) \tilde{\mathbf{b}}_0 + (c_1 \varepsilon_1) \langle s_1 \rangle \tilde{\mathbf{b}}_1 + (c_2 \varepsilon_2) \langle s_2 \rangle \tilde{\mathbf{b}}_2 \right],$$

while

$$\mathbf{B} = \mathbf{B}_K = ((c_0 \varepsilon_0) \mathbf{b}_0 + (c_1 \varepsilon_1) \mathbf{b}_1 + (c_2 \varepsilon_2) \mathbf{b}_2), \ (c_0 \varepsilon_0) = \sqrt{\frac{\varepsilon_0}{\mu_0}},$$

then we have finally the magnetic induction GEK averaged equation

$$\nabla \cdot (\langle \mathbf{B} \rangle) + \frac{1}{\Delta\Omega} \int\limits_{\partial S_w} (\mathbf{B}) \cdot \vec{ds} = -\langle s_1 \rangle ne.$$

The next is that instead of MHL averaged Ampere-Maxwell Upper scale equation

$$\nabla \times \langle \mathbf{B} \rangle + \frac{1}{\Delta\Omega} \int\limits_{\partial S_w} \vec{ds} \times \mathbf{B} = \frac{\partial}{\partial t} \langle \mathbf{E}_{K3} \rangle - \frac{1}{\Delta\Omega} \int\limits_{\partial S_w} (\mathbf{V}_s \mathbf{E}_{K3}) \cdot \vec{ds},$$

where

$$\langle \mathbf{B} \rangle = \left[\langle m_0 \rangle (c_0 \varepsilon_0) \tilde{\mathbf{b}}_0 + (c_1 \varepsilon_1) \langle s_1 \rangle \tilde{\mathbf{b}}_1 + (c_2 \varepsilon_2) \langle s_2 \rangle \tilde{\mathbf{b}}_2 \right]$$

and

$$\mathbf{B} = ((c_0 \varepsilon_0) \mathbf{b}_0 + (c_1 \varepsilon_1) \mathbf{b}_1 + (c_2 \varepsilon_2) \mathbf{b}_2), \ (c_0 \varepsilon_0) = \sqrt{\frac{\varepsilon_0}{\mu_0}},$$

while

$$\langle \mathbf{E}_{K3} \rangle = [\langle m_0 \rangle \tilde{\mathbf{e}}_0 + \langle s_1 \rangle \tilde{\mathbf{e}}_1 + \langle s_2 \rangle \tilde{\mathbf{e}}_2] \text{ and } \mathbf{E}_{K3} = (\mathbf{e}_0 + \mathbf{e}_1 + \mathbf{e}_2).$$

we would have the following Ampere-Maxwell-Klyushin GEK Upper meso-scale GEs written in the form

$$\nabla \times \langle \mathbf{B}_{K2} \rangle + \frac{1}{\Delta\Omega} \int\limits_{\partial S_w} \vec{ds} \times \mathbf{B}_{K2} = \frac{\partial}{\partial t} \langle \mathbf{E}_{K2} \rangle - \frac{1}{\Delta\Omega} \int\limits_{\partial S_w} (\mathbf{V}_s \mathbf{E}_{K2}) \cdot \vec{ds} +$$
$$+ \langle \mathbf{w}_i \cdot \nabla (\mathbf{e}_{K2}) \rangle, \ i = 0.1.2,$$

here with

$$\langle \mathbf{B}_{K2} \rangle = \left[\langle m_0 \rangle \tilde{\mathbf{b}}_0 + \langle s_1 \rangle \tilde{\mathbf{b}}_1 + \langle s_2 \rangle \tilde{\mathbf{b}}_2 \right] \text{ and } \mathbf{B}_{K2} = (\mathbf{b}_0 + \mathbf{b}_1 + \mathbf{b}_2),$$

and with

$$\langle \mathbf{E}_{K2} \rangle = \left[\left(\frac{1}{c_0^2} \right) \langle m_0 \rangle \tilde{\mathbf{e}}_0 + \langle s_1 \rangle \left(\frac{1}{c_1^2} \right) \tilde{\mathbf{e}}_1 + \langle s_2 \rangle \left(\frac{1}{c_2^2} \right) \tilde{\mathbf{e}}_2 \right]$$

and

$$\mathbf{E}_{K2}=\left(\left(\frac{1}{c_0^2}\right)\mathbf{e}_0+\left(\frac{1}{c_1^2}\right)\mathbf{e}_1+\left(\frac{1}{c_2^2}\right)\mathbf{e}_2\right)$$

where

$$\frac{1}{\Delta\Omega}\int\limits_{\partial S_w}(\mathbf{V}_s\mathbf{E}_{K2})\cdot\vec{ds}=$$

$$=\frac{1}{\Delta\Omega}\int\limits_{\partial S_{0p}}\left(\mathbf{V}_{sp}\left(\left(\frac{1}{c_0^2}\right)\mathbf{e}_0\right)\right)\cdot\vec{ds}_0+\frac{1}{\Delta\Omega}\int\limits_{\partial S_{p1}}\left(\mathbf{V}_{sp}\left(\left(\frac{1}{c_1^2}\right)\mathbf{e}_1\right)\right)\cdot\vec{ds}_1+$$

$$+\frac{1}{\Delta\Omega}\int\limits_{\partial S_{p2}}\left(\mathbf{V}_{sp}\left(\left(\frac{1}{c_2^2}\right)\mathbf{e}_2\right)\right)\cdot\vec{ds}_2,$$

and

$$\langle\mathbf{w}_i\cdot\nabla(\mathbf{e}_{K2})\rangle=\langle\mathbf{w}_i\cdot\nabla(\mathbf{e})\rangle_0+\langle\mathbf{w}_i\cdot\nabla(\mathbf{e})\rangle_1+\langle\mathbf{w}_i\cdot\nabla(\mathbf{e})\rangle_2=$$

$$=\left(\frac{1}{c_0^2}\right)\left[\langle m_0\rangle\widetilde{\mathbf{w}}_0\cdot\nabla(\widetilde{\mathbf{e}}_0)+\widetilde{\mathbf{w}}_0\cdot\left(\frac{1}{\Delta\Omega}\int\limits_{\partial S_{0p}}\mathbf{e}_0\,\vec{ds}_0\right)\right]+$$

$$+\left(\frac{1}{c_0^2}\right)<\widehat{\mathbf{w}}_0\cdot\nabla(\widehat{\mathbf{e}}_0)>_0+$$

$$+\left(\frac{1}{c_1^2}\right)\left[\langle s_1\rangle\widetilde{\mathbf{w}}_1\cdot\nabla(\widetilde{\mathbf{e}}_1)+\widetilde{\mathbf{w}}_1\cdot\left(\frac{1}{\Delta\Omega}\int\limits_{\partial S_{p1}}\mathbf{e}_1\,\vec{ds}_1\right)\right]+$$

$$+\left(\frac{1}{c_1^2}\right)<\widehat{\mathbf{w}}_1\cdot\nabla(\widehat{\mathbf{e}}_1)>_1+$$

$$+\left(\frac{1}{c_2^2}\right)\left[\langle s_2\rangle\widetilde{\mathbf{w}}_2\cdot\nabla(\widetilde{\mathbf{e}}_2)+\widetilde{\mathbf{w}}_2\cdot\left(\frac{1}{\Delta\Omega}\int\limits_{\partial S_{p2}}\mathbf{e}_2\,\vec{ds}_2\right)\right]+$$

$$+\left(\frac{1}{c_2^2}\right)<\widehat{\mathbf{w}}_2\cdot\nabla(\widehat{\mathbf{e}}_2)>_2,$$

while again here for the last two $\nabla\times$ equations taken

$$\langle\mathbf{B}_{K2}\rangle=\left[\langle m_0\rangle\widetilde{\mathbf{b}}_0+\langle s_1\rangle\widetilde{\mathbf{b}}_1+\langle s_2\rangle\widetilde{\mathbf{b}}_2\right]\text{ and }\mathbf{B}_{K2}=(\mathbf{b}_0+\mathbf{b}_1+\mathbf{b}_2),$$

and

$$\langle\mathbf{E}_{K2}\rangle=\left[\left(\frac{1}{c_0^2}\right)\langle m_0\rangle\widetilde{\mathbf{e}}_0+\langle s_1\rangle\left(\frac{1}{c_1^2}\right)\widetilde{\mathbf{e}}_1+\langle s_2\rangle\left(\frac{1}{c_2^2}\right)\widetilde{\mathbf{e}}_2\right]\text{ and }\mathbf{E}_{K2}=\left(\left(\frac{1}{c_0^2}\right)\mathbf{e}_0+\left(\frac{1}{c_1^2}\right)\mathbf{e}_1+\left(\frac{1}{c_2^2}\right)\mathbf{e}_2\right).$$

