

“Charm (ν_C) and Beauty (ν_B) flavour of neutrinos and very probably “colours” of neutrino resonances and their Helicity, Polarisation, Cross Section, Mixing angles and Non–Abelian Gauge fields of neutrinos“

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Abstract: This paper according to the Author’s insight to the particle physics brings the next new conception and new point of view on neutrinos, their aroma respectively “flavor” or “colours”, their resonances, helicity, polarization, cross section, mixing angles, and new maths concept of Non–Abelian Gauge Fields of neutrinos.

Aroma or “flavor” and colour of Non–Zero Masses Particles, called neutrinos, their resonance and interference in “Deep Inelastic Scattering” of leptons and neutrinos as their leptonic particles mainly of TAUON, Lepton τ (TAU) NEUTRINO IN SLAC (STANFORD LINEAR ACCELERATOR), here in 1967 Wolfgang Panofsky achieved detection of extraordinary high energy of electron and “superheavy electron” TAUONS RESONANCES APPROXIMATELY ABOUT 18 GeV.

Colours of Neutrinos ordered this particles among very similar to quarks, its extraordinary property is connected with Quark–gluons plasma, which “breathes” this super density state of matter, from full empty vacuum, so called The Hidden Energy of Quantum Vacuum.

On the Day Theme is:

- WHAT ARE IN EMPTY SPACES?
- WHAT EASY IS EMPTY SPACE?
- DOES ANYTHING EXIST IN A VACUUM STATE?
- HOW MUCH OF INNER AND OUTER SPACE IS EMPTY?
- IS NOT TRULY EMPTY BUT INSTEAD CONTAINS FLEETING ELECTRO-MAGNETIC WAVES AND PARTICLES?
- THAT POP INTO AND OUT OF THE EXISTENCE.

The main idea of the paper is ordered to neutrinos, their aroma “flavor” and colour in intention of YANG–MILLS AND GELL–MANN MURRAY THEORIES, SO CALLED CABIBBO UNIVERSALITY, IT’S MIXING OF C (CHARM OR CHARMONIUM) AND B (BEAUTY OR BOTTOM (BOTTOMIUM)) NEUTRINOS. YANG–MILLS RESPECTIVELY NON–ABELIAN GAUGE FIELDS IS CONNECTED WITH GAUGE FIELDS RESPECTIVELY GAUGE BOSONS (YANG–MILLS FIELDS \rightarrow QUANTUM CHROMODYNAMICS IN EARLY 70’S).

SITUATION IN YANG–MILLS TRIPLET γ (NEUTRAL PHOTON) W^\pm GAUGE BOSONS (INTERMEDIARY), Z^0 (electric neutral Z^0 BOSON), Z^0 (VECTOR) BOSON.
IF WE WANT RETHINK ABOUT NEW EXOTIC FERMIONS TYPE "SUPERHEAVY" ELECTRON "TAUON RESONANCES" CAN BE DECAYED TO NEW ν_c (CHARMONIUM NEUTRINO), CREATING "NEUTRINO GAS", MOVING BETWEEN GAUGE FIELDS – LEFT HANDED VORTEX – (SINISTRAL).

ν_B (BEAUTY NEUTRINO) HAS RIGHT DIRECTION VORTEX (DEXTRAL), ACCORDING TO THE QUANTUM BELTS (RIGHT DIRECTION VORTEX DEXTRAL).

THESE NEW NEUTRINOS (ν_c, ν_B) COULD LEAD TO DISSOLUTION OF PUZZLE PARTICLES OF A STANDARD MODEL (SM), LEADING TO THE NEW SUPER SYMMETRIC PARTNERS MODELS (SUSY). THIS CONCEPT IS DESCRIBED BY VORTEX FREE NEUTRINO NEUTRAL GAS.

