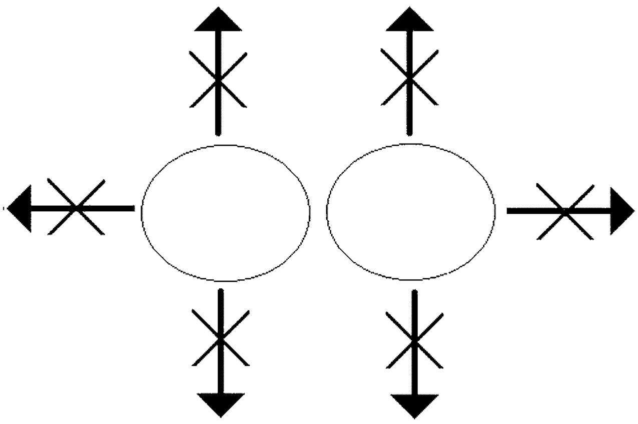
U K R A I N E ISSN 1726-4499

Spacetime & Substance

International Physical Journal



Volume 5, No. 1 (21), 2004

U K R A I N E ISSN 1726-4499

Spacetime & Substance

International Physical Journal

Certificate of the series AB, No. 4858, issued by the State Committee for Information Policy, TV and Broadcasting of Ukraine (February 12, 2001).

The Journal is published by Research and Technological Institute of Transcription, Translation and Replication, JSC(Kharkiv, Ukraine).

It is a discussion journal on problems of theoretical and experimental physics in the field of research of space, time, substance and interactions. The Journal publishes:
— the theories combining space, time, gravitation and others interactions (including the Einstein's SR and GR);
— application of theories for description and/or explanations of properties of the Universe and microcosmos;
— mathematical models and philosophical bases, which touch the description of a physical reality;
— description of set-ups aimed at the realization of fundamental physical experiments and the forthcoming results;
— discussion of published materials, in particular, those questions, which still have not a correct explanation.

The volume of one issue is 48 pages. Format is A4. The periodicity is 5 issues per one year. The language is English. The equivalent versions: paper and electronic (*.TEX, *.PS, *.PDF).

Subscription information:

The price of one paper unit is $2.0 in Ukraine, $2.5 in NIS* states, $10.0 in all other countries (plus $1, $1.5 or $10 postage and handling accordingly). The electronic version price is 25% of the paper version price.

*) NIS (New Independent States without Ukraine) are Azerbaijan, Armenia, Byelorussia, Georgia, Kazakhstan, Kirghizia, Moldova, Russia, Tadjikistan, Turkmenistan, Uzbekistan.

Accounts:

In US Dollars
Correspondent: THE BANK OF NEW YORK
Eastern Europe Division
One WAll Street, New York, NY 10286
Account No. 890-0260-610
Beneficialry Bank: UKRSIBBANK of Ukraine
In favour of ZEMELNY BANK JSC
Account No. 1600-8-50174-01-00
SWIFT: KHAB UA 2K
Beneficiary: NTI TTR JSC
Account No. 26009011415

In UA Hryvnyas
Account No. 26009011415
in KHAB ZEMELNY BANK,
MFO 351652,
AO NTI TTR,
Cod 24473039,
Kharkov, Ukraine
(*for Ukraine subscribers, at the rate of the National Bank*)

The corresponding confermation as to the paying should be sent to the Editorial Office by E-mail.

Editorial Office: Zhuck N.A., RTI TTR, 3 Kolomenskaya St., Kharkov 61166, Ukraine
Tel.: +38 (0572) 19-55-77, (044) 265-79-94. Tel./fax: +38 (0572) 409-298, 409-594, 141-164, 141-165
E-mail: zhuck@ttr.com.ua, spacetime@ukr.net, krasnoh@iop.kiev.ua. http://spacetime.narod.ru

Spacetime & Substance, Vol. 5 (2004), No. 1 (21), pp. 1–5

THE NEW COSMOLOGICAL MODEL

S.S. Sannikov-Proskuryakov[1]

Institute for Theoretical Physics, National Science Center "Kharkiv Institute of Physics and Technology," 1 Academicheskaya St., 61108, Kharkiv, Ukraine

Received February 24, 2004

Proceedings from the idea about existence of immediately non-observed (non-measurable, hidden) physical entity called pre-matter (quintessence or ether) a new cosmological scenario is described. Pre-matter is a kind of two level dynamical system called bi-Hamiltonian one. It is emphasized that the space of Universe may be in three different phase states: continuum, discontinuum, condensate. Three different quantum theories are connected with these space phases. In appendix in the framework of the suggested theory percentage of relic helium and energy of physical vacuum are calculated.

PACS: 13.75Gx

KEY WORDS: quintessence, Big Bang, phase states of space, relic helium, physical vacuum.

1. Introduction

This model is based on the idea that in the beginning of Universe evolution there existed the especial form of matter called pre-matter (quintessence or ether). It is a certain dynamical system called relativistic bi-Hamiltonian one. Covering algebra $U\left[h_{16}^{(*)}\right]$ over the Heisenberg algebra $h_{16}^{(*)}$ and its non-Fock representation in topological vector space F underlies the system [1]. Tensor algebra $T\left[U\left[h_{16}^{(*)}\right]\right]$ and its representation in space $T[F]$ underlies the new cosmological model [2] (general definitions of all these algebraic structures see, for example, in [3]). We say that individual copy $U\left[h_{16}^{(*)}\right]$ describes individual quantum of pre-matter labeled for simplicity as *f*. There are Fermi and Bose quanta f. Hereby tensor algebra $T\left[U\left[h_{16}^{(*)}\right]\right]$ describes an ensemble of such quanta (pre-matter in whole).

Relativistic bi-Hamiltonian system is a kind of two level systems. Its upper level is characterized by positive energies (4-momentum labeled p_μ) and described by the fields $f(x)$. Its lower level (always Bose one) is characterized by negative energies (another 4-momentum labeled $\dot{p}_\mu$, not commuting with p_μ) and described by fields $\dot{f}(\dot{x})$ (here x_μ, $\dot{x}_\mu$ are coordinates of *inner* or "vertical" space-time $T_{3,1}, \dot{T}_{3,1}$ of quanta f and $\dot{f}$; equations for these fields are written in [1], it follows from them that quanta f move in inner space with light velocity c; very important to note that neither coordinates x nor fields $f(x)$ as entities hidden in the isolated point having zero measure are not measurable). At high compression field $f(x)$ is transformed into field $\dot{f}(\dot{x})$, see [1]. This gives rise to the irreversible quantum transition $f \to \dot{f}$ described by the transition matrix element $\left\langle \dot{f}(\dot{x}), f(x)\right\rangle$ (here $\langle\cdot,\cdot\rangle$ is non-Hermite form of the theory). As a result a bilocal field of fundamental particle $\psi(X,Y)$ appears (here $X \sim \frac{1}{2}(x+\dot{x})$ are coordinates of external or "horizontal" space-time of particle or space-time mini-map appearing together with particle).

2. Zero cycle

We identify early Universe (before the first Big Bang) with the ensemble of quanta f. To simplify the consideration we characterize the ensemble f by the mean energy (temperature) T_f. Then mean size λ_f of quanta f is determined by the formula $\lambda_f = ch/T_f$ (analogously for $\dot{f}$: $\lambda_{\dot{f}} = ch/\left|T_{\dot{f}}\right|$) [1]. So quantum f is a certain extended object called in [1] spaceuscula.

It is convenient to introduce an image of *external* (absolute or "horizontal") space as a continuum created by ensemble f and formed in result of sticking together of individual spaceusculas. Hereby gravitational interaction between quanta f (giving rise to the degeneration of quanta f, see [1]) plays decided role. In [2] is demonstrated that the metric of this continuum is described by the Einstein-Hilbert equations with energy-momentum tensor $T_{\mu\nu}^{(f)} = \rho_f u_\mu u_\nu$, where u_μ is 4-velocity of pre-matter in the external space and

[1]E-mail: sanpros@kipt.kharkov.ua

ρ_f is its density. For quanta f press in external space p=0. Starting from the Habble constant $\dot{R}/R = H = 0$ (here R is a size of ensemble f in external space) we come to the Friedman closed model of Universe. Hereby at H =0 density ρ_f is determined as $\rho_f = T_f/c^2\lambda_f^3$, where λ_f^3 is volume of quantum f, and equal to $\rho_f = T_f^4/c^5h^3$ (analogously for $\dot{f}$: $\rho_{\dot{f}} = T_{\dot{f}}^4/c^5h^3$) [1]. Obviously mass of ensemble f (of pre-matter in whole) is $M^{(0)} = T_f N_f^{(0)} = \rho_f \left(R_{max}^{(0)}\right)^3$, where $N_f^{(0)}$ is a number of quanta f in ensemble and $R_{max}^{(0)}$ is maximal ($H = 0$) linear size of ensemble (i.e. of Universe in the zero cycle). In closed model $R_{max}^{(0)}$ is determined as $R_{max}^{(0)} = GM^{(0)}/c^2$, where G is the Newtonian gravitational constant.

To determine the magnitudes $M^{(0)}$, $N_f^{(0)}$, $R_{max}^{(0)}$ note that in closed model maximal volume of Universe is given by the formula $V = \left(R_{max}^{(0)}\right)^3 = G^3M^{(0)3}/c^6$. In the same time we obviously have $V = M^{(0)}/\rho_f = M^{(0)}c^5h^3/T_f^4$, see. [2]. Compare both of these expressions we get the equation (see [2]) from which it follows that $M^{(0)} = c^{11/2}h^{3/2}/G^{3/2}T_f^2 \sim 10^{45}g$. Hereby $N^{(0)} = c^{15/2}h^{3/2}/G^{3/2}T_f^3 \sim 10^{75}$ and $R_{max}^{(0)} = \lambda_f \left(N^{(0)}\right)^{1/3} = c^{7/2}h^{3/2}/G^{1/2}T_f^2 \sim 10^{17}cm$.

It follows from the Friedman equations that after H=0 ensemble f begins to compress. Hereby size λ_f of quanta f begin to decrease. Compression will be last until size of quanta f will be equal to $\lambda_{\dot{f}}$ and radius of Universe will be equal to $R_{min}^{(0)} = \lambda_{\dot{f}} \left(N^{(0)}\right)^{1/3} = c^{7/2}h^{3/2}/G^{1/2}T_f \left|T_{\dot{f}}\right| \sim 10^5cm$. Hereby density is equal $\rho_c = M^{(0)}/R_{min}^{(0)3} = T_f \left|T_{\dot{f}}\right|^3/c^5h^3 \sim 10^{30}g/cm^3$. It is maximally possible density in Universe. After this irreversible quantum transitions $f \to \dot{f}$ begin.

It is interesting to notice that when density approaches to the ρ_c external space (the Friedman's sphere S^3) [2] becomes to be discontinuum (at H=0 it has been continuum). Indeed not far from ρ_c quanta f become to be point like objects ($\lambda_f >> \lambda_{\dot{f}}$) and sphere S^3 is full of holes. So, between $R_{max}^{(0)}$ and $R_{min}^{(0)}$ (size of quanta f are dispersed between $\lambda_f \sim 10^{-8}cm$ and $\lambda_{\dot{f}} \sim 10^{20}cm$) external space is an equilibrium mixture of two phases at the temperature T_f.: continuum and discontinuum (note, transition "Continuum — discontinuum" is the phase transition of the 1-st kind). At compression the external space as if boils.

3. Big Bang. De-Sitter's stage

Total quantum transition $f \to \dot{f}$ is identified to be Big Bang. If these transitions lead to the creation of fundamental hadron the energy $T_f - T_{\dot{f}} \sim \left|T_{\dot{f}}\right|$ ($\left|T_{\dot{f}}\right| >> T_f$) is emitted. As a result mass of Universe increases from $M^{(0)}$ to $M^{(1)} = T_{\dot{f}}N^{(0)} = \eta M^{(0)} \sim 10^{57}g$, where $\eta = \left|T_{\dot{f}}\right|/T_f \sim 10^{12}$. Hereby density ρ (at $R = R_{min}^{(0)}$) must be probably equal to $\rho^* = \eta\rho_c \sim 10^{42}g/cm^3$. But it is impossible because ρ_c is a maximally possible density in Universe. Therefore Universe begins to expand from $R_{min}^{(0)}$ to some R_s which is found from the relation $M^{(1)}/R_s^3 = \rho_c$ and equaled to $R_s = R_{min}^{(0)}\eta^{1/3} \sim 10^9cm$. This stage of Universe expansion we call the De-Sitter's one. It is described by the equation $\dot{R}/R = H_c \sim \sqrt{G\rho_c} \sim 10^{10}s^{-1}$, solution of which is $R(t) = R(0)\,e^{H_ct}$ [4]. (here $R(0) = R_{min}^{(0)}$). This stage is finished in $10H_c^{-1} \sim 10^{-9}s$ after the Big Bang. At this stage press is negative: $p_s = -\rho_c$ (stretching). It follows in particular from the conservation law $\frac{d}{dR}\left(\rho R^3\right) = -3pR^2$ at the condition $\rho = \rho_c = const$ taking place in the Friedman's model [4]. Thus in this stage energy-momentum tensor is $T_{\mu\nu}^{(s)} = -\rho_c g_{\mu\nu}$.

4. First cycle

After termination of the De-Sitter's stage (finishing the transitions $f \to \dot{f}$) Universe continues automatically to expand (but already without energy pumping). Hereby velocity of space expansion is $\dot{R} = H_cR_s \sim 10^{20}cm/s >> c$, that is much more than light velocity. It means that super dense matter of Universe does not move relatively to the space. The process of Universe disintegration goes. Therefore press is equal zero and this stage of expansion (so called the Friedman's one) is characterized by the integral $\rho R^3 = \rho_c R_s^3 = M^{(1)} = T_{\dot{f}}N^{(0)}/c^2$.

If a current temperature T to write in the form of $T = T_f^aT_{\dot{f}}^{1-a} = T_{\dot{f}}/\eta^a$, where $a \geq 0$ is a current parameter so current density for non-relativistic matter $\rho_m = T_fT^3/c^5h^3$ is written in the form $\rho_m = \rho_c/\eta^{3a}$, and current density for ultra relativistic one $\rho_\gamma = T^4/c^5h^3$ - in the form $\rho_\gamma = \rho_c/\eta^{4a}$. At expansion and cooling of Universe some eras are appeared. First of all we call

a)Hadron or nucleon era (hadrons appear, strong interactions between them are switching on) comes when temperature background T becomes compatible with nucleon mass $m_Hc^2 \sim \sqrt{T_fT_{\dot{f}}}$ (parameter $\alpha = 1/2$). The era is characterized by the density

---

[1] Numerical values of the constants $T_f, T_{\dot{f}}, G$ were found in [1]: $T_f \sim 10^{-6}khc$, $T_{\dot{f}} \sim 10^6khc$, $G \sim 10^{-38}c^3/hk^2$, see also [2]where c, h, k are three universal constants hereby $khc \sim 1GeV$.

[2] It is needed to pay attention that the external (absolute) space-time S^4 does not look like the Poincare-Minkowski space-time $A_{3,1}$ used in relativistic particle physics. The latter structure is meanwhile hidden inside the quanta f in the form of $T_{3,1}$ (coordinates x_μ) and only in the first cycle (after the transitions $f \to \dot{f}$ and particles appearing) it outgoes from point and becomes an external measurable space (coordinates X_μ). Hereby discontinuum hides inside the fundamental particles.

$\rho_H = T_f^{5/2} T_{\dot f}^{3/2}/c^5h^3 \sim 10^{15} g/cm^3$, by the size of Universe $R_H \sim 10^{13}cm$, and is finished in $t_H \sim 10^{-3}s$ after the Big Bang. It is essential to notice that proton may not appear one by one without negative charged leptons μ^- or e^- (otherwise charge conservation law would be broken). Therefore there comes

b) Lepton era. Now temperature is compatible with muon mass $m_\mu c^2 \sim T_f^{2/3} T_{\dot f}^{1/3}$ (parameter $\alpha = 2/3$) or electron one $m_e c^2 \sim T_f^{3/4} T_{\dot f}^{1/4}$ (parameter $\alpha = 3/4$). The era is characterized by the density $\rho_\mu = T_f^3 T_{\dot f}/c^5h^3 \sim 10^6 g/cm^3$ or $\rho_e = T_f^{13/4} T_{\dot f}^{3/4}/c^5h^3 \sim 10^3 g/cm^3$, by the radius of Universe $R_L \sim 10^{17}cm$ and is finished in $t_L \sim 10^4 s$ after the Big Bang..

c) Radiation era (relic radiation appears). Energy released from transitions $f \to \dot f$ is spent not only on space expansion and creation of masses of particles but else to excitation of degeneration degrees of ground state $\dot f$ or gauge fields. The latter are characterized by the dispersion relation $k^2 = 0$ (ultra relativistic matter). This kind of matter goes at once after the De-Sitter's stage. As for this component of matter we have $\lambda = hc/T$, so its density is $\rho_\gamma = T/\lambda^3 c^2 = T^4/c^5h^3$.

Usually one considered that ultra relativistic matter is characterized by press $p_\gamma = \rho_\gamma/3$. However after the De-Sitter stage press $p = 0$. How to combine the relativistic component of matter with the condition $p = 0$?

First of all it has to note that at any temperature T there must be $\rho_\gamma + \rho_m \le \rho_c$ (ρ_c is maximum of density) where $\rho_\gamma = T^4/c^5h^3$ and $\rho_m = T_f T^3/c^5h^3$. From here it follows that relativistic component may appear at $a \ge 1/4$ only (compare, hadron era appears at $a = 1/2$). As the ratio ρ_γ/ρ_m is equal to $\rho_\gamma/\rho_m = T/T_f = \eta^{1-a}$, so at $a < 1$ the relativistic component (γ) predominates aver the non-relativistic one (m), but at $a > 1$ all is the opposite. Radiation era is finished at $a = 1$, i.e. in $t_\gamma \sim 10^5 s$ after the Big Bang, when the radius of Universe is $R \sim 10^{21}cm$.

It is very important to understand that with coming relativistic phase temperature T must fall from

$T_{\dot f}$ to $T_f^{1/4} T_{\dot f}^{3/4} = T_{\dot f}/\eta^{1/4}$ (hereby $\rho_\gamma >> \rho_m$ so that $\rho_\gamma = \rho_c$). At only such a condition (downfall temperature) relativistic phase my be combined with zero press. With this jump of press and temperature the 2-d kind phase transition in space "Lebesgue continuum (or discontinuum) - Bohr's compact" is connected (see further). Analysis shows that at $T \sim 10^{3/2} T_f$ and radius of Universe $R \sim 10^{19} cm$temperature increasing $10^{3/2} T_f \to 10^2 T_f$ (once more jump) happens. It is connected with creation of H-atoms (so called recombination process). Hereby the Bohr,s phase is replaced by the usual Lebesgue one.

At $p = 0$ [3] relativistic phase of matter ($0 \le a \le 1$; we call it the Bohr's one else) is characterized by the integrals $\rho_\gamma R_B^3 = T_{\dot f} N/c^2$ and $TR_B^{3/4} = \left(T_{\dot f} N\right)^{1/4} (hc)^{3/4}$ (it follows from here that $\rho_\gamma = T^4/c^5h^3$), and non-relativistic phase ($a > 1$; we call it the Lebesgue one else) is characterized by the another integrals $\rho_m R_L^3 = T_{\dot f} N/c^2$ and $R_L T = (\eta N)^{1/3} hc$ (it follows from here that $\rho_m = T_f T^3/c^5h^3$),

Setting $r = R/\left(N^{(0)}\right)^{1/3}$ to be a current size of cell (mini-map) connected with a fundamental particle we have: in the Bohr' phase $r_B^{3/4} T = T_{\dot f}^{1/4} (hc)^{3/4}$, and in the Lebesgue one $r_L T = \eta^{1/3} hc$. From here at hadron era (parameter $a = 1/2$) $r_B = \lambda_f/\eta^{1/3} \sim 10^{-12}cm$, and at lepton era $r_B = \lambda_f/\eta^{1/9} \sim 10^{-9}cm$ (parameter $a = 2/3$). At $a = 3/4$)(electrons appear $r_B = \lambda_f \sim 10^{-8}cm$ [4].

d) Atomic era. Atoms (as the system $P + e$ "proton+electron") may be created already at lepton era ($a = 3/4$, temperature $T = T_{\dot f}/\eta^{3/4} \sim 10^{-3}GeV$). However these will not be usual Bohr's H-atoms. In lepton era the system $+ e$ is locked in cell with size $\sim 10^{-8}cm$ (it is as if capsulated). In such a situation quite another boundary conditions take place [5]. These conditions underlay another quantum mechanics well adopted to the description of composed systems (in particular atoms, molecules and so on) at shortage of space. It is a quantum mechanics on the Bohr's compact.

Appearance of Bohr phase of space is directly connected with the following circumstance: after the Big Bang a new space-time in the form of $A_{3,1}$ (coordinates X_μ) is created together with particle appearance. Hereby external space (Friedman's sphere S^3) is expanded not so rapidly in order to create at once very much space A_3.

[3]Note only at $p = 0$ there is a possibility to transform the dimensionless variable kR into a new kR' : $kR = f(kR')$ without violation of conservation law $d\left(\rho R^3\right)/dR = 0$. In particular at transformation $kR_L = A\left(kR_B\right)^{3/4}$, where $A = \left(khc/T_f\right)^{1/4}\left(\eta N^{(0)}\right)^{1/12} \sim 10^9$ ($\eta N^{(0)}$ is a number of photons in Universe) conservation law $d\left(\rho_B R^3\right)/dR_B = 0$ is written in the form of $d\left(\rho R_L^4\right)/dR_L = 0$. This transformation describes the space condensation of degree 3/4 and coefficient of compression $A^{-1} = 10^{-9}$.

[4]Let us pay attention that appearing of states $\dot f$, radiation era, hadron era, lepton era and Lebesgue phase is connected with the following values of parameter a: 0, 1/4, 1/2, 2/3, 3/4, 1 (it is interesting to note that the same numbers appear in the theory of musical scale). Contemporary Universe is characterized by the parameter $a = 3/2$.

[5]As is known the usually boundary conditions were prompted to Schroedinger by H.Weyl. However Weyl told to Schroedinger not all then. In fact at temperature $\sim 10^{-3}GeV$ usual H-atom would be in very high excited states having size $r \sim a_\infty n^2$, where $a_\infty = h^2/e^2 m_e$ is the Bohr's radius and $n >> 1$ is the general quantum number. It is seen that the size of the system $+ e$ in usual space depends on not only fundamental parameters $T_f, T_{\dot f}$ ($m_e c^2 \sim T_{\dot f}/\eta^{3/4}$) but also on electromagnetic charge and general quantum number. Sure such an object does not be situated in the cell with size $10^{-8}cm$.

We saw that at $H=0$ external space may be considered to be continuum, but before Big Bang it was as discontinuum. After the Big Bang the space begins to expand. And we have to consider now

5. Integration in extended space

If a cell has the size $2L$ so there is two kind of integration of function $\psi(X)$ given on the cell (one dimensional case is considered): a) usual integration $\int_{-L}^{L}\psi(X)\,dX$, b) mean value $\frac{1}{2L}\int_{-L}^{L}\psi(X)\,dX$. At the limit $L\to\infty$ (space is extended) we come to two kinds of integration:

1) the Riemann-Lebesgue one $\int_{-\infty}^{\infty}\psi(X)\,dX$ (here dX is called the Lebesgue measure);

2) the Besikovich-Bohr integration $\lim_{L\to\infty}\frac{1}{2L}\int_{-L}^{L}\psi(X)\,dX = \lim_{L\to\infty}\frac{1}{2}\int_{-1}^{1}\psi(Ly)\,dy = bmv\int\psi(X)\,dX$ (bmv means Bohr mean value; measure in this integral we call the Bohr one, see. [5]). Different physics (in particular field theories) is connected with these two kinds of integration. It is known that the case "1" is used in the usual quantum mechanics. Quantum mechanics in the case "2" will be considered in another article.

Appendix

a)Usually one considers that creation of cosmic He^4 is a result of nucleon-synthesis or nucleon-fusion [4]. We consider that cosmic He^4 appeared as a result of disintegration of super dense body of Universe at its expansion. Due to the quantum correlation between spin and isospin and switching on the strong interaction between nucleons the bound conglomerates may remain but not only individual nucleons will be. Nucleon skeleton (see [1]) is described by the representation $D_i(1/2)\otimes D_s(1/2)$ of the group $SU_i(2)\otimes SU_s(2)$ (i and s are isotopic and usual spin indices; $\otimes$ is the direct product). Two-particle conglomerates are described by the representation $(D_i(1/2)\otimes D_s(1/2))\times(D_i(1/2)\otimes D_s(1/2)) = (D_i(1/2)\times D_i(1/2))\otimes(D_s(1/2)\times D_s(1/2))$ ($\times$ is the Kronecker multiplication). As $D(1/2)\times D(1/2)=D(0)+D(1)$, so we have $(D_i(0)+D_i(1))\otimes(D_s(0)+D_s(1))=D_i(0)\otimes D_s(0)+D_i(1)\otimes D_s(1)+D_i(1)\otimes D_s(0)+D_i(0)\otimes D_s(1)$.

Due to the Pauli exception principle only two latter terms are realizable in the Nature; hereby states $D_i(0)\otimes D_s(1)$ correspond to the deuteron d. Proceeding from these states we build four nucleons conglomerates. They are described by the representation $(\mathrm{D}_i(1)\otimes\mathrm{D}_s(0)+\mathrm{D}_i(0)\otimes\mathrm{D}_s(1))\times(\mathrm{D}_i(1)\otimes\mathrm{D}_s(0)+\mathrm{D}_i(0)\otimes\mathrm{D}_s(1)) = (\mathrm{D}_i(0)+\mathrm{D}_i(1)+\mathrm{D}_i(2))\otimes\mathrm{D}_s(0)+2\mathrm{D}_i(1)\otimes\mathrm{D}_s(1)+\mathrm{D}_i(0)\otimes(\mathrm{D}_s(0)+\mathrm{D}_s(1)+\mathrm{D}_s(2))$.

He^4 is an isosinglet with usual spin s=0,1,2. It is described by the representations $2\mathrm{D}_i(0)\otimes\mathrm{D}_s(0)$, $\mathrm{D}_i(0)\otimes\mathrm{D}_s(1)$ and $\mathrm{D}_i(0)\otimes\mathrm{D}_s(2)$. At strong interaction switching on the latters correspond to the bound states of four nucleons (He^4). The rest are states of four nucleons without bound states. Number of possible states with isospin i and usual spin s is $(2i+1)(2s+1)$. Using this formula we get that the total number of states consisting of four nucleons is 36. Number of states for He^4 is 10. Ratio 10/36=0,27 gives the percentage of He^4 in the Universe. Cosmic observations give the same number [4].

b) Here a contribution of physical vacuum (zero vibrations of the Lagrangian particle fields) into energy of Universe is calculated.