Further, instead of MHL averaged Faraday law like the induction equation

$$\nabla\times\langle\mathbf{E}_{K3}\rangle+\frac{1}{\Delta\Omega}\int\limits_{\partial S_w}\vec{ds}\times\mathbf{E}_{K3}=-\frac{\partial}{\partial t}\langle\mathbf{B}_{K2}\rangle+\frac{1}{\Delta\Omega}\int\limits_{\partial S_w}(\mathbf{V}_s\mathbf{B}_{K2})\cdot\vec{ds},$$

where we take that

$$\langle\mathbf{E}_{K3}\rangle=[\langle m_0\rangle\widetilde{\mathbf{e}}_0+\langle s_1\rangle\widetilde{\mathbf{e}}_1+\langle s_2\rangle\widetilde{\mathbf{e}}_2]\text{ and }\mathbf{E}_{K3}=(\mathbf{e}_0+\mathbf{e}_1+\mathbf{e}_2)$$

and

$$\langle\mathbf{B}_{K2}\rangle=\left[\langle m_0\rangle\widetilde{\mathbf{b}}_0+\langle s_1\rangle\widetilde{\mathbf{b}}_1+\langle s_2\rangle\widetilde{\mathbf{b}}_2\right]\text{ and }\mathbf{B}_{K2}=(\mathbf{b}_0+\mathbf{b}_1+\mathbf{b}_2)$$

then we would derive the following Faraday-Klyushin GEK Upper meso-scale

$\nabla\times(<m_0>\{\mathbf{e}_0\}_0)$ GE with the same components summation:

for an aether phase

$$\nabla\times(\langle m_0\rangle\tilde{\mathbf{e}}_0)+\tfrac{1}{\Delta\Omega}\int\limits_{\partial S_{0p}}\vec{ds}_0\times\mathbf{e}_0=-\tfrac{\partial}{\partial t}\langle\mathbf{b}_0\rangle_0+\tfrac{1}{\Delta\Omega}\int\limits_{\partial S_{0p}}(\mathbf{V}_{sp}(\mathbf{b}_0))\cdot\vec{ds}_0-$$
$$-\Bigg[\langle m_0\rangle\tilde{\mathbf{w}}_0\cdot\nabla\left(\tilde{\mathbf{b}}_0\right)+\tilde{\mathbf{w}}_0\cdot\left(\tfrac{1}{\Delta\Omega}\int\limits_{\partial S_{0p}}\mathbf{b}_0\,\vec{ds}_0\right)+$$
$$+<\hat{\mathbf{w}}_0\cdot\nabla\left(\hat{\mathbf{b}}_0\right)>_0\Bigg],$$

the averaged Faraday-Klyushin equation in electrons phase (for inside of electron the hypothetical field that have not a hypothetical, but real electron's surface fields)

$$\nabla\times(\langle s_1\rangle\tilde{\mathbf{e}}_1)+\tfrac{1}{\Delta\Omega}\int\limits_{\partial S_{p1}}\vec{ds}_1\times\mathbf{e}_1=-\tfrac{\partial}{\partial t}\langle\mathbf{b}_1\rangle_1+\tfrac{1}{\Delta\Omega}\int\limits_{\partial S_{p1}}(\mathbf{V}_{sp}(\mathbf{b}_1))\cdot\vec{ds}_1-$$
$$-\Bigg[\langle s_1\rangle\tilde{\mathbf{w}}_1\cdot\nabla\left(\tilde{\mathbf{b}}_1\right)+\tilde{\mathbf{w}}_1\cdot\left(\tfrac{1}{\Delta\Omega}\int\limits_{\partial S_{p1}}\mathbf{b}_1\,\vec{ds}_1\right)+$$
$$+<\hat{\mathbf{w}}_1\cdot\nabla\left(\hat{\mathbf{b}}_1\right)>_1\Bigg],$$

the next is the Faraday-Klyushin equation averaged for the photons phase

$$\nabla\times(\langle s_2\rangle\tilde{\mathbf{e}}_2)+\tfrac{1}{\Delta\Omega}\int\limits_{\partial S_{p2}}\vec{ds}_2\times\mathbf{e}_2=-\tfrac{\partial}{\partial t}\langle\mathbf{b}_2\rangle_2+\tfrac{1}{\Delta\Omega}\int\limits_{\partial S_{p2}}(\mathbf{V}_{sp}(\mathbf{b}_2))\cdot\vec{ds}_2-$$
$$-\Bigg[\langle s_2\rangle\tilde{\mathbf{w}}_2\cdot\nabla\left(\tilde{\mathbf{b}}_2\right)+\tilde{\mathbf{w}}_2\cdot\left(\tfrac{1}{\Delta\Omega}\int\limits_{\partial S_{p2}}\mathbf{b}_2\,\vec{ds}_2\right)+$$
$$+<\hat{\mathbf{w}}_2\cdot\nabla\left(\hat{\mathbf{b}}_2\right)>_2\Bigg],$$

then summing the three equations together we have the Faraday-Klyushin Upper scale (meso-scale) equation

$$\nabla\times\langle\mathbf{E}_{K3}\rangle+\tfrac{1}{\Delta\Omega}\int\limits_{\partial S_w}\vec{ds}\times\mathbf{E}_{K3}=-\tfrac{\partial}{\partial t}\langle\mathbf{B}_{K2}\rangle+\tfrac{1}{\Delta\Omega}\int\limits_{\partial S_w}(\mathbf{V}_s\mathbf{B}_{K2})\cdot\vec{ds}-\langle\mathbf{w}_i\cdot\nabla(\mathbf{b}_{K2})\rangle,\ i=0,1,2.$$

In this way we got all of the above and other averaged equations from the sub-atomic ($10^{-15}\div10^{-10}$) [m] scales to the some meso-scale ($10^{-7}\div10^{-5}$) [m] in a pretty obvious and complicated form.

It should be mentioned here that the additional "strange" fluctuation and integral terms in the above equations are about that exactly phenomena of volumetric and surficial physics that COH physics can not deliver and even to discover - What are those and for what purpose?

One needs to understand that these three-phase two-scale GEK governing equations give a numerous ways for connecting the sub-atomic and meso-scale electrodynamics in any medium, substance within the conditions of moderate environmental boundary influence.

Also, it is useful to remind here that the similar sets of governing scaled equations had been formulated, theorized, solved and brought in for the various physical disciplines as fluid mechanics, atomic physics, thermal physics, acoustics, electrodynamics, solid state continuum mechanics, engineering disciplines, etc. the unknown for COHP results including and the physical phenomena that can not be revealed, uncovered in the one scale Homogeneous physics, see, for example [6,9-13,16-18,21-25] etc. with references therein.

For a complete set of modeling HSP equations for the RCFR in the following sets should be included, as for a minimum the Two-phase Two-scale physical and mathematical models: of energy, heat, momentum, and media structures dynamics inside the CF chamber. These kinds of equations [6,9-13,16-18,21-25,29,32-40] nobody else at this moment can even formulate, not talking about simulations. Manufacturers will realize the needs for the other than of COH physics and mathematical modeling and simulation procedures later on and in a pretty strong way.

5. Some Elements of Structured Magnetism in E-Cat Reactor

In https://en.wikipedia.org/wiki/Isotopes_of_nickel seen that "Naturally occurring nickel is composed of 5 stable isotopes; ^{58}Ni, ^{60}Ni, ^{61}Ni, ^{62}Ni and ^{64}Ni with ^{58}Ni being the most abundant (68.077% natural abundance). ^{62}Ni is the most stable nuclide of all the existing elements, with binding energy greater than both ^{56}Fe, often incorrectly cited as most stable, and ^{58}Fe."

5.1 Mechanism of Exchange Interaction via QM and with the HSP-VAT Volumetric Electrons

The Wikipedia text as a collective COHP author tells us about the exchange interaction phenomenon as: ..."Therefore, under certain conditions, when the orbitals of the unpaired outer valence electrons from adjacent atoms overlap, the distributions of their electric charge in space are further apart when the electrons have parallel spins than when they have opposite spins. This reduces the electrostatic energy of the electrons when their spins are parallel compared to their energy when the spins are anti-parallel, so the parallel-spin state is more stable. In simple terms, the electrons, which repel one another, can move "further apart" by aligning their spins, so the spins of these electrons tend to line up. This difference in energy is called the exchange energy."