ALTHOUGH HAVE THESE RESONANCES (VORTEXES) CLEAR LEPTONIC REACTION WITH NEUTRINOS HAVE SMALL CROSS SECTION, CROSS SECTIONS ARE CLEAR WEAK. NEUTRAL STREAMS, WERE DISCOVERED IN YEAR 1973, EXACTLY ON PROCESSES:

a) process: *muon neutrino + electron \rightarrow muon neutrino + electron* ELASTIC SCATTERING OF MUON NEUTRINO AND ELECTRON. Detected in bubble chamber GARGAMELLE CERN AND IN FERMI NATIONAL LABORATORY (FNAL) U.S.A..

b) process: *electron \rightarrow antimuon + electron neutrino* (Gargamelle CERN)

Keywords: ν_c charm neutrino (CHARMONIUM), ν_B beauty neutrino (bottomium), neutrino colours, aroma flavor (NEUTRINO RESONANCE), TAUON SUPERHEAVY ELECTRON, SLAC, FNAL, CABIBBO UNIVERSALITY, WOLFGANG PANOFSKY, NICOLO CABIBBO, Non–Abelian Gauge Theories, WANG-MILLS THEORIES, gauge particle and field.

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Comment no.1

Wolfgang K. H. Panofsky

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“Bubble Chamber Photograph“

- Professor of particle physics,
- Caltech,
- Princeton University.



Source: www.nasonline.org

Comment no.2

Nicolo Cabibbo

*10.4.1935 Roma, Italy +16.8.2010 Roma, Italy

- Italian Nuclear Physicist, KNOWN FOR HIS RESEARCH OF WEAK NUCLEAR INTERACTION,

- WAS A PRESIDENT OF ITALIAN NATIONAL INSTITUTE ON NUCLEAR PHYSICS, AND WAS PRESIDENT OF POPE ACADEMY OF SCIENCES.



Source: <https://en.wikipedia.org>

1. Introduction

Namely in the sixties and seventies years, the particle and nuclear physics developed hand in hand. From these decades was predicted and theoretically explained many and many subatomic and atomic particles.

The last a few years was in physically communities spoken about Pentaquark, and Rydberg Polaron, here we stopped in this text, because Rydberg Polarons are Polarons according the definition an Atom included in an Atom, this hypothesis is based on the theories of Microsolar system in Solar System (for example Planet Jupiter or Saturn and his “family” planets of Jupiter – Ganymedes (diameter 5262 km), Callisto, Europa and Io and many more “planets or moons”, the biggest terrestrial (according Terra in Latin Earth), are called “Galileian moons”).

Intersystem Planets circulated on Jupiter or Saturn – orbits like electron in an atom.

Saturn and his biggest moon Titan.

Together has Jupiter 79 moons, for example Metis,Adrastea, Amalthea, Thebe, Dia, Carpo, Thyone, Themisto, Leda, Himalia, Lysithea, Elara and many more and an analogy in Uran and Neptun microstar system.

Saturn moons: Enceladus, Titan (5150 km), Dione, Tethys, Aegir, Albiorix, Atlas, Bergelmir, Calypso, Daphnis, Epimetheus, Hyperion, Prometheus, Rhea, Skoll and many more (62 satelites).

2. Flavour and Colours of Neutrinos

Neutrino oscillation arises by mixing angles between the flavor and mass, eigenstates of neutrinos.

Are known three neutrino states, probably fourth and more states that interact with the charged leptons (muon neutrino, electron neutrino, tauon neutrino) in weak interaction are each a different superposition of the three (propagating) neutrino states of definite mass. Neutrinos are emitted and absorbed in a weak and electro-weak processes in their flavour eigenstate but travelled a mass eigenstates.

As a neutrino superposition propagates through the space, the quantum mechanical phases of the three or fourth mass state. This results in a changing superposition mixture of mass eigenstates as the neutrino travels, different mixture of mass eigenstates correspond to a different mixture of flavor states → quantum foam.

As long as the Quantum Mechanical state maintains coherence (coherence lengths) for neutrino oscillations this superpositional/microscopic quantum effect becomes observable over macroscopic distances.

The nuclear β decay, muon decay, pion decay and kaon decay, when a neutrino and charged leptons are emitted, the charged lepton is emitted in an incoherent mass eigenstates such as $|e^- \rangle$, because of its large mass.

Physicists searching for MAJORANA PARTICLES – IF THE NEUTRINO IS IDENTICAL OF ITS ANTINEUTRINO. Whether or not they are unknown.

Anomalies in The Large Hadron Collider's Data

A particle called a beauty meson was breaking down. Heavy Flavor Physics: KAONS, CHARM AND BEAUTY LEPTONS (NEUTRINOS), TAUONS AND NEUTRINOS. Production and decays of these particles, antiparticles "NEUTRINO PRODUCED IN PION DECAY IN FLIGHT."

