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New Perspective of Modern Physics – Neutrino oscillation and knocking on open doors of neutrino communication

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Abstract:

This publication says about new phenomena of Modern Physics – Neutrinics – particles called neutrinos. In introduction author says about his personal experience with this elusive and mysterious, subatomic particles, where he for the first time registered about this "phantom" of physics. He summarizes publications of authors or scientists, which influenced him to his interests in particle and nuclear physics. Author describes briefly principles of detection of neutrinos in underwater neutrino detectors, like AMANDA / ICE CUBE, ANTARES, Baikal, NESTOR, DUMAND and NEMO. Author of this article fills this text by his own pictures or figures of neutrino detection, transmission and oscillation. He lays the question like for example: "is neutrino unstable subatomic particle?" It's very difficult to integrate to the Standard Model. Author further put on description of neutrino transmission under leading physicist Daniel Stancil and the scientific group of physicists from State University of Northern Carolina, which in Fermilab successfully realized teleporting of onefold message – word "neutrino" with help of particles neutrinos on the distance 1 kilometer. Next mention is about neutrino cross efficient section, mixing angles and mixing matrix (nut) of neutrinos. Neutrino cross section according author of this text fluctuates between $\delta_{VN} = 10^{-42} m^2$ to $\delta_{VN} \cong 10^{-50} m^2$. Oscillations are here described with help of Pontecorvo, Maki, Nakagawi and Sakata matrix (nut). Extraordinary attention is devoted to Exciton theory. In the end could be said, that physicists are sure, that communication by intermediary neutrinos is principly possible.

Keywords:

Neutrinics, neutrinos, underwater neutrino detectors, neutrino detection, transmission and oscillation, neutrino cross section, neutrino mixing angles, neutrino mixing matrix (nut), Pontecorvo, Maki, Nakagawi and Sakata matrix (nut), neutrino telecommunication, exciton theory.

Contents:

1. Introduction

For the first time I registered the concept of neutrino in science-fiction literature - space opera by Arthur C. Clarke's "The Songs of Distant Earth" (1993), when I was sixteen and I had not yet got presentiment about depth of continuity with modern disciplines of physics, by this occasion I introduce at least someone, for example superknown experiment of Raymond Davis, Jr. and John Bahcall situated in golden mine in Homestake (South Dakota) U.S.A. The second remembrance for my experience with neutrino was study seminary (mathematical-physical) in Secondary School Eko-gymnázium, Street

Labská 27, Brno, when I read the popular-science journal Vesmír, where was an article from Prof. Ing. Jiří Niederle, DrSc. with name: “Nobel Prize for Physics 1995: “For Detection of Neutrino and Lepton Tau.””

From 1995 till 1998 I visited many presentations and lectures in Brno's Observatory on Cow Mountain 2, where was director excellent Associate-Professor Dr. Zdeněk Pokorný, CSc., he led me to study Astronomy.

In 1998 I began to collaborate in problems of neutrino with physicists from Department of Theoretical Physics and Astrophysics at Faculty of Science, MU Brno, Kotlářská Street 2. Associate-Professor Dr. Petr Burcev, CSc. dedicated me the publication “Elementary Particles” from Dr. Antonín Vančura, CSc., Academia Praha 1970, 128 p.

From 1998 to 2004 I regularly visited Brno's Observatory on Cow Mountain 2, lectures ŽEŇ OBJEVŮ (THE HARVEST OF DISCOVERIES) by Dr. Jiří Grygar, CSc. and Atomic Physicist Dr. Vladimír Wágner, CSc. From Czech Academy of Science.

In 1998, I also read very successful book from American-Poland Scientist-Astronomer-Astrobiologist Prot. Carl Sagan: “Cosmos”, and I read publication from Prof. Dr. Vanýsek, DrSc. : BASICS OF ASTRONOMY AND ASTROPHYSICS.

From my gained information from recently time is it for example Facts and mysteries in elementary particle physics, Veltman Martinus, Academia Praha 2007, 288 p.

And the last book, which I read is from Frank Close: “NEUTRINO”, 2012, 181 p.

2. Selected Underwater Neutrino Projects and Principle of Detection of Neutrinos

Detection of high energy neutrinos under water, used the water in sea or lake.

Principle:

1. Interaction of neutrino with nucleus of hydrogen or oxygen.
2. Production of muons and electrons.
3. Generation of Cherenkov light during the flight arisen particles.
4. Detection of Cherenkov light by photomultipliers

Water Detection Neutrino Projects:

2.1 ANTARES

(Mediterranean Sea, Europe) - 25 km on the south of Marseille (France) – the biggest submarine detector of high energy neutrinos. Detector is situated on the area 0.1 km^2 in the depth of 2.5 km below surface of the sea. Probably 1 000 photomultipliers have waited for authentic messengers from remote Universe.

2.2 AMANDA / ICE CUBE

AMANDA (ANTARCTIC MUON AND NEUTRINO DETECTOR ARRAY)

The Ice Cube telescope uses the crystal-clear ice of the South Pole to look for the signatures of high-energy cosmic neutrinos, elusive particles produced in violent cosmic events, such as colliding galaxies, distant black holes, quasars, and other phenomena occurring at very margins of the Universe. With its detector volume of one cubic kilometer, Ice Cube will dwarf existing neutrino detectors and become the

largest particle detector ever built. It will be 30 times larger than its predecessor telescope AMANDA, around which it is being built. AMANDA in turn is already 30 times bigger than the famous Super-Kamiokande neutrino detector located in Japanese mine. Since 1997, AMANDA has detected more than 4 000 neutrinos. Lake Vostok, the giant lake trapped under thousands of meters of Antarctic ice. Lying 4 kilometers beneath the Russian Antarctic field station, with a surface area of around 14 000 square kilometers, Lake Vostok is the largest and deepest subglacial lake ever discovered.