In quantized field theory energy of *physical vacuum* is determined by the expression $P_0 =< 0\,|\int T_{00}\left(\vec{X},t\right)d^3X|0>$, see [6], where $T_{\mu\nu}$ is the total energy-momentum tensor of all quntized fields and —0¿ is the state of physical vacuum. Magnitude P_0 may be expressed as the following sum $\sum_{s,m}(-1)^{2s}(2s+1)\frac{1}{i}\frac{\partial^2}{\partial t^2}D_m^+(0,t)\,|_{t=0}\int d^3X$ where $D_m^+(X)$ is the Pauli-Jordan function of positive frequency, s and m are spin and mass of particle. In the local theory (point-like particles) energy density of vacuum is given by the sum (see [6]) $\rho^{vac} = \sum_{s\ m}\left[\pm(2s+1)\int d^3p\sqrt{\vec{p}^2+m^2}\right]$ (where signs "+" and "-" are for bosons and fermions correspondingly). It is obviously infinite magnitude. However in the bilocal field theory (non-point, smearing particles [1]) particles have the space-time structure described by the function $\theta(I)\frac{sin\sqrt{I}}{\sqrt{I}}$ where $I=(pY)^2-p^2Y^2$, $\theta(I)$ is the Heaviside function and $Y=\left(Y_0,\vec{Y}\right)$ are the inner space-time coordinates of particle. In the case of physical vacuum these variables are free (see [1]; for massless particles structure function is $\cos(pY)$). For smearing particles the Pauli-Jordan function $D_m^+(X,Y)$ is given in [1]. Using this function the expression for energy density of vacuum is written in the form of sum of integrals $\pm(2s+1)\int d^3p\sqrt{\vec{p}^2+m^2}\frac{sin\sqrt{(pY)^2-p^2Y^2}}{\sqrt{(pY)^2-p^2Y^2}}$ (here we took into account that for free particles $p^2=m^2$; for massless particles we have the sum $\sum\left[\pm2\int d^3p\,|\vec{p}|\cos pY\right]$ because there are only two chiral states). We else may choose the system in which $\vec{Y}=0$ and therefore $(pY)^2-p^2Y^2=\vec{p}^2Y_0^2$. In result the expression for ρ^{vac} is the sum of items

$$\pm(2s+1)\int d^3p\sqrt{\vec{p}^2+m^2}\frac{sin\,|\vec{p}|\,Y_0}{|\vec{p}|\,Y_0}=$$

$$= \mp (2s+1) \frac{4\pi}{Y_0^4} (mY_0)^2 K_2 (mY_0),$$

where K_2 is the Macdonald's function. So for bosons ρ^{vac} is a negative magnitude and for fermions it is a positive one. At the limit of small mY_0 this gives $\mp (2s+1) 8\pi/Y_0^4$ (at m=0 when the structure function is $\cos\{pY\}$ we have $\mp 48\pi/Y_0^4$). In another limit $mY_0 \to \infty$ we have $m^{3/2} e^{-mY_0}/Y_0^{5/2}$.

To estimate the numerical value of ρ^{vac} we resort to the following consideration. So far as at the Universe expansion the ratio R/λ (where λ is a free length and R is the radius of Universe) is invariant (see above) so we have to consider that $Y_0 \sim R$. Obviously the physical vacuum appeared together with particle appearance after the so called De-Sitter's stage when the radius R of Universe has been $R_s = c^{7/2} h^{3/2} / G^{1/2} T_f^{5/3} T_f^{1/3}$. At this stage Y_0 had the minimal value equaled to the fundamental "length" $1/k$. At the Lebesgue phase (space for elementary particles is always the Lebesgue one) $Y_0 = R/kR_s$ and hence

$$\rho^{vac} = \sum_{s\,m} \mp (2s+1) 4\pi k^4 hc \times$$

$$\times \left(\frac{R_s}{R}\right)^4 \left(\frac{mcR}{hkR_s}\right)^2 K_2 \left(\frac{mcR}{hkR_s}\right).$$

At small masses $\left(mc^2 << khc \sim 1GeV\right)$ and $R \sim R_s$ (just after the De-Sitter's stage) we have

$$\mp (2s+1) 8\pi k^4 hc \left(\frac{R_s}{R}\right)^4 =$$

$$= \mp (2s+1) 8\pi k^4 hc \left(\frac{T}{T_f}\right)^4 =$$

$$= \mp (2s+1) \sigma_{vac} T^4/c.$$

Here the condition $RT = R_s T_f$ is used (see above), where $\sigma_{vac} = 8\pi k^4 hc^2/T_f^4$ and $T_f \sim 10^{15} eV$ (see above). It follows from here that for nucleon vacuum $\rho^{vac} \sim 10^{45} eV/cm^3$ (that is compatible with the density of nuclear matter). Nowadays $R \sim 10^{27} cm$, $R/R_s \sim 10^{18}$ and hence $\rho^{vac} \sim e^{-10^{18}} eV/cm^3$ for nucleon vacuum that is, of course, negligible small magnitude.

More over at m=0 we have the strict equality $\rho^{vac} = \rho_F^{vac} + \rho_B^{vac} = 0$ because there are two neutrinos with chiralities 1/2 and two states of photon with chiralities 1.

Note that charge and spin densities of physical vacuum are strictly zero because integrals $\int d^3p \frac{sin|\vec{p}|Y_0}{|\vec{p}|Y_0} = 0$ and $\int d^3p \cos||\vec{p}|Y_0| = 0$.

References

[1] S.S. Sannikov-Proskuryakov, *Ukr. J. Phys.*, 46, No. 8, pp. 775–783; No. 10, pp. 1019–1027 (2001).

[2] S.S. Sannikov-Proskuryakov, *Russian Physical Journal*, No. 2, pp. 106–115 (1995); No. 8, pp. 72–82 (1996).

[3] S. Lang, "Algebra," N.-Y., 1965.

[4] S. Weinberg, "Gravitation and Cosmology," N.-Y., 1972.

[5] H. Bohr, "Fast periodische Funktionen," Berlin, 1932.

[6] N.N. Bogolyubov, D.V. Shirkov, "Introduction to the Quantized Field Theory," Moskow, 1973.

Spacetime & Substance, Vol. 5 (2004), No. 1 (21), pp. 6–9

TIME AS A PHACE SPACE OF ALTERNATIVE REALITY

Miroslav Súkeník[1] and Jozef Šima[2]

Slovak Technical University, FCHPT, Radlinského 9, 812 37 Bratislava, Slovakia

Received February 13, 2004

This contribution is aimed at describing the time as a phase space of alternative reality (PSAR). Contrary to a space-time cone, stemming from the conception of real and imaginary times, the PSAR takes into account the whole Universe with its beginning and end. The Universe is characterized as an object with an infinitive number of alternative states in the past and future, but as a single state in the present.

Based on the identity of the gravitational field intensity of a hypothetical particle at a distance of its Compton wavelength λ_C and that of a primordial black hole at its surface, the Compton wavelength is calculated as $\lambda_C = 9.336 \times 10^{-29}$ m and the corresponding energy $E_{\max(calc)} = 1.328 \times 10^{13}$ GeV. Since no present-time real particle may have a higher intensity of its gravitational field than a black hole has, the energy $E_{\max(calc)}$ is the maximum particle energy quantum at present. This energy exceeds the highest energy cosmic rays observed up-to-now (the Fly's Eye built in the Utah desert) $E_{\max(obs)} \cong 3.2 \times 10^{11}$ GeV. To the energy $E_{\max(calc)}$, the minimum present "elementary time interval" (time of one wave cycle) of the value $t_{(\min)} \cong 3 \times 10^{-37}$ s corresponds. This time is higher than the Planck time and is increasing with the Universe evolution. Relation to the conception of parallel universes is discussed.

1. Introduction

The physical meaning of time, its true nature, chemical aspects, biological impact, psychological perception, and cosmological importance form a set of probably the most mysterious enigmas for the mankind.

The shortest time interval taken into account in the science is Planck time (5.39056 x 10^{-44} s). In particle physics, time intervals down to 10^{-30} s are estimated for some processes, current experimental measurements are, however, limited to femtosecond (10^{-15} s) and attosecond (10^{-18} s) time domains [1]. In physical disciplines, a change from the absolute (Newtonian) to relative concept of the time (as integral part of Einstein's time-space) has been generally accepted.

A very peculiar nature of time is associated with biological and life processes. As an example, a grain of wheat left for some thousand years in the dark space of an Egyptian pyramid can serve. When being put in a moisture medium, millions of concurrent and consecutive chemical and physical processes, called life, start to proceed yielding a new plant. A question naturally arises on the role of time occurrence during the years of conservation.

Physiologically, time is perceived as a direct and one-way continual past–to-present-to-future change. Its single direction is still a matter of discussion stimulated e.g. by Wheeler's and Feynman's ideas of advanced and retarded waves [2] or in the conception of time direction of the positron [3]. Feynman pointed out that a positron traveling forward in time was mathematically equivalent to an electron traveling backwards, so proceeded to draw them as backwards arrows in the Feynman diagrams, but he never claimed that positrons were literally electrons traveling backwards in time.

Scientists are trying to understand what the time actually is and several conceptions have been elaborated [4, 5], some of them, exemplified by [6, 7] also offered to the public.

To the conception of time, conceptions of the Universe(s) are related. In the majority of models devoted to the issue, the existence of parallel universes is hypothesed [8, 9]. Such models consider the simultaneous existence of several mutually possibly communicating universes.

Contrary to the conception of parallel universes, this contribution is aimed at describing the time as a phase space of alternative reality (PSAR) and a single Universe with alternatives in the past and future but an unambiguous state in the present.

2. Phase space of alternative reality

The principles of phase space of alternative reality are schematized in Figure 1 representing a graph in the complex Gaussian plane in the Cartesian coordinate system. This system was originally used by Feynman [3] whose imaginary time is illustrated as a second form

[1]E-mail: sukenik@minv.sk
[2]E-mail: sima@chtf.stuba.sk

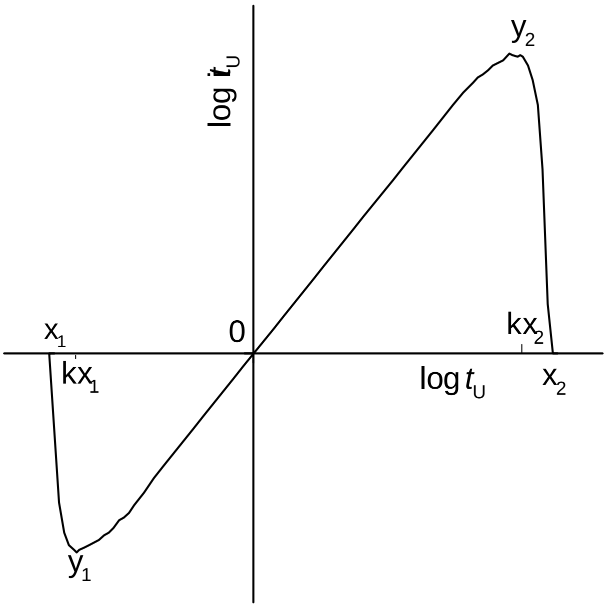


Figure 1: Schematic plot of logarithm of cosmological time versus logarithm of imaginary cosmological time

of time that could be visualized as being at "right angle" to normal time. It should be stressed that the time cannot be understood as a fourth spatial dimension (it transforms differently under Lorentz transforms).

While the x-coordinate is a common logarithm of the cosmological time t_U

$$x = \log t_U \tag{1}$$

the y-coordinate represents a common logarithm of the imaginary time

$$y = \log\, i\, t_U \tag{2}$$

used also by Hawking [6] with the aim of avoiding the initial and end singularities.

In Fig. 1, point x_1 represents the beginning of the Universe expansion in the Planck time t_{Pc}

$$x_1 = \log \frac{t_{Pc}}{t_U(pr)}. \tag{3}$$

Situation at $x = 0$ is a logarithm of the present cosmological time $t_{U(pr)}$

$$t_{U(pr)} = 4.296 \times 10^{17}\ \mathrm{s} \tag{4}$$

taking in this paper into account as a unit time. The point x_2 is a logarithm of the maximal cosmological time which, however, need not be a singularity

$$x_2 = \log \frac{t_{U(\max)}}{t_{U(pr)}} \tag{5}$$

Any time may then be expressed as

$$t_x = 10^x t_{U(pr)}. \tag{6}$$

The function $y_{(x)}$ represents a plot of logarithm of the imaginary time versus a logarithm of the real time. The exact analytical form of the function is arbitrary and its shape will be rationalized in the following paragraphs.

The area S_1 under the curve is the phase space of alternative reality (PSAR) in which any point represents the whole Universe. The area S_1 is obtained as a definite integral between x_1 and 0

$$S_1 = \int_{x_1}^{0} y_{(x)} dx \tag{7}$$

and it covers all possible alternative states of our Universe in the past. There is a causal association of these past states with the present time and they lead necessarily to the present time.

The area S_2 under the curve

$$S_2 = \int_{0}^{x_2} y_{(x)} dx \tag{8}$$

represents all alternative futures of our Universe having a causal connection with the present time and leading to the end state $t_{U(\max)}$.

$\Psi_{(x)}$ is the probability amplitude of the existence of an alternative reality in the time corresponding to the point x

$$\Psi_{(x)} = \frac{y}{i\, x_j}, \tag{9}$$

where $j = 1$ for the past, $j = 2$ for the future.

A total probability of crossing from the Planck time to the present time must equals 1. It comprises a sum over all trajectories (an analogue of the Feynman's sum over histories [3]) of all possible curves connecting a point x_1 with the point $x = 0$, however, all of them crossing the area S_1. This, in a nutshell, complies with the Feynman approach.

In this mode a wavefunction of the Universe $\Psi_{(U)}$ can be postulated as having the value of

$$\Psi_{U(pr)} = 1. \tag{10}$$

It is obvious that at the beginning of the Universe expansion, at present and at its end no alternatives exist for the Universe. Just following the beginning of the Universe, the probability of alternative possibilities has increased, likely in an exponential mode (proportionally to the Universe space dimensions D). Based on current theories of the spacetime, string theories including, the value of D = 9 is taken into consideration in this paper. The maximal deflection $y_{(x)}$ in the point $x_{(past)}$ in the past is

$$x_{(past)} = k\, x_1, \tag{11}$$

where

$$k = \frac{D-1}{D} = \frac{8}{9}. \tag{12}$$

Later on the probability amplitude drops reaching zero value at present. In future it will increase up to the point $x_{(future)}$

$$x_{(future)} = k\, x_2. \tag{13}$$

Then its value will decrease approaching the zero at the time $t_{(U)\max}$, i.e. at the end of the Universe.

All the alternative realities - past and future - must be coupled with the present reality in a causal mode. A curve of the imaginary time, $y_{(x)}$ envelopes the phase space of alternative reality. The negative values of both $\log t$ and $\log it$ express the past, the positive ones the future. Contrary to a space-time cone, the PSAR takes into account the whole Universe with its beginning and end.

Consequently, the time can be defined as a set of all PSAR points, i.e. it represents a mode of existence of alternative reality.

Function $y_{(x)}$ is the most general equation of the reality, and to its full description the value of $t_{(U)\max}$, i.e. the time of the Universe end, must be known. Hawking and Penrose in their famous book [6] explain why in the beginning the universe was so uniform, as evinced by the microwave background radiation left over from the big bang, whereas the end of the universe must be messy. The nature of the Universe at its end does not, however, contradict to a postulate on the necessity of the end.

3. The present "elementary time interval"

It has become obvious that the primordial black holes could not fully evaporate [10]. Their present-time mass is about

$$m_{BH(prim)} \approx 10^{12} \text{ kg} \tag{14}$$

and, as rationalized in [11], their radius is

$$r_{BH(prim)} = \left(l_{Pc}^2\, r_U\right)^{1/3} = 3.116 \times 10^{-15} \text{ m}, \tag{15}$$

where l_{Pc} is the Planck length and r_U is the Universe radius (its present-time value is 1.299×10^{26} m [12]). Suppose, there is a particle having identical gravitational field intensity at a distance of its Compton wavelength λ_C as a primordial black hole has at its surface. The Compton wavelength is then

$$\lambda_C = \left(l_{Pc}^2\, r_{BH(prim)}\right)^{1/3} = 9.336 \times 10^{-29} \text{ m} \tag{16}$$

and the corresponding calculated energy

$$E_{\max(calc)} = 1.328 \times 10^{13} \text{ GeV}. \tag{17}$$

It can be postulated that $E_{\max(calc)}$ is the maximum particle energy quantum at present.

The highest energy cosmic rays ever recorded (the Fly's Eye built in the Utah desert [13]) had the energy of

$$E_{\max(obs)} \cong 3.2 \times 10^{11} \text{ GeV} \tag{18}$$

and is much higher than the cut-off energy calculated by Greisen, Zatsepin and Kuzmin in 1965 (GZK cut-off of 6 x 10^{10} GeV). While the composition of the primary particle is not known with certain, the best guess is that it was a moderate mass nucleus (something like oxygen). It should be pointed out that the energy is still of more that an order of magnitude lower than that given by (17).

A possibility of the fractal-like structure incorporation emerges of the mentioned data. If the whole mass of a primordial black hole (14) is compressed into the volume of a ball with the radius λ_C it would have the Planck density (about 10^{97} kg m^{-3}) which equals the density of the whole Universe compressed into the volume of a primordial black hole. A possibility of the maximum density of a singularity follows directly. It holds

$$\lambda_C^9 = l_{Pc}^8\, r_U \tag{19}$$

and, at the same time,

$$\lambda_C \approx \left(r_U\right)^{1/D}, \tag{20}$$

where D represents the Universe dimensionality. The Universe is characterized thus by 9 space and 2 time dimensions. Owing to a gradual increase in the Universe radius r_U, energies higher as those given by (17) might exist in the past. It leads to a conclusion on possibility to travel into the past and, in case of

$$E \cong 10^{19} \text{ GeV} \tag{21}$$

a possibility of the formation of a parallel universe follows. If such parallel universes do really exist [8, 9], no time paradox or causality principle breaking would happen. To the energy quantum value (17) the minimum present "elementary time interval," i.e. the time of one wave cycle

$$t_{(\min,pr)} \cong 3 \times 10^{-37} \text{ s} \tag{22}$$

corresponds. Within the Universe evolution this "elementary time interval" will increase due to a decrease in the maximum particle energy. This is the time represented by a minimum value of the logarithm of imaginary time at the x axis.

4. Conclusions

The concept of PSAR opens new possibilities of rationalization of the Universe nature. These possibilities evolve from an analogy with quantum mechanics. In quantum mechanics, the reality is manifested in the moment of wavefunction collapse. Should the parallel universes exist, it can be expected that our universe is in a quantum superposition with an indefinite number of alternative pasts and futures which exist in these parallel universes. During the Universe time evolution (following the time evolution of $y_{(x)}$) a collapse of indefinite number of the Universe wavefunctions [14] occurs which is responsible for manifestation of the Universe reality. Of course, new wavefunctions simultaneously appear. In this case, the whole Universe may be understood as a single quantum mechanical state.

Acknowledgements

The financial support of this work by grant 1/6106/99 of the Slovak Grant Agency (VEGA 1/925/02) is appreciated.

References

[1] F. Krausz, "From femtochemistry to attophysics," *Phys. World*, 14 (2001). 41-46

[2] J.A. Wheeler, R.P. Feynman, "Interaction with the absorber and the mechanism of radiation," *Rev. Mod. Phys.*, 17 (1945) 157–181.

[3] P.R. Feynman, "QED: The Strange Theory of Light and Matter," Princeton University Press, Princeton, 1988.

[4] M. Kozlowski, J. Marciak-Kozlowska, "The Time Arrow in a Planck Gas," *Phys. Lett.*, 10 (1997) 295–299.

[5] N. Zhuck, *Spacetime & Substance*, 4 (2003), in press.

[6] S.W. Hawking, R. Penrose, "The Nature of Space and Time," Princeton University Press, Princeton, 1996.

[7] P. Coveney, R. Highfield, "The Arrow of Time: A Voyage Through Science to Solve Time's Greatest Mystery," Fawcett Books, New York, 1991.

[8] D. Deutch, "The Fabric on Reality — The Science of Parallel Universes and Its Implications," Penguin Books, New York, 1997.

[9] F.A. Wolf, "Parallel Universes — The Search for Other Worlds," Simon & Schuster, New York, 1989.

[10] C. Sivaram, "Black hole Hawking radiation may never be observed," *Gen. Rel. Grav.*, 33 (2001) 175–181.

[11] J. Šima, M. Súkeník, "Entropy — Some Cosmological Questions Answered by Model of Expansive Nondecelerative Universe," *Entropy*, 4 (2002) 152–163.

[12] M. Súkeník, J. Šima, "Neutron Star Properties Viewed by the ENU Model," *Spacetime & Substance*, 3 (2002) 35–37.

[13] D.J. Bird, S.C. Corbato, H.Y. Dai, J.W. Elbert, K.D. Green, M.A. Huang, D.B. Kieda, S. Ko, C.G. Larsen, E.C. Loh, M.Z. Luo, M.H. Salamon, J.D. Smith, P. Sokolsky, P. Sommons, J.K.K. Tang, S.B. Thomas, *Astrophys. J.*, 441 (1995) 144–151.

[14] "Battelle Recontres" (B.S. de Witt, J.A. Wheeler, Eds.), Benjamin, New York, 1968.

Spacetime & Substance, Vol. 5 (2004), No. 1 (21), pp. 10–16

STRUCTURE OF LEPTON

Harry Yosh[1]

HECO Ltd., 1-33 Willeroo Street, Lakemba, NSW 2195, Australia

Received October 30, 2003

Lepton is thought to be a point-like object. However lepton has various properties such as electric charge, flavor or generation, so it might be possible to consider lepton as the composite of more fundamental substances. Here lepton is supposed to be composed of two different particles "$a-on$" and "$b-on$" and their electroweak interaction is considered. As the consequence, the difference of masses among lepton generations is explained as caused from different eigenstates on that composite of $a-on$ and $b-on$. Finally the consistency of that model with Dirac equation is discussed under the low energy conditions.

Keywords: structure of lepton, lepton generations, Weyl equation, Dirac equation, standard model, spontaneous break of symmetry

1. Introduction

When lepton is supposed to be composed of two more fundamental substances, i.e. $a-on$ and $b-on$, immediately we encounter the problem for the spins of these substances. Since lepton is fermion, the composite of $a-on$ and $b-on$ must have the spin 1/2. If these substances belong to bosons, that composite can not have spin 1/2, but if they belong to fermions, that composite must have the spin 0 or 1 or any integer number and it contradicts with the property of lepton. Here both $a-on$ and $b-on$ are supposed to be neither fermions nor bosons, namely they don't have the property of spin, although they follow the statistics of fermions. The mechanism causing spin on actual lepton from the composite of spinless substances is discussed relating to the consistency with Dirac equation later. Here $a-on$ and $b-on$ are called a "mhon" as a general term. Mhon has electric charge, flavor and fractional electric charge as shown in the table below:

	Flavor: up	Flavor: down
$a-on$	$+e/2$	$-e/2$
$b-on$	(not exist)	$-e/2$

where $-e$ is the electric charge of electron. $a-on$ doesn't have chiral symmetry, but $b-on$ has. It is supposed that $b-on$ having the flavor up does not exist in the nature. It is also supposed that any mhon doesn't have original mass. Therefore it is meaningless to consider the property of generation on mhon. The difference of masses of leptons belonging to different generations is discussed later relating to the difference of eigenstates caused from the interaction between $a-on$ and $b-on$.

2. Electroweak interaction between $a-on$ and $b-on$ in lepton

The electroweak interaction for electron is interpreted with that for $a-on$ and $b-on$. Since mhon doesn't have mass, the equation of motion for mhon can be described with Weyl equation [1]. Gauge invariability is imposed on the Lagrangian deriving Weyl equation. Firstly the Lagrangian density for left-handed $a-on$ L_{aL} is described as

$$L_{aL} = a_L^* i\sigma^\mu(\partial_\mu - (ig/2)\sigma\cdot\mathbf{A}_\mu)a_L;$$

$$(\sigma^\mu\partial_\mu = \sigma^0\partial_0 - \sigma^1\partial_1 - \sigma^2\partial_2 - \sigma^3\partial_3;$$

σ is Pauli's matrices; * is Hermite conjugate),
where the field of left-handed $a-on$ a_L is the doublet as.

$$a_L^* = [a(up)_L^* a(down)_L^*]$$

Since $b-on$ has chiral symmetry, the corresponding Lagrangian density also has chiral symmetry. It is described as

$$L_b = b(down)^* i\sigma^\mu(\partial_\mu + (ig'/2)B_\mu)b(down)$$

The total Lagrangian density for left-handed lepton is the sum of these Lagrangian density.

$$L_L = L_{aL} + L_b.$$

Setting the quartet l_L as

$$l_L^* = [a(up)_L^* a(down)_L^* 0 b(down)^*]$$

[1]E-mail: tiddler2@bigpond.com

the Lagrangian density L_L is described with l_L as

$$L_L = l_L^* i g^\mu (\partial_\mu - (ig/2)\sigma \cdot \mathbf{A}_\mu + (ig'/2)B_\mu) l_L .$$

This expression coincides with the ordinary Lagrangian density for left-handed lepton on the standard model formally [2]. Now the electron is supposed to be composed of down-$a-on$ and down-$b-on$. The interaction terms of Lagrangian density for left-handed electron are

$$L_{eL} = (-1/2)a(down)_L^* g\sigma^\mu A_\mu^3 a(down)_L + \\ +(-1/2)b(down)^* g'\sigma^\mu B_\mu b(down).$$

Using the expressions of weak bosons with the field A_μ and B_μ such as

$$W_\mu^- = 2^{0.5}(A_\mu^1 + iA_\mu^2), W_\mu^+ = 2^{0.5}(A_\mu^1 - iA_\mu^2);$$

$$Z_\mu = (g^2 + g'^2)^{-0.5}(-gA_\mu^3 + g'B_\mu), A_\mu = \\ = (g^2 + g'^2)^{-0.5}(g'A_\mu^3 + gB_\mu)$$

the above L_{eL} is rewritten as

$$L_{eL} = (-1/2)gg'(g^2 + g'^2)^{-0.5}\{a(down)_L^* \sigma^\mu A_\mu \times \\ \times a(down)_L + b(down)^* \sigma^\mu A_\mu b(down)\} + \\ +(-1/2)(g^2 + g'^2)^{-0.5}\{-a(down)_L^* g^2 \sigma^\mu Z_\mu \times \\ \times a(down)_L + b(down)^* g'^2 \sigma^\mu Z_\mu b(down)\}.$$

Physically the term L_{eL} indicates that the electric interaction of down-$a-on$ in the electron has the same strength as that of down-$b-on$ but their interaction causes repulsion. That effect is reasonable because both of down-$a-on$ and down-$b-on$ have the same electric charge $-(1/2)e$. It also indicates that the strength of weak interaction of down-$a-on$ in the electron is different from that of down-$b-on$ but their interaction causes attraction, and it is mediated by Z boson. When down-$a-on$ and down-$b-on$ are very close, it is thought that the attraction mediated by Z boson is much stronger than electric repulsion between them due to the reason discussed later. And that electric repulsion energy between down-$a-on$ and down-$b-on$ in the electron is stored as "binding energy," or converted to the rest mass of electron as shown later.