Neutrino possess a weak nuclear charge and hypercharge but no electric, but probably color of charge. Colour and "aroma" of elementary particles, antiparticles we have identified for their explanation the interaction of neutrinos and antineutrinos flavor symmetries of massive neutrinos.

Neutrinos can transparently going through by common matter, because, not at all interacted with atoms. The neutrino coming through the our home planet and Sun, like the light coming through glass.

Fig. 3. CLASSICAL ANALOGUE OF NEUTRINO OSCILLATIONS AND RESONANCE.

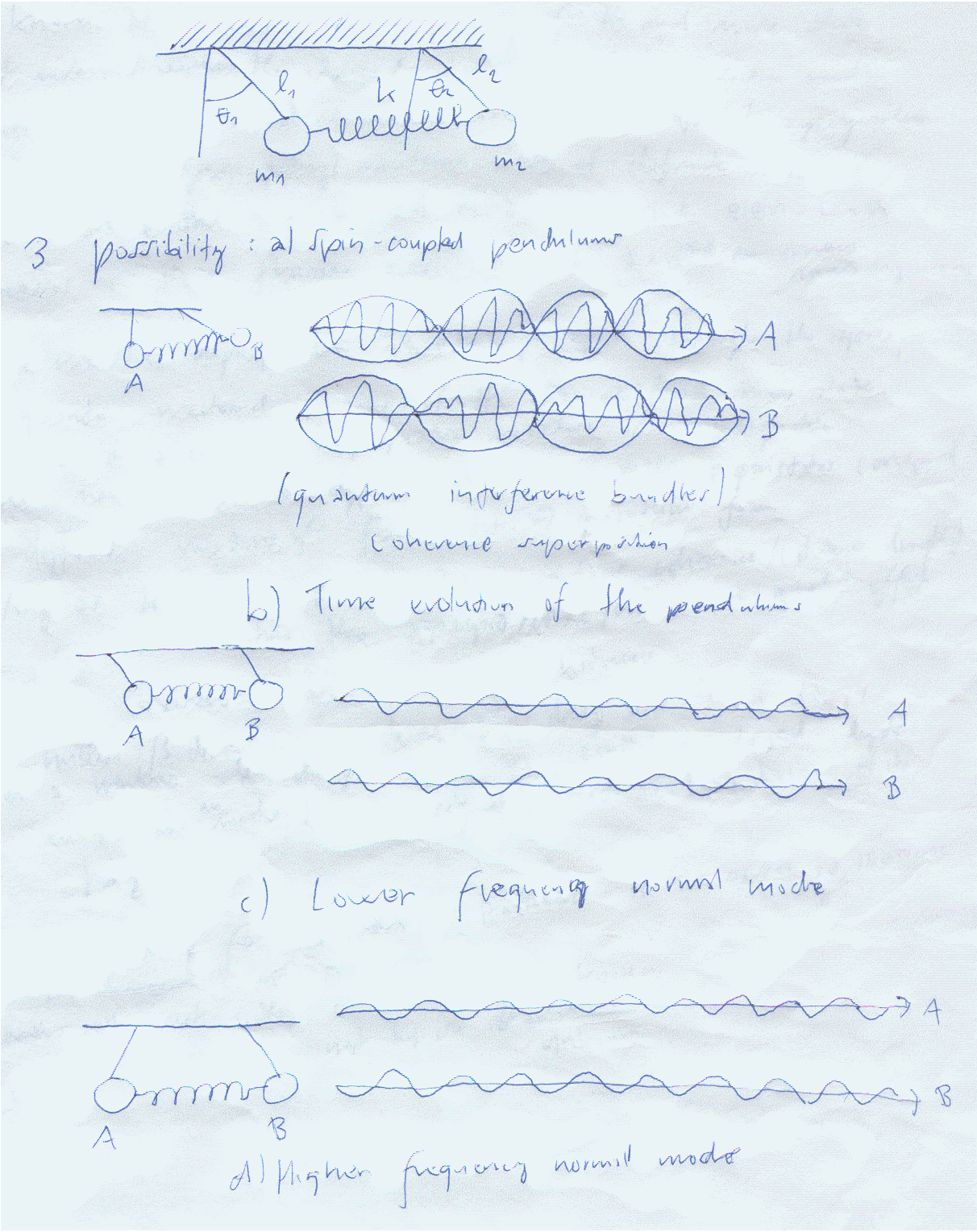


Fig. 4. Feynmann's diagrams of lowest order for process $n \rightarrow p + e + \bar{\nu}_e$

a) in a model of Fermi type,

b) in a model with intermediar boson output adaptable ($\bar{\nu}$) is basically described.