Scientists hope to discover unique life forms in the water that could hint at what kind of life may be lurking in ice-covered bodies of water elsewhere in the Solar System, such as those on Jupiter's Galileos moons Europa, Ganymed and Callisto.

Source: Ice Cube: "Big stain in the middle is our Moon, which shades cosmic rays from Universe …"

Evidence for High-Energy Extraterrestrial Neutrinos at the Ice Cube Detector in Antarctica is significant. As protons and nuclei are accelerated, they interact with gas and background light near the source to produce subatomic particles such as charged pions and kaons, which then decay to muons, emitting neutrinos.

Finally of an all sky search for these neutrinos at energies above 30 TeV in the cubic kilometer Antarctic Ice Cube observatory between May 2010 and May 2012.

2.3 BAIKAL EXPERIMENT

Main results obtained with neutrino telescope NT 200 (BDUNT) – "in the Baikal deep underwater neutrino telescope" is situated deepest in the world - cryptodepression 1625 m depth of the lake.

The Baikal neutrino telescope NT 200 has been taking data since April 1998. The Baikal survey for high-energy neutrinos searches for bright cascades produced at the neutrino interaction vertex in a large volume around the neutrino telescope.

The upper limit obtained for a diffuse $(\nu_e + \nu_\mu + \nu_\tau)$ flux with E^{-2} shape is
$E^2\Phi = 8.1 x 10^{-7}\ cm^{-2}s^{-1}sr^{-1}GeV$.

The limits on fast magnetic monopoles and on $\overline{\nu_e}$ flux at the resonant energy 6.3 x 10^6 GeV are presently the most stringent.

To extend the search for diffuse extraterrestrial neutrinos with higher sensitivity, NT 200 was significantly upgraded to NT 200+, a detector with about 5Mton enclosed volume, which takes data since April 2005. The three-year sensitivity of NT 200+ to the all-flavor neutrino flux is approximately
$2 x 10^{-7}\ cm^{-2}s^{-1}sr^{-1}GeV$ for $E > 10^2\ TeV$.

In parallel with exploiting NT 200+ was started research and development activities towards a Gigaton volume detector in Lake Baikal.

2.4 DUMAND

(Deep Underwater Muon and Detector Project) existed from 1976 through 1995. The goal was the construction of the first deep ocean high-energy neutrino detector, to be placed at 4 800 m depth in the Pacific Ocean off Keahole Point on the Big Island of Hawaii. There was measured the cosmic ray muon flux in the deep ocean.

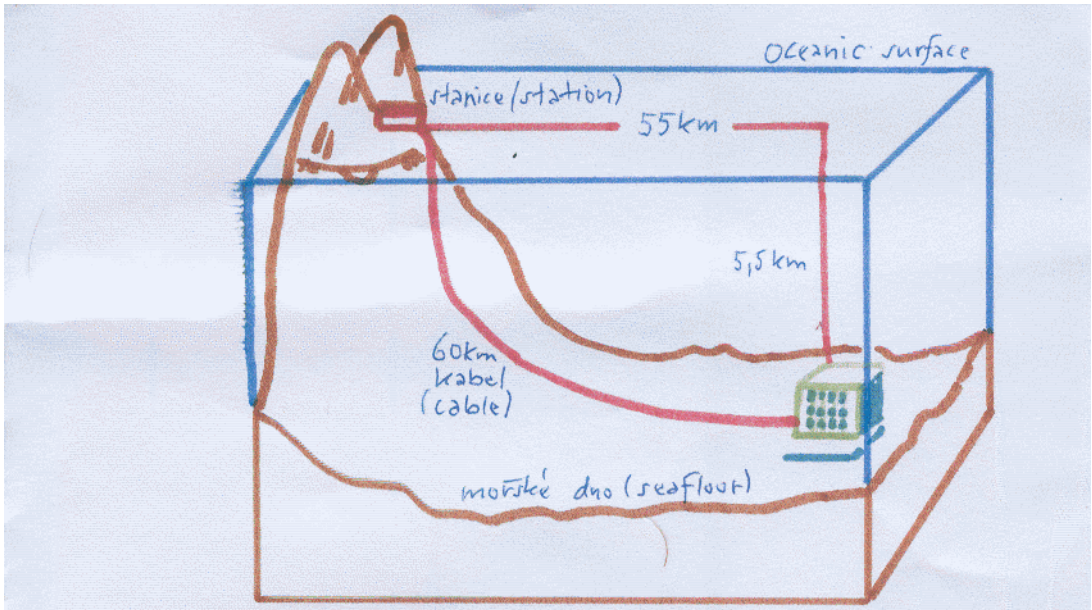

Fig. 1. Localization of detectors neutrino's project DUMAND near Hawaian Islands (Krištof, I. according journal Empire of the stars)

The Deep Underwater Muon and neutrino Detection (DUMAND) Project existed from about 1976 through 1995.

2.5 NEMO

NEMO (THE NEUTRINO ETTORE MAJORANA OBSERVATORY)
NEMO 3 / SUPERNEMO – INTERNATIONAL COLLABORATION)
NEMO (NEUTRINO MEDITERRANEAN OBSERVATORY)
NEMO PROJECT (UNDERWATER CHERENKOV NEUTRINO DETECTOR)

After nearly 8 years of running at the Fréjus Underground Laboratory (LSM) and about effective years of data collection, the NEMO3 experiment was stopped on Tuesday January 11th, 2011. LSM in Modane (Savoie, France) is a very low radiation backsized detector.