We neglect the words like "the orbitals of the unpaired outer valence electrons from adjacent atoms overlap" because there is no orbitals and no "circling" of electrons around of nucleus (Figs. 7-9), but some vibrations caused by external mostly forces around the stable position of each electron against of each separate proton in the nucleus.

The phenomenon of "exchange interaction" in COHP is based on spontaneous interaction of magnetic moments and electrostatic (electrodynamic actually) fields of electrons in atoms (molecules) and of free electrons in a metal, metallic compound or composite.

How it can happen the COH physics cannot explain in details.

Because this is the collective interaction of magnetic moments, magnetic dipoles and charges of electrons and nuclei, the collective interaction that the COH physics has no mechanisms, methods, tools, theories to describe in exact terms the physics of phenomena, the electrons cloud structure and interactions within it, and of their collective electromagnetic fields interaction.

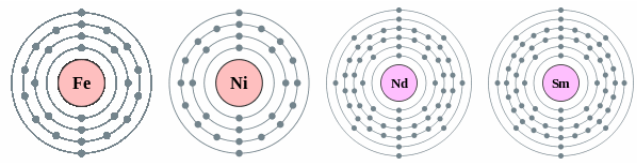

Figure 7. Electrons "Circling" around of Iron, Nickel, Neodymium, Samarium nuclei as presented in Wikipedia.

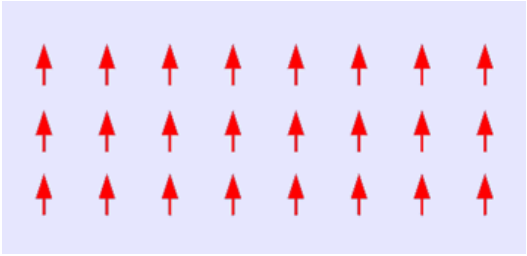

Figure 8. Pseudo-explanation of the magnetism phenomena in COHP.

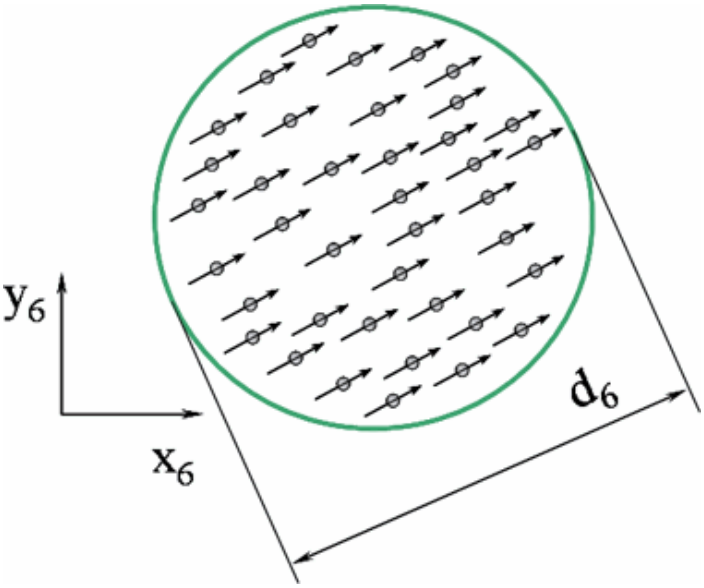

Figure 9. Another pseudo-explanation of electrons magnetic momentum alignment as for the magnetism phenomena in COHP. Ferromagnetism explained in COHP at the sub-atomic Fifth (A5)4 and Sixth (A6)5 zoomed scales distribution of free electrons, atoms and ions in a substance [21-23]. This volume with magnetic particles only inside of it cannot be correctly theorized and modeled in COHP.

There is no circling of electrons around of nucleus. It was the fairy tale of 1910-1920s and beyond. Students ought to wake up and read at first Ph.M. Kanarev's publications [45-53].

Obtaining the nonlocal averaged governing equations for an outlined free form Representative Elementary Volume (REV) in the specified volume with the solid phase of magnetic material and with the amount of free electrons within the space of a sample (Fig. 10) is the ultimate goal in the overall problem modeling and simulation.

That in turn, gives the mechanism for simulation of the Upper scale magnetic field B that will be the most accurate three-scale, at least, estimation and quantitative simulation of magnet's bulk response to the external fluctuation of the EM fields.

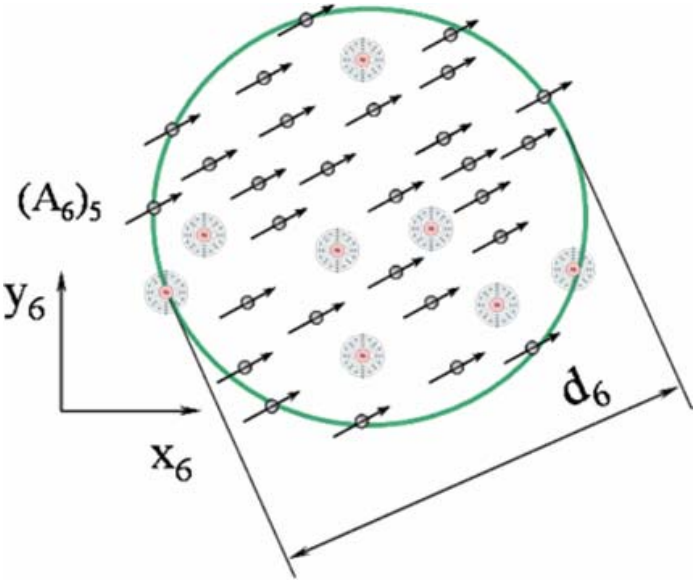

Figure 10. RE volume explained in HSP, while the electrons and Ni atoms and ions are taken as in COHP.

The known and explained in HSP-VAT mechanisms of magnetization and demagnetization have no relationships to the COHP explanation of magnetism that is using the fantastic definitions and procedures for point-mass-charge-spin electrons and their movement, for other particles, atoms involvement, and dynamics of all of them.

In the previous 1980 - 2010s we have solved a great number of the HSP-VAT two-scale problems, some of them have been solved analytically. Heterogeneous mathematics as well as solved strictly the scaled problems in various disciplines of physics have strongly confirmed that the stringent mathematics for scaleportation does exist, ready for application and its advancements pave the way for HSP-VAT application to various fields of physics.

All these methods above make possible the true scaleportation and interconnection of sub-atomic and continuum mechanics magnetism mechanisms. That in its turn makes at first the connection of sub-atomic and any measurements upper scale magnetism characterizations visible and their features explainable.

5.2 The Scales of Interest in Magnetism

There are a few scales that can be viewed as the fundamental scales with their physics of magnetism. In most known now Conventional Orthodox Homogeneous Physics definitions and techniques related to magnetism phenomena there are no direct methods that could summarize,

combine the collective effects either of electrons or atoms, molecules in a bulk. We mean the correct methods, what is used are the Homogeneous approximations.

The overall physical real picture of observation of Cold Fusion Rossi's type known processes (apart of the alleged catalyst) in the reactor appeals for recognition of a few scales and physical entities and processes in the technology. First of all we recognize the presence of aether and volumetric sub-atomic particles as electrons, photons, nucleons, possible positrons; nuclei, atoms and molecules of hydrogen, iron, nickel, copper, possible cobalt, and some other metals, also as of volumetric space located and oriented complicated structural bodies; nano- and microsize Ni particles (let them be of pure Ni) that are the Heterogeneous continuum medium volumes; continuum spatial volume filled with the hydrogen. We will recognize and the types of hydrogen molecules - of ortho - and para-hydrogen.

With regard of the magnetism phenomena explanation and modeling in materials we can distinguish the three, at least, important scales with their physics:

1) On the phenomena around of electron and nucleus and physics of the sub-atomic scale(s). Of course, the aether is included as the "phase" in the volume.

2) Number two scale is the scale and polyphase physics of imaginable material with the huge number of particles or/and atoms in it, the scale ~(10^(-7)-10^(-5))[m]. Still with the modeling capabilities of the sub-atomic HS physics, not of quantum COHP base.