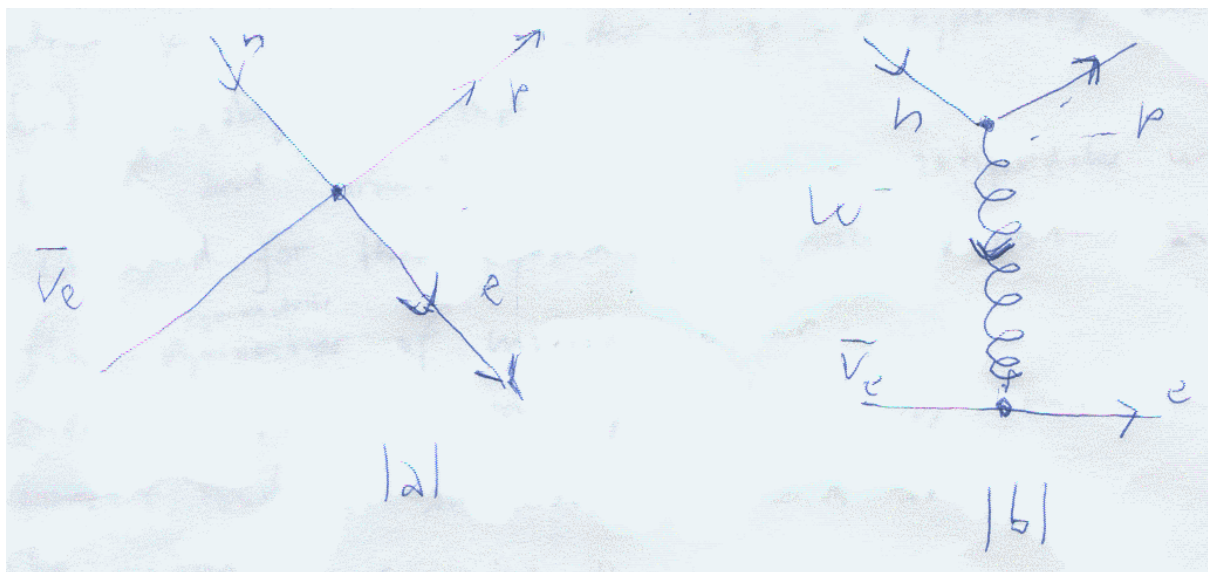
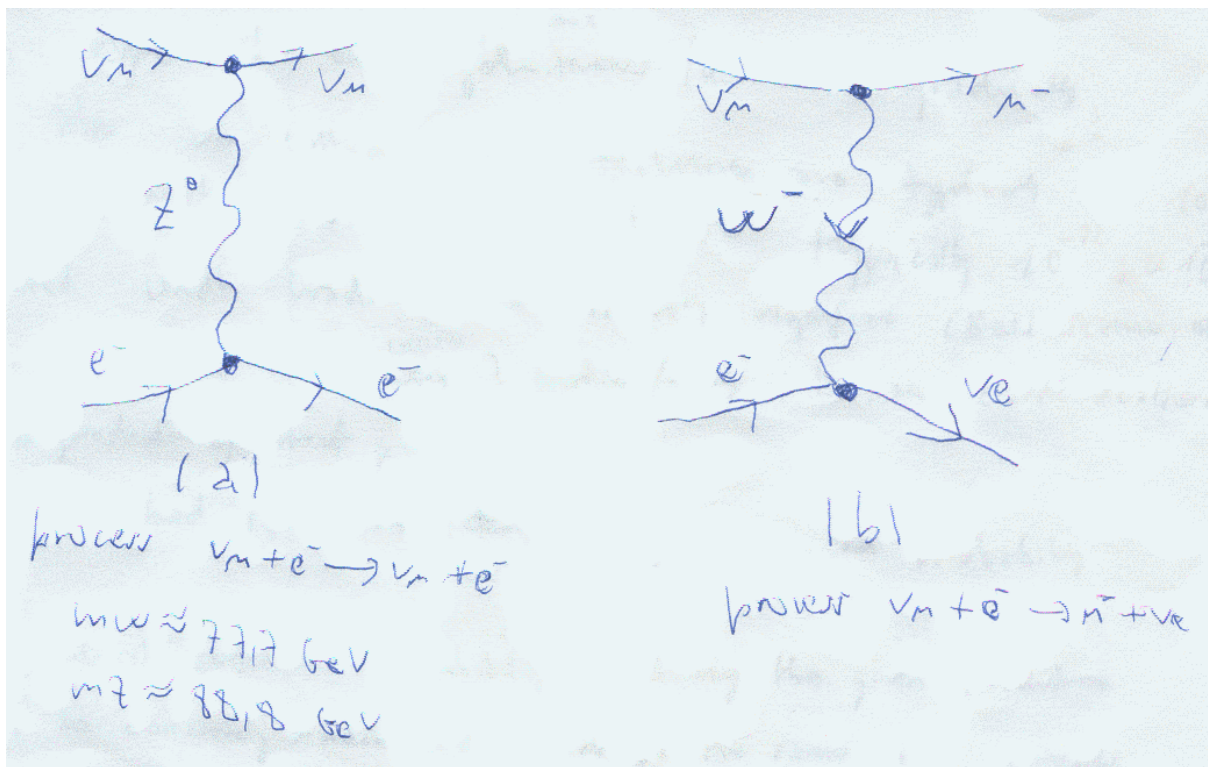