2.6 NESTOR

(NEUTRINO EXTENDED SUBMARINE TELESCOPE WITH OCEANOGRAPHIC RESEARCH)

The Greek National NESTOR INSTITUTE FOR DEEP SEA RESEARCH, TECHNOLOGY AND NEUTRINO ASTROPARTICLE PHYSICS has been operating for several years and has its headquarters at Pylos in Navarino Bay: 300 km South of Athens. Nearby is the Hellenic trench, the deepest point in Mediterranean Sea.

At these depths the goal is to deploy 4 km high towers of optical modules. To support these towers of optical modules and provide a staging post for the experiment, NESTOR is developing the Delta Berenike ballasted floating platform being made for the NESTOR - underwater detector, the 60 m triangular platform (hence Delta) with an array of photodetectors. In the deepest point in Mediterranean Sea (Depth 5 200 m).

Berenike was the wife of Ptolemy III. and Coma Berenikes is a galaxy in the Bootes Constellation.

2.7 Explanation of Cherenkov Light on example LSND, (U.S.A.)

LSND (Liquid Scintillator Neutrino Detector, U.S.A.)

LSND Detector, located probably 30 m from source of neutrinos was built by cylinder filled with 167 tones of mineral oil and small quantity of organic scintillator – oil has higher refraction index than the water, therefore in oil is lower energy threshold for genesis of Cherenkov light. Walls of cylinder had covered photomultipliers, which detect partly Cherenkov light of electron and muon.

Source: University of Alabama, U.S.A.

Cherenkov light (radiation)

In surroundings with relative refraction index n > 1 electron could may, but other charged particle with velocity βc, moving faster than is expanding of electro-magnetic radiation in these surroundings.

Mach light cone of radiation behind fast moving charged particles is named Cherenkov radiation.

Was named according Russian physicist PAVEL CHERENKOV, who like the first described this superrelativistic effect.

Theoretical explanation of this phenomenon described in 1937 Soviet scientists ILJA FRANK and IGOR TAMM. Whole trinity gained Nobel Prize for Physics in the year 1958.

3. Review of neutrino's masses during the oscillations, Is neutrino unstable?

Because neutrinos and antineutrinos are neutral particles, is possibly, that have gone about identically particles.

Each particle individual partner has supersymmetrical partner - Majorana's neutrinos, according to the Italian scientist ETTORE MAJORANA.

Neutrino Masses During the Oscillations

Review of Neutrinos	Symbol	Mass
Fermion		
	Electron Family	
Electron neutrino	ν_e	< 2.5eV
Electron antineutrino	$\overline{\nu_e}$	< 2.5 eV

1 eV (electronvolt) is approximately 1.8 x 10^{-33} g is approx. 1.602 176 565 x 10^{-19} J is approx. 593km.s^{-1}.

From Russian and German measurements of spectrum β Tritium, is evident, that neutrino had has masses approximately about 2.3 eV.

	Muon Family (Family of heavy electron)	
Muon neutrino	ν_μ	< 170 keV
Muon antineutrino	$\overline{\nu_\mu}$	< 170 keV
	Tauon Family (Family of superheavy electron)	
Tauon neutrino	ν_τ	< 18 MeV
Tauon antineutrino	$\overline{\nu_\tau}$	< 18 MeV

According Eidelman (2003): "is number of types of light neutrinos (about masses < 1 MeV) = 2.984 ± 0.008 ."

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Heavy and superheavy neutrinos (masses about > 1 MeV) and sterile neutrinos are observed at superaccelerators like LHC (Large Hadron Collider) IN CERN and in the dark matter or dark energy in Universe.

If the whole masses of all 3 types of neutrinos get over 50 eV (to one neutrino), in the Universe will be maybe so much matter, that the Universe have led to collapse or new oscillation from Big Bang to Big Crunch.

This border could be suppressed with supposition, that neutrino is unstable?

However this will be very difficulty to integrate to the Standard Model. In the ending part of tunnel of superaccelerator LHC (Large Hadron Collider) is located, so called "Beam Stopper", which have absorbed all particles except neutrinos.

On these cause is possibly to make muon neutrino beam ν_μ with energies approximately 19 GeV (Gigaelectronvolt), which is very pure.

4. Neutrino Cross Efficient Section (Cross Section), Mixing Angles, and Mixing Matrix (Nut)

NEUTRINO CROSS SECTION DURING INTERACTION WITH NUCLEON $\delta_{VN} = 10^{-42}\ m^2$ WITH AVERAGE DENSITY OF EARTH BODY ρ is approx. 5 500 kg.m^{-3} $\Rightarrow\ \nu_e + n \rightarrow p + e^-$

According: www_ucjf.troja.mff.cuni/~zdrahal/…

$\delta_{VN} = 10^{-50}\ m^2$ depends on increasing energy of particle.

According: Mikulášek, Z. (1999): Introduction to Astrophysics, Masaryk University Brno, 195 p.