Since both of left-handed and right-handed electrons have the same mass, it is thought that the electric interaction of $a-on$ and $b-on$ in the right-handed electron is the same as left-handed one. As discussed later, since the difference of masses among generations is caused from the individual eigenstates under the weak interaction mediated by Z boson, it is thought that the weak interaction of $a-on$ and $b-on$ in the right-handed electron is also the same as left-handed one. Consequently the interaction terms for $a-on$ and $b-on$ in the right-handed electron is supposed to be described as

$$L_{eR} = (-1/2)gg'(g^2 + g'^2)^{-0.5} \times \\ \times\{a(down)_R^* \sigma^\mu A_\mu a(down)_R + b(down)^* \times \\ \times \sigma^\mu A_\mu b(down)\} + (-1/2)(g^2 + g'^2)^{-0.5} \times \\ \times\{-a(down)_R^* g^2 \sigma^\mu Z_\mu a(down)_R + b(down)^* \times \\ \times g'^2 \sigma^\mu Z_\mu b(down)\}.$$

Thus the interaction terms of Lagrangian density for right-handed $a-on$ are,

$$L_{aR} = (1/2)\{a(up)_R^* g\sigma^\mu A_\mu^3 a(up)_R\} - \\ -(1/2)\{a(down)_R^* g\sigma^\mu A_\mu^3 a(down)_R\}.$$

3. Second spontaneous break of symmetry

Neutrino is supposed to be composed of up-$a-on$ and down-$b-on$. The interaction terms of Lagrangian density for neutrino are,

$$L_{nL} = (1/2)a(up)_L^* g\sigma^\mu A_\mu^3 \times \\ \times a(up)_L + (-1/2)b(down)^* g'\sigma^\mu B_\mu b(down) = \\ = (1/2)gg'(g^2 + g'^2)^{-0.5}\{a(up)_L^* \sigma^\mu A_\mu \times \\ \times a(up)_L - b(down)^* \sigma^\mu A_\mu b(down)\} + \\ +(-1/2)(g^2 + g'^2)^{-0.5}\{a(up)_L^* g^2 \sigma^\mu Z_\mu \times \\ \times a(up)_L + b(down)^* g'^2 \sigma^\mu Z_\mu b(down)\}.$$

Since up-$a-on$ and down-$b-on$ have the electric charges $+e/2$ and $-e/2$ respectively, it is reasonable that the electrical interaction terms in the above expression indicates the attraction between up-$a-on$ and down-$b-on$. However the weak interaction terms in the above expression indicate repulsion between them. Now it is necessary to introduce the "second" spontaneous break of symmetry. This spontaneous break of symmetry occurs in Lorentz space, not in the inner space where gauge transformation is applied [3], owing to the mass of gauge boson. Namely if the second spontaneous break of symmetry occurred on the coordinate, say x_2, the field of mhon ψ is expressed around the ground state of potential as

$$\psi = \psi(t, x_1, x_2 - \lambda, x_3),$$

where λ is a constant and the point (0, λ , 0) in the space is the locally ground point on the potential. When there is the second spontaneous break of symmetry happening, it is suggested that the local interaction

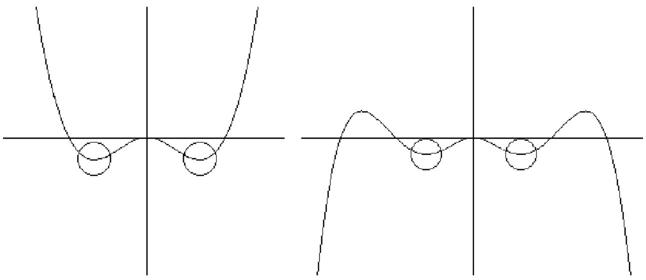


Figure 1: The examples of potential

around the ground state is always attraction even if the global potential indicates the repulsion. The following figures show the examples of potential. The left and right figures are the potentials of attraction and repulsion having second spontaneous break of symmetry respectively. The regions encircled are the locally minimal states causing attraction.

An analogy is also suggestive. When pushing an elastic stick which stands vertically on the desk, it settles the stablest state which breaks the rotational symmetry. Any small displacement around that stablest state causes the setting back force. That setting back force is interpreted as attraction when the repulsion is represented by the elasticity of that stick.

Another significant feature on the second spontaneous break of symmetry is that attraction around the ground state affects only one dimensionally. This is derived from the fact that the second spontaneous break of symmetry still keeps the symmetry of potential under the rotation around the global origin. Namely the potential changes locally along only the direction to the global origin. For example, it is easily confirmed that the gradient of the potential $V = -(x_1^2 + x_2^2 + x_3^2) + (x_1^2 + x_2^2 + x_3^2)^2$ on the ground point (0, $2^{-0.5}$, 0) is null except x_2-component. Since the quantization of field is applied around the ground point of potential, the vibration of harmonic oscillator on that point does not propagate except the direction x_2.

4. The feature of potential in lepton

Now the current-current interaction of down-$a-on$ and down-$b-on$ is calculated under the supposition that the second spontaneous break of symmetry has happened on the weak interaction mediated by Z boson in the electron. From the interaction terms of Lagrangian density for electron, it is expressed in energy-momentum space as

$$H_{eL/R} = -(e^2/4)a(down)^*_{L/R}\sigma^\mu \times$$
$$\times a(down)_{L/R}(1/k^2)b(down)^*\sigma^\mu b(down)-$$
$$-(e^2/4)a(down)^*_{L/R}\sigma^\mu a(down)_{L/R}\times$$
$$\times[(g_{\mu\nu} - k_\mu k_\nu \cdot M_Z^{-2})/(k^2 - M_Z^2)]\times$$
$$\times b(down)^*\sigma^\nu b(down)$$
$$(\Leftarrow g^2 g'^2/(g^2 + g'^2) = e^2)$$
$$= -(e^2/4)a(down)^*_{L/R}\sigma^\mu a(down)_{L/R}\times$$
$$\times(1/k^2)b(down)^*\sigma^\mu\times$$
$$\times b(down) - (e^2/4)a(down)^*_{L/R}\sigma^\nu a(down)_{L/R}\times$$
$$\times[1/(k^2 - M_Z^2)]b(down)^*\sigma^\nu b(down)$$
$$(\Leftarrow k_\nu b(down)^*\sigma^\nu = 0 \ since \ b(down)^*$$
$$satisfies \ Weyl \ equation)$$
$$= -(e^2/4)a(down)^*_{L/R}\sigma^\mu a(down)_{L/R}(1/k^2)\times$$
$$\times b(down)^*\sigma^\mu b(down) - (e^2/4)a(down)^*_{L/R}\times$$
$$\times\sigma^\nu a(down)_{L/R}[sgn \cdot \tau^{-2}/(k_{(0)}^2 - k_{(j)}^2 - M_Z^2)]\times$$
$$\times b(down)^*\sigma^\nu b(down)$$
$$(\Leftarrow only(0) - and \ (j) - component \ of$$
$$energy - momentum \ k \ survived \ due \ to$$
$$the \ second \ spontaneous \ break \ of \ symmetry.$$
$$sgn \ is \ a \ constant \ depending \ on \ whether\times$$
$$the \ global \ interaction \ is \ attraction\times$$
$$orrepulsion. Inthiscasesgn = -1),$$

where M_Z is the mass of Z boson (unit: m^{-1}). τ^2 is thought to be the extent of Z boson. Down-$a-on$ and down-$b-on$ in the electron are regarded as connected by a "string" which has the extent of Z boson. Here τ^2 is called T-area.

Next the expression of current-current interaction $H_{eL/R}$ is transformed into Lorentz space. We suppose it doesn't depend on time. Then it is expressed as

$$H_{eL/R} = \int d^4 k e^{ikx} H_{eL/R} =$$
$$= -(e^2/4)a(down)^*_{L/R}\sigma^\mu a(down)_{L/R}\times$$
$$\times(4pr)^{-1}b(down)^*\sigma^\mu b(down) - (e^2/4)\times$$
$$\times a(down)^*_{L/R}\sigma^\nu a(down)_{L/R}(2\tau^2 M_Z)^{-1}\times$$
$$\times exp(-M_Z|x_{(j)}|)b(down)^*\sigma^\nu b(down)$$
$$(\Leftarrow remark(1)).$$

The above expression indicates the potential of weak interaction mediated by Z boson has the form: $-exp(-M_Z|x-y|)$ where $|x-y|$ is the distance of down-$a-on$ and down-$b-on$ in the electron. Since potential has the physical meaning in its relative difference, it can be rewritten as $V = (e^2/4)(2\tau^2 M_Z)^{-1}\{1 - exp(-M_Z r)\}$, where $r = |x-y|$. The following figure is the illustration of that potential.

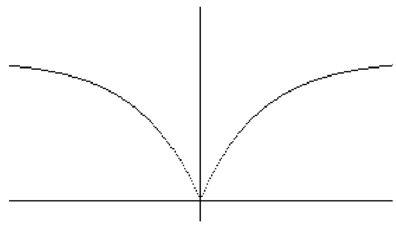


Figure 2: The illustration of that potential

5. Eigenstates of mhons in lepton

Although $a-on$ and $b-on$ are not recognized as particles as mentioned before, it is thought their kinetic motions are still described with conventional physical laws, i.e. the energy E and momentum p of $a-on$ and $b-on$ satisfy the following equation in the free state.

$$E^2 = p^2 (\Leftarrow mhon\ (a-on/b-on)\ doesn't have rest mass)$$

However in electron, down-$a-on$ and down-$b-on$ are combined with the potential V. Thus the above equation is modified as

$$E^2 = p^2 + V^2.$$

Supposing the condition of down-$a-on$ and down-$b-on$ doesn't depend on time and transforming the coordinates so as to put down-$b-on$ on the origin of potential, the down-$a-on$ in electron satisfies the following equation.

$$p(x_{(j)})^2 + V(|x_{(j)}|)^2 = E^2,$$

where E is constant. Quantizing the equation, we get the following Schroedinger-type equation

$$-(h/2\pi)^2 c^2 \cdot d^2\phi(x)/dx^2 + V^2\phi(x) =$$

$$= E^2\phi(x)(\Leftarrow p \ \rightarrow i(h/2\pi)c \cdot d/dx),$$

where $\phi(x)^* = [\phi_1(x)^*\phi_2(x)^*]$ is the wave function of down-$a-on$. Since ϕ_1 and ϕ_2 are the independent solutions for the above equation, we choose one of these solutions and write it as ϕ from now on. It should be noticed although ϕ is the function of the distance from down-$b-on$ which resides on the origin, down-$a-on$ has the certain extent equivalent to T-area on the plane which is vertical to the direction to down-$b-on$, or the origin of potential.

So far the effect of electrical interaction between down-$a-on$ and down-$b-on$ in the electron has been neglected in the previous discussion. It is shown later the electrical effect is relatively smaller than that of weak interaction, however that electrical effect between down-$a-on$ and down-$b-on$ generates the mass of lepton and the difference of masses among generations is directly linked to the eigenstates appearing on the above equation.

We apply WKB method to solve the eigenvalue problem for the above equation. Firstly the above equation is rewritten as

$$d^2\phi/dx^2 + (h/2\pi)^{-2}c^{-2}(E^2 - V^2)\phi = 0$$

then WKB requires the following equation should be satisfied.

$$\int_A^B dx(h/2\pi)^{-1}c^{-1}(E^2 - V^2)^{0.5} =$$

$$= (n + 1/2)\pi (n = 0, 1, 2, ...)$$

where $E = V$ when $x = A$ and B. Approximating V as

$$V \cong (e^2/4)(2\tau^2 M_Z)^{-1} M_Z x$$

we get (approximative) energy eigenvalue E_n as

$$E_n = \{2(h/2\pi)ce^2(8\tau^2)^{-1}(n + 1/2)\}^{0.5} \qquad (1)$$

Now we set following suppositions.

1. Total of generations are three.

2. Mass of lepton is caused from electrical repulsion between down-$a-on$ and down-$b-on$.

If a particle belonging to the forth generation is found, the following calculations should be altered. The second supposition implies the mass of not only lepton but also quark is caused from electrical repulsion between more fundamental substances in it. From the above suppositions, it is guessed the electron corresponds to the eigenstate which has the energy E_2. Roughly supposing that the down-$a-on$ resides on the position r, where $E_2 = V$, i.e.

$$E_2 = (e^2/4)(2\tau^2 M_Z)^{-1}\{1 - exp(-M_Z r)\} \qquad (2)$$

(r is distance between down-$a-on$ and down-$b-on$) the potential of electrical repulsion between down-$a-on$ and down-$b-on$ is calculated with that r as

$$P_e = (e/2)^2(4\pi r)^{-1}.$$

From the second supposition shown above, P_e is just equivalent to the mass of electron, i.e.

$$M_e = P_e \qquad (3)$$

In the equations (1) and (2) the unknown parameter is only τ, therefore from the equation (3) we can calculate the concrete value of τ using the actual mass of electron. The result is

$$\tau = 1.016 \times 10^{-19} m (\Leftarrow remark(2))$$

namely the T-area is

$$T - area = \tau^2 = 1.032 \times 10^{-38} m^2.$$

Using this value the mass of muon is calculated. Since muon is thought to correspond to the eigenstate which has the eigenvalue of energy E_1, the following equations should be satisfied.

$$E_1 = (e^2/4)(2\tau^2 M_Z)^{-1}\{1 - exp(-M_Z r')\};$$

$$P_m = (e/2)^2 (4\pi r')^{-1};$$

$$M_m = P_m,$$

where r' is the distance between down-$a - on$ and down-$b - on$ in muon and it is calculated from the first equation shown above using T-area. The result is

$$M_m = 113.69 \text{ MeV},$$

which is relatively close to the experimental value: 105.7 MeV. However when calculating the mass of tauon with similar way, the result is considerably different from experimental value. When supposing down-$a - on$ in tauon is on E_0 state, the calculated mass of tauon is

$$M_t = 285.62 \text{ MeV}$$

and the mass of tauon obtained from experiment is 1784 MeV. That difference is thought to be caused from the previous rough approximation about the position of down-$a - on$ in the lepton, i.e. down-$a - on$ has been supposed to reside on the position where $E = V$. However obviously the distribution of down-$a - on$ varies continuously following the previously mentioned Schroedinger-type equation:

$$-(h/2\pi)^2 c^2 \cdot d^2\phi/dx^2 + V^2\phi = E^2\phi. \quad (4)$$

In the cases of electron and muon, the peaks of distribution are certainly seen around the position where $E = V$ as shown in the following figures. However in the case of tauon, since E_0 state is in "zero-point vibration," the peak of distribution is seen at the center of potential as shown in the following figure, not the position where $E_0 = V$. Therefore the effect of electrical repulsion should be considered much more than that of previous calculation.

As known from calculating the eigenvalue using the equation (1), the potential of weak interaction mediated by Z boson is very deep. Even in the base state the energy eigenvalue E_0 is around 180 Gev, which is almost twice mass of Z boson. Hence the influence of electrical repulsion between down-$a - on$ and down-$b - on$ in lepton to the energy eigenvalue is almost negligible.

As previously mentioned, neutrino is thought to be composed of up-$a - on$ and down-$b - on$. Since the electrical charge of up-$a - on$ and down-$b - on$ are $+e/2$ and $-e/2$ respectively, there is an electrical attraction between them. In the case of ν_e, the attraction has the same strength of the repulsion between down-$a - on$ and down-$b - on$ in electron. However that attraction is thought to be canceled out with the centrifugal force between up-$a - on$ and down-$b - on$ in neutrino. Consequently there isn't any mass observed for neutrino. However in the viewpoint of quantum field theory, the current-current interaction discussed above is regarded as the first-order approximation of perturbation on the Hamiltonian including interaction. When the second or higher order approximation is considered, neutrino may have its original mass.

6. Consistency of mhons with Dirac equation

Relativistic motion of electron interacting with electromagnetic field is described with Dirac equation. Therefore the model of electron described above should be consistent with Dirac equation under the influence of electromagnetic field. In this case the weak interaction is not considered in Lagrangian form. Namely the Lagrangian density for down-$a - on$ and down-$b - on$ are simplified as

$$L_{down-a} = a(down)^* i\sigma^\mu(\partial_\mu + i(g/2)A_\mu)a(down);$$

$$L_{down-b} = b(down)^* i\sigma^\mu(\partial_\mu + i(g/2)A_\mu)b(down)$$

since electric interaction has chiral symmetry, the symbols L and R are omitted. The total Lagrangian density for electron should include the interaction term derived from weak interaction between down-$a - on$ and down-$b - on$. As described above, the electric interaction is negligibly smaller than weak interaction in electron, therefore that interaction term should be almost independent from electric interaction, i.e. it is written as

$$L_{int} = a(down)^* M b(down) - b(down)^* M a(down),$$

where M corresponds to the electric potential energy between down-$a - on$ and down-$b - on$ in electron and it is equivalent to the rest mass of electron. Thus the total Lagrangian density for electron is

$$L_{electron} = L_{down-a} + L_{down-b} + L_{int}.$$

Solving the equation

$$\delta \int d^4x L_{electron} = 0$$

we get

$$i\sigma^\mu(\partial_\mu + i(g/2)A_\mu)a(down) + M b(down) = 0; \quad (5)$$

$$i\sigma^\mu(\partial_\mu + i(g/2)A_\mu)b(down) - M a(down) = 0. \quad (6)$$

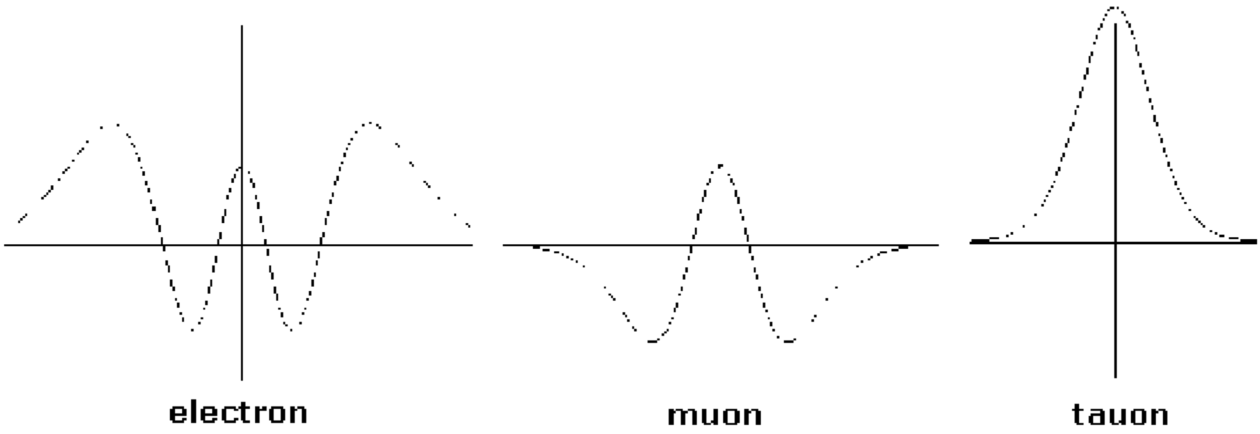


Figure 3: Wave functions for down-$a-on$ in electron, muon, and tauon

$(H.C.)$

Let 4-component field ψ as

$$\psi^* = [a(down)_1^* a(down)_2^* b(down)_1^* b(down)_2^*]$$

then from the equations (5) and (6), we know ψ satisfies following equation,

$$\gamma^\mu(\partial_\mu + i(g/2)A_\mu)\psi + M\psi = 0,$$

where γ^μ is Dirac's matrix. This equation is modified by appropriate gauge transformation as

$$\gamma^\mu \partial_\mu \psi' + M\psi' = 0$$

This is just Dirac equation. Next we consider to express the spin of electron using down-$a-on$ and down-$b-on$ in the electron. Since the constant M appeared in (5) and (6) has the unit: m^{-1}, we rewrite M with the rest mass of electron M_e as

$$M = M_e c/(h/2\pi).$$

The coupling constant g is expressed as $e/\{(h/2\pi)c\}$, therefore the equation (5) and (6) are rewritten as

$$i\sigma^\mu(\partial_\mu + ie/\{2(h/2\pi)c\}A_\mu)a(down)+$$
$$+\{M_e c/(h/2\pi)\}b(down) = 0; \tag{7}$$
$$i\sigma^\mu(\partial_\mu + ie/\{2(h/2\pi)c\}A_\mu)b(down)-$$
$$-\{M_e c/(h/2\pi)\}a(down) = 0. \tag{8}$$

Since $a(down)$ and $b(down)$ are the solutions of the same Dirac equation, they have the same energy if they have positive energy. Now the gauge field A_μ is supposed to be independent from time, and $a(down)$ and $b(down)$ are supposed to be expressed as

$$a(down)(\mathbf{x},t) = a(down)(\mathbf{x},t=0)\times$$
$$\times exp\{-iEt/(h/(2\pi))\};$$
$$b(down)(\mathbf{x},t) = b(down)(\mathbf{x},t=0)\times$$
$$\times exp\{-iEt/(h/(2\pi))\}$$

then the equations (7) and (8) are rewritten as

$$i\sigma^k(\partial_k + ie/\{2(h/2\pi)c\}\mathbf{A}_k)a(down)+$$
$$+\{E/((h/2\pi)c) + e\phi/((h/2\pi)c)+$$
$$+M_e c/(h/2\pi)\}b(down) = 0; \tag{9}$$
$$i\sigma^k(\partial_k + ie/\{2(h/2\pi)c\}\mathbf{A}_k)b(down)+$$
$$+\{E/((h/2\pi)c) + e\phi/((h/2p)c)-$$
$$-M_e c/(h/2\pi)\}a(down) = 0, \tag{10}$$

where A_k and ϕ are vector potential and scalar potential respectively. Supposing

$$E = M_e c^2 + E^{NR}|E^{NR}|, |e\phi| << M_e c^2$$

the equation (10) is modified with the above approximations as

$$a(down) \cong -\{i(h/2\pi)/(2M_e c)\}\sigma^k\{\partial_k+$$
$$+ie\mathbf{A}_k/(2(h/2\pi)c)\}b(down).$$

Substituting $a(down)$ in the equation (8) with the above expression, we get

$$[-\{(h/2\pi)^2/(2M_e)\}\{\partial_k + ie\mathbf{A}_k/(2(h/2\pi)c)\}^2+$$
$$+\{e(h/2\pi)/(4M_e c)\}\sigma^k B_k - e\phi]b(down) =$$
$$= E^{NR} b(down)$$

$$(\Leftarrow formula: (\sigma^k a_k)(\sigma^j b_j) = a_l b_l + i\sigma^l(\mathbf{a}\times\mathbf{b})_l)$$

Applying appropriate gauge transformation, it is modified as

$$[-\{(h/2\pi)^2/(2M_e)\}\partial^k\partial_k+$$
$$+\{e(h/2\pi)/(4M_e c)\}\sigma^k B_k-$$
$$-e\phi]b(down)=E^{NR}b(down).$$

Physically this equation means the $b(down)$ has the magnetic moment $-e(h/2\pi)/(4M_e c)$ under the Coulomb potential $-e\phi$ and magnetic field B. Similarly it is shown that $a(down)$ also has the magnetic moment $-e(h/2\pi)/(4M_e c)$. Therefore the total magnetic moment is $-e(h/2\pi)/(2M_e c)$ and it is equivalent to that of electron.

Remarks

1. The first term is conventional electrical interaction.

To induce the second term, we consider the following equation.

$$d^2V/dx^2 - M_Z^2 V = (e^2/4)\tau^{-2}\delta(x).$$

This is an ordinary differential equation for the Green function V. Applying Fourier transformation on it, we get,

$$v(k) = -(2\pi)^{-1}\int dx e^{-ikx}V(x) =$$
$$= -(e^2/4)\tau^{-2}(2\pi)^{-1}(k^2+M_Z^2)^{-1}.$$

Hence,

$$V(x) = -(e^2/4)\tau^{-2}(2\pi)^{-1}\int_{-\infty}^{\infty} dk e^{ikx}(k^2+M_Z^2)^{-1}.$$

There is only one pole on the upper half-plane for $e^{ikx}(k^2+M_Z^2)^{-1}$, and its residue is $exp(-M_Z x)/(2iM_Z)$, therefore we calculate the above $V(x)$ with Cauchy's residue theorem as

$$V(x) = -(e^2/4)\tau^{-2}(2\pi)^{-1}(2\pi i)\times$$
$$\times exp(-M_Z x)/(2iM_Z) = -(e^2/4)\tau^{-2}\times$$
$$\times exp(-M_Z x)/(2M_Z).$$

2. Practically τ is calculated from equations (1), (2), and (3) as

$$\tau = (e/4M_Z)\cdot((h/2\pi)c)^{-0.5}(2+1/2)^{-0.5}\times$$
$$\times\{1-exp(-e^2M_Z/16\pi M_e)\},$$

where $M_Z = 92900$ MeV $\cdot c/(h/2\pi) = 4.708\times 10^{17}[m^{-1}]$ and $M_e = 0.511$ MeV.

References

[1] H. Weyl, "Electron und Gravitation," *Z. f. Phys.*, **56**, 330 (1929).

[2] S. Weinberg, "Recent Progress in the Gauge Theories of the Weak, Electromagnetic and Strong Interactions," *Rev. Mod. Phys.*, **46**, 255 (1974).

[3] Y. Nambu and G. Jona-Lasinio, *Phys. Rev.*, **112**, 345–358 (1961).

Spacetime & Substance, Vol. 5 (2004), No. 1 (21), pp. 17–22

THE SPACE-TIME TRANSFORMATIONS AND MAXIMUAL ACCELERATION

Miroslav Pardy[1]

Institute of Plasma Physics ASCR, Prague Asterix Laser System, PALS, Za Slovankou 3, 182 21 Prague 8, Czech Republic;
Department of Physical Electronics Masaryk University, Kotlářská 2, 611 37 Brno, Czech Republic

Received June 18, 2003

We determine nonlinear transformations between coordinate systems which are mutually in a constant accelerated motion. In case of the symmetrical constant mutual acceleration, we immediately get the maximal acceleration limit which was derived by Caianiello from quantum mechanics. Maximal acceleration is an analogue of maximal velocity in special relativity. We discuss the possible verification of derived formulae by the measurement with ultracentrifuge. It is argued that the derived results can play crucial role in modern particle physics and cosmology.

1. Introduction

The problem of acceleration of charged particles or systems of particles is the permanent and the most prestige problem in the accelerator physics. Particles can be accelerated by different ways. Usually by the classical electromagnetic fields, or, by light pressure of the laser fields [1], [2], [3], [4], [5] and [6]. The latter method is the permanent problem of the laser physics for many years.

However, the theoretical problem is not only to find the mechanisms of acceleration but also the space-time relations between systems which are mutually in the accelerated motion. The uniformly accelerated systems are well known, also the rotating systems represented for instance by the centrifuges are also known and theoretically investigated by many authors.

Here, we determine transformations between coordinate systems which moves mutually with acceleration. We determine transformations between nonrelativistic and relativistic uniformly accelerated systems. We derive also some consequences following from the nonlinearity of motion of these systems.