Fig. 5. Feynmann's diagrams for an interaction of neutral and charged fluxes $\nu_\mu + e^- \rightarrow \mu^- + \nu_e$



3. Cross Section (50. – 60-ties)

In an experiment on cyclotrons (kosmotrons) gradually gained also so called RESONANCES, which are typically extremely short of half life typically 10^{-22} till 10^{-29} s. Connected with hadrons states is very significant CROSS SECTION OF REACTION INDUCED OF COLLISION OF 2 PARTICLES (may it be, an elastic scattering), also a production of next particles.

This gain size had represented ideally set by the norm probability thought physical process (it's probability of during the given condition has gone to concretely reaction and so it's at the same time concretely value of intensity/strength connected with an interaction.

Cross section has a dimension of surface and gives in the multiple of m^2 nuclear and particle physics has usually used an unit barn, what is BARN = $10^{-28} m^2$.

4. Neutrino Helicity

In 1957 in "SECOND WAVE" of non-preservation of Parity of Particles.

In one of these experiments was measured difference of number of dextral or right-handed electrons and left-handed (sinistral) electrons produced in β -nuclear decay, it's a quantity called "a grade of polarization".

(Comment: right-handed, resp. left-handed, which we have on a mind, response to positive resp. negative helicity.)

The Helicity is defined like a projection of a spin on the movement direction.

Measurements proved, that during high energies – in a region relativistic and superrelativistic velocities – are electrons practically always sinistral (left-handed, it's their polarization is full), what exactly was responded to maximally disruption of particle parity.

In a second (until today a totally unique experiment was non-direct measured helicity of neutrinos in process inverse β -decay: $e^- + p \rightarrow n + \nu_e$, and was proved, that neutrino ν_e is always left-handed (sinistral).

These two results are enough have confirm sinistral.

Feynmann-Gell-Mann Theory (in sector of electron – lepton type) and totally refuse the alternative of scalar and tensor form of interaction, because it predicts mismatched helicity of electron and neutrino.

5. Neutrino Mixing Angles and Resonances

In experiments in colliders slowly increased too, so called resonances, which is significantly with extremely short time of life (HALFTIME), typically $10^{-22} - 10^{-29}$ s. For proximately high lightning of substance of these hadron states is need at the first remembered, one very important thing – cross section neutrino sector.

5.1 Mixing Angles

The mixing parameters θ_{13} is measured using electron antineutrinos from nuclear reactors.

From atmospheric and solar neutrino oscillation experiments, it's known that two mixing angles of the PMNS matrix are large and the third is smaller.