Oscillation of Neutrinos

During the weak interaction neutrinos have arisen, so called proper states (flavours) ν_e, ν_μ, ν_τ particles, which we observed, they are combinations, so called masses of proper states. Mixing is going according matrix (nut) P_{PMNS}, which is named to the memory of discoverers B. Pontecorvo, Maki, Nakagawi and Sakata:

$$\begin{pmatrix} \nu_e \\ \nu_\mu \\ \nu_\tau \end{pmatrix} = \left(P_{PMNS}\right) \cdot \begin{pmatrix} \nu_1 \\ \nu_2 \\ \nu_3 \end{pmatrix}$$

For easily understanding we could have imagine 2 sorts of neutrinos (2 Flavours), ν_e, ν_μ and 2 own states ν_1, ν_2, which are together connected by unitary nut (matrix) **U**.

$$\begin{pmatrix} \nu_e \\ \nu_\mu \end{pmatrix} = \begin{pmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{pmatrix} \cdot \begin{pmatrix} \nu_1 \\ \nu_2 \end{pmatrix} = U \cdot \begin{pmatrix} \nu_1 \\ \nu_2 \end{pmatrix}$$

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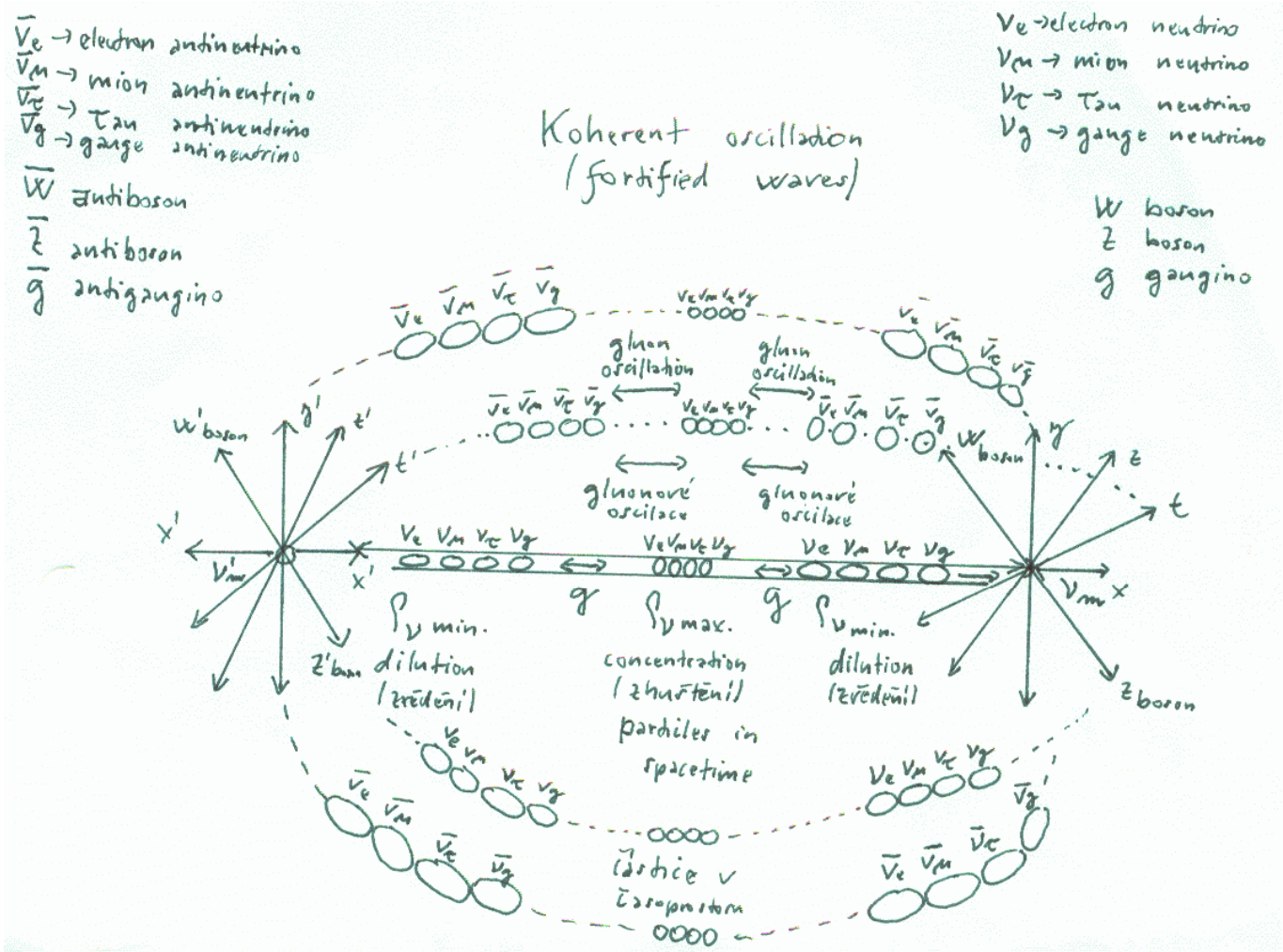

Fig. 3. Principle of superposition of states of neutrino's entit's in spacetime / "OSCILLATION OF NEUTRINOS" in Majorana intention according author this article I. Krištof, Mgr.