3) Number three in the scale's row is the scale and polyphase physics of the "local" characteristics of the bulk magnetic material, that might be of ~(10^(-5) - 10^(-3))[m]. The continuum presentations physics that can be used for the Upper scale Cold Fusion reactor and that actually used in COHP for modeling of E-Cat reactor's rough output. In HS physics description these "local" scales have very different physical and mathematical modeling fundamentals as partly we have shown in the above sections of this text.

We constructed the spatial 3D morphologies of physical space occupied with the 3D physical structural volumetric models of electron arrays and photons presence, the similar 3D spatial physical models of structural atoms arrays with the specific for each particle and atom electrodynamic local governing set of equations.

The local EM fields at each scale of the sample of a material have been modeled via the 3P electrodynamics theory MHL or GEK (Galilean electrodynamics by Klyushin) while the averaged Upper spatial scale distributions are determined through the governing equations for Heterogeneous medium that consists of the particulate phases, atomic "phases" and an aether in the volume of a sample.

That gives the ability and methods for the HSP-VAT theory and modeling of non-local bulk electrodynamics and momentum dynamics of the all participating and interacting particles and atoms in the outlined volume.

This also gives the tools for the sub-atomic, atomic scales phenomena modeling with strict physical and mathematical models for known phenomena at these scales via governing equations justified in mathematical and physical sense. We do not support the unphysical theories based on unphysical point-mass-charge particles description and one phase Homogeneous mathematics established in COHP at the beginning of XX for these phenomena in particle and atomic physics.

6. Nuclear Physics Structured Application to the E-Cat Reactor

6.1 Structure of Hydrogen (H) Nucleus, Atom and Molecules

We consider here the short text on the ground of that the hydrogen's atom and hydrogen's molecules are having the structural nature of electrons, nucleons, nucleus and atoms themselves. According to studies of Kanarev [45-53] and also by other physicists this is considered as the fundamental turn in understanding of hydrogen atom and molecules as a few form spatial and electrodynamic structures. Here is the pictures of ortho- and para-hydrogen with the simplified appearance of nuclei. This might be appropriate to mention that only the methods and results of HSP allow to consider, model, and simulate not only single elements and structures of hydrogen and of hydrogen's atoms (Fig. 11), molecules, but and their collective features as of the Lower and Upper scales (at least for the two scales) properties [17-23,34].

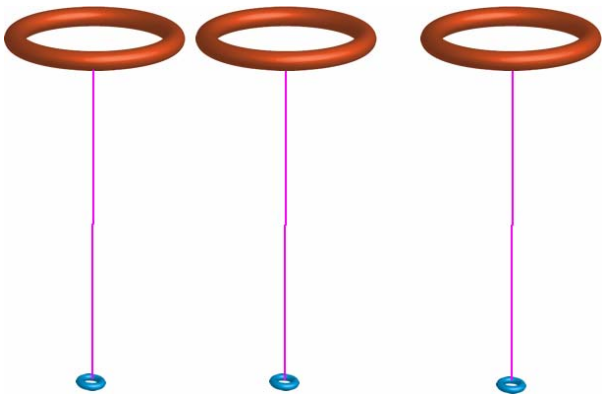

Figure 11. Hydrogen atoms.

Now we can say that with Heisenberg's prediction about the hydrogen molecule that must exist in two different forms (Fig. 12) probably the best explanation can be found via this picture and obvious attempt for regular arrangement of atoms in a volume as shown in the figure.

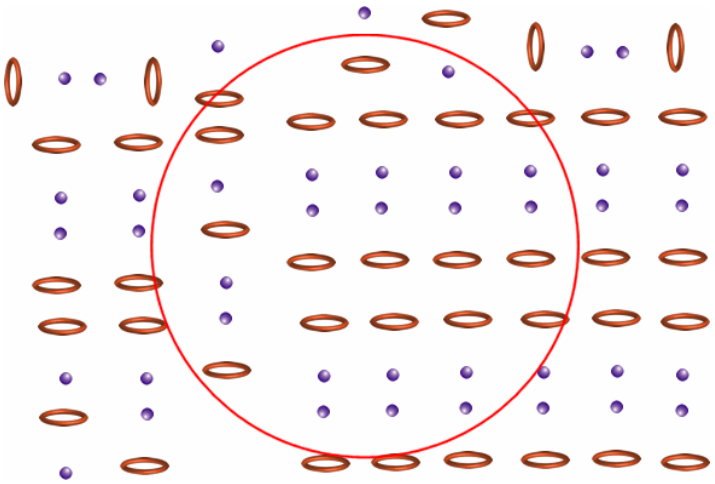

Figure 12. Hydrogen molecules at moderate temperatures and pressure - hydrogen gas (ortho- and para-hydrogen molecules) in a volume.

The hydrogen gas properties can be shown have obvious and straightforward definitions and models for their simulation. It has at least three phases - gaseous molecules, photons, and an aether) problems of gaseous media in a volume.

6.2 Structure of Iron's (Fe-26) Nuclei and Atom

We would like to start with the reminding that the electron and some atoms are not the point-mass mythical particles, and when the atom has a structured nucleus (Fig. 13) and physically explained structure of electron's array of the atom [21-23] - then the physics of nuclei is different of what is described in COHP texts.

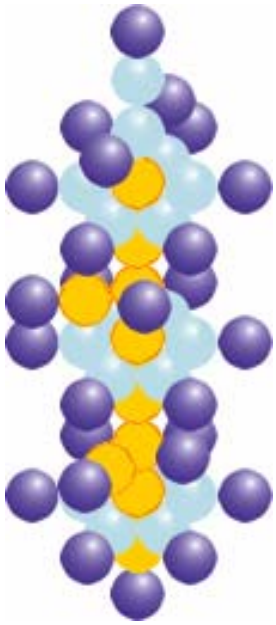

Figure 13. Iron element (Ferrum) nucleus in 3D (of the Fe^(56) isotope) - shown here without magnetic momentum and surface dynamics of nucleons as spheres. Protons are the external nucleons.

In COH nuclear physics workers draw nuclei in the same mode as in COH chemistry - close packing of balls (nucleons) with no regard of how they interact at least graphically - and no surface dynamics and magnetism, but "nuclear forces." Meanwhile, the EM fields inside and around of atom (Fig. 14) have the governing equations and an atom itself as well.

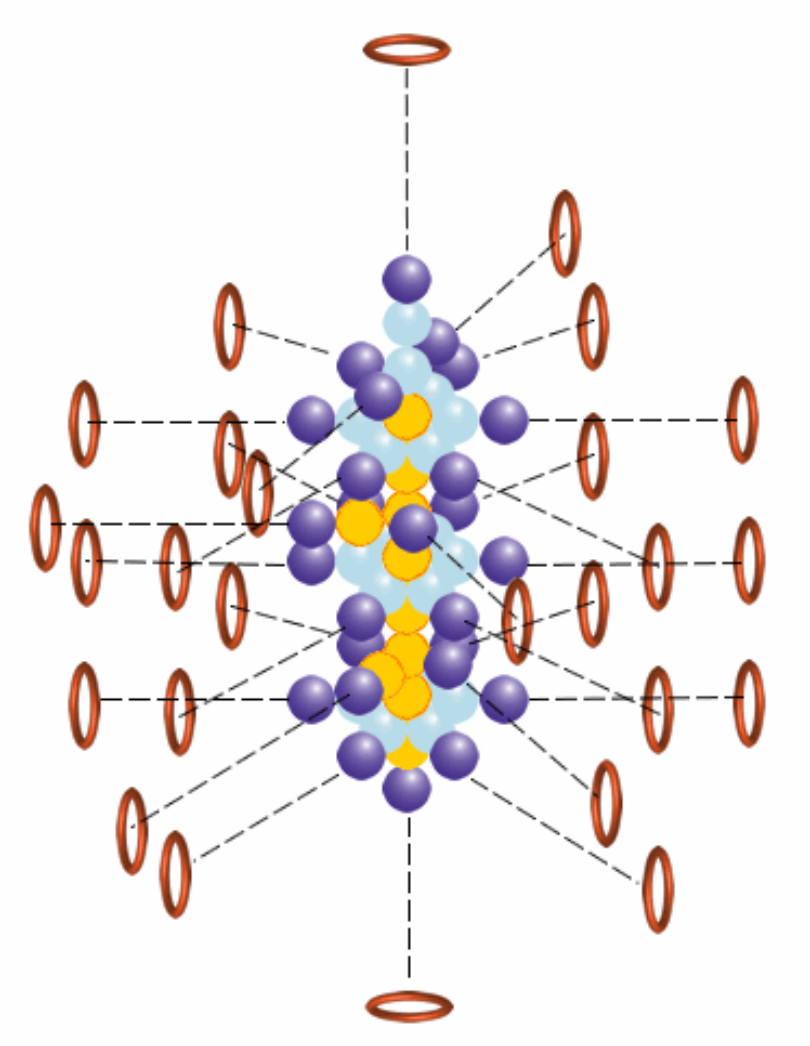

Figure 14. Ferrum (Lat.) atom - not a correct scale used in a figure regarding the sizes of electrons and the distances, otherwise it will go beyond the page. Each proton has its own corresponding electron. Shown first time in publication, not depicted even in Ph.M. Kanarev's works. This theory and model for Fe has some discrepancies with Kanarev's narrative.