We show that the transformation laws between accelerated systems can be derived from the infinitesimal Lorentz transformation on the one hand, or, by postulation some kinematical symmetries between these systems on the other hand. These two approaches give different results. In the case of the first approach which is based on the original Lorentz transformation, the derived results can be taken for sure-footed.

We do not consider in this article the problem of accelerated strings, which is solved for instance by Bachas [7] because string theory is under permanent development and according to Witten [8] it is not in the final form.

[1]E-mail: pamir@physics.muni.cz

2. The infinitesimal form of the Lorentz transformation

We know, that the Lorentz transformation between two inertial coordinate systems $S(0,x,y,z)$ and $S'(0,x',y',z')$ (where system S' moves in such a way that x-axes converge, while y and z-axes run parallel and at time $t=t'=0$ for the beginning of the systems O and O' it is $O\equiv O'$) is as follows:

$$x' = \gamma(v)(x - vt), \quad y' = y,$$
$$z' = z', \quad t' = \gamma(v)\left(t - \frac{v}{c^2}x\right), \tag{1}$$

where

$$\gamma(v) = \left(1 - \frac{v^2}{c^2}\right)^{-1/2}. \tag{2}$$

The infinitesimal form of this transformation is evidently given by differentiation of the every equation. Or,

$$dx' = \gamma(v)(dx - vdt), \quad dy' = dy,$$
$$dz' = dz, \quad dt' = \gamma(v)\left(dt - \frac{v}{c^2}dx\right). \tag{3}$$

If we put $dt = 0$ in the first equation of system (3), then the Lorentz length contraction follows in the infinitesimal form $dx' = \gamma(v)dx$. Or, in other words, if in the system S' the infinitesimal length is dx', then the relative length with regard to the system S is $\gamma^{-1}dx'$. Similarly, from the last equation of (3) it follows the time dilatation for $dx = 0$. Historical view on this effect is in the Selleri article [9].

If the velocity depends on time, which is for instance in the case of the nonlinear motion, then we write

$$dx' = \gamma(v(t))(dx - v(t)dt), \quad dy' = dy,$$

$$dz' = dz, \quad dt' = \gamma(v(t))\left(dt - \frac{v(t)}{c^2}dx\right). \tag{4}$$

This infinitesimal form enables the integration and if we know the dependence of v on time, then there is no obstacles to get the Lorentz-like transformation between two nonlinear systems. At the same time the transformations (4) does not change the so called Minkowski metric element, the square of which is

$$ds^2 = c^2dt^2 - dx^2 - dy^2 - dz^2. \tag{5}$$

The Lorentz transformation for coordinates and time referring to two inertial systems harbours the assumption that the following expression holds good: $(x = ct) \iff (x' = ct')$, where the invariant function $x = ct$ being considered in the special theory of relativity as the mathematical expression of the principle of constant light velocity. From the mathematical point of view the relation is the formal mathematical requirement for unambiguous determination of the Lorentz transformation and it follows from the theory of the continuous group of transformations [10]. The physical meaning of ds is usually defined as a distance between two infinitesimal events, however, some authors consider ds as a formal mathematical object with no physical meaning [11].

3. Uniformly accelerated systems

According to Einstein [12], Fok [13] and Logunov [14], space and time, or, space-time is a form of the existence of matter. To study space-time means to study form of the existence of matter. Special theory of relativity investigates behavior of matter and fields in case of the inertial systems in the inertial motion. The behavior of space-time in case that the systems are mutually or individually accelerated is investigated here.

Let us suppose that in the finite time interval the system S' is accelerated by the constant acceleration in such a way that the motion is nonrelativistic one. So, for the velocity of the system S' we have $v = at$ and from the equations (4) we have for the infinitesimal Lorentz transformation:

$$dx' = \gamma(at)(dx - atdt), \quad dy' = dy,$$

$$dz' = dz, \quad dt' = \gamma(at)\left(dt - \frac{at}{c^2}dx\right), \tag{6}$$

where

$$\gamma(at) = \left(1 - \frac{a^2t^2}{c^2}\right)^{-1/2}. \tag{7}$$

After integration of equation (6) we get for the coordinate and time components:

$$x' = x\left(1 - \frac{a^2t^2}{c^2}\right)^{-1/2} - a\int tdt\left(1 - \frac{a^2t^2}{c^2}\right)^{-1/2} =$$

$$= x\left(1 - \frac{a^2t^2}{c^2}\right)^{-1/2} + \frac{c^2}{a}\left(1 - \frac{a^2t^2}{c^2}\right)^{1/2} \tag{8}$$

and

$$t' = \frac{c}{a}\arcsin\left(\frac{at}{c}\right) - x\frac{at}{c^2}\left(1 - \frac{a^2t^2}{c^2}\right)^{-1/2}. \tag{9}$$

In case of the relativistic motion of a body with mass m which is caused by the action of the constant force F on this body, the dependence of velocity on time is [15]

$$v = \frac{at}{\sqrt{1 + \left(\frac{at}{c}\right)^2}}. \tag{10}$$

Then, the relativistic coefficient $\gamma(v)$ is given by the relation

$$\gamma(v) = \left(1 + \frac{a^2t^2}{c^2}\right)^{1/2}. \tag{11}$$

In this situation we get for the coordinate and time transformation:

$$x' = x\left(1 + \frac{a^2t^2}{c^2}\right)^{1/2} - a\int tdt =$$

$$= x\left(1 + \frac{a^2t^2}{c^2}\right)^{1/2} - \frac{a}{2}t^2 \tag{12}$$

and

$$t' = \frac{1}{2ac}\left[at\sqrt{a^2t^2 + c^2} + \right.$$

$$\left. + c^2 \operatorname{arg\,sinh}\left(\frac{at}{c}\right)\right] - x\frac{at}{c^2}, \tag{13}$$

where $\operatorname{arg\,sinh}(at/c)$ can be expressed in the logarithmic form according to he following formula:

$$\operatorname{arg\,sinh}\left(\frac{at}{c}\right) = \ln\left[\left(\frac{at}{c}\right) + \sqrt{\left(\frac{at}{c}\right)^2 + 1}\right]. \tag{14}$$

Let us remark, that the problem of transformations between nonlinear systems was also discussed by Møller [16] and Fok [13]. The transformations derived by Møller are not identical with ones derived by us. According to Fok, the nonlinear transformation of space-time is as follows:

$$x' = x\cosh\left(\frac{at}{c}\right) - \frac{c^2}{a}\left(\cosh\left(\frac{at}{c}\right) - 1\right) \tag{15a}$$

and

$$t' = \frac{c}{a}\sinh\left(\frac{at}{c}\right) - \frac{x}{c}\sinh\left(\frac{at}{c}\right). \tag{15b}$$

The trasnformations between system S and uniformly accelerated system S' was also derived by Logunov [14], but in the substantially different form:

$$x' = x\frac{c^2}{a}\left[\sqrt{1+\frac{a^2t^2}{c^2}} - 1\right]; \quad t' = t, \tag{16}$$

where equation $t' = t$ can be chosen according to Logunov as a meaningful logical step. The Logunov approach is not still in the final form.

The transformations derived in [16] reduces for

$$\frac{at}{c} \ll 1 \tag{17}$$

to the Galileo transformation in the form

$$x' = x - \frac{1}{2}at^2; \quad t' = t. \tag{18}$$

After insertion of transformation (15) into space-time element (4), we get:

$$ds^2 = \left(c - \frac{ax}{c}\right)^2 dt^2 - dx^2 - dy^2 - dz^2, \tag{19}$$

which is approximately (for $|ax| \ll c^2$) the same as the square of the space-time element in the homogenous gravitational potential $U = ax$. It means that the uniformly accelerated system forms some analogue with the homogenous gravitational field. The analogy is usually defined as the principle of equivalence.

However, the principle of equivalence can be easily derived from the special theory relativity from the well known relation $E = mc^2$. This relation means that to every mass corresponds energy. And the energy has the same inertion in the arbitrary acceleration field. It means, there is no difference between gravitational and inertional mass. So, the principle of equivalence between inertial and gravitational mass follows from the Einstein relation $E = mc^2$. From this proof it follows, that no future experiment will reveal the difference between inertial and gravitational mass. To our knowledge, this elementary theorem was not published in any journal. What is then the meaning of experiments looking for such difference. The aswer is very simple. The experiment represent the technological virtuosity, which is important for progressive development of society. Similarly, string theory represents the mathematical virtuosity which is very important for the development of physical sciences.

We can say, that there is some different nonequivalent possibilities in the derivation of the transformations for nonlinearly moving systems. It signalizes that the theory of the space-time transformation between nonlinear systems is not in the definite form.

The inverse transformations to the derived ones are evidently of the different form (excepting the Logunov transformation) than the original transformations. We show, In the following section that it is possible to find such transformations between coordinates and time, that they are symmetrical. The physical meaning of such transformation is open.

4. Uniformly accelerated frames with space-time symmetry

Let us take two systems $S(0,x,y,z)$ and $S'(0,x',y',z')$, where system S' moves in such a way that x-axes converge, while y and z-axes run parallel and at time $t = t' = 0$ for the beginning of the systems O and O' it is $O \equiv O'$. Let us suppose that system S' moves relative to some basic system B with acceleration $a/2$ and system S' moves relative to system B with acceleration $-a/2$. It means that both systems moves one another with acceleration a and are equivalent because in every system it is possibly to observe the force caused by the acceleration $a/2$. In other words no system is inertial.

Now, let us consider the formal transformation equations between two systems. At this moment we give to this transform only formal meaning because at this time, the physical meaning of such transformation is not known. On the other hand, the consequences of the transformation will be shown very interesting.

We write the transformation equations in the form:

$$x' = a_1x + a_2t^2, \quad y' = y,$$
$$z' = z, \quad t' = \sqrt{b_1x + b_2t^2}, \tag{20}$$

where constants involved in the equations will be determined from the viewpoint of kinematics. Since from the viewpoint of kinematics, both systems are equivalent, for the inverse transformation to the transformation (20) it must hold:

$$x = a_1x' - a_2t'^2, \quad y' = y,$$
$$z' = z, \quad t = \sqrt{-b_1x' + b_2t'^2}. \tag{21}$$

The minus sign with coefficients a_2 and b_1 appearing for the reason that constant a_2 has the rate of acceleration while constant b_1 the rate of inverse value of acceleration.

Similarly, as in inertial systems, the hypothetical requirement can be now expressed that the transformation equations for system moving relative to themselves with acceleration include a suitable invariant function. Let us now define such transformations as follows:

$$x = \frac{1}{2}\alpha t^2, \tag{22a}$$

$$x' = \frac{1}{2}\alpha t'^2, \tag{22b}$$

where α is the constant having the rate of acceleration.

If we now substitute (21) into (20) we obtain

$$x' = x'(a_1^2 - a_2 b_1) + t'^2(a_2 b_2 - a_1 a_2), \tag{23}$$

$$t'^2 = x'(a_1 b_1 - b_1 b_2) + t'^2(b_2^2 - b_1 a_2). \tag{24}$$

After comparing the left and right sides in the relations (23), we get

$$a_1 = b_2, \quad a_1^2 - b_1 a_2 = 1. \tag{25}$$

If we put in the relation (20) $x' = 0$, we obtain $x = -(a_2/a_1)t^2$. In accordance with the assumption the motion of the beginning of the system S' relative to system S is described by the $x = \frac{1}{2}at^2$, we thus obtain

$$a_2 = -\frac{1}{2}a_1 a. \tag{26}$$

From $[x' = (1/2)\alpha t'^2] \Longleftrightarrow [x = (1/2)\alpha t^2]$, we get

$$\frac{\frac{1}{2}\alpha b_2 - a_2}{a_1 - \frac{1}{2}\alpha b_1} = \frac{1}{2}\alpha. \tag{27}$$

Through solving the equations (26) and (27), we obtain

$$a_1 = b_2 = \frac{1}{\sqrt{1 - \frac{a^2}{\alpha^2}}}, \quad a_2 = -\frac{1}{2}\frac{a}{\sqrt{1 - \frac{a^2}{\alpha^2}}},$$

$$b_1 = -\frac{2}{\alpha^2}\frac{a}{\sqrt{1 - \frac{a^2}{\alpha^2}}}. \tag{28}$$

Using (28), we can rewrite the transformation (20) in the definite form:

$$x' = \Gamma(a)(x - \frac{1}{2}at^2), \quad y' = y,$$

$$z' = z, \quad t'^2 = \Gamma(a)\left(t^2 - \frac{2a}{\alpha^2}x\right) \tag{29}$$

with

$$\Gamma(a) = \frac{1}{\sqrt{1 - \frac{a^2}{\alpha^2}}}. \tag{30}$$

Let us remark that the more simple derivation of the last transformation can be obtained if we perform in the Lorentz transformation the elementary change of variables as follows: $t \to t^2, \quad t' \to t'^2, \quad v \to \frac{1}{2}a, \quad c \to \frac{1}{2}\alpha$.

After performing such elementary transition which is practically redenotation of variables, we really get the Lorentz-like transformation (29) between accelerated systems.

The physical interpretation of this nonlinear transformations is the same as in the case of the Lorentz transformation only the physical interpretation of the invariant function $x = (1/2)\alpha t^2$ is open.

However, we know from history, that Lorentz transformation was taken first as physically meaningless by Lorentz himself and later only Einstein decided to put the physical meaning to this transformation and to the invariant function $x = ct$. We hope that the derived transformation will appear as physically meaningful.

Now, let us prove the following assumption. The transformation (29) forms one-parametric group with parameter a. To prove it we must prove by the direct calculations the four requirements involving in the definition of a group. However, we know, that using relations $t \to t^2, \quad t' \to t'^2, \quad v \to \frac{1}{2}a, \quad c \to \frac{1}{2}\alpha$, the nonlinear transformation is expressed as the Lorentz transformation forming the one-parametric group. And this is a proof. Such proof is equivalent to the proof by direct calculation. The integral part of the group properties is the so called addition theorem for acceleration.

$$w_3 = \frac{w_1 + w_2}{1 + \frac{w_1 w_2}{\alpha^2}}. \tag{31}$$

where w_1 is the acceleration of the S' with regard to the system S, w_2 is the acceleration of the system S'' with regard to the system S' and w_3 is the acceleration of the system S'' with regard to the system S.

The relation (31), expresses the law of acceleration addition theorem on the understanding that the events are marked according to the relation (29). In this formula as well as in the transformation equation (29) appears constant α which cannot be calculated from the theoretical considerations, or, from the theory. What is its magnitude and whether there exists such a physical field that is consistent with the designation of the events given by the relations (29) can be established only by experiments. On the other hand the constant α has physical meaning of the maximal acceleration and its meaning is similar to the maximal velocity c in special relativity. The notion maximal acceleration is not new in physics, because Caianiello [17] introduced it as some consequence of quantum mechanics and Landau theory of fluctuations. Revisiting view on the maximal acceleration was given by Papini [18]. At present time it was argued by Lambiase et al. [19] that maximal acceleration determines the upper limit of the Higgs boson and that it gives also the relation which links the mass of W boson with the mass of the Higgs boson. The LHC and HERA experiments probably give the answer to this problem.

5. Dependence of mass on acceleration

If the maximal acceleration is the physical reality, then it should have the similar consequences in a dynamics as the maximal velocity of motion has consequences in the dependence of mass on velocity. We can suppose in analogy with the special relativity that mass depends on the acceleration for small velocities, in the similar way as it depends on velocity in case of uniform motion. Of course such assumption must be experimentally verified and in no case it follows from special theory of relativity, or, general theory of relativity [20]. So, we postulate ad hoc, in analogy with special theory of relativity:

$$m(a) = \frac{m_0}{\sqrt{1-\frac{a^2}{\alpha^2}}}; \quad v \ll c, \quad a = \frac{dv}{dt}. \tag{32}$$

Let us derive as an example the law of motion when the constant force F acts on the body with the rest mass m_0. Then, the Newton law reads [15]:

$$F = \frac{dp}{dt} = m_0\frac{d}{dt}\frac{v}{\sqrt{1-\frac{a^2}{\alpha^2}}}. \tag{33}$$

The first integral of this equation can be written in the form:

$$\frac{Ft}{m_0} = \frac{v}{\sqrt{1-\frac{a^2}{\alpha^2}}}; \quad a = \frac{dv}{dt}, \quad F = const.. \tag{34}$$

Let us introduce quantities

$$v = y, \quad a = y', \quad A(t) = \frac{F^2t^2}{m_0^2\alpha^2}. \tag{35}$$

Then, the quadratic form of the equation (34) can be written as the following differential equation:

$$A(t)y'^2 + y^2 - A(t)\alpha^2 = 0, \tag{36}$$

which is nonlinear differential equation of the first order. The solution of it is of the form $y = Dt$, where D is some constant, which can be easily determined. Then, we have the solution in the form:

$$y = v = \frac{t}{\sqrt{\frac{m_0^2}{F^2} + \frac{1}{\alpha^2}}}. \tag{37}$$

For F $\to \infty$, we get $v = \alpha^2 t$. This relation can play substantial role at the beginning of the big-bang, where the accelerating forces can be considered as infinite, however the law of acceleration has finite nonsingular form. At this moment it is not clear if the dependence of the mass on acceleration can be related to the energy dependence on acceleration similarly to the Einstein relation uniting energy, mass and velocity [21], [20].

6. The rotating systems

According to Einstein, there is an analogy between gravitational fields and noninertial reference system. Therefore, when studying properties of gravitational fields in relativistic mechanics, we can start from this analogy.

The description of the rotation system can be described in the Cartesian coordinate system [15], or, in the more appropriate form using the polar coordinate r, φ [22]. Then, we write

$$x = r\cos(\varphi + \omega t), \quad y = r\sin(\varphi + \omega t). \tag{38}$$

The corresponding space-time element is as follows:

$$ds^2 = \left(1 - \frac{\omega^2 r^2}{c^2}\right)(cdt)^2 - $$

$$-\frac{2\omega r^2}{c}d\varphi(cdt) - dz^2 - dr^2 - r^2 d\varphi^2. \tag{39}$$

We see from the time term in (39) that if we suppose that the velocity of light in the rotating system is constant, then the elapsing of time depends on acceleration.

Although the rotating system cannot be considered as equivalent to the linear accelerated system, nevertheless, the radial component of every part of this system is in the permanent acceleration.

If the element 1 of the rotating plane at the radial coordinate r_1 has acceleration w_1 and if the element of the rotating plane at the radial coordinate r_2 has acceleration w_2, then the relative acceleration w_r of the element 2 with regard to the element 1 is not $w_2 - w_1$, but must be determined according to the formula

$$w_r = \frac{w_2 - w_1}{1 - \frac{w_1 w_2}{\alpha^2}}. \tag{40}$$

The last formula is an analogue of the formula which determines the relative velocities in case of the inertial motion in the special theory of relativity. The last formula is true only if the transversal effect do not influence the radial effects. It can be verified optically, because we know that the optical frequency of the emission source is influenced by acceleration, or, equivalently by the gravitational field.

Similarly, it is possible to verify the dependence of mass on acceleration, also by the ultracentrifuge.

7. Discussion

We have derived transformations between accelerated systems moving mutually uniformly. We have discussed also the rotating systems. We have derived some consequences following from the nonlinearity of motion of these systems. In case, when we used the symmetry principle in derivation of the space-time transformation, we derived by the formal way so called maximal acceleration which was derived using quantum mechanics by Caianiello [17]. Our derivation of the maximal acceleration is not equivalent to the Caianiello derivation and at the same time it is not in the contradiction with his approach because the heuristical ways to the maximal acceleration were substantially different.

If some experiment will confirm the existence of maximal acceleration α, then it will have certainly crucial consequences for Einstein theory of gravity because this theory does not involve this factor. Also the cosmological theories constructed on the basis of the original Einstein equations will require modifications. In such a way, Einstein equations can play a role only in the specific conditions where the maximal acceleration can be neglected. Maximal acceleration does not allow the existence of black holes with arbitrary big mas. Also standard model in particle physics will require generalization because it does not involve the maximal acceleration.

One of the prestige problem in the modern theoretical physics is the Unruh effect, or, the existence of thermal radiation detected by accelerated observer. The theory of the Unruh effect is in the development [23] and the serious statement or comment to the relation of this effect to the maximal acceleration cannot be given.

Let us remark in conclusion that it is possible to extend general relativity in such a way that it includes the maximal acceleration and it is compatible with the strong principle of relativity. The brilliant mathematical form of such extension was given by Schuller [24].

References

[1] A. Ashkin, *Phys. Rev. Lett.*, 24, 156 (1970).

[2] A. Ashkin, *Scientific American*, 226, (2), 63 (1972).

[3] N.B. Baranova, B.Ya. Zel'dovich, *JETP*, 78, (3), 249 (1994).

[4] M. Pardy, *Phys. Lett. A*, 243, 223 (1998).

[5] M. Pardy, *Radiation Physics and Chemistry*, 61, 391 (2001).

[6] M. Pardy, *International J. of Theor. Physics*, 42, No. 1, 99 (2003).

[7] C. Bachas, e-print LPTENS 02/63, hep-th/0212217, (2002).

[8] E. Witten, e-print hep-th/0212247, (2002).

[9] F. Selleri, *Foundations of Physics*, 27, No. 11, 1527 (1997).

[10] L.P. Eisenhart, "Continuous Groups of Transformations," Princeton, (1943).

[11] L. Brillouin, "Relativity Reexamined," Academic Press, New York and London, (1970).

[12] A. Einstein, "Collective Scientific Works," Vol. I, Moscow, (1965) (in Russian).

[13] V.A. Fok, "The theory of Space, Time and Gravity," second edition, GIFML, Moscow, (1961) (in Russian).

[14] A.A. Logunov, "Lectures on the Theory of Relativity and Gravitation," Nauka, Moscow, (1987) (in Russian).

[15] L.D. Landau, E. M. Lifshitz, "The Classical Theory of Fields," 2nd ed., Pergamon Press, Oxford, (1962).

[16] C. Møller, *Works of Denmark Academy of Sciences*, Vol. 2, No. 19, Kobenhavn, (1943).

[17] E.R. Caianiello, *Lett. Nuovo Cimento*, 32, 65 (1981).; ibid. Revista del Nuovo Cimento, No. 4, (1992).

[18] G. Papini, e-print quant-ph/0301142, (2003).

[19] G. Lambiase, G. Papini, G. Scarpetta, e-print hep-ph/9808460, (1998); ibid. Nuovo Cimento B, 114, 189 (1999).

[20] L. B. Okun, *Nucl. Phys. B (Proc. Suppl.)*, 110, 151 (2002).; e-print physics/0111134, (2001).

[21] M. Sachs, *International Journal of Theoretical Physics*, 8, No. 5, 377 (1973).

[22] F. Goy, F. Selleri, e-print gr-qc/9702055, (1997).

[23] A.M. Fedotov, N. B. Narozhny, V. D. Mur, V. A. Belinski, e-print hep-th/0208061, (2002).

[24] F.P. Schuller, *Annals of Physics*, 299, 174 (2002).

Spacetime & Substance, Vol. 5 (2004), No. 1 (21), pp. 23–28

WAVE MECHANICS ON THE BOHR'S COMPACT

S.S. Sannikov-Proskuryakov[1]

Institute for Theoretical Physics, National Science Center "Kharkiv Institute of Physics and Technology," 1 Academicheskaya St., 61108, Kharkiv, Ukraine

Received February 24, 2004

It is demonstrated that oscillator with an infinite small frequency is described by a new quantum mechanics, in which configuration manifold is condensed (continuum endowed by the Bohr's measure). Hereby momentum space is dispersed (discontinuum). Thus the symmetry between both these manifolds taking place in the usual quantum mechanics is completely broken here. The set of wave functions described such a oscillator forms the non-separable Hilbert space. We consider the well known (living) forms of matter stand behind this theory.

PACS: 102.30.Nw+03.65.-w+03.65.Bs+03.65Db

KEY WORDS: continuum, discontinuum, Bohr's compactification, non-separable Hilbert space, biological structures.

1. Introduction

As is known in the Heisenberg-Schroedinger quantum mechanics usual Fourier transformation plays essential role. It is written in the form (one dimensional case is considered now)

$$\psi(p) = \frac{1}{2\pi}\int_{-\infty}^{\infty} e^{-ipq}\psi(q)\,dq, \quad \psi(q) = \int_{-\infty}^{\infty} e^{ipq}\psi(p)\,dp. \tag{1}$$

Connected with it scalar product

$$(\psi,\varphi) = \int_{-\infty}^{\infty} \bar{\psi}(q)\,\varphi(q)\,dq = 2\pi\int_{-\infty}^{\infty} \bar{\psi}(p)\,\varphi(p)\,dp \tag{2}$$

(Plancherel formula) defines the separable Hilbert space L_2 of square integrable functions on configuration manifold $R \supset q$ (and momentum one $\tilde{R} \supset p$ too) [1]. Both ones R and $\tilde{R}$ are separable and endowed by the Lebesgue measures dq and dp correspondingly. They are dual relatively the Fourier transform (1). It follows from (1) and (2) that hereby there is a certain equilibrium between R and $\tilde{R}$ expressed by the formulas $\hat{p} = -i\partial/\partial q$, $\hat{q} = i\partial/\partial p$ (so called Dirac's symmetry [2]) takes place.

As is known the simplest dynamical system - oscillator - has played the essential role at building of the usual quantum mechanics [3]. Here we pay attention first of all to it in order to make clear the mathematical structure and physical meaning of quantum theory suggested in [4], in which configuration manifold R is the Bohr's compact bR (sometimes we call this just cell).

2. Oscillator in the usual quantum mechanics

The system is characterized by two parameters mass m and frequency ϖ. These parameters go into the Hamiltonian of the system $\hat{H} = \frac{1}{2m}\hat{p}^2 + \frac{m\varpi^2}{2}q^2$ (here the Planck constant is put $h = 1$) and usually are considered to be finite magnitudes. In quantum mechanics with scalar product (2) the spectrum of operator $\hat{H}$ is described by the formula $E_n = \varpi\left(n + \frac{1}{2}\right)$, n=1,2,3,..., its eigenfunctions are $\psi_n(q) = \left(\frac{m\varpi}{\pi}\right)^{\frac{1}{4}} \frac{1}{\sqrt{2^n n!}} e^{-\frac{m\varpi}{2}q^2} H_n\left(\sqrt{m\varpi}q\right)$ (H_n are the Hermite polynomials). If to introduce mean values $\bar{p} = (\psi,\hat{p}\psi) = \rho$, $\bar{q} = (\psi,\hat{q}\psi) = \sigma$ and dispersions $\Delta p = \|(\hat{p}-\rho)\psi\| = \varepsilon$, $\Delta q = \|(\hat{q}-\sigma)\psi\| = \eta$ (here $\|\cdot\| = \sqrt{(\cdot,\cdot)}$), so in the case of $\psi = \psi_n$ we have $\varepsilon = \sqrt{m\varpi\,(n+1/2)}$, $\eta = \sqrt{\frac{n+1/2}{m\varpi}}$ [3], i.e. $\varepsilon\eta = (n+1/2) \geq 1/2$, $\varepsilon\ /\eta = m\varpi$. In connection with this one considers coherent states which minimize the Heisenberg uncertainty relations $\varepsilon\eta \geq 1/2$. Such states satisfy the equation $(\hat{p}-\rho)\,\psi = im\varpi\,(\hat{q}-\sigma)\,\psi$ [1] and are written in the form $\psi = Ce^{-\frac{m\varpi}{2}(q-\sigma)^2 + i\rho q}$ (C is a normalized con-

[1]E-mail: sanpros@kipt.kharkov.ua

stant).