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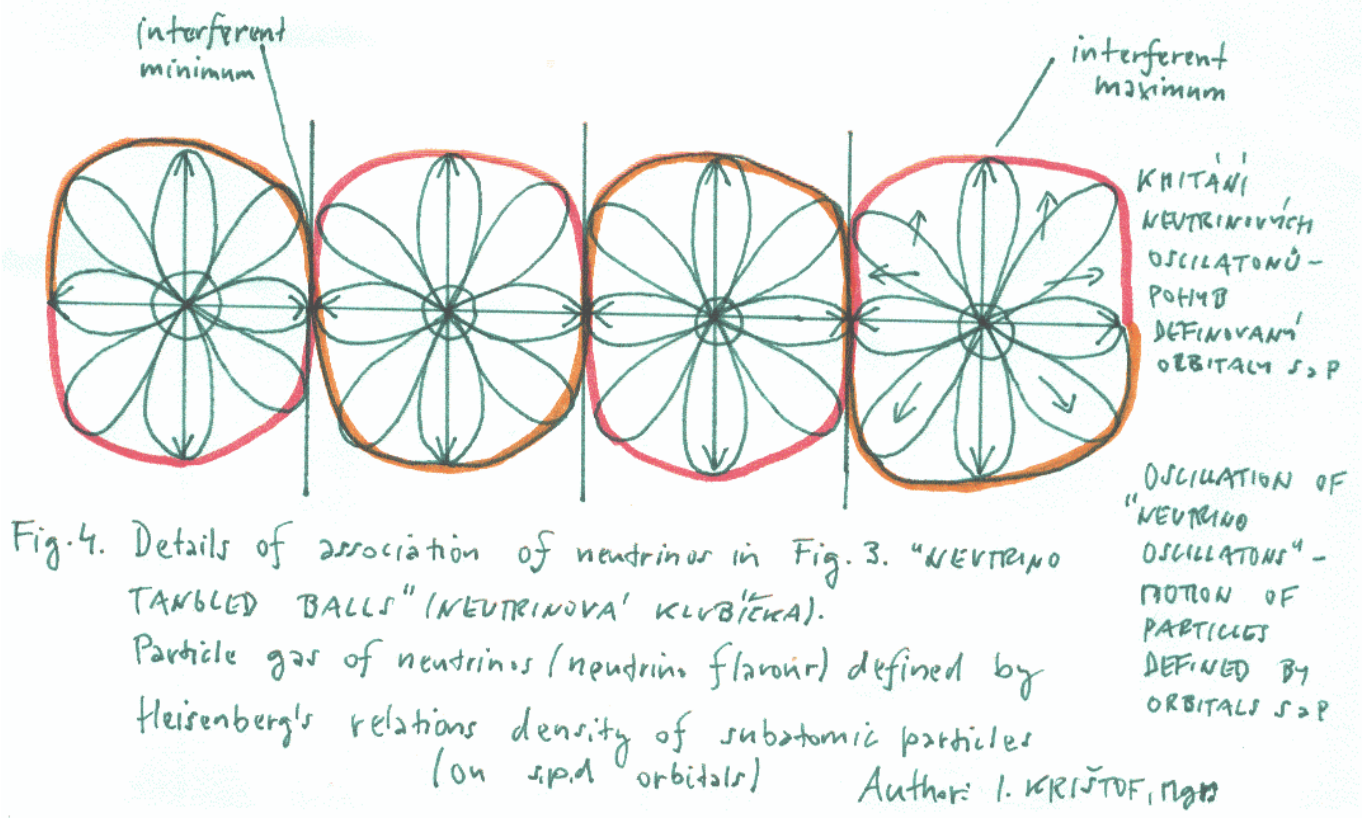
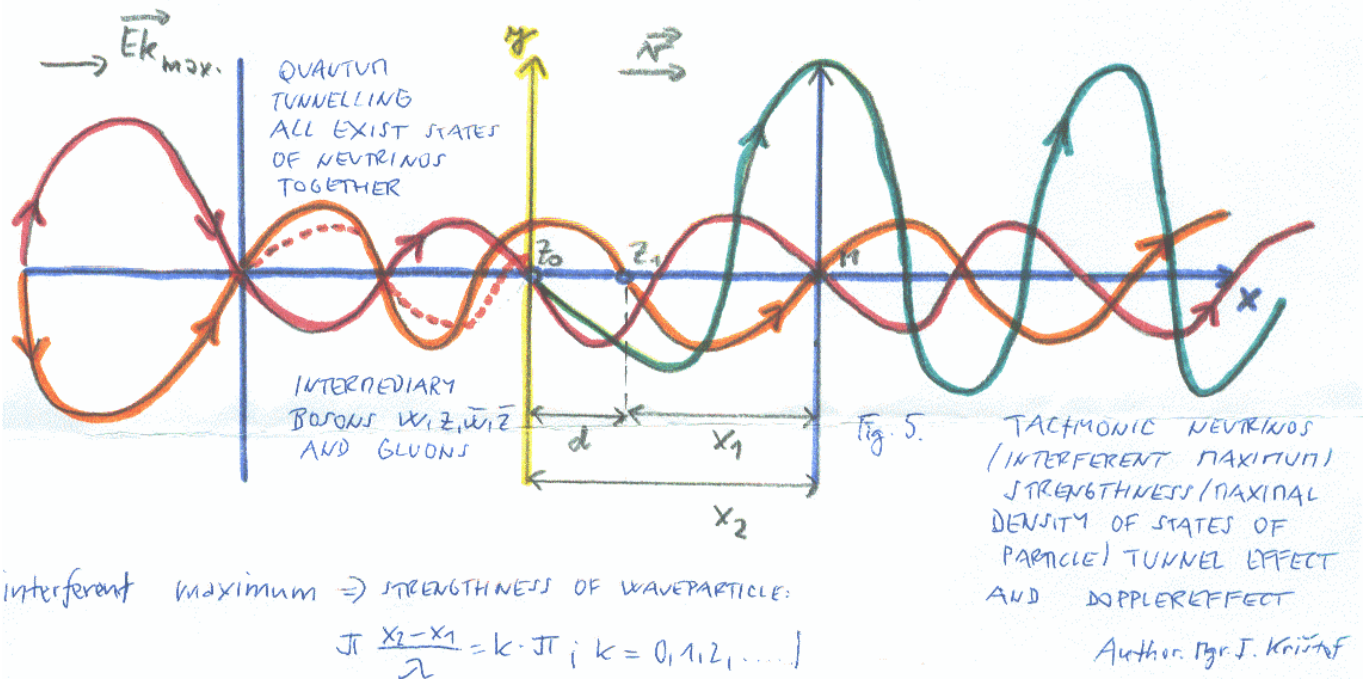