The structure of atomic EM fields is following the structure of atom's nucleus and of the nucleons and electron's energy distributions. Then only we obtain the ability to talk about and model the magnetic fields of an atom and of the array of atoms in the aether, other substance. This task is not possible to perform in the COH physics, because COHP is not able to do the local-nonlocal interaction, and the averaging of the processes.

6.3 Structure of Nickel (Ni-28) Nuclei and Atom

We obtained [21-23] the following structures for the Nickel element Figs. 15-17:

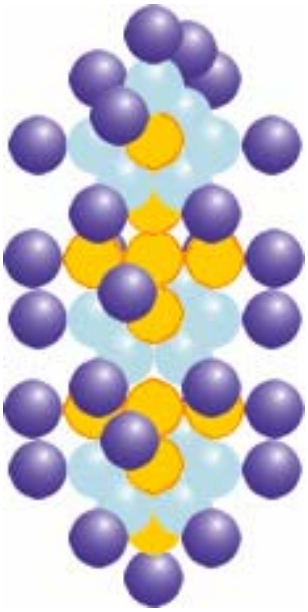

Figure 15. Nickel (Ni-28) element (^{58}Ni) nucleus.

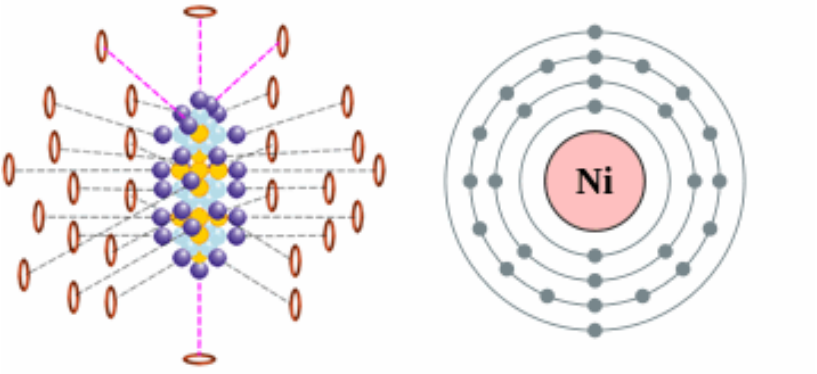

Figure 16. Nickel element (^{58}Ni) atoms in structured HS atomic physics and in COHP.

What a difference ?

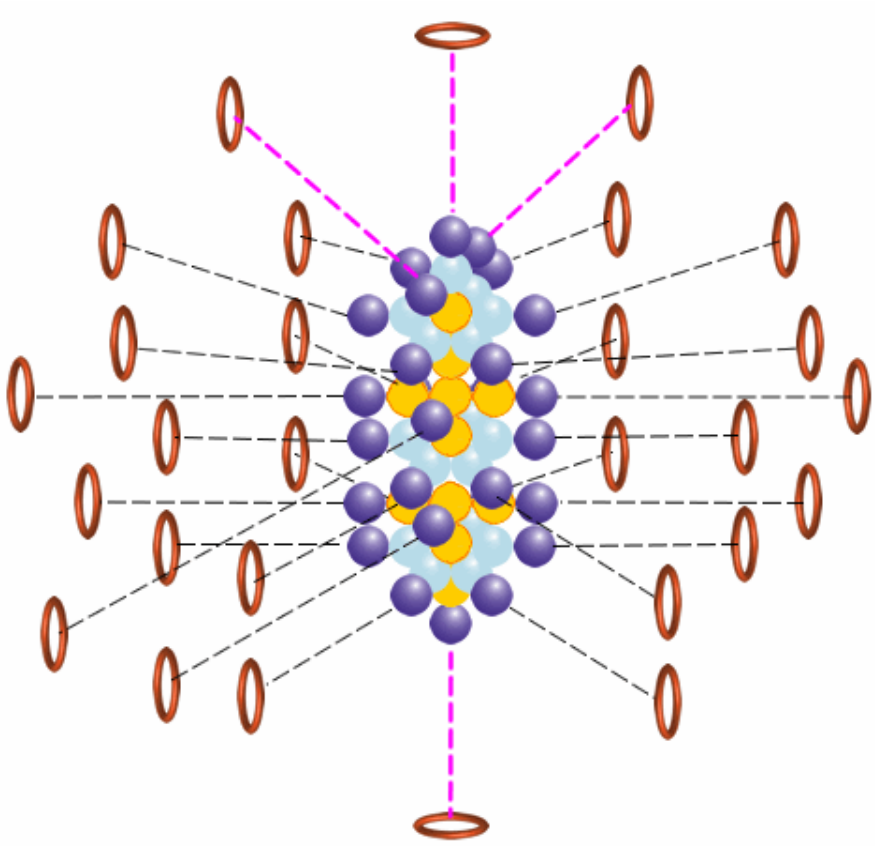

Figure 17. Nickel (Ni-28) atom - not a correct scale used in a figure regarding the sizes of electrons and the distances.

6.4 Structure of Copper (Cu-29) Nuclei and Atom

We obtained [21-23] the following structures for the Copper element Figs. 18-19:

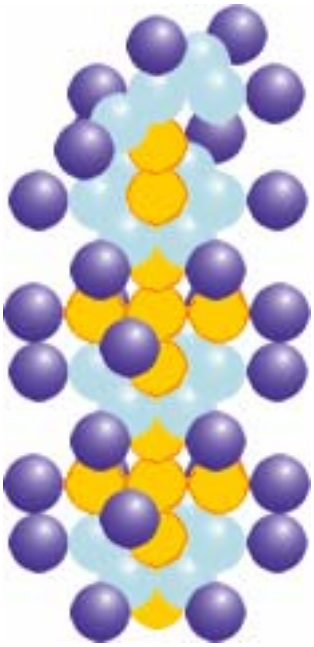

Figure 18. Copper element (^{63}Cu) nucleus.