3. Oscillator in the new quantum mechanics

Now we are interested in the case of the frequency $\varpi \to 0$. Hereby spectrum E_n obviously is constricted into one point 0: all $E_n = 0$ (at arbitrary n), and all eigenfuntions turn out zero: $\psi_n = 0$, hereat their norms, are of course, zero: $\|\psi_n\| = 0$[1]. This means that not only space L_2, but any its topological extension in particular rigged Hilbert space $\Phi \subset L_2 \subset \Phi'$ are constrictable [2]. But this does not mean that at $\varpi \to 0$ oscillator does not exist, however it is described by the quite another quantum mechanics.

First of all its Hamiltonian written as $\hat{H} = \frac{1}{2m}\hat{p}^2$ has as is known solid spectrum: at any real E solutions of the equation $-\frac{1}{2m}\frac{d^2\psi}{dq^2} = E\psi$ are the functions $\psi = Ce^{\pm i\sqrt{2mE}q}$,and it is needed to determine the class of functions to which they belong. It is of course not Φ', as such a space does not exist now (it was constricted into zero, see above).

As is known the waves $e^{i\rho q}$ describe free motion of particle with momentum ρ. Therefore usually one considers that at the limit $\varpi \to 0$oscillator problem becomes free particle motion one. However in the case of free particle motion there exists the space $\Phi \subset L_2 \subset \Phi'$. In fact from functions $e^{i\rho q}$ it may be constructed the wave packets in the form of integrals $\int\limits_{-\infty}^{\infty} e^{i\rho q}\psi(\rho)\, d\rho$ belonging to the space L_2, than they may by orthogonalized on the Schmidt method and normalized onto unity. In result the space L_2. may be constructed. Hereby the waves $e^{i\rho q}$ are considered as distributions over the fit function space Φ. In our case there is no space $\Phi \subset L_2 \subset \Phi'$ and therefore waves $e^{i\rho q}$ must be considered to be elements of some another space.

Even at the classical level free particle is quite another dynamical system as it accomplishes infinite motion: in fact moving in the direction to $+\infty$(or to $-\infty$) it never comes back. But oscillator only at $|q| << 1\sqrt{m\varpi}$ may be considered as free particle. Going to the point (distance) $L \sim 1/\sqrt{m\varpi}$ oscillator obligatory comes back into for example point $q = 0$: at limit $\varpi \to 0$ oscillator remains the system accomplishing finite motion (in L and -L there are as if walls from which particle is reflected: at such a distance attraction potential $\frac{m\varpi^2}{2}q^2 \sim \varpi$ plays the role).

As is known with a finite motion limited by interval [-L,L] the class of periodical functions (Hilbert space H_L) is connected in which the system of functions $\{e^{i\frac{\pi n}{L}q}\}_{n=-\infty}^{\infty}$ is complete: any function $\psi(q)$ may be decomposed into Fourier series

$$\psi(q) = \sum_{n=-\infty}^{\infty} \psi_n e^{i\frac{\pi n}{L}q}. \tag{3}$$

Hereby Fourier coefficients ψ_n are determined by the Fourier transformation of the function $\psi(q)$:

$$\psi_n = \frac{1}{2L}\int\limits_{-L}^{L} e^{-i\frac{\pi n}{L}q}\psi(q)\, dq \tag{4}$$

(such space cells are used in the theory of crystals). As $L \sim \frac{1}{\sqrt{m\varpi}}$ and in order to embrace the case of $\varpi \to 0$ ($L \to \infty$), it is needed to consider the Fourier transformation in the form [3] (here $\pi n/L$ is labeled p)

$$\psi(p) = \lim_{L\to\infty}\frac{1}{2L}\int\limits_{-L}^{L} e^{-ipq}\psi(q)\, dq =$$

$$= \lim_{L\to\infty}\frac{1}{2}\int\limits_{-1}^{1} e^{-iLpx}\psi(Lx)\, dx, \tag{5}$$

essentially distinguished from (1). Connected with it scalar product (mv means mean value)

$$(\psi, \varphi)' = \lim_{L\to\infty}\frac{1}{2L}\int\limits_{-L}^{L} \bar{\psi}(q)\,\varphi(q)\; dq =$$

$$= mv\int \bar{\psi}(q)\,\varphi(q)\; dq, \tag{6}$$

is essentially distinguished from (2) and underlies a new quantum mechanics in which configuration space is the Bohr' compact. It is some condensate (space of sticking together points labeled bR). Another words it is non-Hausdorf topological space endowed by the Bohr's measure (so we call the measure in integral (5); hereby the essential role plays a neighborhood of infinite far point).

[1] In fact, for example, we have $\lim\limits_{L\to\infty}\lim\limits_{\varpi\to 0}\sqrt{m\varpi}\int\limits_{-L}^{L} e^{-m\varpi q^2}dq = \lim\limits_{L\to\infty}\lim\limits_{\varpi\to 0}\int\limits_{-\sqrt{m\varpi}L}^{\sqrt{m\varpi}L} e^{-x^2}dx \le \lim\limits_{L\to\infty}\lim\limits_{\varpi\to 0} 2\sqrt{m\varpi}L = 0$.

[2] Remember (see any course of algebraic topology) a topological space M is constrictable into zero if $\varepsilon M \to 0$ at $\varepsilon \to 0$, i.e. for any element $m \in M$ there is $\varepsilon m \to 0$. In particular all vector spaces (and real axis as open interval $]-\infty, +\infty[$) are constrictable.

[3] This means that the operation $\bigcup\limits_L H_L$ (union) of all H_L and its linear covering $l.c.\bigcup\limits_L H_L$ and topological closeness under the scalar product (4) are considered. Getting by such a manner space is the space of almost periodical functions H' (see further).

Note the Fourier transformation (1) usually one gets proceeding from the Fourier series (3) and using *formal* procedure $L \to \infty$ (see for example [5]) at which sum is changed by integral.

The scalar product (6) is used in the H.Bohr's theory of almost periodical functions [6]; connected with it Hilbert space H' is non-separable one (remember it includes all periodical functions). Hereby topology on the momentum space $\tilde{R}$, induced by the topology of almost periodical functions considered on configuration space R, is the strongest or discrete. At such a topology the space $\tilde{R}$ is quite non-connected one or discontinuum (it is labeled $\tilde{R}'$). It follows from here important conclusion: *the spectrum of oscillator with infinite small frequency is solid but non-connected manifold.* Hereby it is impossible to integrate on such a manifold, it is possible summation only [8]. A stationary and normed state of such an oscillator is described by real function $\sqrt{2}\cos\left(\sqrt{2mE}q+\delta\right)$.

From the H.Bohr's theory it is known that any almost periodical function on R may be written in the form of general Fourier series

$$\psi'(q)=\sum_i \psi_i e^{i\rho_i q}, \tag{7}$$

where $\{\rho_i\}$is a finite or infinite countable sequence of momentum. Decomposition coefficients ψ_i are determined by the Fourier transformation

$$\psi_i = m.v. \int \psi'(q)\, e^{-i\rho_i q}dq. \tag{8}$$

Hereby the Parseval equality $mv\int \mid \psi'(q)\mid^2 dq = \sum\limits_i \mid\psi_i\mid^2$ takes place. Arbitrary function on $\tilde{R}'$ is written in the form of series

$$\psi(\rho)=\sum_i \psi_i \delta_{\rho,\rho_i} \tag{9}$$

where δ_{ρ,ρ_i} is the Kronecker symbol. (Note in the given theory, as it follows from (6)-(8), $\eta=\infty$ and in that case when $\varepsilon\neq 0$ (for example for a superposition (7)).

As is seen in the quantum theory connected with class of almost periodical functions there is no symmetry (Dirac's symmetry) between manifolds R and $\tilde{R}'$: formula $\hat{p}=-i\partial/\partial q$ takes place but the another formula $\hat{q}=i\partial/\partial p$ makes no sense ($\tilde{R}'$ is non-differentiable manifold). Hereat all essential in the Heisenberg-Schroedinger theory becomes non-essential in the new theory as the Hilbert space with scalar product (2) is a kernel of the form (4). It follows from here: under the action of some perturbation a state of usual oscillator does not transit into a state of oscillator with zero frequency (in this case the scalar product (4) is used), however reverse transition is possible (here the scalar product (2) is used). In general it is connected with the following circumstance: the Bohr's compact $b\,R$ has entropy *less* than entropy of the Lebesgue manifold R (see further) [4].

4. Three dimensional case. Potential interaction

Just considered limit exists not only for the oscillator potential. In the case of Coulomb potential $V=-e^2/r$ if charge $e\to 0$ the same situation gives rise: all $E_n = -me^4/2n^2 \to 0$ (limit $e\to 0$ is similar to the limit $n\to\infty$, see [5]). Hereby all radial functions $R_{nl}\to 0$ as $1/n^{3/2}$. Hence both spectrum of Bohr's atom and Hilbert space of its state vectors is constricted to zero. Nevertheless the equation $-\frac{h^2}{2m}\Delta\psi = E\psi$ has solutions written in the form of $\psi(\vec{x})=\sum\limits_i \psi_i e^{i\vec{p}_i\vec{x}}$ where all $\vec{p}_i^{\,2}/2m = E$. However such solutions may not be considered as distributions from Φ' on the space Φ of fit functions because in this case rigged Hilbert space $\Phi\subset L_2\subset\Phi'$ does not exist (see above). Mentioned above functions belong to another space namely to the class of almost periodical functions considered on the manifold R_3, i.e. on the Bohr's compact $b\,R_3$. On such a manifold integration on radial coordinate r is determined by the formuls $\lim\limits_{R\to\infty}\frac{1}{R^3}\int\limits_0^R |\psi(r)|^2 r^2 dr$ (appearance of boundary R is connected with the circumstance that at $r\sim n$ the attraction Coulomb potential begins to display, cf. with oscillator case). Thus in this case electron is not free particle because it accomplishes finite (compact) motion. In compact $b\,R_3$ we have another kind of atom, non-N.Bohr's one (i.e. non-Rutherford-Bohr planet model), it is quite another dynamical system. Another words we deal here with principally another boundary conditions in configuration manifold than in the case of N.Bohr's atom. [5]. We will call this object Thomson's atom (the Thomson oscillator model).

Let us consider now general case of stationary Schroedinger equation $\left(-\frac{h^2}{2m}\Delta+V\right)\psi = E\psi$ when ψ belongs to the class of almost periodical functions, i.e. $\psi(\vec{x})=\sum\limits_i \psi_i e^{i\vec{p}_i\vec{x}}$ (such solutions we call almost periodical crystal). If V is a potential decreasing in infinity we obviously have $mv\int\bar{\psi}V\psi\, d^3x = 0$ (see (5)), and the Schroedinger equation is reduced to the equation $-\frac{h^2}{2m}\Delta\psi = E\psi$ of 3-dimensional oscillator with zero frequency. This means that *on the class of almost periodical functions usual potentials are not effective.* In fact what is potential interaction? As is known potential $V\left(\vec{X}\right)$ as a function describing a fundamental interaction is connected with the Green function $G\left(\vec{X},t\right)$ of this interaction by means of formula

[4]It follows from the comparison of topologies of $b\,R$ and R: the first is set by two subsets ($\emptyset$,$b\,R$) only (this is topology of "all or nothing"; here $\emptyset$ is the empty set), while the base of R is set by infinite large number of subsets.

[5]In connection with this it is interesting to remember that boundary conditions for the Bohr's atom were promted to Schroedinger by H.Weyl. But Weyl told to Schroedinger not all then.

$V\left(\vec{X}\right) = \int\limits_{-\infty}^{\infty} G\left(\vec{X}, t\right) dt$. If $G(X)$ obeys the equation $G(X) = \delta^4(X)$ potential V obviously satisfies the equation $\Delta V\left(\vec{X}\right) = \delta^3(X)$. Hereby we may use in capacity of G the Green functions G^c, G^{ret}, G^{adv}. However if $G = G^s = \frac{1}{2}\left(G^{ret} + G^{adv}\right) = \frac{1}{2} sign(t)\, D$, where $D(X)$ is the permutation Pauli-Jordan function (such a Green function is used for description of interactions at very small distances, see [7], cf. Dirac [8], where space is not enough, for example, in the case of the Bohr's compact when an interaction quantum is forced to accomplish the a sort of "Zitterbewegung" in time: forwards-backwards) potential, it is natural, to form as $V\left(\vec{X}\right) = \frac{1}{2}\left(\int\limits_0^T G^{ret}\left(\vec{X}, t\right) dt + \int\limits_0^{-T} G^{adv}\left(\vec{X}, t\right) dt\right) = \frac{1}{2}\int\limits_{-T}^{T} D\left(\vec{X}, t\right) dt$, or $V\left(\vec{X}\right) = \frac{\pi}{|\vec{X}|} ln\left(\frac{1+|\vec{X}|/Tc}{1-|\vec{X}|/Tc}\right)^2 = 4\pi/Tc$. It is zero at $T \to \infty$ (stationary regime). We say that in such a case potential is not effective or not formed at all.[6].

It is clear that the H.Bohr' compact $b\,R_3$ (like a crystal cell) has lower symmetry then the Lebesgue continuum (with infinite Lebesgue measure). Therefore *objects existing in* $b\,R_3$ *have smaller entropy then objects in Lebesgue space* R_3[7].

It is important to emphasize that the transitions from states of the N.Bohr's atom having high entropy into states of the Thomson's one having low entropy (when the H.Bohr's integration is used) are impossible, but reverse transitions (when the Lebesgue integration (2) is used) are possible. Note also that the state of Thomson atom (unlike the N.Bohr one) is characterized by uncertain angular momentum l and in general case uncertain momentum $\vec{p}$[8].

4.1. New wave mechanics and biological structures

Symmetry group of compact bA_3. As is known Hilbert space of functions set on a Lebesgue manifold is separable. [7] but on the Bohr's manifold the space is non-separable [8]. Of course quantum mechanics as a field theory may be built in both cases. It turns out the quantum mechanics on the Bohr's compact bA_3 is well adopted to the description of a special material structures characterized (as well as itself space bA_3 in which they are created) by very low entropy.. Knowledge the symmetry group of bA_3 is very important in connection with spectral analysis on it.

As is known the symmetry group of Lebesgue space A_3 is $SO(3) \times T_3$, where T_3 are translations and $SO(3)$ are rotations. Hereby spherical fibration $\left(R_+, S^2\right)$ of A_3 plays important role, where $R_+ = [0, \infty[$ and S^2 is the two dimensional sphere. In the case of bA_3 symmetry group and fibration are written in another way. Distinction of bA_3 from A_3 is contained in the following: any inner part of bA_3 with dimension 3 as a subset of zero Bohr's measure may be extracted, see [9], and function on such subsets may be arbitrary change (the Egorov theorem), in particular it may be put there to be equaled zero: essential role plays only behavior of function in the neighborhood of infinite far point half-interval R_+ (see (5)). In such a case the linear connectedness of infinite far sphere and spherical fibration for bA_3 are written in another form, namely fibration is $\left(R_+, \tilde{S}^2\right)$, where $\tilde{S}^2$ is 1-chain fibration built over sphere S^2, connected with 1-chain group $\tilde{SO}(3)$ built over the group $SO(3)$ [11]. The exact representations of this group correspond to arbitrary angular momentum and are called in [11] almost periodical non-Neumanniam ones.

Many-valued functions on a sphere and membrane. First of all we write the Laplaceian on the space A_3 in spherical coordinates: $\Delta = \frac{\partial^2}{\partial r^2} + \frac{2}{r}\frac{\partial}{\partial r} - \frac{\vec{L}^2}{r^2}$, where $-\vec{L}^2 = \frac{\partial^2}{\partial\theta^2} + ctg\theta\frac{\partial}{\partial\theta} + \frac{1}{sin^2\theta}\frac{\partial^2}{\partial\varphi^2}$ is Laplaceian- on a sphere S^2 (θ, φ are angles on the sphere). Note that well known solutions $\psi = \frac{1}{\sqrt{r}} J_{l+1/2}(pr)\, Y_l^{(m)}(\theta, \varphi)$ of the equation $\left(\frac{\partial^2}{\partial r^2} + \frac{2}{r}\frac{\partial}{\partial r} - \frac{\vec{L}^2}{r^2} + p^2\right)\psi = 0$ ($J_{l+1/2}$ are the Bessel functions, $Y_l^{(m)} = e^{im\varphi} P_l^m(\cos\theta)$, P_l^m - adjoin Legandre polynomials hereby $\vec{L}^2 Y_l^{(m)} = l(l+1)\, Y_l^{(m)}$), used in the usual quantum mechanics and corresponding to integer angular momentum $l = 0, 1, 2, ...$ are not almost periodical functions as in asymptotic $r \to \infty$ they decrease like $e^{\pm ipr}/r$. The reason of such a behavior is the members $\frac{2}{r}\frac{\partial}{\partial r}$, $\frac{\vec{L}^2}{r^2}$, which are zero at $r \to \infty$. Neglecting them we come to the equation $\left(\frac{\partial^2}{\partial r^2} + p^2\right)\psi = 0$, solutions of which are almost periodical functions $\sim e^{\pm ipr}$. However the member $\vec{L}^2/r^2$ may be asided only at that case if the operator $\vec{L}^2$ is bounded, i.e. if its spectrum is ended in some finite point $\lambda^*(\lambda^* + 1)$). (In usual quantum mechanics using separable Hilbert space operator $\vec{L}^2$ is unbounded as spectral sequence $l(l+1)$ is diverged; for example, on the functions $e^{i\vec{p}\vec{r}}$it is unbounded, because $\vec{L}^2 e^{i\vec{p}\vec{r}} \sim r^2 e^{i\vec{p}\vec{r}}$). It is clear the spectrum $l(l+1)$ may not be cut at some l_0, because finite system of

[6] That is also why the strong interaction is bad described by means of potential.

[7] Obviously the Bohr's manifold (compact) topology base of which consists of two elements only has entropy $S_B = ln2$ independently on its dimension (hereby empty set is characterized by the minimal rate of entropy equaled $S_0 = ln1 = 0$). A Lebesgue compact has finite entropy (like a set consisting of m elements and having $S \leq m ln2$). Entropy of non-compact space topology base of which consists of infinite number of elements is infinite large.

[8] Since we have $\sqrt{2}\cos(\vec{p}\vec{x} + \delta) = \sqrt{\frac{\pi}{pr}} \sum\limits_{l=0}^{\infty} (2l+1)\cos\left(\frac{\pi l}{2} + \delta\right) P_l(\cos\theta)\, J_{l+\frac{1}{2}}(pr)$, where $\vec{p}\vec{x} = pr\cos\theta$.

functions $Y_l^{(m)}$ $(l=0,1,2,...,l_0)$ is not complete. In order to make the $\vec{L}^2$ bounded its spectrum consisting of infinite points must be convergent to some finite $\lambda^*(\lambda^*+1)$, where λ^* is in general case fractional angular momentum (or even complex one). Hence quite another spectrum of $\vec{L}^2$ (and quite another infinite complete systems of functions) are connected with the Bohr's compact bA_3.

These functions are written in the form

$$\overset{\pm}{Y}{}_{\lambda}^{(\mu)}(\theta,\varphi)=A_{\mu m}e^{\pm i\mu\varphi}\frac{1}{sin^{\mu}\theta}C_m^{\frac{1}{2}-\mu}(\cos\theta), \qquad (10)$$

where $\mu=m-\lambda$, hereby $m=0,1,2,..[\lambda]$ (it is the condition of square integrability of functions $\overset{\pm}{Y}{}_{\lambda}^{(\mu)}$), and $C_m^{\frac{1}{2}-\mu}(\cos\theta)$ are the Gegenbauer polynomials ($A_{\mu m}$ are normalization constants). First such functions were considered in [9], where wave mechanics on configuration discontinuum is built (hereby momentum manifold is the Bohr's compact).

Functions $\overset{+}{Y}$ and $\overset{-}{Y}$ belong to two distinct irreducible infinite dimensional representations $D^+(\lambda)$ and $D^-(\lambda)$ of the Lie algebra $so(3)$ of the rotation group $SO(3)$. Hereby representations D^+ and D^- separately are not invariant under the transformations from the Weyl group (group of spatial coordinate reflections $P:\ \vec{r}\to-\vec{r}$). It means *absence of the mirror symmetry of the objects described by the functions* $\overset{+}{Y}$ *or* $\overset{-}{Y}$. (Taking into account that the right screw is found very often in the biological structures, we choose the functions from the D^+ only) [9].

Putting $\lambda=l+\varepsilon$, where $l=[\lambda]$ is entire part of λ and $0<\varepsilon<1$ (the condition of finiteness of functions $\overset{\pm}{Y}{}_{\lambda}^{(\mu)}$), $\overset{\pm}{Y}{}_{\lambda}^{(\mu)}$ may be represented in the form of $\overset{\pm}{Y}{}_{\lambda}^{(\mu)}(\theta,\varphi)=A_{\mu m}\left(e^{\mp i\varphi}sin\theta\right)^{\varepsilon}g_{lm}^{(\varepsilon)}(\theta,\varphi)$, where $\left(e^{\mp i\varphi}sin\theta\right)^{\varepsilon}$ is many-valued part of the function on a sphere (and one-valued on the corresponding Riemannian surface $\bar{S}^2_{0,\pi}$ or on the fibration $\tilde{S}^2$), and $g_{lm}^{(\varepsilon)}(\theta,\varphi)=\left(e^{\mp i\varphi}sin\theta\right)^{l-m}C_m^{\frac{1}{2}+\varepsilon+l-m}(\cos\theta)$ is one-valued function. As ε are small we may write $g_{lm}^{(0)}(\theta,\varphi)=e^{\mp i\varphi(l-m)}(-1)^{l-m}\frac{(l-m)!\,2^{l-m}}{(2(l-m))!}P_l^{l-m}(\cos\theta)$. And if the frame is chosen so that $m=l$, the one-valued part is polynomial $P_l(\cos\theta)$. The simplest complete infinite system of functions on a sphere is written in the form of (see above)

$$\{\overset{+}{Y}{}_{\varepsilon_i}^{(-\varepsilon_i)}(\theta,\varphi)=$$
$$=\sqrt{\frac{\Gamma(\varepsilon_i+3/2)}{\sqrt{\pi}\Gamma(\varepsilon_i+1)}}\left(e^{-i\varphi}sin\theta\right)^{\varepsilon_i}\}_{i=1}^{\infty}, \qquad (11)$$

where $0<\varepsilon_i<1$. We emphasize

the quantization of angular momentum (integer l) takes place only in the Lebesgue manifold (where there is classical Newtonian limit of the quantum mechanics and measurement process is possible)*; in the Bohr's manifold angular momentum mas not quantized (fractional λ)* [10].

Thus, solutions of the equation $\left(\partial^2/\partial r^2+p^2\right)\psi=0$ representing outgoing waves are written in the form $\psi=e^{ipr}\psi^+(\theta,\varphi)$ (here p is large; such solutions we call biological structures). On these solutions operator $\vec{L}^2$ is *bounded.* (They differ from another solutions $\sum\limits_j\psi_je^{i\vec{p}_j\vec{r}}$ [4], on which operator $\vec{L}^2$ is *unbounded*). Here $\psi^+(\theta,\varphi)=\sum\limits_{\lambda,\mu}c_{\lambda\mu}\overset{+}{Y}{}_{\lambda}^{(\mu)}(\theta,\varphi)$, and $\overset{+}{Y}{}_{\lambda}^{(\mu)}(\theta,\varphi)$ is determined above functions. Such functions describe some 2-dimensional surfaces or membranes $(r\to\infty)$ of considering objects. As λ are fractional, so a *membrane is a many-fiber structure homeomorphic to some Riemannian surface* - covering of the sphere $S^2_{0,\pi}$, having two pricked out points: north $(\theta=0)$ and south $(\theta=\pi)$ poles (we call they branch points) and the cut joining them. The real (standing) waves are $\psi=e^{ipr}\psi^+(\theta,\varphi)+e^{-ipr}\psi^-(\theta,\varphi)$, where $\psi^-(\theta,\varphi)=\overline{\psi^+(\theta,\varphi)}$.

We can see under the membrane there exists another physical world distinguished from the well studied non-living one. We connect with it biological structures. They consist of living cell, nucleus of cell and so on. All they are characterized by entropy (and symmetry) lower than entropy of non-living ones. And this property is a reason of such phenomena of biological structures as anabolism and mythos.

5. Conclusion

As is well known macroscopic situation (encirclement) plays important role at forming of quantum mechanical state of a micro system. It includes of course not only the state of macroscopic bodies, but also the phase states of space (configuration manifold). Phase state of space is determined by that or another macroscopic encirclement of course. The latter naturally is described in language of several boundary conditions. Note this

[9] Important to note that $D^{\pm}(\lambda)$ are analytical continuation of finite dimensional representation $D(l)$ out of integer l into upper and lower half-plane of λ correspondingly. So that $D(l)$ is made up of two parts: one part originates from D^+, another - from D^- (see [9]).

[10] Note on the Bohr's manifold there is no classical mechanics because in such a manifold endowed by the topology of sticking together points there is no notion of trajectory. Therefore measurement process is impossible there. But waves exist. As a consequence the Feynman's formulation of new wave mechanics is impossible. Note also wave mechanics on Bohr's configuration manifold is essentially non-relativistic theory because space-time in the form of (bA_3,A_1) does not possess Lorentzian symmetry. Therefore it does not admit the second quantized version. In fact pure formally anti-commutation relations $\{\hat{\psi}(\vec{p}),\hat{\bar{\psi}}(\vec{p})\}=0$ taking place in momentum picture have trivial solution $\hat{\psi}\equiv0$ in Hilbert space, see [9].

topological phenomenon may be generalized on all canonical quantum systems (q, p): Lagrangian plane (configuration manifold) q may be in three distinct phase states: continuum, discontinuum, cell. Hereby it is interesting to note that these phases are contained in real cosmological model developed in [10].

References

[1] J. Neumann, "Mathematical foundations of quantum mechanics." Princeton, 1955.

[2] P.A.M. Dirac, "The principles of quantum mechanics." Oxford, 1958.

[3] V.A. Ffock, "The principles of quantum mechanics." Leningrad, 1976.

[4] S.S. Sannikov-Proskuryakov, *Nucl. Phys. B (Proc. Suppl.)*, **102&103** (2001), p. 328.; *Rus. Phys. J.*, **No4**, (2003), p. 92.

[5] A.N. Kolmogorov, S.V. Fomin, "Elements of theory of functions and functional analysis." Moskow, 1968.

[6] H. Bohr, "Fastperiodische functionen." Berlin, 1932.

[7] S.S. Sannikov-Proskuryakov, *Ukr. J. Phys.*, **47** (2002), p. 615.

[8] P.A.M. Dirac, *Proc. Roy. Soc.*, **A167** (1938), p. 148.