Strenghtness and Weakness of Vibrations of Particles Called Neutrinos

Neutrinos Almost not Surrendered on Effects of Electro-magnetic Fields

Then the wavelength $\lambda = v \cdot T = \frac{v}{f} = \frac{2\pi v}{\omega}$, where v is phase's velocity of waveparticle and T is period.



interferent maximum → strenghtness of waveparticle

$$\pi \frac{x_2 - x_1}{\lambda} = k \cdot \pi ; (k = 0,1,2,...)$$

interferent minimum → $d = (2k+1)\frac{\lambda}{2} ; (k = 0,1,2,3,...)$, where d is difference or remainder

conditions of coherence → constant trajectory remainder $d = |x_2 - x_1|$

→ constant phase's remainder $\Delta\varphi = 2\pi \frac{x_2 - x_1}{\lambda} = \Delta\varphi = 2\pi \frac{d}{\lambda}$

$\Delta\varphi \sim d$

Application of coherence of neutrinos according author of this publication:

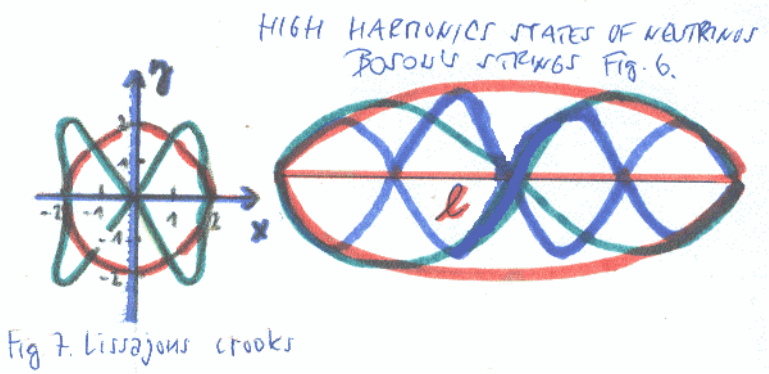
Is the NEUTRINO HOLOGRAM

Dopplereffect by braking and accelerating of neutrinos!

SUPERSTRING (HETEROTIC) THEORY → HIGH HARMONIC STATES OF NEUTRINOS BOSON'S STRINGS

High harmonic vibration esthetic shaped French physicist Jules-Antoinne Lissajous

Application: measuring and study of frequency



Daya Bay Collaboration (China) was measured mixing angle θ_{13} (THÉTA 13) with energy spectrum:

$$\sin^2(2\theta_{13}) = 0.090 \pm \begin{matrix} 0.009 \\ 0.009 \end{matrix}$$

At the Neutrino 2014 Conference they showed a result using 621 days of data:

$$\sin^2(2\theta_{13}) = 0.084 \pm 0.005$$

Mixing Nut (Matrix) in essence rotation in plane (Planary Rotation) about Angle θ Théta, is called Mixing Angle θ (Fig. 8)

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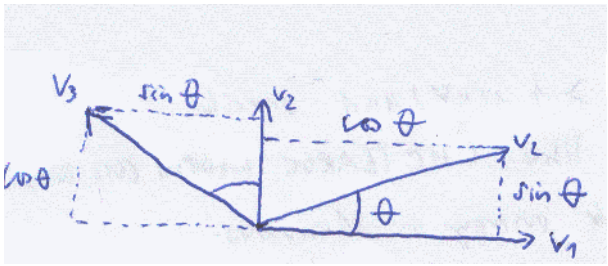
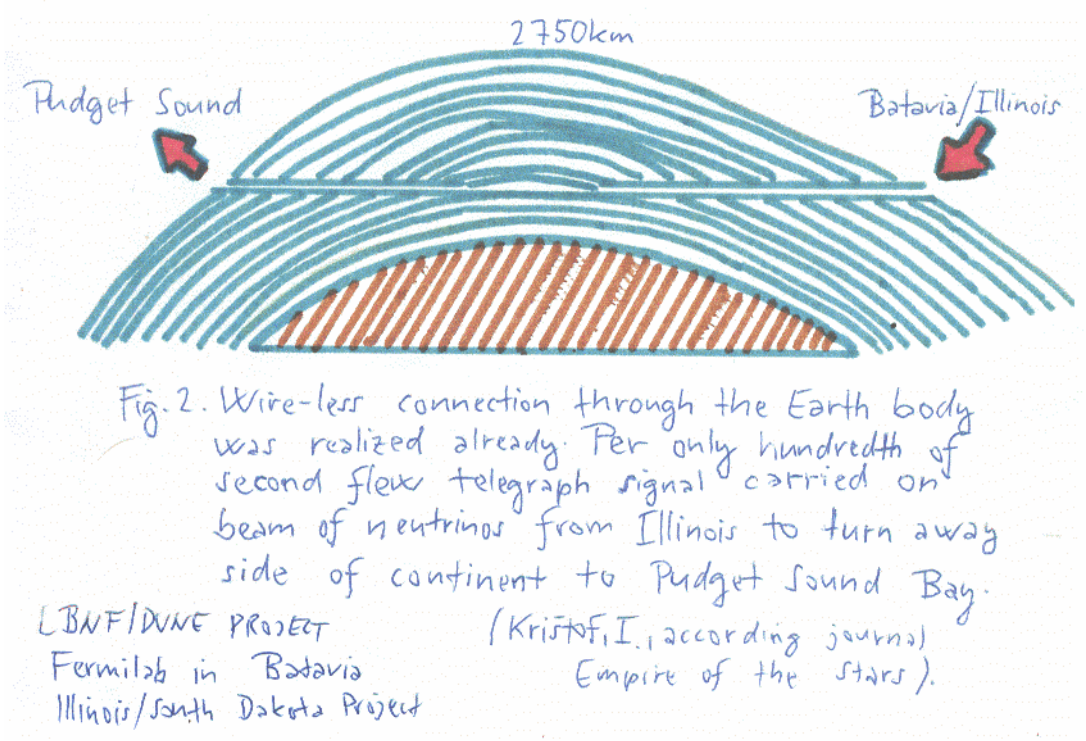