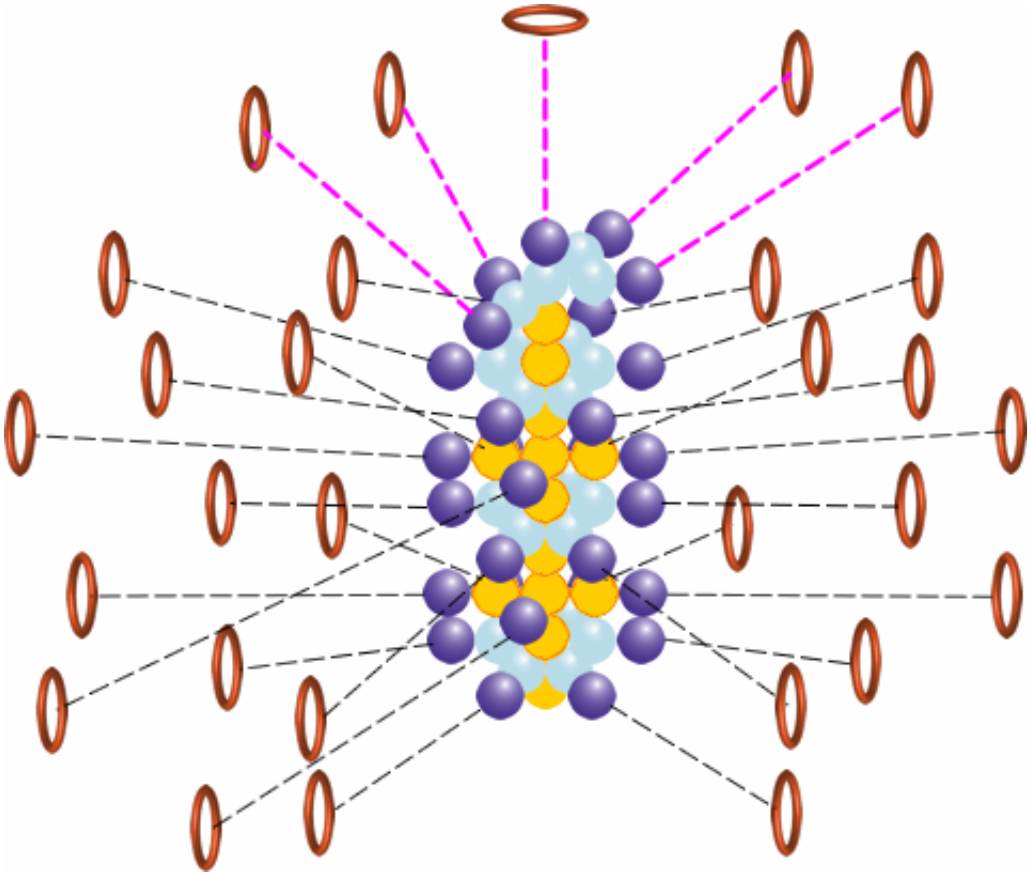

Figure 19. Copper (Cu-29) atom (^{63}Cu).

These element atoms shown here as long as it was reported that in the chamber of CF Rossi type reactor had been found these metals and other components.

6.5 Transmutation possibilities in the E-Cat reactor

By Prof. Christos Stremmenos in the "Journal of Nuclear Physics":

"A detailed Qualitative Approach to the Cold Fusion Nuclear Reactions of H/Ni"

References:

(1) www.journal-of-nuclear-physics.com/Focardi Rossi/ (A new energy source from nuclear fusion)

"* I believe that the phasmatometric tracing of copper is the most definitive sign of nuclear fusion: From the relative bibliography (HANDBOOK OF CHEMISTRY AND PHYSICS, 66TH edition), it follows that the stable non radioactive isotopes of nickel are the following five:

58 ($_{28}Ni_{30}$), ($_{28}Ni_{32}$)60, ($_{28}Ni_{33}$)61, ($_{28}Ni_{34}$)62 and ($_{28}Ni_{36}$)64. These, when fused with a hydrogen nucleus, are being transmuted relatively to Cu-59 ($_{29}Cu_{30}$), Cu-61($_{29}Cu_{32}$), Cu-62($_{29}Cu_{33}$), Cu-63 ($_{29}Cu_{34}$) and Cu-65 ($_{29}Cu_{36}$).

From these isotopes of copper only the last two (Cu-63 ($_{29}Cu_{34}$) and Cu-65 ($_{29}Cu_{36}$)) are not radioactive, i.e. they are stable.

The other three Cu-59, Cu-61, Cu-62, are being transmuted again to Nickel, with an average life expectancy of some hours and the most unstable Cu-59 in 18 seconds."

Notice, that here C.Stremmenos is not talking about the procedures, ways of fusion, transmutations. He does not contemplate on the game of neutrons in this kind of fusion? And this cannot be done with the chart of steps, apart of writing the possible nuclear reactions.

The reason behind of this writing manner is general, coming since the 1900-1930 nuclear physics language establishments. Because the nuclei in COHP are structureless - then you can use only the language of external post-events.

7. Algorithms of the Cold Fusion in the E-Cat Chamber

As long as the initial impacts to the chamber's volume comes from the Upper scale physical events it is natural considering the path as of the Top-Down sequence of physical events at the beginning. Then, the alleged nuclear transmutation makes the release of energy for transfer to the Upper scales and finally to the continuum scale.

7.1 Scales and Scaleportations

We start from the Upper (larger) scale - the scale of the chamber itself is $\sim 10^{-1}$ [m].

And at this scale the heating and EM pulsing impact actually begin to disturb the reactor chamber's interior. That means the Top-Down scale input of control forces commences at the scale $\sim 10^{-1}$ [m] .

This scale can be considered as the Upper one (4th) of the four major scales in the Rossi Cold Fusion Reactor (RCFR).

As we accepted the 3 other scales that are important for the magnetism and general electrodynamics, thermodynamics, and gas dynamics within this regard of the phenomena explanation and modeling in polyphase materials in RCFR we can distinguish these three, at least, important scales with their physics:

1) On the phenomena around of electron and nucleus and physics of the sub-atomic scale(s). Of course, the aether is included as the "phase" in the volume.

2) Number two scale is the scale and polyphase physics of materials volume in the RCFR as hydrogen in gaseous form, with the huge number of nanoparticles of Ni or/and atoms in it, the scale ~(10^(-7)-10^(-5))[m]. Still with the modeling capabilities of the sub-atomic HS physics, not of quantum COHP base.

At this scale should be provided the research on the two scale heterogeneous polyphase materials with the impact of external fields.

3) Number three in the RCFR's scale Bottom-Up row is the scale and polyphase physics of the "local" characteristics of the bulk solid state of nano-powder (magnetic) and/or gaseous material, that might be of ~(10^(-5) - 10^(-3))[m]. The continuum presentations physics that can be used for the Upper scale Cold Fusion reactor and that actually used in COHP for modeling of the E-Cat reactor's rough output.

At this scale should be provided the research for the two and three scale Top-Down and Bottom-Up the heterogeneous polyphase materials with the impact of external fields [19,21-23,29,34,62].

As long as the core energy releasing phenomena occur at the sub-atomic scales, but the final valuable effect is up to the 10^{-2} - 10^{-1} [m] scale, there is the number of physical fields and effects that are transformed up and down the scales, i.e. the process undergoes changes over the scales - it is being scaleported.

7.2 Possible Transmutation Paths for Ni in the E-Cat Chamber Based on the Polyscale Nature of the Media and Process and the Scaleportation of the Physical Effects (Fields)

We are using for the process of transmutation within the RCFR chamber the real physical objects that are at play. That is why the language used here is quite different from the COHP sub-atomic, particle, and physics language that full of mathematical definitions and objects that have no direct connection to the physical phenomena of interests, but to a certain extent smearing the nature of phenomena because often the COHP conceptions were created to shift the focus from the physical object and to put on the table instead the mathematical theory that already has some development and surely does not spread itself to the physics of the current task.

As we can imagine the some major ways that electromagnetic impulse that is the periodic change of electromagnetic fields inside of the chamber that effects the movements of free particles and atoms. Atoms those are at the surface of Ni nanoparticles should be forced to vibrate in accordance to the frequency of the EM fields.

As long as the temperature in the chamber also are rather elevated comparing to the room temperature that makes an input to the H atoms, free electrons, photons, and surface Ni atoms

first of all to be responsive to the higher rate of photons exchange in the chamber which is the nature of temperature characteristic in it.

Increased photon exchange rate influences the energy exchange rate within the electron and atoms "phases". All of this has the mathematical HSP-VAT formulation and ability to be solved mathematically.

The enforced vibration via the EM fields and temperature impact (Figs. 20-22) over the particles and atoms makes them easier to remove electrons away and break (transmute) the nuclei, at least in the nanoparticles of Ni surface layer, in accordance to the external force fields.