[9] S.S. Sannikov-Proskuryakov, *Phys. Lett.*, **19** (1965), p. 216.; *Ukr. J. Phys.*, **46** (2001), p. 647; **45** (2000), p. 5.

[10] S.S. Sannikov-Proskuryakov, "A new cosmological model" (will be submitted to PLA).

Spacetime & Substance, Vol. 5 (2004), No. 1 (21), pp. 29–31

EXPLANATION OF SENSE OF RELATIVISTIC MECHANICS

V.R. Terrovere[1]

Laboratory of an applied mathematics, Perm State University, 15, Bakireva Str., Perm 614600, Russia

Received May 19, 2004

Author demonstrates that a true sense of Relativistic Mechanics is a substitution of the material point with the revolving two-point structure. A neutral meson is this Structure. His Quarks "live" in the cylindrical world and the speed of Quarks is equal to c always. According to the present interpretation Special Relativity describes the helix motion of the valent Quarks of particles. A "Lorenz shortening" means a change of the length of the particle wave. A deceleration of the physical time means a change of the Quark rotation frequency. A spiral motion of Quark explains a corpuscular — wave dualism of quantum particles. A theory of Photon bears no relation to the Special Relativity's Kinematics. An Author's explanation of sense of Relativistic Mechanics is different from the view of Einstein in the main in Essence.

KEY WORDS: particle, quark, spiral motion, relativity

"Our theory of Phenomenon replaces a reality of the Thing by an objective of the Phenomenon."

J.P. Sartre [1]

1. Introduction

The present work is a continuation of the article [2]. If a theory begins since a physical model of the Object, that is to be studied, then a question about a Sense of this theory doesn't arise. Founders of Special Relativity began direct since a mathematical model. Therefore a question arose about a Sense of this theory naturally enough. A great number of the Interpretations are appeared. Though there are many Interpretations, but a Sense of Special Relativity is one however. For example, Newtonian Mechanics describes a motion of the material Point. The material point is well-known phenomenon that Newton proposed. A Sense of Newtonian Mechanics consists in this phenomenon. And what motion and what Object does Relativistic Mechanics describe? Author has attempted to prove that Relativistic Mechanics describes a motion of the revolving "Dumb-bells". A true Sense of the Kinematics of Special Relativity is a replacement of the material point with the revolving two-point Structure! A revolving two-point Structure is the new Phenomenon that Author proposed [2].

2. Global Relativistic Particle

That is a particle who moves with a constant speed c along the geodesic of the circular cylinder R. A Quark of the neutral Meson is a typical example of the relativistic particle on condition that this Quark "lives" in the cylindrical world and if his speed is equal to c always. What geometry does a spiral motion of Quark raise? First of all it is obvious, that a dimension of the Quark space is equal two. And two only! What metric does a motion of Quark generate in this space? Since a geometry of the cylinder is flat then straight lines x^0 are the geodesics on the evolvent of the cylinder. We shall bring right angled co-ordinates in this plane: x^1 — along the generatrix of the cylinder and s - along the arc of the cylinder circle. We call a plane (x^1, s) the Newtonian plane. We mark out this plane an elementary triangle

$$(dx^0)^2 = ds^2 + (dx^1)^2.$$

Since

$$ds = R\,d\varphi, \qquad d\varphi = \omega\,dt, \qquad dx^1 = u^1\,dt,$$

then

$$(dx^0)^2 = R^2\,d\varphi^2 + (u^1/\omega)^2\,d\varphi^2.$$

[1]E-mail: vterrovere@yandex.ru

Let speeds of own Quark are equal $u_1{}^1, \omega_1$ and speed of other Quark are equal $u_2{}^1, \omega_2$. Then

$$(dx^0)_1^2 - (u^1/\omega)_1^2\, d\varphi^2 =$$
$$= (dx^0)_2^2 - (u^1/\omega)_2^2\, d\varphi^2 = R^2\, d\varphi^2 = inv.$$

Using a limit of Quark speed, we turn out

$$d\varphi = \omega\, dt = \omega_{max}\, d\tau,$$
$$dx^0 = c\, dt, \qquad dt/d\tau = \omega_{max}/\omega. \tag{1}$$

We shall call τ an absolute Newtonian time and t — a relative Minkowski time. These times are bind by ratio

$$c^2\, dt^2 - (u^1\, dt)^2 = c^2\, d\tau^2.$$

Hence it follows

$$dt = \gamma\, d\tau, \qquad \omega = \omega_{max}/\gamma, \tag{2}$$
$$\gamma = (1-\beta^2)^{-1/2}, \qquad \beta = u^1\,/c.$$

We shall consider our space dx^1 real quantity. Then hence it follows that an interval ds is an imaginary quantity

$$(i\, ds)^2 = (i\, dx^0)^2 + (dx^1)^2. \tag{3}$$

We call a plane (ix^0, x^1) a complex plane of Minkowski. The Lorenz transformations follow from the condition (3) for any two-component vector

$$\begin{pmatrix} x^0 \\ x^1 \end{pmatrix} = \gamma \begin{pmatrix} 1 & \beta \\ \beta & 1 \end{pmatrix} \begin{pmatrix} x^0 \\ x^1 \end{pmatrix}'. \tag{4}$$

Quark does own revolution

$$S = 2\,\pi\, R \tag{5}$$

in a period T and by that one goes a distance x^1 that is equal a wave- length λ. In the present case according (5) a geometrical Sense of the Interval S is a circle - length of the cylindrical world in which "lives" the present Quark. It is evident that

$$u^1 = x^1/t = \lambda/T.$$

Let own Quark moves with parameters $\lambda_1, T_1, u_1{}^1$ and other Quark moves with parameters $\lambda_2, T_2, u_2{}^1 < u_1{}^1$. Then on the grounds (4)

$$\begin{pmatrix} cT_1 \\ \lambda_1 \end{pmatrix} = \gamma \begin{pmatrix} 1 & \beta \\ \beta & 1 \end{pmatrix} \begin{pmatrix} cT_2 \\ \lambda_2 \end{pmatrix}, \tag{6}$$

where

$$\beta = (\beta_1 - \beta_2)\,/\,(1 - \beta_1\,\beta_2).$$

This according to (6) a physical Sense of the Lorenz transformations is in particular that they establish a connection between the wave-properties of two Quarks.

On the grounds (2) and (6) we may insist that the Paradox of Clock and Lorenz shortening do not exist in reality. We call a plane (x^0, x^1) a real plane of Minkowski. According to (3) its metric is the pseudo - Euclidean metric

$$(i\, ds)^2 = g_{\mu\nu}\, dx^\mu\, dx^\nu, \qquad g_{\mu\nu} = \begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix}. \tag{7}$$

By analogy with a vector (x^0, x^1) of the world-point we shall bring a speed-vector (v^0, v^1). We call own-component speed $v^1 = dx^1/d\tau$ a Newtonian speed. We call two-component speed $u^\mu = dx^\mu/dt$ a Minkowski speed. We shall calculate an invariant $v^\mu v_\mu$.

$$v^0 = \gamma\, c, \qquad v^1 = \gamma\, u^1, \qquad v_\mu = g_{\mu\nu} v^\mu.$$

The speed v^0 is absent in a Newtonian Mechanics!

$$v^\mu v_\mu = -c^2. \tag{8}$$

A physical Sense of this Invariant is that a speed of the valent Quark is equal c always under a definition of Quark.

3. Local Relativistic Particle

That is a particle which moves with constant speed c along the non- geodesic of the circular cylinder. It means that a particle moves with an acceleration in the direction of x^1. We call $a^1 = dv^1/d\tau$ a Newtonian acceleration. We call two-component acceleration $b^\mu = du^\mu/dt$ a Minkowski acceleration.

$$a^0 = c\gamma\, d\gamma/dt, \tag{9}$$
$$a^1 = \gamma^2\, du^1/dt + u^1\,\gamma\, d\gamma/dt.$$

Taking into account (9)

$$a^1 = \gamma^2\, b^1 + \beta\, a^0. \tag{10}$$

In the rest-frame of Quark K' $\quad u^1 = 0$. Therefore

$$(a^0)' = 0, \qquad (a^1)' = (b^1)'.$$

On the grounds (4)

$$\begin{pmatrix} a^0 \\ a^1 \end{pmatrix} = \gamma \begin{pmatrix} 1 & \beta \\ \beta & 1 \end{pmatrix} \begin{pmatrix} a^0 \\ a^1 \end{pmatrix}'.$$

Excepting a^0 and a^1 from (10), we obtain

$$b^1 = (a^1)'\,(1-\beta^2)^{3/2}. \tag{11}$$

The acceleration $(a^1)'$ can be created by any physical fields. In particular, if to take into consideration that an acceleration g is constant in the falling freely lift, then a Solution of the equation (11) has the appearance of Hyperbola

$$(x^1)^2 - (x^0)^2 = c^4/g^2 = \rho^2. \tag{12}$$

In Newtonian plane a world line of Quark is Parabola $x^1 = gs^2/2c^2$. In conclusion, a world line (12) in the complex plane of Minkowski assumes a cone section too, and namely it is a circumference ρ and the curvature K of this world line is directly proportional to an acceleration

$$K = g/c^2. \tag{13}$$

From here we have own step to General Relativity!

4. Conclusion

∘ Author suggested an explanation of Sense of Special Relativity Kinematics that differs from the view of Einstein in main in Essence. In particular, a word "Light" isn't mentioned in the text anywhere. But it is no coincidence since a theory of Photon is a special talk [3] that bears no relation to the Special Relativity Kinematics.

∘ A spiral motion of Quark explains corpuscular - wave dualism of quantum particles.

∘ No knowing a Sense of the Physical theory we may indulge, of course, to all sorts of meaningless generalizations of the theory for the sake of themselves eternally and without an End. But it won't be a Physical theory already. It will be a Pseudo - theory, that has no heuristic and theoretically cognitive Value.

References

[1] J.P. Sartre, "L'etre et le neant." Paris, 1930, p. 13.

[2] V.R. Terrovere, *Spacetime & Substance*, **1**, no.5, p. 233 (2000), (in Russian).

[3] V.R. Terrovere. In: "Recent Problems of Field Theory." 2001–2002. ed. A.V. Aminova (Kazan State University, Kazan 2003) p. 430 (in Russian).

Spacetime & Substance, Vol. 5 (2004), No. 1 (21), pp. 32–33

MASS OF THE NEUTRINO AND ITS AXIAL - VECTOR ELECTROMAGNETIC NATURE

Rasulkhozha S. Sharafiddinov[1]

Institute of Nuclear Physics, Uzbekistan Academy of Sciences, Tashkent, 702132 Ulugbek, Uzbekistan

Received June 9, 2004

The neutrino possesses the anapole and electric dipole moments. Their interaction with field of emission can also lead to the neutrino elastic scattering by spinless nuclei. In this letter we present some implications implied from the processes cross sections. One of them states that there exists a hard connection between the neutrino magnetic and anapole moments. The equation for the anapole and electric dipole form factors is also obtained. They define the electronic neutrino axial - vector moments. All findings are generalized to the case of a Majorana neutrino.

According to the standard electroweak theory of elementary particles, the neutrinos are strictly massless. At the same time a consistent theoretical generalization of the $SU(2)_L \otimes U(1)$ model predicts the existence of a massive Dirac neutrino. Herewith the neutrino interaction with virtual photon is described by the vertex operator Γ_μ containing the vector Γ_μ^V and axial - vector Γ_μ^A parts:

$$\Gamma_\mu(p,p') = \Gamma_\mu^V(p,p') + \Gamma_\mu^A(p,p'), \tag{1}$$

$$\Gamma_\mu^V(p,p') = \overline{u}(p',s',)[\gamma_\mu F_{1\nu}(q^2) - -i\sigma_{\mu\lambda}q_\lambda F_{2\nu}(q^2)]u(p,s), \tag{2}$$

$$\Gamma_\mu^A(p,p') = \overline{u}(p',s')\gamma_5[\gamma_\mu q^2 G_{1\nu}(q^2) - -i\sigma_{\mu\lambda}q_\lambda G_{2\nu}(q^2)]u(p,s). \tag{3}$$

Here $\sigma_{\mu\lambda} = [\gamma_\mu, \gamma_\lambda]/2$, $q = p - p'$, $p(s)$ and $p'(s')$ denote the four - momentum (helicity) of the neutrino before and after emission. The functions $F_{1\nu}(q^2)$, $F_{2\nu}(q^2)$, $G_{1\nu}(q^2)$ and $G_{2\nu}(q^2)$ define at $q^2=0$ the static size of the neutrino charge [1], magnetic [2], anapole [3] and electric dipole [4] moments:

$$e_\nu = -F_{1\nu}(0), \quad \mu_\nu = F_{2\nu}(0), \tag{4}$$

$$a_\nu = -G_{1\nu}(0), \quad d_\nu = G_{2\nu}(0), \tag{5}$$

from which a_ν also can be measured experimentally [5], and for e_ν, μ_ν and d_ν was found the laboratory [6] and cosmological [7] limits. However, the crucial value has for us a question of whether there exists any dependence of form factors themselves.

The observation of such a regularity would help to elucidate the nature of neutrinos of the different structure [8]. All they therefore was discussed in the present work studying the behavior of unpolarized and longitudinal polarized electrons and their neutrinos at the elastic scattering on a spinless nucleus arising because of the existence of fermions anapole and electric dipole moments. Starting from the exactly formulas for the processes cross sections, the equation between the anapole and electric dipole form factors of light leptons have been established. A connection of the magnetic moment and anapole is obtained. They state that if the neutrino corresponds to the electron $(\nu = \nu_e)$, the functions $G_{1\nu}(0)$ and $G_{2\nu}(0)$ in the framework of the $(V - A)$ version of electroweak theory must have the form

$$G_{1\nu}(0) = \frac{3eG_F}{8\pi^2\sqrt{2}}, \quad G_{2\nu}(0) = \frac{3eG_F m_\nu}{4\pi^2\sqrt{2}}. \tag{6}$$

Here and further $e > 0$.

Using (5), (6) and taking [9]

$$G_F = 1.16637 \cdot 10^{-5}\ \mathrm{GeV}^{-2},$$

for axial - vector moments of the neutrino with mass [10] $m_\nu = 10$ eV, we find

$$a_\nu = \frac{3G_F m_e}{4\pi^2\sqrt{2}}\,\mu_\mathrm{B} = 3.2 \cdot 10^{-19}\,\mu_\mathrm{B}\left(\frac{1}{1\ \mathrm{eV}}\right), \tag{7}$$

$$d_\nu = 6.268 \cdot 10^{-25}\left(\frac{m_\nu}{1\ \mathrm{eV}}\right)\ \mathrm{e \cdot cm} = = 6.27 \cdot 10^{-24}\ \mathrm{e \cdot cm}, \tag{8}$$

where $\mu_B = e/2m_e$ is the electron Dirac magnetic moment.

It is seen that a_ν at the recent state of the theory do not depend on the neutrino mass. At the same time the structural multipliers G_F and m_e were measured with sufficiently exactness. Therefore, to the estimate

[1]E-mail: rasulkhozha@suninp.tashkent.su

of (7) one must apply simultaneously as to the laboratory one. Insofar as the parameter d_ν is concerned, its value becomes, according to the experimental data [11], equal to [12] $d_\nu < 0.44 \cdot 10^{-20}$ e · cm. On the other hand the cosmological reasoning [7] give the justification that $d_\nu < 2.5 \cdot 10^{-22}$ e · cm. Such a bound closely to the size of (8), but the difference therein still exists.

Passing to the question about the Majorana neutrino [13], one can as a starting recall [14] that a truly neutral neutrino do not have the vector interaction, and its axial - vector interaction is stronger than the Dirac fermions.

Our analysis shows that a massive Majorana neutrino similarly to the Dirac neutrino must possess not only one of the anapole [15] or the electric dipole [16] moments, but each of them. We can present their in the form

$$G_{1\nu_M}(0) = \frac{3eG_F}{4\pi^2\sqrt{2}}, \quad G_{2\nu_M}(0) = \frac{3eG_F m_{\nu_M}}{2\pi^2\sqrt{2}}. \tag{9}$$

These functions together with form factors (6) reflect just some structural properties of all the masses of fermions.

References

[1] R.S. Sharafiddinov, *Dokl. Akad. Nauk Ruz., Ser. Math. Tehn. Estest.*, **7**, 25 (1998).

[2] K. Fujikawa and R.E. Shrock, *Phys. Rev. Lett.*, **45**, 963 (1980).

[3] Ya.B. Zel'dovich, *Zh. Eksp. Teor. Fiz.*, **33**, 1531 (1957); Ya.B. Zel'dovich and A.M. Perelomov, *Zh. Eksp. Teor. Fiz.*, **39**, 1115 (1960).

[4] R.B. Begzhanov and R.S. Sharafiddinov, *Mod. Phys. Lett.*, **A 15**, 557 (2000); *Izv. Russ. Acad. Nauk, Ser. Fiz.*, **64**, 2221 (2000).

[5] M.J. Musolf and B.R. Holstein, *Phys. Rev.*, **D 43**, 1956 (1991).

[6] S. Davidson, B. Campbell and K.D. Bailey, *Phys. Rev.*, **D 43**, 2314 (1991).

[7] J.A. Morgan and D.B. Farrant, *Phys. Lett.*, **B 128**, 431 (1983).

[8] R.B. Begzhanov and R.S. Sharafiddinov, in "Proc. Int. Conf. on Nuclear Physics," Moscow, June 16–19, 1998 (St-Petersburg, 1998), Abstracts, p. 353.

[9] G. Bardin et al., *Phys. Lett.*, **B 137**, 135 (1984).

[10] R. G. H. Robertson et al., *Phys. Rev. Lett.*, **67**, 957 (1991).

[11] H. S. Gurr, F. Reines and H. W. Sobel, *Phys. Rev. Lett.*, **28**, 1406 (1973).

[12] A.P. Rekalo, *Ukrain. Fiz. Zh.*, **18**, 213 (1973).

[13] E. Majorana, *Nuovo Cimento*, **14**, 171 (1937).

[14] P.B. Pal and L. Wolfenstein, *Phys. Rev.*, **D 25**, 766 (1982).

[15] B. Kayser, *Phys. Rev.*, **D 26**, 1662 (1982).

[16] J.F. Nieves, *Phys. Rev.*, **D 26**, 3152 (1982).

Spacetime & Substance, Vol. 5 (2004), No. 1 (21), pp. 34–41

ON NATURAL STRUCTURES: THE UNIFICATION OF NATURE

Walter Cabrera-Febola[1]

University N.M. San Marcos, Apartado 170090, Oficina 29, Lima 17, Peru

Received May 7, 2004

Starting out from the statement of an objectivity principle, to reduce the plethora of subjectivism which has pervaded science until now, a unified approach to nature is proposed by means of the conceptualization of a natural structure (NE). It will be used the acronym NE, with E from the Spanish word ?estructura? equivalent to ?structure? in order to avoid any confusion with the usage in string theory of the acronym NS for the Neveu-Schwarz boundary condition or algebra. A number of complementary definitions are presented in order to clarify what is meant by the main concept. Some of the properties of natural structures which can at present be recognised are described.

Since it is important to be able to recognize natural structures in nature, it is shown that they exist at all levels from the micro to the macro world.

This is complemented by an attempt to answer a question that arises naturally from the forgoing: is the whole of nature composed of natural structures? It is found that, although this is basically the case, some entities could exist which are not exactly natural structures.

In a complementary paper some kinds of natural structures will be identified, and some general ideas which can be derived from the theory will be developed.

Key words: Natural Structure, NE-connection, Objectivity Principle.

Introduction

Science has developed dividing in separate receptacles, with an increasing lack of communication between each other, i.e., there has been an ingreasing specialization with people working in narrow areas yet into the same scientific discipline, for instance there are population ecologists without communicating with ecosystem ecologists or high energy theoretical physicists without communicating with condensed matter physicists. This has given the mistaken impression that nature is divided up in the same way, without nothing in common to the whole of it.

In this paper, an attempt is made to restore the unity of nature from a starting point which is similar to but distinct from that of similar approaches such as structuralism postulated by Piaget and Levi-Strauss among others. Since it is of primary importance to avoid the pervading subjectivism of science which puts in nature what is only a result of our reduced capabilities as may be appreciated, for example, in ecology where the dominat paradigm was population ecology due to our inability of making precise observations at greater scales both endurationaly and spatialy intending to neglect the fact that local ecological phenomena were dependent on major ecological entities like ecosystems as is now becoming to be realized guiding ecological studies to a more global perspective. An objectivity principle is established to serve this aim.

Since the purpose here is to grasp the unity of nature, i.e., to take up what is in the whole of it out of any consideration of scale or boundaries between scientific areas, attention is focused on one of the underlaying entities of nature over which it also acts. This leads to the definition of a Natural Structure, which is presented together with the complementary analysis required to avoid mistaken interpretations.

The necessary complementary steps are taken to describe the various relevant characteristics of NEs, in order to provide as complete as possible account of them. The NE concept provides the basis for the development of new ideas and the enhancement of old ones in the search to understand nature from a standpoint which as far as possible avoids the embarrassment of less naturalistic theoretical developments, which have sometimes emphasized the pursuit of more idealized aims developing as perfectly as possible mathematical systems without a real connection to nature.

1. Objectivity Principle

First of all, it is necessary to begin with a digression in order to establish an objectivity principle, which can be expressed in the following manner. Objectivity implies that nature does not behave to be observed, predicted, used, etc., by an observer (i.e., nature does not fulfill the expectations of the observer). Nature behaves

[1]E-mail: wcabreraf@unmsm.edu.pe

without the manipulation of any being outside or inside it. As Ghiselin (1987) has stated, "a natural system is something we discover, not something we created." Perhaps "thing" would be a better word than "system" because the latter is an overused term with many different meanings in agree with the user and this could misslead what is tried to be expressed, while "thing" in addition of lacking this problem is a more grounded word. Therefore anything that is established in terms of the capacity, necessity, interest or desire of any observer is not objective. "Terms of the capacity" implies that if the observer is unable to completly and correctly understand and grasp something, this does not mean that it is as captured by his/her capabilities. This also implies that other ideas of objectivity are not that, thus the most accepted are those saying that objective is what is real or what is shared but the first is relative to the culture and this is subjectivism in agree with the principle, the second is refered to something been shared by different observers which does not necessarily mean that it is real, mass deceptions are an example of this which is, basically, subjectivism in agree with the principle. This principle is not within the empiricist positivist philosophical tradition, because this tradition, as emphasized by Webster and Goodwin (1982), only considers to have a real existence which is observable, and would thus be defined as subjectivism according to the principle. The value of the principle can be appreciated from the work of Mizobuchi and Ohtak (1992) regarding the validity of one of the tenets of orthodox quantum theory; a theory that is to a great extent subjective (Anonymous, 1992, Ghose et al., 1992). From all the above it is clearly stated that we have to try to postpone all our human weaknesses in order to make a good approximation to the understanding and explanation of nature.

Before anything else, it is necessary to state what is a being. A being is any entity that is alive and able to react like a bacterium or a tree. An entity is anything which is individualized from the rest that have existed, exists or may exist even if it cannot be recognized or identified by an observer. In what follows we will be referring to natural entities whose smallest constituent parts are elementary particles, unless otherwise indicated. Following this initial digression we will proceed to define a NE.

2. Definition of a Natural Structure

A Natural Structure is a distribution of elements which are NE-connected at least in pairs. The elements and the NE-connections together constitute a whole or unity, with elementary particles as the base elements. It is formed by natural processes. To see examples look at section 4.

Elementary particles are considered to be the base elements of any NE, because according to the present state of knowledge these are regarded as indivisible entities of nature. But it is to be doubted whether what are now considered to be elementary particles really are indivisible and not composed of subparticles in a descending ladder to an unknown end. Some glimpses of these have been provided by an experiment made at Fermilab which open up the possibility that quarks may actually be made up of something even smaller (Durrani, 1996, Glanz 1996, Mukerjee 1996, Wilczek 1996). Could superstrings or branes (M, p, and D) be the truly elementary particles? Probably not; this possibility is dicussed in some extent by Mukerjee (1996).

To accept that NEs are composed ultimately of elementary particles does not mean that they are nothing but elementary particles and atoms, as Ayala (1987) points out. He also indicates the error of what has been denominated by philosophers as the "nothing but" fallacy, which is the inference that if something is composed only of something else, it is nothing but this "something else." He emphasizes that "organisms consist exhaustively of atoms and molecules, but it does not follow that they are nothing but heaps of atoms and molecules. A steam engine may consist only of iron and other molecules, but it is something else than iron and other components. Similarly an electronic computer is not only a pile of semiconductors, wires, plastic and other materials. Organisms are made up of atoms and molecules, but they are highly complex patterns, and patterns of patterns of these atoms and molecules." These observations could be applied to some extent to almost any NE. Therefore the acceptance of elementary particles as the base elements of any NE does not signify a bare and crude reduction of all nature to heaps of elementary particles and nothing else. Especially if one takes into account the doubts which exist with respect to the existence of a truly elementary particle.

2.1 At this point the necessity arises to establish the meaning of things relevant to the definition of a NE. We will begin by stating that a connection is anything that will not permit two or more entities to be separated under standard conditions (i.e., anything that holds two or more entities together or makes two or more entities to remain joined; see Fig. 1). Hereinafter this will be called NE-connection or epiploke (from the Greek term used to designate the same idea) in order to avoid confusion with the usage of the term connection to mean communication. Some examples, of epiplokes, are the interactions binding the atomic nucleus, the binding of cells in an organism, the binding of a couple of mates, the attraction of gravity binding a galaxy, etc. It may be produced by the NE-connected entities themselves, by another entity or other entities or in any other natural way. The NE-connection may be equally or unequally shared by the NE-connected entities. By standard conditions it is meant the conditions where

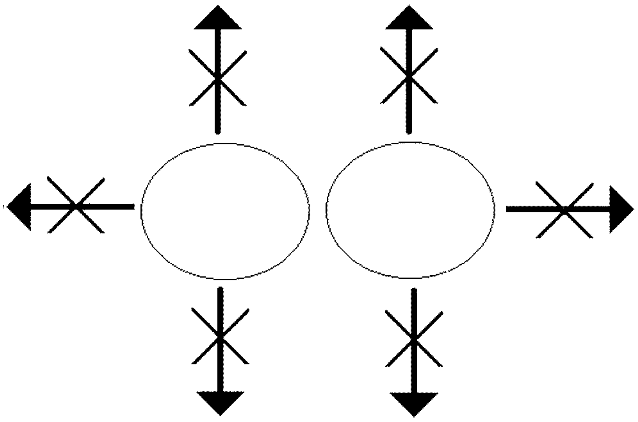


Figure 1: Schematic representation of a NE-connection. Showing a couple of entities (circles) that remain joined by the action of any entity. The crossed arrows pointing out give the idea that the two entities cannot separate

there is nothing specifically directed at separating the entities or although not specifically directed at separating them but whose activity has that effect or the conditions in which the NE-connection appears and exists. But this does not mean that the epiploke cannot be maintained under conditions other than standard by the contrary it will do its action against anything trying to separate the NE-connected entities. When it is said that the NE-connection is produced by another entity or other entities, it is meant that the NE-connection operates between the NE-connected entities and not between them and the entity or entities that produced the NE-connection. Perhaps there are some cases of an entity which is NE-connected to two or more entities and at the same time it is producing something that NE-connect these entities. There may also be other cases. Basically, it seems that the NE-connection acting between the NE-connected entities is a distinct entity. Two or more entities are indirectly NE-connected when they are NE-connected to one or more entities between them that are themselves NE-connected. They are directly NE-connected if there is no other entity out of the NE-connection between them. The elements of a NE can be NE-connected in pairs or in groups of n. Thus when it is said that they are grouped at least in pairs, this leaves open the second possibility that there may be n mutually NE-connected elements. The elements themselves may be NE-connected by one or n NE-connections (n NE-connected).