Fig. 8. Mixing Angle θ

5. Knocking on Open Doors of Neutrino Telecommunication

Neutrino particles will be ideal medium for teleporting information in surroundings, where couldn't propagate electro-magnetic signal – for example – underwater, in the core of Sun, in the core of the Earth or inside of the Earth body or other planet's body of Solar System, across whole Galaxies and so on.



Considering to very weak interaction of neutrino with matter, it could have disposition to this communication very massive beams of neutrino particles and very massive detectors.

Teleporting of the messages by the neutrinos is therefore music of distant future.

In March 2012 was performed the first step to neutrino telecommunication. The scientific group of physicists under leading of Daniel Stancil, from State University of Northern Carolina were in Fermilab and successfully realized teleporting of onefold message – word “neutrino” with help of particles neutrinos on the distance 1 kilometer, from this way 240 metres led through the Dolomite rocks surroundings. Velocity of transmission was only 0.1 bits per second and fault of transmission was 1%.

Physicists are sure by these opinions, that communication by intermediary neutrinos is in principle possible.

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6. Exciton Theory

6.1 Introduction to Exciton Theory

According to singleelectron stripe theory is in dielectricum or own semiconductor by temperature T = 0 K valency stripe completely filled by electrons and conduction stripe is empty. Absorption of photon with energy sufficiently to transfer of electrons through the forbidden stripe on levels in conduction stripe be hence to be pursued by genesis of vacant bearing of current - electron and hole. Dependence on coefficient of absorption on energy of photon (absorption edge) be in this simple model not present softness structure.

Even of these conclusions many experiments confirmed, other showed, that sometimes is possibly absorb photon, without genesis of vacant electron and hole, it is photoconduction. Like showed WANNIER (and MOTT), in this case between negative electron and positive hole have stayed electrostatic connection, in this way bounded pair has created new, electrically neutral quaziparticle – exciton – spreading with defined kinetic energy by graduallized motion and quaziimpulse.

In addition to has have inner motion too, resembled atom of hydrogen.Transitions on reacting system of energy levels of hydrogen type (which may have lay in forbidden stripe, too) then may have led to genesis of hypersoftness structure of absorption edge.

In common semiconductors with small effectively masses of electron and holes and greatly big permittivity may have been radius of 1st orbit of relative motion of electron around the hole equal up to tens of latticed distances (for example in Ge it is approximately 4 nm).

Insertion of permittivity is in these cases acceptable, because electron is influenced by central potential of lattice in zone, which orbit walks on.

6.2 Frenkel's Exciton (Exciton with Small Radius)

In historical context predecessed idea of Wannier. Frenkel's exciton is better visible formal relatives with problem of spin waves and magnons.

6.2.1 Frenkel's Exciton in Molecular Crystals

Because to us is going only about perception typically features of solution, we will reduce to simple model: set of N identically atoms with one valent electron localized in lattice points Born-Kármán's elementary zone of any Bravais lattice. Let $\mathbf{H^0}$ is hamiltonian of isolated atom. His norm own functions marked $\varphi f(r)$, resp. $|f\rangle$ and belonging to energies ε_f (f = 0 belonging to elementary state, f = 1,2,… of excited states); ail energy levels (f = 0,1,…) suppose non-degenerative. Spin's part of wave function will not be accepted. In summary then is valid

$$H^0\varphi f(r)=\varepsilon f\varphi f(r),\quad resp.\ H^0|f\rangle=\varepsilon f|f\rangle \qquad (6.2.1.a)$$

$$\langle f'|f\rangle=\int \varphi^*_f,(r)\varphi f(r)d^3r=\delta_{ff'}\ . \qquad (6.2.1.b)$$

From atoms we created static (non-oscillating) Bravais lattice with Hamiltonian

$$H=\sum_m H^0_m(r_m)+\frac{1}{2}\sum_{\substack{m,n\\ m\neq n}} V_{mn}\ , \qquad (6.2.2)$$

where H_m^0 is H^0 for atom localized in lattice point T_m and $V_m = V(R_{mn}, r_m, r_n)$ is interaction energy between atoms in points T_m, T_n. Between neutral molecules is it at the first approximation dipole-dipole interaction

$$V_{mn} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{R_{mn}^3}\left(r_m \cdot r_n - \frac{3(r_m \cdot R_{mn})(r_n \cdot R_{mn})}{R_{mn}^2}\right). \qquad (6.2.3)$$

The right wave function - exciton's wave is

$$\left|\Psi_k^{(1)}\right\rangle = \frac{1}{\sqrt{N}}\sum_p e^{ik\cdot T_p}\left|\Psi_p^{(1)}\right\rangle, \qquad (6.2.4)$$

where k is vector gained N values.

Excitons as the same as other group excitations are hence bosons. Is possibly defined exciton creation and annihilation operators tau, and pre-transformed hamiltonian.