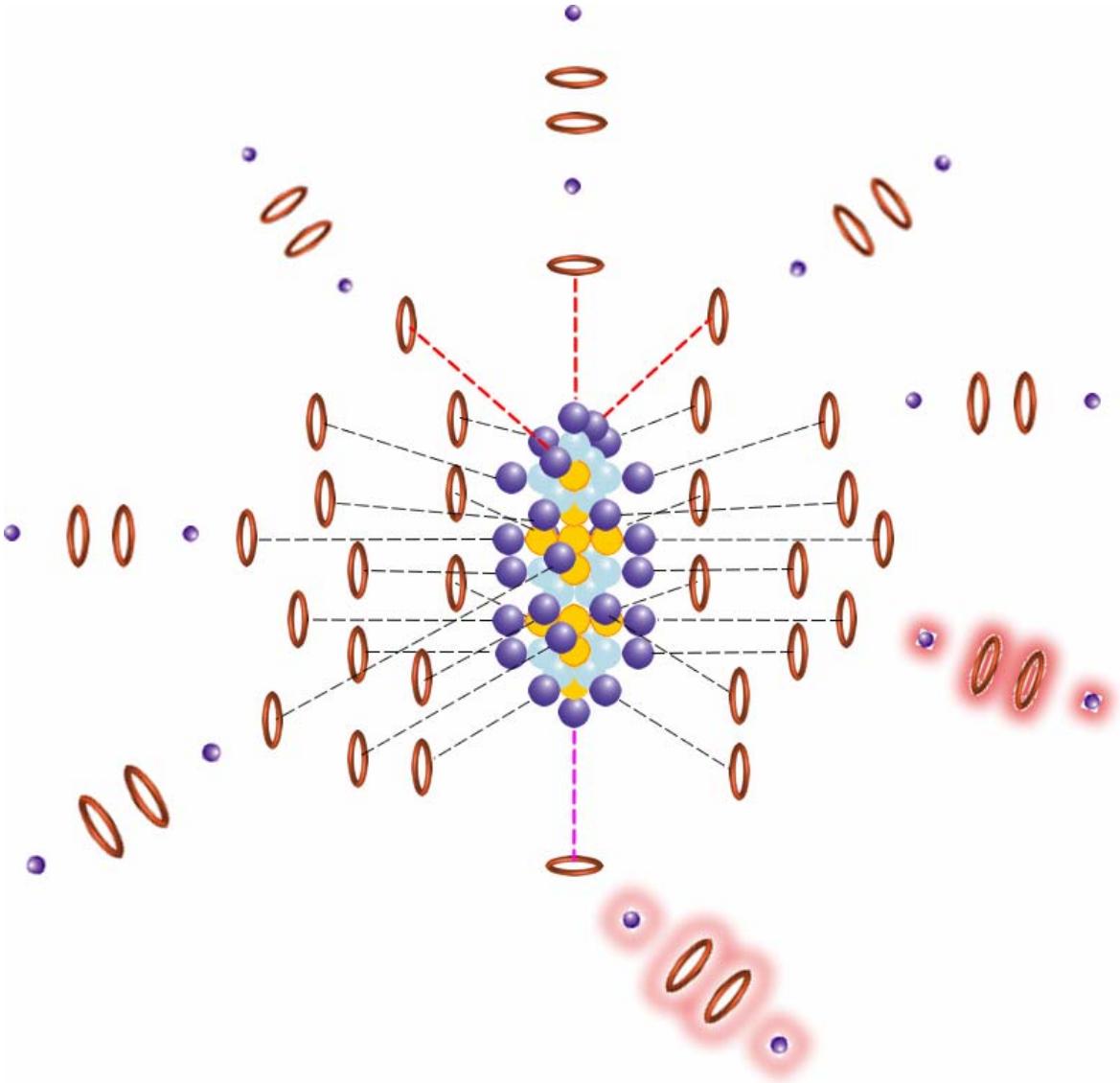

Figure 20. Excited H_2 molecules are closing to the Ni atom.

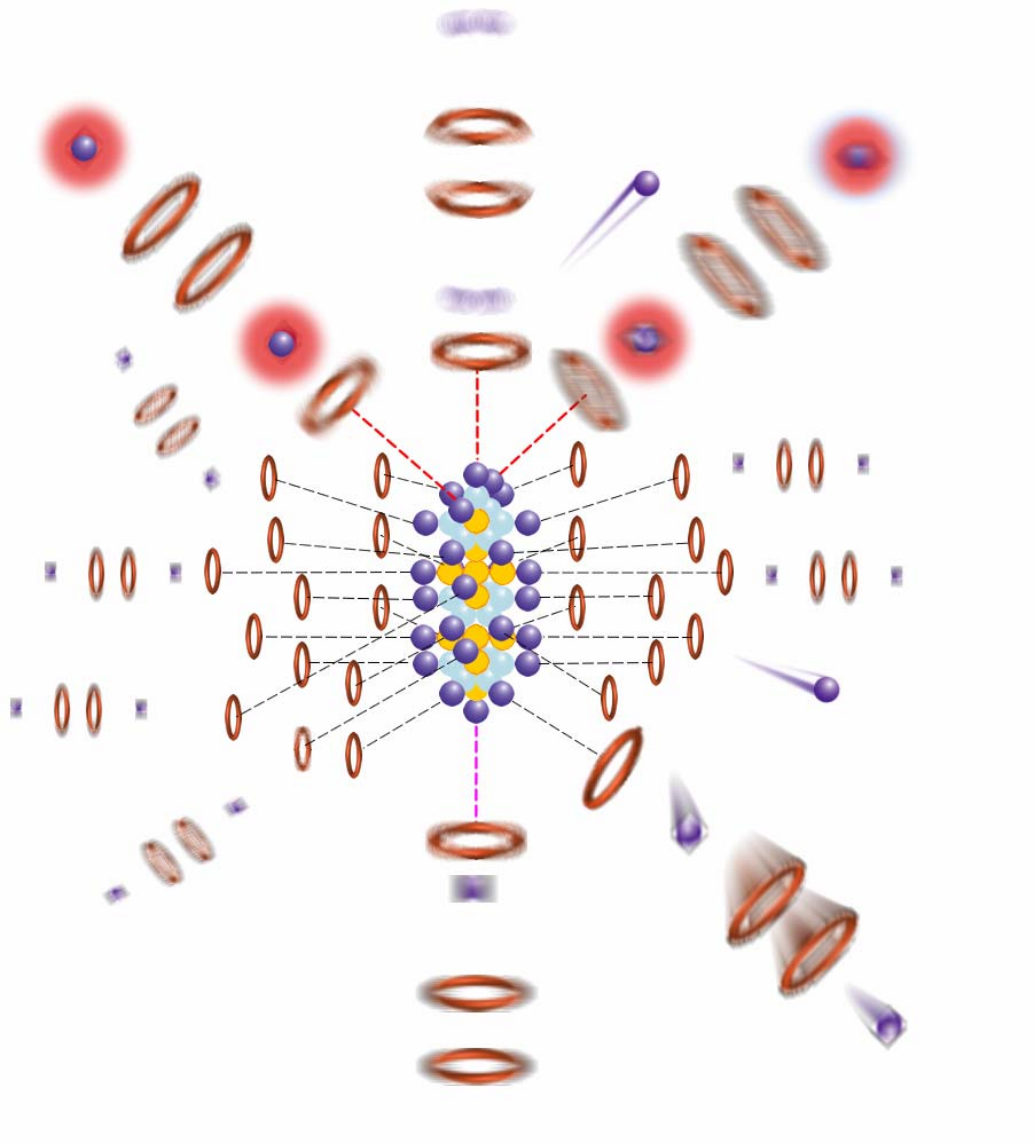

Figure 21-a. Excited H_2 molecules starting to shake in a disturbing way the electrons of the Ni atom.