2.2 Natural is anything that is not produced by an external action made by a being (i.e., not produced by a working of a being done externally to it) or by any device made by a being. In consequence, non-natural is something that is produced externally by a being, or in the case of a device something produced either internally or externally to it. Thus, protein molecules, for instance, are produced internally to the cell, so they are natural; while spider webs and honeycombs are produced externally to the spiders and bees respectively. Therefore they must be non-natural; in spite of the fact that the raw material is natural, the structure (i.e., the network of honeycomb) is not.

2.3 It seems that it may be possible to distinguish three groups of things making up any entity. These are:

a) A constituent is anything which conforms an entity (e.g., substances, colours, etc). Probably it could be said that a constituent is any trait of an entity.

b) An element is any thing composed ultimately of elementary particles that makes up an entity.

c) A part or component is anything which is also composed of elementary particles making up an entity, being relevant to the nature of this entity.

Thus in the case of a dog, some of its constituents will be its colour, smell, atoms, and organs. Some of its elements will be its elementary particles, its atoms and its organs. Finally, its parts will start from perhaps some of its molecules, and include also its cells and up to its organic systems. Hence a dog is not a bunch of elementary particles or atoms related or NE-connected in any way. It possesses some kinds of atoms in common with other animals, plants and also inorganic entities, but it probably also has some kinds of molecules that pertain only to dogs, and it has cells, tissues and other entities that pertain only to dogs, i.e., that make a dog what it is.

2.4 Whole or unity implies that when it is complete each element must be NE-connected at least with one of the others that pertains to it (i.e., all of the elements of the whole or unity must be NE-connected to each other either directly or indirectly). In consequence, to be a whole or unity it is necessary that when any element of it is acting or being acted upon it must be NE-connected to all the rest of the whole or unity (i.e., the complete entity is present and NE-connected in its entirety and with this element), if it has lost some element(s) the previous assertion must be fulfilled for the remaining of it which will be an incomplete whole or unity; this is the case of a complete dog which is the whole that becomes an incomplete whole when it has lost, say, a leg. Hence wholeness and NE-connectedness are inextricably linked, because the whole is dependent on NE-connection. In consequence, since wholeness is the basic characteristic of a NE, the existence of NE-connection or epiploke is the fundamental condition which has to be satisfied in order for a thing to be a NE. This is also reflected, intuitively, by Rickart (1995), who talks about the "association" or "connection" (his quotation marks) and of a unified whole which is dependent on it.

It appears that in defining a NE it might be necessary to state that it constitutes a whole and acts as a whole; but it is evident that the only way a whole can act is as such.

Totality is a group of elements which are participating in some specific action; the elements may be NE-connected or not. In consequence, whole or unity is included within totality. In the case of a whole the elements will participate directly or indirectly in the action.

2.5 Process is a sequence of steps (i.e., a sequence of changes), or in some cases it could be a sequence of states. Therefore, a natural process is a sequence of steps that is not produced by any being inside or outside of the process like metabolism. A NE is not a process, but a step within a process and/or an arena for a process or processes. Change is to become different in some way (i.e., to undergo a variation in some respect).

2.6 Separate refers to two cases. The first case is when entities are NE-disconnected; this means that there is nothing pertaining to a totality and related to the entities which make up it which causes them to remain joined. In this case separate means that one or more entities are removed from the totality. The second case is when entities are NE-connected, so that there is/are something(s) pertaining to a totality and related to the entities making up it which causes them to remain joined. In this case separate, in addition of having the first meaning, means that one or more of the entities making up a totality can be acted upon in such a way that they or other of the entities of the totality could then be taken away from it without encountering any resistance from the totality or the entities making up this totality. Thus in this case separate does not necessarily mean that the entity(ies) is/are removed from the totality.

3. Some properties of Natural Structures

From the observation of some recognizable NEs in nature like animals, plants, and crystals and the analysis of the topics on NEs stated above it has been possible to infer some properties of NEs which will be specified, leaving open the possibility that further properties of them will be identified in future studies.

Wholeness is the property of being a whole or unity; this property is a central tenet of NEs.

NE-connectedness is the property of being NE-connected. As has been shown, wholeness depends on NE-connectedness; therefore the latter is the very core of NEs.

Form is a distribution of entities or simply a distribution. Position is to be situated in a place, as determined with respect to other entities. As a result there are entities located in different sites, i.e., distributed. Distribution is a consequence of the position of entities, therefore it is the position of all sub-entities of an entity. In this way, it should be noted that to have distribution it is necessary at least two sub-entities. Any change in form is a deformation.

Boundary is everything that delimits, in some way, an entity from the rest.

Finiteness is to have an end in endurance and extension.

Self-remaining is the property of persisting for a period as a result of inherent capacities and/or characteristics.

Geometryness is linked to form and depends on the arrangement of the elements of an entity and the distances between them. Also linked to form is topologyness, which depends on NE-connection, distribution, and continuity although NEs are made of discret unities.

4. Identification of Natural Structures in Nature.

There are entities in nature which are clearly NEs as for instance a molecule of DNA and any other molecule, a bacterium, a cell, a multicellular organism, the earth, and any planet. Below we are going to consider some, but obviously not all of the entities which are not easily recognisable as NEs. (The kinds of NE-connections will be listed in the appendix of a following paper).

Water seems to be an unrigidly and weakly NE-connected NE. It is a NE because it is NE-connected by Hydrogen bonds, as well as by the surface tension which can be observed in a drop of water. Its fluidity appears to be derived, not from its weaker bonding, but from a "flattening" of the potential-energy barriers to rotation and translation (Ball 1991, Sciortino et al., 1991). It should be taken into account that all the Earth's water is not a whole, because water is divided into many parts although some could think that this is not so because of the water cycle but this does not mean that all the water is a whole, a cycle simply is equivalent to the return of something once and again but this something can be formed of separated parts that is the case of water with perpetual snows, drops of rain, isolated andean lagoons, and other water bodies of different size; but each of these parts is a whole in itself.

From the above it can be deduced that every liquid is a NE with the same possibility of being divided into many parts.

A river is a NE because its parts are NE-connected: the water and the sediments with the river bed which acts as a recipient, creating a NE-connection. A river would appear to be rigidly and strongly NE-connected. For the same reasons a watershed should also be considered as a NE with, in general, the same kinds of NE connections. Lakes and other enclosed bodies of water are NEs similar in kind to rivers, and with the same kinds of NE connections. The sea is a NE for the same reasons.

Planetary systems are NE-connected by gravitational forces, and are therefore NEs. In general they are unrigidly NE-connected and probably strongly NE-connected. A planet and its moons is a NE of the same kind as a planetary system. A good example of a NE would be the solar system which in addition shows the Edgeworth-Kuiper Belt and the Oort Clouds surrounding it forming a boundary (Yamamoto, 1996).

The atom is NE-connected by the electromagnetic and strong interactions: thus it is a NE. The nucleus seems to be rigidly NE-connected. The electrons seem to be strongly connected to the nucleus, but unrigidly, because they can change its level and its movement around it.

The earth is a NE, unrigidly and strongly NE-connected.

It seems that liquid crystals are NEs, unrigidly NE-connected, and intermediate between strongly and weakly NE-connected.

Galaxies are NE-connected by gravitational forces; therefore they are NEs. It is difficult to know whether or not they are rigidly and strongly NE-connected because of their size, but at first sight they appear to be rigidly NE-connected.

It seems that clusters are NE-connected: therefore they are NEs. Superclusters are also NE-connected by low density "bridges"; therefore they are NEs. For the same reasons above expressed, it is difficult to know whether or not they are rigidly and strongly NE-connected, but they too could be rigidly NE-connected.

Stars are NEs which are connected by gravitational forces, they appear to be unrigidly and strongly NE-connected. The same seems to be true of globular clusters of stars.

The universe is a NE. It is formed by the Nes mentioned above and at a large scale by the superclusters, containing tens of clusters NE-connected by low-density "bridges" consisting mainly of single galaxies, in the form of long filaments or shells... Separating the superclusters are large spherical or elliptical void regions. Matter extends into a vast network of filaments, knots and voids known collectively as the large-scale structure of the universe (Vogel, 1996, Waldrop, 1983). Other something recent discoveries include a "great wall," consisting of a system made up of thousands of galaxies arrayed accross space in the form of a "crumpled membrane" (Hecht, 1989), "megawalls" or sheets of galaxies spaced at regular intervals (Schilling, 1990) and a long band of quasars (Chown, 1991). It has been noted that the distribution of galaxies is complex and highly-structured: more like sculpture than spatter... The results reported by Lapparent, Geller and Huchra show a tapestry-like pattern, with long chains of galaxies in thin contours surrounding large empty regions nearly devoid of galaxies (Dressler 1991). In mapping the position of the galaxies... it was found that they tend to cluster along gigantic filaments and sheets... found dense globs of galaxies alternating with voids (Horgan, 1995) and filamentary radio structures known as "threads" (Gray et al., 1991). It was also noted that galaxies are seen clumping together in sheets and bubbles which surround relatively barren voids (Spergel and Turok, 1992). A great attractor has been discovered and it is proposed that more of them exist (Dressler, 1991). All of the above gives the impression of the universe as a giant NE formed by sheets or walls, knots, filaments and voids, surrounded by membrane-like walls. It might exist in a medium, which would be a very smooth one, perhaps formed by cold dark matter and/or the cosmic microwave background or perhaps spacetime itself. Whether the universe is rigidly and strongly NE-connected or not is difficult to ascertain for the same reasons adduced above in relation to superclusters.

A shoal of fishes is a NE, which is NE-connected principally by visual or in some cases by other kinds of signals. A flock of birds would be a similar kind of NE. In both cases these NEs would be unrigidly and weakly NE-connected. There are other somewhat similar agroupations of mammals, such as packs of wolves and herds of wild horses.

There are some groupings of animals which are NEs, permanent or not. Examples include the Mexican mosquito spiders which group together very tightly in the dry season, with the legs of the outer individuals acting as a skin other similar examples include: The Oecophylla ants when they are sowing together two leaves; the Atta ants when a pair of ants is cutting a leaf; dolphins helping an injured fellow; family groups which help to protect the breed; family groups of Galapagos sea lions with a dominant male; family groups in general. It can also be added groupings of other organisms like bacteria and microalgae (Kessler, 1989).

It appears that prey and predator together form a NE, with the two populations being NE-connected by virtue of this relationship. In most cases they would be rigidly NE-connected (note that their position is relational and not spatial), and either strongly or weakly NE-connected, depending on the specific nature of the relationship in each case.

The host-parasite relationship is a NE. The two are connected in the same way as the predator and its prey, but in this case the relationship is a much more intimate one. In most cases they would also be rigidly NE-connected, with the strength or weakness of the NE connection depending on the specific nature of the relationship.

Mutualistic associations appear to be NEs, which may or may not be permanent. The kind of NE connection would depend on the strength of the mutualism. The same appears to be the case for commensal relationships, but in this case these are permanent NEs.

In general, pairs of mates are NE-connected; therefore they are NEs. A pair of animals fighting are also NE-connected; therefore they are a NE. In both cases the NEs appear to be temporary, with the kind of connection depending on the specific features of the relationship in each case.

Some interesting cases of NEs seem to be that of self-organized spatial structures related to metapopulations and spatial cooperation with its kaleidoscope of forms where the NE-connections seem to be the mechanisms that tie the subpopulations and deterministic movement rules, and the local interactions within a spatial array respectively (May, 1994, Nowak and May, 1992).

Another example, perhaps less obvious, of a NE would be linkage and linkage groups, which in general appear to be strongly and rigidly NE-connected. This is an interesting NE, because of its role in passing on and preserving traits from one generation to another.

Clouds are colloids of water vapour or snowflakes and gas (E.Curril, personal communication, 1994) . Therefore they are NE-connected being NEs.

Interesting cases of NEs, which are produced in experimental settings, are the rhombic patterns that form in reaction-diffusion systems (Ouyang et al., 1993) and the oscillons formed in a vibrating layer of sand (Fineberg, 1996; Umbanhowar et al., 1996). Another case, and a very interesting one, seems to be that of Bose-Einstein condensates, where the NE-conection seems to be produced by the cooling of the dilution, and also their variations like atom laser and rubidium-87 molecules (Towsend et al., 1997; Miesner, Ketterle, 1998; Andrews, et al., 1998; Dunfee, Ketterle, 1998; Castin et al., 1999; Stamper-Kurn, and Ketterle, 2001; Wynar et al., 2000).

It seems that gases are NE-disconnected and thus not NEs, because their molecules are moving fastly and frequently collisioning tending to separate from each other. The same is true of air which is a mixture of gases.

5. Is Nature Composed only of Natural Structures?

To answer this question we have to look for NE-connected entities composed ultimately of elementary particles; in this general sense it appears that nature is basically composed of NEs or special cases or kinds of them. Between the two extremes of proper NEs and what are merely aggregates or conglomerates, it is possible that some intermediate cases exist. Truly elementary particles are a very special case of NEs. They are the base elements of all NEs, but it seems they are not strictly speaking NEs because they do not contain elements other than itself. But, perhaps the minimum number of elements a NE could have is one. That element has a position, and being the only element of the NE it is NE-disconnected and at the same time NE-connected from any other element and to itself respectively. Consequently, it might be a whole because of the latter. To be NE-connected to itself means that it is not separating from itself producing exact copies of itself, this seems to be another charachterisitic of NEs which could be called self-NE-connected.

An aggregate is a collection of distributed elements which are not NE-connected, and therefore do not constitute a whole. Its base elements are elementary particles. It is formed by natural processes, even if on occasions the “source” of the attraction might not be natural. What might be termed a conglomerate differs from an aggregate in its formation: while the elements of an aggregate are brought together by external forces, the elements of a conglomerate are released from some entity. The first is the case of flies attracted by a light source like a bulb, the latter is the case of some organic material released by an organism.

Aggregates and conglomerates can be considered as degenerate NEs, since they do not have NE-connections, i.e., their elements are not NE-connected. Their elements could be NEs or formed by NEs or by other aggregates or conglomerates or a combination of them, as would be the case of aggregates of aggregates. Perhaps the most extreme case would be an aggregate of elementary particles, which would be a case of total degeneration. Aggregates and conglomerates are not wholes but totalities. There is no action that they can make as a whole, since their elements are independent of each other. In an aggregate, the elements are not held together by NE-connections, but by an external "force, source, or stimulus"; perhaps, therefore, they are NE-connected to this external "force." By contrast, in a whole the entities are NE-connected by "forces" inherent to the entity. An aggregate disappears when the external "force" holding it together disappears. A whole is not affected in the same way by anything external to it.

Other entities are mediums and substratums. A medium is anything that can surround or pervade other entities, with which these entities may exchange matter, energy and anything else. Substratum is something which lies beneath and supports other things; for example the ground or material to which a plant is attatched or upon which an animal moves or to which it is fastened. Mediums and substratums may be NEs or not. To give a siple example, in the case of certain forests, pasture could be the medium in which the forest is immersed. This is because the pasture pervades and surrounds the forest (i.e., it is inside and outside of the forest); although this would be a case in, specifically, two dimensions.

A medium must also be homogenous, in the sense that its components are the same throughout the extension of the medium, as in the case of water molecules or perhaps the component organisms of the pasture in the above case. It should also be noted that some entities may be in more than one medium, in the sense that different parts of them could be in different mediums.

Acknowledgements

The author would like to thank M.T. Guiselin and O. Obando for their valuable comments on the objectivity principle and S. Cousins, L. Del Valle-Mendoza, B. Goodwin, R. Guevara-Carrasco, A. Halliday, M.-W. Ho, M. Laime, K. Mangin, H. Parkin, H. Polo Vieyra and M. Zegarra for their comments on the whole paper, also to C. Limaco for his invaluable technical assistance. They should not however be blamed for any remaining shortcoming.

References

[1] Andrews M., Durfee D., Inouye S., Stamper-Kurn D., Miesner H.-J., Ketterle W, 1998. "Studies of Bose-Einstein condensates." *Journal of Low Temperature Physics*, **110**, 153–166.

[2] Anonymous, 1992. "When is a wave also a particle?" *New Scientist*, **135**, 13.

[3] Ayala F.J., 1987. "Biological reductionism. The problems and some answers." In: Yates, F. E. (Ed.), "Self-Organizing systems. The Emergence of Order." Plenum Press, New York, pp. 315–324.

[4] Ball P., 1991. "Water goes with the flow." *Nature*, **354**, 188.

[5] Castin Y., Dum R., Sinatra A., 1999. "Bose condensates make quantum leaps and bounds." *Physics World*, **12**, 37–42.

[6] Chown M., 1991. "Giant structure spells trouble for cosmology." *New Scientis*, **129**, 24.

[7] Dressler A., 1991. "The great attractor: do galaxies trace the large-scale mass distribution?" *Nature*, **350**, 391–397.

[8] Durfee D., Ketterle W., 1998. "Experimental studies of Bose-Einstein condensation." Optics Express **2**, 299–313.

[9] Durrani M., 1996. "Smaller than a quark?" *Physics World*, **9**, 7.

[10] Fineberg J., 1996. "Physics in a jumping sandbox." *Nature*, **382**, 763–764.

[11] Ghiselin M.T., 1987. "Species, concepts, individuality, and objectivity." Biol and Phil, **2**, 127–143.

[12] Ghose P., Home D., Agarwal G.S., 1992. An "experiment to throw more light on light: implications." *Physics Letters, A*, **168**, 95–99.

[13] Glanz J., 1996. "Year of strange events leaves standard theory unscathed." *Science*, **274**, 179.

[14] Gray A.D., Cram R.D., Ekers R.D., Goss W.M., 1991. "A filamentary radio source near the Galactic Centre." *Nature*, **353**, 237–239.

[15] Hecht J., 1989. "Cosmic contradictions trouble the astronomers." *New Scientist*, **12**, 34.

[16] [16] Horgan J., 1995. "From complexity to perplexity." *Scientific American*, **272**, 74–79.

[17] Kessler J., 1989. "Path and Pattern — the mutual dynamics of swimming cells and their environment." *Comments on Theoretical Biology*, **1**, 85–108.

[18] May R., 1994. "The effects of spatial scale on ecological questions and answers." In: Edwards P., May R., Webb N. (Eds.), "Large-Scale Ecology and Conservation Biology." Blackwell Scientific Publications, Oxford, p. 1–17.

[19] Mizobuchi Y., Ohtak Y., 1992. An "experiment to throw more light on light." *Physics Letters, A*, **168**, 1–5.

[20] Mukerjee M., 1996. "Explaining everything." *Scientific American*, **274**, 72–78.

[21] Nowak M., May R., 1992. "The spatial dilemmas of evolution." *International Journal of Bifurcation and Chaos*, **3**, 35–78.

[22] Ouyang Q., Gunaratne G., Swinney H., 1993. "Rhombic patterns: Broken hexagonal symmetry." *Chaos*, **3**, 707–711.

[23] Rickart C.E., 1995. "Structuralism and structures. A mathematical perspective." World Scientific, Singapore.

[24] Schilling G., 1990. "Soviet theory may explain galaxy clustering." *New Scientist*, **128**, 35.

[25] Sciortino F., Geizer A., Stanley H.E., 1991. "Effect of deffects on molecular mobility in liquid water." *Nature*, **354**, 218–221.

[26] Spergel D.N., Turok N.G., 1992. "Textures and cosmics structure." *Scientific American*, **266**, 36–43.

[27] Stamper-Kurn D., Ketterle W., 2001. "Spinor condensates and light scattering from Bose-Einstein condensates." In: Kaiser R., Westbrook C., David F. (Eds.), 1999. "Les Houches Session LXXII. Coherent Atomic Matter Waves." Springer, New York, p. 139–217.

[28] Towsend C., Ketterle W., Stringari S., 1997. "Bose-Einstein condensation." *Physics World*, **10**, 29–34.

[29] [29] Umbanhowar P., Melo F., Swinney H., 1996. "Localized excitations in a vertically vibrated granular layer." *Nature*, **382**, 793–796.

[30] Vogel G., 1996. "Goodness gracious, great walls afar." *Science*, **274**, 343.

[31] Waldrop M. M., 1983. "The large-scale structure of the universe." *Science*, **219**, 1050–1052.

[32] Webster G., Goodwin B.C., 1982. "The origin of species: a structuralist approach." *J. Social Biol. Struct.*, **5**, 15–47.

[33] Wilczek F., 1996. "A crack in the standard model?" *Nature*, **380**, 19–20.

[34] Wynar R., Freeland R., Han D., Ryer C., Heinzen D., 2000. "Molecules in a Bose-Einstein condensate." *Science*, **287**, 1016–1019.

[35] Yamamoto T., 1996. "Are Edgeworth-Kuiper Belt objects pristine?" *Science*, **273**, 921.

Spacetime & Substance, Vol. 5 (2004), No. 1 (21), pp. 42–45

MICHEL BOUNIAS AND HIS ROLE IN DEVELOPING A DEEPER KNOWLEDGE ABOUT REAL SPACE

V. Krasnoholovets[1]

Institute of Physics, National Academy of Sciences, Prospect Nauky 46, UA-03028 Kyïv, Ukraine

Received July 17, 2004

A brief story about late Professor Michel Bounias, a member of Advisory Board of Spacetime & Substance, is stated in the present note. His remarkable studies aimed at the understanding the constitution of the real space allow us to consider his findings as an actual breakthrough in the fundamental science. Bounias' studies shed light on the organization of space arranged as a mathematical lattice of topological balls – founding elements of the real space. He investigated the space structure and the substructure of balls, fractality of the real space derived from first (submicroscopic!) principles and specified origins of matter, charge and fields and disclosed the way of their manifestation in the space tessellattice.

Michel Bounias, a board member of *Spacetime & Substance*, passed away on 23 March 2003. Professor Bounias was very interested in developing of our journal, because he called it an actual forum presenting new progressive ideas and concepts in the fundamental science. He fairly believed that it is this subject that is under taboo in the mainstream physical journals; hence *Spacetime & Substance* is able to give free rein to any scientist who wishes to state one's ideas, concepts and theories, especially regarding the constitution of the universe.

French Professor Michel Bounias was a high-level scientist whose researches were wide known among many mathematicians all over the words. He published hundreds of papers in about a hundred of different journals, e.g. *Comptes-Rendus de l'Academy des Sciences* (Paris), *J. of Mathemat. Analysis and Appl.* (USA), *Nature* (UK), *Int. J. Comput. Anticipatory Systems* (Liege, Belgiue), *Indian J. Theor. Phys.* (Calcutta), *Ultra Scientist of Physical Sciences* (India), *Physics Essays* (Canada), *Spacetime & Substance* (Kharkiv, Ukraine), *Chimie Analitique* (Paris), *Biochemistry Journal* (USA), *Biochemistry Intern.* (Australia), *Canadian J. of Forest Research*, *Brazilian J. of Medical and Biological Research*, *Science of the Total Environment* (Italy), *Zeitschrift fuer Naturforschung* (Germany), and etc. He published about ten books at such Publishers as Springer-Verlag (Berlin), Masson (Paris) and others.

Michel Bounias was married, had a son. Though later he lived along in proper houses, initially in Avignon, then in the countryside in the South of France at distances 2 to 3.5 hours by car from the Avignon University where he taught mathematics. As a teacher, he delivered lectures also in other places, for instance, the Belgrade University. As a researcher, he visited and worked in many scientific centers and was the research director at the Alexandria Institute, New York. In 2001 he in collaboration with other scientists initiated a manifesto entitled "Science Responsibility and Scientists Concerns for Evolution of Planet Earth: A Manifesto on Action for World's Peace and Harmony." Here is the abstract:

During the last centuries, human technologies have grown to such an extent that their power has reached a level and a range comparable to that of natural forces. The Earth is witnessing an ever-increasing human technological intervention, in almost all areas of human life and Nature in general, with unfortunately a deficit in philosophical and humanistic approach, whatever the consequences this may imply for the present and future of humankind and Planet. An increasing load of damage has resulted from the consequences of human population growth and development, with poverty, stress and violence still spreading in every part of the world. While political and industrial lobbies argue against the capability of science to give them lessons of objectivity and wisdom, religions have also failed to provide adequate guidelines for the way humanity should behave in harmony with the whole of the living community, and religious wars still rage worldwide. The three parts of the present appeal successively deal with the following parts of the tragedy: (i) the technological and economical aspects; (ii) the social and philosophical implications; (iii) the moral and spiritual messages.

[1]E-mail: krasnoh@iop.kiev.ua; http://www.inerton.kiev.net

A new way of thinking about identification of correct behavior and management that would allow the living community to evolve towards a optimum future is sketched and the whole of the scientific community is invited to contribute out of conflicts of interest to fill the appeal with the wisdom that Science should be able to bestow to humanity, in conjunction with Arts and Philosophy whose contribution is emphasized.

Bounias' scientific interests were exceptionally wide. After the graduation in the mid 1960s, he started as a researcher in the nuclear weapon program of France and worked in this area for 7 years. Then he was teaching the math and conducted researches in many branches of pure and applied mathematics, biomedicine, analytical chemistry, environmental protection, UFOlogy, theoretical physics, etc. During his last years he was keenly interested in the study of negative influence of herbicides on the quality of foodstuff and the health of bees that pollinate cultivated plants.

Bounias did not have a TV set, but a switched receiver was constantly on his writing-table. He could receive a fax from an Australian broadcast company somewhere at the mid night, another correspondent wished to interview him twenty minutes before a New Year. He could suddenly receive an invitation to visit a camp of researchers somewhere in a desert in Mexico for a couple of weeks or so, etc. The same as many thinkers, Bounias negatively perceived top politicians considering them as people who only purposed their corporate economic objects. He very critically expressed his opinion about the war against Yugoslavia. He was in depression looking at what was going on the Mediterranean coast in France: all buildings were constructing directly near the shore without taking into account any directions of conservancies.

For about thirty years the major subject of Bounias' study was the investigation and understanding the phenomenon of life. Bounias' Global Project concentrated on the following questions [1]: (i) does a physical universe exist? (ii) if so, on which conditions could it exist? (iii) what life really represents, and why as a part of the whole universe, does it seem to apparently not follow some of the so-called "laws of physics". In the frame of the Project he could complete clarify points (i) and (ii), and the main contribution to solving point (iii) was made in last years.

Those studies have imperishable meaning not only for biologists and mathematicians whose work directly touches the phenomenon of life. His investigations are paramount important also for those physicists who investigate space as such. Indeed, he could show that a physical space can exist as a collection of closed topologies in the intersections of abstract topological subspaces provided with non-equal dimensions. In particular, the Project allowed him to raise and then to solve (rather finally!) what was considered as 'time' in human perception.