6.3 Wannier's Exciton (Exciton with Large Radius)

We come out from orthonormal system of Bloch's functions $\Psi_{k.n}(r)$ (spin we have not respected). With these functions have had hamiltonian in representation of engaged numbers form:

$$H_B = \sum_{n,k} E_n(k) c_{k,n}^+ c_{k,n} . \qquad (6.3.1)$$

where $c_{k,n}^+$ $(c_{k,n})$ is creation / annihilation operator of electron in state $\Psi_{k,n}(r)$.

Substitute for valence stripe n→V and for conductivity stripe n→L and mark $\left|\psi_Z\right\rangle$ wave function of elementary state with filled up valence stripe and empty conductivity stripe. Then

$$\left|\psi_{k,k}^{(1)}\right\rangle = c_{k,l}^+ c_{k:v}\left|\psi_z\right\rangle \qquad (6.3.2)$$

is wave function of state with vacant electron and hole.

In next phase of calculation add to hamiltonian (6.3.1) electrostatic interaction V between electrons and own function of spreaded (multi electron) hamiltonian.

$$H = H_B + V$$

Find like linear combination of functions (6.3.2), i.e.

$$\left|\Psi^{(1)}\right\rangle = \sum_{k,k'} a_{k,k'}\left|\psi_{k,k'}^{(1)}\right\rangle . \qquad (6.3.3)$$

Substitution to Schrödinger equation with hamiltonian H get system of algebraic's equations for coefficients $a_{k,k'}$. For small k, k' is according Wannier possibly transfer them to equation formal identically with Schrödinger equation for two quaziparticles – electron and hole with mutual electrostatic interaction.

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6.4 Significance of Excitons in Solid Materials

Fundaments of Theory of excitons were layed in thirties years of 20 century by FRENKEL, MOTT, PEIERLS and WANNIER. From this time was theory greatly developed, enriched about the row of new features and particularly in last few decades was submitted and many-sided, even though still not yet exhausting experimental tested.

It turned out, that beside already traditionally interpretation of absorption's spectres could have excitons played great role during explanation of luminescence, photoconductivity and photoemission.

6.5 Electron-phonon interaction

6.5.1 Interaction Hamiltonian

Into the most common express of electron-phonon interaction belong without contest non-zero's electric resistence, into the most surprised then transition some materials to supraconductivity state.
If the adiabatic approximation is a good sketch, then must have to be possibly to managed a basic express of electron-phonon interaction using the defect calculation. To this problem is however necessary to have find interaction hamiltonian.

6.5.2 Fröhlich Interaction Hamiltonian

$$H_{e-f} = \sum_{k}\sum_{q}\sum_{j=1}^{3} M_{k,q,j}\left[a^{+}_{-q,j} + a_{q,j}\right]c^{+}_{k+q}c_{k} \,. \qquad (6.5.2.1)$$

In order to work we made onefold, we confine to models, in which existed pure longitudinal and transversal elastic waves. Electrons in them, namely interacted only with longitudinal acoustic wave, because for transversal waves is $q \cdot e(q,TA)$ and also $M_{k,q,j}$ is equal to zero. We forget it, polarization index j and relevant sum in (6.5.2.1) let out and will write:

$$H_{e-f} = \sum_{k}\sum_{q} M_{k,q}\left[a^{+}_{-q} + a_{q}\right]c^{+}_{k+q}c_{k} \,. \qquad (6.5.2.2)$$

7. Conclusions

This proposed publication may have illustrated and explanated in the last few decades frequently discussed questions, mysterious, explanation and finally most important applications of super high-tech research of genesis, transformation, oscillation, detection and many physical, technical and scientific applications.

For example, the fact, that neutrinos masses are non-zero's (have oscillated) is for whole Modern Physics and namely for Cosmology very relevant, namely too for particle physics and cosmological physics, connected with Standard Model (elementary particles, dark matter, dark energy and inflation theory).

If the masses of all 3 or 4 types of neutrinos get over 50 eV, in the Univere will be maybe so much matter, that the Universe have led to collapse or new oscillation from Big Bang to Big Crunch (OSCILLATION AND INFLATION UNIVERSE THEORY).

Author of this article (text and figures) struggles for better theoretical and practical understanding of oscillation and detection of neutrinos and position of neutrinos in Standard Model.

Maybe the most significant application of neutrino oscillation will be used in wire-less telecommunication in the future centuries, because neutrino probably will be ideal medium for teleporting of information.

Physicists are sure by these opinions: “that communication by intermediary neutrinos is in principle possible”.

Fortunately the great water neutrino projects like DUMAND, ANTARES, BAIKAL AND NESTOR HAVE NOT ONLY COSMOLOGICAL OR PHYSICAL SIGNIFICANCE, BUT TOO OCEANOGRAPHICAL, GEOLOGICAL, GEOPHYSICAL. Not small importance will have neutrinos in medical diagnostics and non invasive operations like nowadays PET (POSITRON EMISSION TOMOGRAPHY).

Is possibly to say, that next three centuries will be connected with understanding and applying this magical particles to everyday technical or scientific practice of future days (probably like NEUTRINICS). Is the most surely too, that Nobel Prize for neutrino research and application will be awarded to many scientists, many times in future.

In the final part of this article author has dedicated many space to theoretical explanation of boson-fermion interaction of subatomic particles or quaziparticles like exciton, phonon, electron, electron neutrino with special matter, for example with semiconductor Germanium (physical appearance “photoconductivity”). This medium (Ge) is used in Neutrino Project SAGE (SOVIET-AMERICAN GALLIUM-GERMANIUM EXPERIMENT) in valley of Baksan Caucasus.

8. References

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