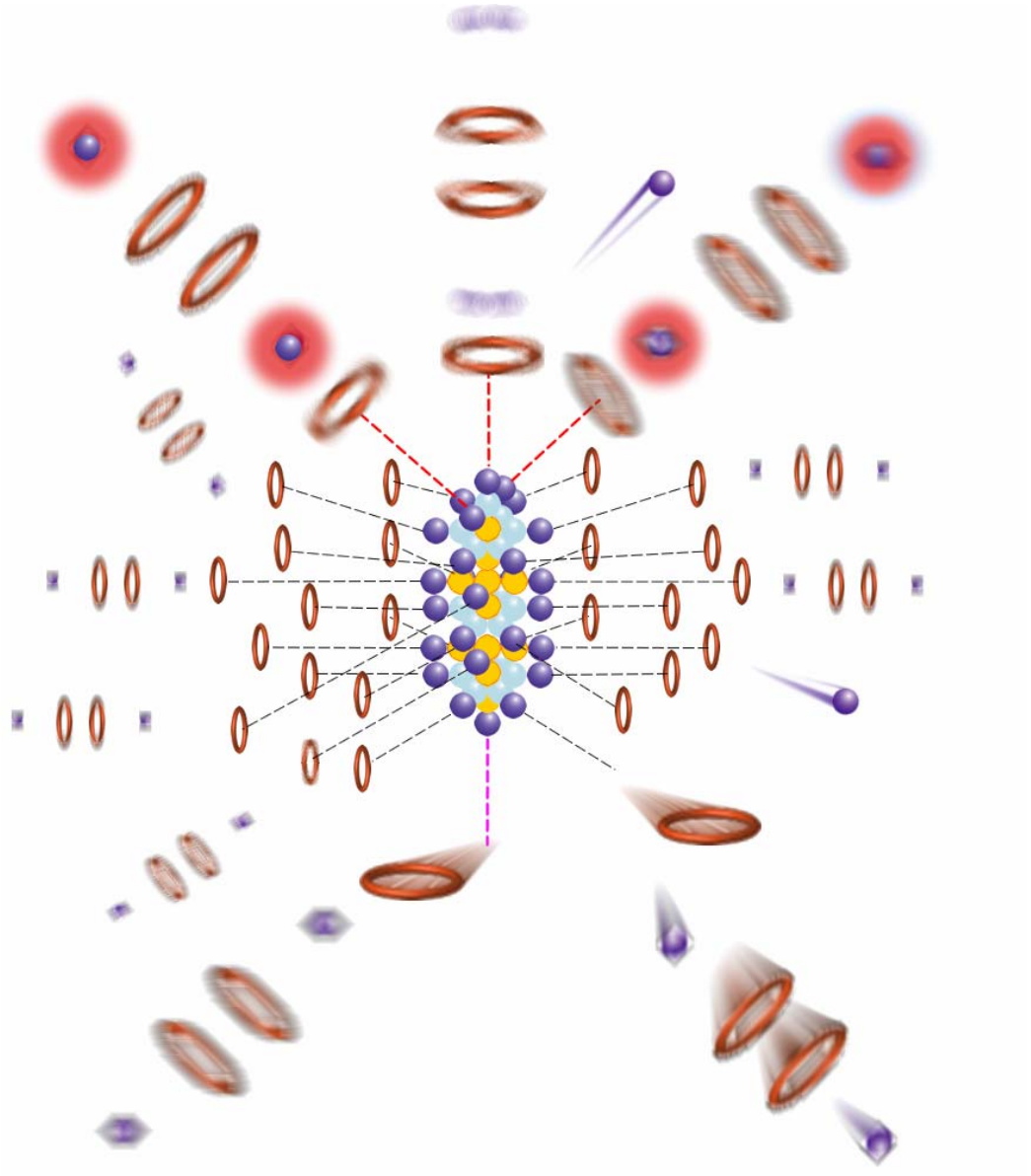

Figure 21-b. Excited H_2 molecules starting to shake in a disturbing way the electrons of the Ni atom.

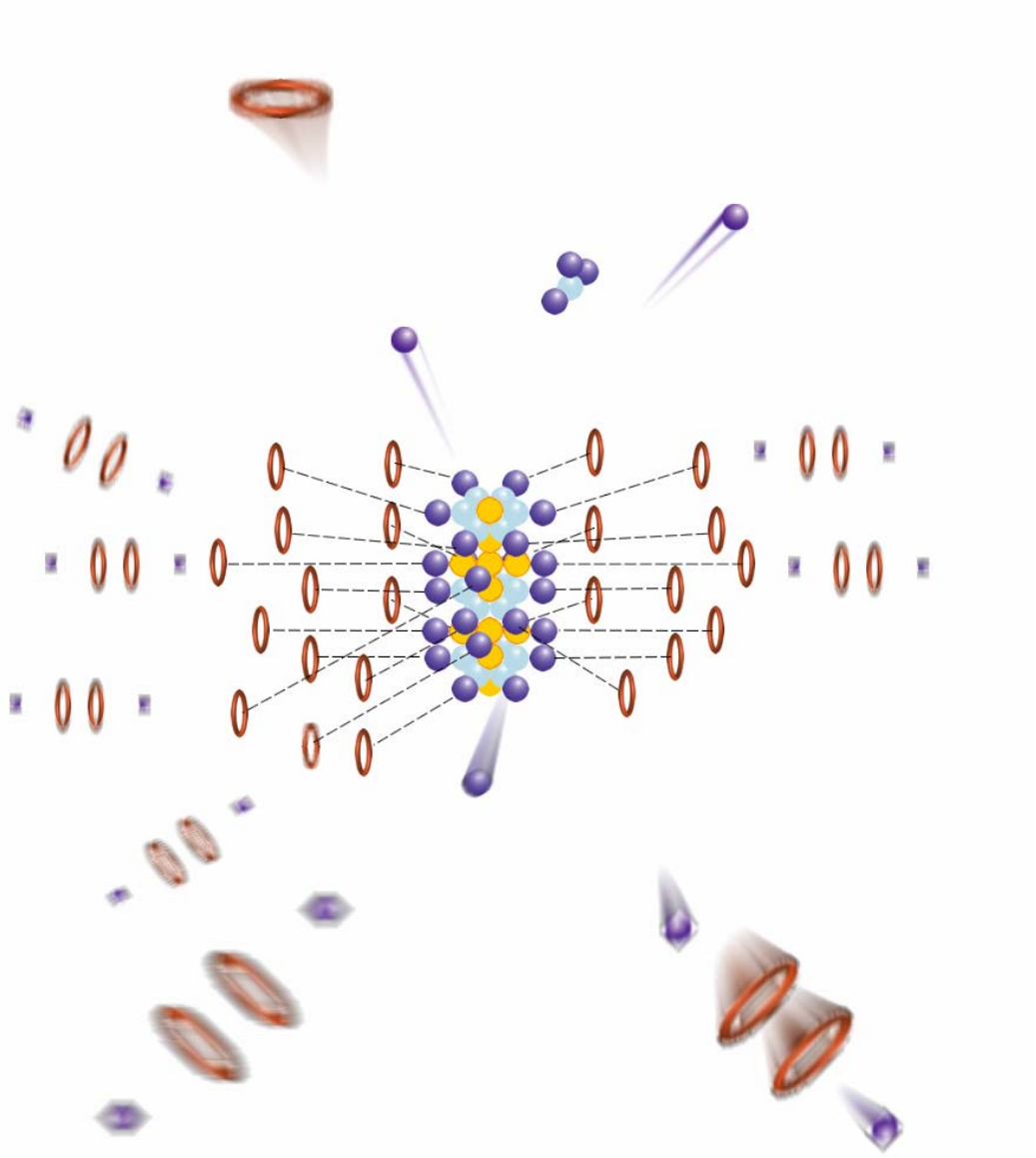

Figure 22. Excited H_2 molecules are breaking off the electrons and protons from the Ni atom.

This is only one of possible scenarios, the one that can be modified based on numerous data regarding the specifics of species atoms structural morphology, isotopes of substances, variations of spatial structure of molecules, heterogeneities of the media at scales, and external fields distribution.

We will extend this analysis in the separate manuscripts.

8. Conclusions

We have shown in this paper for the first time the full path to derivation of the poly-scale (local-nonlocal) mathematical formulation for the sub-atomic scale particulate, continuum nano-scale particles and heterogeneous Polyphase-Polyscale-Polyphysics (3P) dynamics phenomena in E-cat Cold Fusion reactor when the particles at any scale are the volumetric objects, but not the fictitious point-like particles of conventional particle physics or unspecified continuum polyparticle one-phase one-scale Homogeneous media that are accepted in COHP.

Students are never told the real meaning of this kind presentation for sub-atomic particles. The kind of volumetric particulate polyphase medium portrayal was not achieved throughout the previous 100 something years.

There was the lack of needed directly applicable concepts, methods and mathematics in the past ~100 years.

Now, at the beginning of XXI there appeared the understanding that the fictitious point-like sub-atomic particles are not the physical object, but mathematical simplification which opened a way for numerous discussions on the topics like - " how many devils can occupy the needle tip?".

Which is the metaphysical question, but not of physics.

Now it is understood the reasons that century ago physicists could not go in a real particle characteristics chapter study. There were not enough methods, tools in physics and primarily in mathematics - that was and is the primary tool for polyphase physics modeling.

One of the great fatal choices was to abandon the aether as an intermediate medium. That was the way to open a "Pandora pithos" in physics; so many things should have been treated in an artificial and wrong ways.

The sufficient number of advancements was accumulated enough for new polyphase, polyscale particles treatment only during and after 1970-80s.

That are the treatment of sub-atomic particles as of volumetric particles with their internal and surficial properties; the dynamics of particles according to their electromagnetic properties with an individual and collective dynamics equations; the more correct and mathematically fundamental electrodynamics governing equations - GEK equations; the inclusion in all dynamics of sub-atomic particles the intermedium of the aether; and methods for considering the particles dynamics in a unitary way as well as at the same time and of collective Upper scale Polyphase-Polyscale-Polyphysics physical processes.

Now the 3P tools and methods of HSP-VAT particle and nuclear physics are available for adequately educated students and exploratory scientists.

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