The PMNS (Pontecorvo-Maki-Nakagawa-Sakata matrix)

The idea of neutrino oscillation was first proposed out forward in 1957.

$$m_1^2 - m_2^2, m_2^2 - m_3^2.$$

MNS (MAKI, NAKAGAWA – SAKATA) matrix (MNS) matrix, PMNS matrix, lepton mixing matrix, unitary mixing matrix which contains information on the mismatch of quantum states of neutrinos when they propagate freely and when they take part in the weak interaction.

This matrix was introduced in 1962 by ZIRO MAKI, MASAMI NAKAGAWA and SHOICHI SAKATA, to explain the neutrino oscillations predicted by Bruno Pontecorvo.

Three states of the weak interaction form a complete orthonormal basis for the Standard Model neutrino. Three neutrino states of definite mass: ν_1, ν_2, ν_3 , which diagonalize the neutrino's free-particle Hamiltonian.

5.2 Detectors and Mixing Angle θ [Théta]

Atmospheric neutrino oscillations have observed on large Detectors such as IMB, MACRO, and KAMIOKANDE II, observed a deficit in the ratio of the flux of muon to electron flavor atmospheric neutrino (muon decay).

In December 2011, the experiment Double Chooz firstly found that $\theta_{13} \neq 0$ and in 2012 the Daya Bay experiment announced a discovery that $\theta_{13} \neq 0$, with a significance of 5,2 σ these results have since been confirmed by RENO.

β -beam neutrino oscillation produced particle accelerator MINOS experiment and K2K, using neutrino weight and energy of few MeV (10 – 200 MeV) MegaElectronvolt.

6. Non – Abelian Gauge Fields of Neutrinos

On the breakpoint of 50. – 60. years exists extraordinary attractive theoretical frame – theory of Non–Abelian gauge fields, based on common principle of local inner symmetry, which in year 1954 defined Chen Ning Yang and Robert Mills.

Comment no. 4: Prof. Jang Čen–ning or Chen Ning Yang
(*1.10.1922 96 years old)

is American Scientist, physicist, Chinese origin, together with Li Cheng–tae the winner of Nobel Prize for Physics in 1957 for basic research, so called, law of preserve parity, it leads to significant discoveries of elementary particles.



Source: <https://en.wikipedia.org>

Comment no. 5:

Robert Laurence Mills

(*15.4.1927 Englewood (N.Y.) – 27.10.1999 Charleston (U.S.A.))

was American physicist known for tensor equation for Yang – Mills Theory (1954),

Princeton Advanced Studies,

Ohio State University.



Source: <https://www.learner.org>

7. Non-Abelian (Yang – Mills Gauge Symmetry)

From a historical reasons is this symmetry called “calibration” or (“gauge symmetry”).

From clear mathematical point of view responded changing phases of Abelian (it’s commutative) unitary transformations and it’s (one parametric) group, is called like $U(1)$. Yang and Mills in their fundamental work defined concept of gauge symmetry on a case, when it’s transformations of fields are mathematically defined by non-commutative matrix. It’s creates non-Abelian groups (the onefold example is isospin symmetry represented by group $SU(2)$).

Local calibration symmetry, we must introduced interaction with multiplet of vector fields (Particle with spin 1).

In cause of local isospin symmetry $SU(2)$ is necessary triplet of vector fields (for local $SU(n)$ are $n^2 - 1$).

Yang–Mills vector fields are called non-Abelian gauge fields, they have “selfinteraction” motion equations, are non-linear.

Local symmetry–Abelian or Non-Abelian request, that calibration fields were intangible.

Mathematic formula of interaction “gauge bosons” are particles responsible Yang–Mills fields. It’s strictly determined by algebraic properties of concrete symmetry (coupled constants predict power of these theories). Models based on principle local gauge symmetry are called “gauge theories”.

In 70. years → BORN QUANTUM CHROMODYNAMICS.

8. Results and Conclusion

The finding suggested there must be a fourth NEUTRINO, one invisible in experiments. A few years before, an experiment called the Liquid Scintillator Neutrino Detector (LSND), based in the U.S. LSND had seen tantalising evidence, that neutrinos were oscillating in a way, that made no sense at all with the results of other experiments, including Super-K.

“More neutrinos, more problems.”

These words appeared in Cosmos 80 – Spring 2018. Some extra neutrinos did show up in Mini Boo Ne in a different energy range.

They were inconsistent with LSND and every other experiment perhaps suggesting the existence of even more flavours of neutrino.