After publishing his remarkable book on the creation of live in 1990 [2], he concentrated on the understanding the constitution of space. Those studies were mostly carried out jointly with his friend Dr. Andre Bonaly from the University of Paris X. Namely, they published such works as "A topological model for fundamental structures" [3], "On mathematical links between physical existence, observability and information: towards a "theorem of something" [4], "Timeless space is provided by the empty set" [5], "The trace of time in Poincaré sections of a topological space" [6], "On metrics and scaling: physical coordinates in topological spaces" [7], "Some theorems on the empty set as necessary and sufficient for the primary topological axioms of physical existence" [8], "The theory of something: a theorem supporting the conditions for existence of a physical universe, from the empty set to the biological self" [9]. In particular, he was proud by work "On spacetime differential elements and the distribution of bio-Hamiltonian components" [10] published in *Space-time & Substance*. In this paper it has been discussed how various Hamiltonian models are derived for chemical structures belonging to living organisms while the Hamiltonian concept has not been applied to life as a whole. For the first time paper [10] has identified differential elements of space-time, from which it delimits a probabilistic fuzzy-like invariance standing for conservativity of biological Hamiltonian. In 2002 he also contributed to a book of American Dr. Ilonka Harezi writing a long mathematical part entitled "A Scientific Trip from Nothingness to Something. Mathematics Generating Physics up to Life".

Let us now examine what is space-time in the Bounias' approach. What he proposed initially was the founding element. Namely, it is generally recognized that in mathematics some set does exist. A weaker form can be reduced to the existence of the empty set. If one provides the empty set $(\emptyset)$ with the combination rules $(\in, \subset)$ and the property of complementary $(\complement)$, a magma can be defined. Those preliminaries allowed Bounias to fortunate the following theorem.

The magma $\emptyset^{\emptyset} = \{\emptyset, \complement\}$ constructed with the empty hyperset and the axiom of availability is a fractal lattice.

Writing $(\emptyset)$ denotes that the magma reflects the set of all self-mappings of $\emptyset$. It has been shown that the space constructed with the empty set cells of the magma $\emptyset^{\emptyset}$ is a Boolean Lattice and this lattice $S(\emptyset)$ is provided with a topology of discrete space. A lattice of tessellation balls then has been called the "tessellattice" and the magma of empty hyperset becomes a fractal tessellattice.

The introduced lattice of empty sets has ensured existence to a physical-like space. Indeed, looking at the inferring spaces (W^n), (W^m), ... formed as parts of the empty set $\emptyset$, Bounias has proved that the intersections of such spaces having non-equal dimensions give raise to spaces containing all their accumulating points forming closed sets. Therefore, our space-time becomes one of the mathematically optimum ones. And time is an emergent parameter indexed on non-linear topological structures guaranteed by discrete sets. In other words, the foundation of the concept of time is the existence of order relations in the sets of functions available in intersect sections.

The symmetric difference between sets and its norm can be treated as a new, more general, non-metric "distance". The generalized set distance as the extended symmetric difference of a family of closed spaces

$$\Delta(\mathrm{A_i})_{\mathrm{i}\in\mathrm{N}} = \complement_{\cup\{\mathrm{Ai}\}} \bigcup_{\mathrm{i}\neq\mathrm{j}} (\mathrm{A_i}\cap\mathrm{A_j}).$$

The complementary of Δ, i.e. $\cup_{i\neq j}(A_i \cap A_j)$, in a closed space is closed. As distances Δ are the complementaries of objects, the system stands as a manifold of open and closed subparts. Mapping of these manifolds from one to another section, which preserve the topology represent a reference frame in which the "analysis situ" - the original name for "topology" given by Poincaré - has allowed one to specify the changes in the configuration of main components: if morphisms are observed, then this enables the interpretation as a motion-like phenomenon, when one compares the state of a section with the state of mapped section. The research came him to the theorem: A space-time-like sequence of Poincaré sections is a non-linear convolution of morphisms.

Thus time is not a primary parameter. And the physical universe has no more beginning: time is just related to ordered perceptions of existence, not to existence itself. The topological space does not require any fundamental difference between reversible and steady-state phenomena, nor between reversible and irreversible process. Rather relation orders simply hold on non-linearity distributed topologies, and from rough to finest topologies.

One of the remarkable achievements of Bounias is the determination of relative scales in the empty-set lattice, i.e. the tessellattice. This allowed him to introduce intervals constructed from mappings $\mathcal{G} : \mathrm{N^D} \mapsto \mathrm{Q}$ of $(\mathrm{N} \times \mathrm{N} \times \mathrm{N} \times ...)$ in Q. It has been found that the size of structures is a function of iterations (n). At each step (ν_j) the ration of size in dimension D will be: $(\prod \nu_\mathrm{j})^\mathrm{D}$, so that the maximal will be

$$\rho \propto \left\{(\prod \nu_\mathrm{j})^\mathrm{D} (\prod \nu_\mathrm{j} - 1)^\mathrm{D}\right\}_{\mathrm{j}=1\to\mathrm{n}}.$$

The manifold $(\prod \nu_\mathrm{j})^\mathrm{D}$ is a Bourbaki-multipliable indexed on the integer section $\mathrm{I} = [1, \mathrm{n}]$. Predictable orders of size, from the Planck scale (the size of an elementary cell of the tessellattice, which can be estimated as 10^{-30} m), roughly comply with quark-like size (clusters with 10^{10} of elementary cells), atoms size (clusters embracing down to 10^{17} cells), human size (clusters including about 10^{28} cells) and then clusters that represent higher scale universes: stars and solar systems (10^{40-42}), etc. So, we can see that the universe suggests a quite different organization of matter at different scales.

It should be particularly emphasized that Bounias was very prejudiced against general relativity. Indeed, the geometry employed in the relativity, which does not involve the notion of mass in its mathematical formalism, is very far from those transparent ideas that were established by Poincaré for the comprehensive study of space, namely, topology that is based on such fundamental notions as point, distance and similitude. They were those elements which Bounias used in his sophisticated analysis of the constitution of space. He had planes to reconsider the phenomenon of gravitation starting from first (submicroscopic) principles, which would bring us to a new theory with a radically new postulates. The theory should describe all the phenomena predicted by general relativity, such as the motion of Mercury perihelion, the deviation of light ray by the sun, and the red shift. In this theory the major role will play the inner structure of space, i.e. its presentation in the form of the tessellattice with its proper cell structure. The conventional metrics of general relativity, as a phenomenological formal characteristic, is substituted for the set-distance and therefore the theory will deal with the distribution of the deformations of balls in the tessellattice. The first stage is the deriving of Newton's potential $1/r$ basing on the principles of motion of particles and field particles in the tessellattice. Next stages will deal with the interaction of objects in the tessellattice, which should result in the corrections to Newton's law formally revealed by general relativity... This is a short scheme of further studies designated by Bounias. Anyone can join to this intriguing line of research.

I am honored that I could work tightly with Michel Bounias in the area of the foundations of the fundamentals. Starting from topology, set theory and fractal geometry we have shown how the physical space generates particles (i.e., matter) and fields (matter field, called the inerton field, and the electromagnetic filed). Proceeding from first submicroscopic principles we could determine such basic notions as a particle, mass, distance, spin, charge, the reduction of mass and distance, etc. We introduced the notion of mass [12] and introduced the fractal decomposition principle. In other words, a local deformation of a cell of the tessellattice is able to allocate itself by a huge number of surrounding cells, which means the migration and so-called dispersion of the local deformation. Thus the exchange of structures revealed in the tessellattice exactly corresponds to the motion of "inertons", elementary excitations of the matter waves and carriers of the gravitational interaction previously introduced by the author in a series of works dedicated to the foundations of quantum mechanics.

We also examined the phenomenon of the electric and magnetic charges in the tessellattice [13]. It was argued that the phenomenon of charge is associated with the shape of a cell: protuberances on the cell surface corresponds to the positive charge and concavities are characterized the negative charge. The magnetic charge appears due to the motion of the electric charge and hence the motion of elements of its surface.

At last, our final conjecture that allows the solution of the Hubble expansion of the universe: cells in the tessellattice exhibit increasing volumes from the center to the periphery of a 3D stacking.

Bounias' last researches [10-14] clear the way to a deeper understanding the inner links dominating in the nature. He has introduced a radically new approach that for the first time allows us to look at the submicroscopic construction of the real space. This automatically redefines basic directions in the fundamental science and starts a radically new trend for those who travel on the path for the truth.

Bounias' scientific archive consists of files, journals, papers and books whose total weight reached 10 tons. He contributed much of his own resources in scientific literature and communicated with a huge number of scientists all over the worlds, which allowed him to hold his highest-level position in the fundamental science.

Michel Bounias had a big heart. Let he be remembered forever. It will be great if Bounias' rich scientific heritage inspires new generations of researchers paving the way to new productive discoveries in Science.

References

[1] M. Bounias. "A Theorem Proving the Irreversibility of the Biological Arrow of Time, Based on Fixed Points in the Brain as a Compact, Δ-Complete Topological Space," *American Institute of Physics' Conference Proceeding*, Symposium 8, pp. 20–24 (2000).

[2] M. Bounias. "La Création de la Vie: de la Matière l'Esprit." Editions du Rocher, Paris, 1990.

[3] A. Bonaly and M. Bounias. "A Topological Model for Fundamental Structures," *Ultra Scientist of Physical Sciences*, **5**, No. 2, 175–184 (1993).

[4] A. Bonaly and M. Bounias. "On Mathematical Links Between Physical Existence, Observability and Information: Towards a Theorem of Something," *Ultra Scientist of Physical Sciences*, **6**, No. 2, 252–259 (1994).

[5] A. Bonaly and M. Bounias. "Timeless Space is Provided by the Empty Set," *Ultra Scientist of Physical Sciences* **8**, No. 1, 66–71 (1996).

[6] A. Bonaly and M. Bounias. "The trace of Time in Poincare Sections of a Topological Space," *Physics Essays*, **8**, No. 2, 236–244 (1995).

[7] A. Bonaly and M. Bounias. "On Metrics and Scaling: Physical Coordinates in Topological Spaces," *Indian Journal of Theoretical Physics* **44**, No. 4, 303–321 (1996).

[8] A. Bonaly and M. Bounias. "Some Theorems on the Empty Set as Necessary and Sufficient For the Primary Topological Axioms of Physical Existence," *Physics Essays*, **10**, No. 4, 633–643 (1997).

[9] M. Bounias. "The Theory of Something: A Theorem Supporting the Conditions for Existence of a Physical Universe, from the Empty Set to the Biological Self," *International Journal of Computing Anticipatory Systems*, **5**–**6**, 1–14 (2000).

[10] M. Bounias. "On Spacetime Differential Elements and the Distribution of Biohamiltonian Components," *Spacetime & Subsrtance*, **3**, No. 1, 15–19 (2002).

[11] M. Bounias and V. Krasnoholovets. "Scanning the Structure of Ill-known Spaces: Part 1. Founding Principles About Mathematical Constitution of Space," *Kybernetes: The International Journal of Systems and Cybernetics*, **32**, No. 7/8, 945–975 (2003) (also http://arXiv.org/abs/physics/0211096).

[12] M. Bounias and V. Krasnoholovets. "Scanning the Structure of Ill-known Spaces: Part 2. Principles of Construction of Physical Space," *Kybernetes: The International Journal of Systems and Cybernetics*, **32**, No. 7/8, 976–1004 (2003) (also http://arXiv.org/abs/physics/0212004).

[13] M. Bounias and V. Krasnoholovets. "Scanning the Structure of Ill-known spaces: Part 3. Distribution of Topological Structures at Elementary and Cosmic Scales," *Kybernetes: The International Journal of Systems and Cybernetics*, **32**, No. 7/8, 1005–1020 (2003) (2003) (also http://arXiv.org/abs/physics/0301049).

[14] M. Bounias and V. Krasnoholovets. "The Universe from Nothing: A mathematical Lattice of Empty Sets," *International Journal of Anticipatory Computing Systems* (2004), ed. D. Dubois, in press (also http://arXiv.org/abs/physics/0309102).

Spacetime & Substance, Vol. 5 (2004), No. 1 (21), pp. 46–48

THE NUMERICAL CALCULATION FOR THE CONVECTIVE COVER OF THE SUN HAVING THE NULL CONDITIONS AT THE SURFACE

Emil Tatomir[1]

Universitatea Transilvania Brasov, B-dul Eroilor 29, Facultatea de Matematica si Informatica, Brasov, 2200, Romania

Received January 29, 2004

In this paper there is presented the way the integrated equations describe the structure of the convective cover. There are numerical results of the convective cover considering null conditions at the surface of the Sun.

1. Presentation of the Problem

There is considered a model of the Sun having the radiative nucleus and a convective cover. In (Tatomir, 2003) it is showed the way we have obtained the numerical results for the radiative nucleus.

For the whole convective cover of the Sun, there are considered to be true the equation of the hydrostatic equilibrium, the equation of the mass distribution and the adiabatic equation (see, e.g., Menzel and others, 1963; Aller and McLaughlin, 1965; Cox and Giuli, 1968).

$$\frac{dP(r)}{dr} = -\frac{GM(r)\rho(r)}{r^2};$$

$$\frac{dM(r)}{dr} = 4\pi r^2 \rho(r);$$

$$P(r) = K \cdot \rho^{\gamma}(r) \tag{1}$$

or

$$P(r) = K_1 \cdot T(r)^{\frac{\gamma}{\gamma-1}}$$

with $\gamma = \frac{5}{3}$ and the law of the perfect gas is considered to be true:

$$P(r) = \frac{k}{\mu \cdot H}\rho(r) \cdot T(r). \tag{2}$$

Using Schwarzschild's equations (Schwarzschild, 1958):

$$P(r) = p \cdot \frac{GM^2}{4\pi R^4};$$

$$T(r) = t\frac{\mu H}{k} \cdot \frac{GM}{R}; \tag{3}$$

$$M(r) = q \cdot M;$$

$$r = R \cdot x.$$

We apply these equations to system (1), where x, q, t, p are a dimensional variables. System (1) becomes:

$$\frac{dp}{dx} = -\frac{pq}{tx^2};$$

$$\frac{dq}{dx} = \frac{px^2}{t}; \tag{4}$$

$$p = E \cdot t^{2.5}$$

or

$$\frac{dt}{dx} = -\frac{1}{2.5E} \cdot \frac{pq}{t^{2.5}x^2}.$$

System (4) can be integrated using the null conditions for pressure and temperature at the surface of the Sun:

$$x = 1;$$

$$t = p = 0; \tag{5}$$

$$q = 1.$$

The mean molecular weight is given by:

$$\mu = \frac{4}{3 + 5X - Z}. \tag{6}$$

For the radiative nucleus (Tatomir, 2003), and also for the convective cover, there has been considered:

$$X = 0.709; \tag{7}$$

$$Z = 0.021$$

[1] E-mail: emil_tatomir@lycos.com

Table 1: The results for pressure P, the reduced mass q, temperature T and the density ρ,

x	P	q	T	ρ
1	0	1	0	0
0.998	$0.18122\cdot10^{-10}$	1	0.01130	$0.11921\cdot10^{-4}$
0.996	$0.81549\cdot10^{-10}$	1	0.02268	$0.26729\cdot10^{-4}$
0.986	$0.19481\cdot10^{-8}$	0.999997	0.08057	$0.17974\cdot10^{-3}$
0.976	$0.77109\cdot10^{-8}$	0.999989	0.13967	$0.41041\cdot10^{-3}$
0.966	$0.18928\cdot10^{-7}$	0.999977	0.19999	$0.70357\cdot10^{-3}$
0.956	$0.37023\cdot10^{-7}$	0.999959	0.26157	$0.10522\cdot10^{-2}$
0.946	$0.63436\cdot10^{-7}$	0.999934	0.31734	$0.14860\cdot10^{-2}$
0.936	$0.09964\cdot10^{-6}$	0.999901	0.38867	$0.19057\cdot10^{-2}$
0.926	$0.14715\cdot10^{-6}$	0.99986	0.45427	$0.24080\cdot10^{-2}$
0.916	$0.20760\cdot10^{-6}$	0.999811	0.52132	$0.29603\cdot10^{-2}$
0.906	$0.28268\cdot10^{-6}$	0.999753	0.58983	$0.35627\cdot10^{-2}$
0.896	$0.37421\cdot10^{-6}$	0.999684	0.65987	$0.42157\cdot10^{-2}$

representing the proportion of the hydrogen, respectively the abundance of the metals.

We introduce three new parameters:

$$U = \frac{d\log M(r)}{d\log r};$$
$$V = -\frac{d\log P(r)}{d\log r}; \qquad (8)$$
$$(n+1) = \frac{d\log P(r)}{d\log T(r)}.$$

After making the calculations in (8), we obtain:

$$U = 4\pi r^3\frac{\rho(r)}{M(r)} = \frac{px^3}{qt};$$
$$V = \frac{\rho(r)}{P(r)}\cdot\frac{GM(r)}{r} = \frac{q}{tx}; \qquad (9)$$
$$(n+1)_{conv} = 2.5.$$

2. The Numerical Solving of the Problem

Starting with the integration of the equations of the radiative nucleus (Tatomir, 2003) from center, it stops when $(n+1)_{rad} = 2.5$. In the point where the integration of the equation of the nucleus has stopped and where we fit the solution of the radiative nucleus with the one of the convective cover, we obtain the values (Tatomir, 2003):

$$U_0 = 0.0064; \qquad (10)$$
$$V_0 = 24.44.$$

We use for the system (4) the limit conditions (5). System (4) has a non-determination of the type $\frac{0}{0}$ for $x = 1$. Using the development in Taylor series around the point $x = 1$, there has been obtained:

$$p(x) = \frac{E}{(2.5)^{2.5}}\cdot(1-x)^{2.5} + ...$$
$$q(x) = 1 - \frac{E}{(2.5)^{2.5}}\cdot(1-x)^{2.5} + ... \qquad (11)$$
$$t(x) = \frac{1}{2.5}(1-x) + \frac{14E}{4+25E}(1-x)^2 + ...$$

From (11) we have obtained the values of the parameters p, q, t in a point around $x = 1$. Next, the integration of the system (4) is made using the Runge-Kutta method (see, e.g., Moszynki, 1973; Tatomir, 2003). We make integration choosing different values for the constant E.

In each point of integration x_i, we calculate $U(x_i)$ and $V(x_i)$. We integrate system (4) until:

$$V(x_i) < V_0. \qquad (12)$$

In the point x_i in which we apply (12), there is tested:

$$|U(x_i) - U_0| < \varepsilon_1, \varepsilon_1 = 10^{-5}. \qquad (13)$$

If the condition (13) is fulfilled, we consider the integration finished. If the condition (13) cannot be applied, we continue the integration of another value for E, value which we note E_1.

$$E_1 = E + h_1$$

if $U_0 - U(x_i) > \varepsilon_1$;

$$E_1 = E - h_1 \qquad (14)$$

if $U_0 - U(x_i) < -\varepsilon_1$.

At the beginning, we consider $h_1 = 0.2$, and if the condition (13) is not satisfied, we start a new integration of $\frac{h_1}{2}$. We consider:

$$x_i = 1 - i\cdot h. \qquad (15)$$

3. Results and Consultions

If we consider the null conditions (5) for pressure and temperature at the surface of the Sun, we obtain:

$$E = 0.89.$$

and in Table 1 there are given the results for pressure P, the reduced mass q, temperature T and the density ρ which correspond to the convective cover

In table 1, pressure P is calculated in units of $10^{18}\frac{dyne}{cm^2}$, the temperature T in units of $10^6\ {}^oK$, the density ρ in $\frac{gr}{cm^3}$, and q is the reduced mass.

We will compare the results that we have obtained in this paper with the ones from (Tatomir, 2003). In Table 2, there are given the results that we have obtained (Tatomir, 2003) in the fitting point x_i. In Table 3 there are given the values that correspond to the point x_i, using the null conditions at the surface of the Sun.

Table 2: The results that we have obtained (Tatomir, 2003) in the fitting point x_i

x_i	P	q	T	ρ
0.897	0.3639E-6	0.9997	0.6531	0.0041

Table 3: The values that correspond to the point x_i, using the null conditions at the surface of the Sun

x_i	P	q	T	ρ
0.896	0.3742E-6	0.99968	0.65987	0.0042

On the one hand, by comparing the results which have been presented in Table 2-3, we can conclude that the results that we have obtained in this paper concord well with the ones that have been obtained in (Tatomir, 2003) for the radiative nucleus.

The values of the constants that appear in this paper are:

$$G = 6.672 \cdot 10^{-8}\ cm^3 g^{-1} s^{-1};$$

$$R = 6.96 \cdot 10^{10}\ cm;$$

$$H = 1.6725 \cdot 10^{-24}\ gr;$$

$$M = 1.99 \cdot 10^{33}\ gr;$$

$$k = 1.3805 \cdot 10^{-16}\ \frac{erg}{K}.$$

References

[1] Aller L.H. and McLaughlin D.B.: 1965, Stellar Structure, University of Chicago Press.

[2] Burbridge G.R. and Burbridge E.M.:1958, Handbuch der Physik, V.5, P.251.

[3] Christensen-Dalsgaard J. - Berthomieu G.:1992, Solar Interior and Atmosphere, University of Arizona Press.

[4] Cox J.P. and Giuli R.T.: 1968, Principles of Stellar Structure, Gordon and Beach, New York.

[5] Haselgrove C.B. and Hoyle F.:1959, Mon. Not. Roy. Astr. Soc., 119, pp. 112.

[6] Kirsten T. and The Gallex Collaboration:1990, Inside the Sun, Kluwer Academic Publishers.

[7] Kurucz R.L.: 1991, Stellar Atmospheres, Beyond Classical Models.

[8] Menzel D. et al.: 1963, Stellar Interior, vol VI, Chapman and Hall Ltd. London.

[9] Moszynsky K., Numerical Methods of Solving the Ordinary Differential Equations, Technical Press, Bucharest (1973).

[10] Schwarzschild M.: 1958, Structure and Evolution of the Stars, Princeton University Press.

[11] Sears R.L.: 1964, Astrophys. J., V.140, P.477.

[12] Tatomir E.: 1986, Thesis, University of Cluj-Napoca.

[13] Tatomir E.: 2003, A Model of the Interior of the Sun, Spacetime and Substance, 1-16, International Physical Journal.

Spacetime & Substance
International Physical Journal

INFORMATION FOR AUTHORS

The Editorial Council accepts the manuscripts for the publication only in an electronic variant in the format for LATEX 2.09. They should be completely prepared for the publication. The manuscripts are accepted by e-mail or on diskettes (3.5"). The manuscripts can be adopted in other view only for familiarization.

The original manuscripts should be preferably no longer then 6 pages. They should contain no more than 4 figures. Length of the manuscript can be up to 10 pages only in exclusive cases (at arguing problems of primary importance). If the length of the manuscript exceeds 10 pages, it should be divided by the author into two or more papers, each of which should contain all pieces of a separate paper (title, authors, abstracts, text, references etc.). The Editorial Council accepts for the publication the brief reports too.

The payment for the publication of the manuscripts is not done. Each author gets the electronic version of that Journal edition, in which his paper was published free of charge.

An E-mail message acknowledging the receipt of the manuscript will be sent to the corresponding author within two working days after the manuscript receipt. If a message is not received please contact *krasnoh@iop.kiev.ua* to inquire about the manuscripts.

The Style File and Instructions for its use can be found at http://spacetime.narod.ru (sample.zip, 19 kb).

An abstract (within 20 lines) must be submitted. This one should be concise and complete regardless of the paper content. Include purpose, methodology, results, and conclusions. References should not be cited in the abstract. The abstract should be suitable for separate publication in an abstract journal and be adequate for indexing.

If the argument of an exponential is complicated or long, "exp" rather than "e" should be used. Awkward fractional composition can be avoided by the proper introduction of negative degrees. Solidus fractions (l/r) should be used, and enough enclosures should be included to avoid ambiguity in the text. According to the accepted convention, parentheses, brackets, and braces are in the order { [( )] }. Displayed equations should be numbered consecutively throughout the paper; the number (in parentheses) should be to the right of the equation.

Figures (black-and-while) should be of minimal size providing clear understanding. Breadth of the figure should not exceed 84 mm or 174 mm (in exclusive cases). Figures should be made out as separate files in the format of *.pcx (300 dpi/inch) or *.eps (minimum of kb).

Each figure must be cited in numerical order in the text and must have figure legend.

Tables should be typed as authors expect them to look in print. Every table must have a title, and all columns must have headings. Column headings must be arranged so that their relation to the data is clear. Footnotes should be indicated by reference marks [1], [2] etc. or by lowercase letters typed as superiors. Each table must be cited in the text.

The Editorial Council accepts also response on papers, published in the Journal. They should be no more than 1 journal page in length and should not contain figures but only to refer to the already published materials. But they can contain the formulas. The recalls are publishing in section "Discussion."

The list of references may be formed either by first citation in the text, or alphabetically.

Only works cited in the text should be included in the reference list. Personal communications and unpublished data or reports are not included in the reference list; they should be shown parenthetically in the text: (F.S. Jones, unpublished data, 1990).

The title of paper is permissible not to indicate. It is permissible to give only the initial page number of a paper. The format of the reference list is as indicated below.

References

[1] F.W. Stecker, K.J. Frost, *Nature*, **245**, 270 (1973).

[2] V.A. Brumberg, "Relativistic Celestial Mechanics", Nauka, Moskow, 1972 (in Russian).

[3] S.W. Hawking, in: "General Relativity. An Einstein Centenary Sutvey", eds. S.W. Hawking and W. Israel, *Cambr. Univ. Press*, Cambridge, England, 1979.

Read the Journal before sending a manuscript!

Spacetime & Substance Volume 5, No. 1 (21), 2004

CONTENTS

S.S. Sannikov-Proskuryakov. THE NEW COSMOLOGICAL MODEL **1**

Miroslav Súkeník and Jozef Šima. TIME AS A PHACE SPACE OF ALTERNATIVE REALITY **6**

Harry Yosh. STRUCTURE OF LEPTON **10**

Miroslav Pardy. THE SPACE-TIME TRANSFORMATIONS AND MAXIMUAL ACCELERATION **17**

S.S. Sannikov-Proskuryakov. WAVE MECHANICS ON THE BOHR'S COMPACT ... **23**

V.R. Terrovere. EXPLANATION OF SENSE OF RELATIVISTIC MECHANICS **29**

Rasulkhozha S. Sharafiddinov. MASS OF THE NEUTRINO AND ITS AXIAL - VECTOR ELECTROMAGNETIC NATURE **32**

Walter Cabrera-Febola. ON NATURAL STRUCTURES: THE UNIFICATION OF NATURE............ **34**

V. Krasnoholovets. MICHEL BOUNIAS AND HIS ROLE IN DEVELOPING A DEEPER KNOWLEDGE ABOUT REAL SPACE **42**

Emil Tatomir. THE NUMERICAL CALCULATION FOR THE CONVECTIVE COVER OF THE SUN HAVING THE NULL CONDITIONS AT THE SURFACE **46**