Superkamiokande is a gigantic and versatile detector able to detect neutrinos with energies between a few MeV and a few hundred GeV (GigaElectronvolt).

Super-K started data taking on 1st of April in 1996, after 5 years construction period and obtained significant (relevant) evidence of atmospheric neutrino oscillation in 1998, 2000 tons of water (inner volume) surrounded by ~1000 PHT'S (photo multipliers tubes) of 50 cm in diameter.

Hyperkamiokande is started to begin in April 2020.

Fig. 8. Engineers inspect photo sensors as part of a 2008 upgrade of Super-Kamiokande in Japan.



Source: <https://physicstoday.scitation.org>

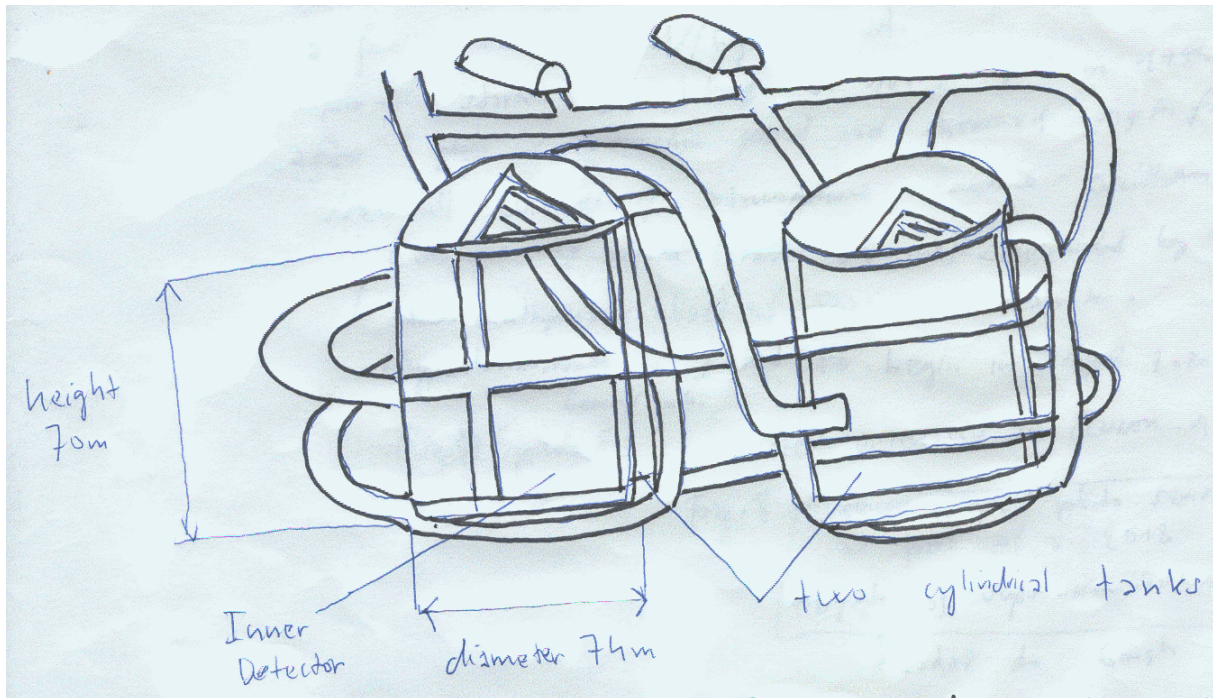
The Hyper-Kamiokande researches have successfully developed a new 50 cm photodetector with better timing resolution and twice the sensitivity to photons than sensors used in the Super-Kamiokande experiment.

After reoptimization of the detector Hyper-Kamiokande will have two cylindrical tanks, each 74 m in diameter and 60 m in height, which will be deployed in stages. Each tank will contain 260 kilotons of water, with a sensitive region equivalent to 190 kilotons, an order of magnitude larger than of Super-Kamiokande.

The inner region of the tanks will be instrumented with 40000, 50-cm photodetectors and provide 40% photocatode coverage.

The outer region of each tank will be instrumented with 6700 smaller photodetectors.

Fig.9. Scheme of Detector Hyper–Kamiokande.
Author of Sketch: Imrich KRIŠTOF, M.Sc.



9. Acknowledgement

At the first, I would to thank to My KINDLY AND VERY OUTSTANDING INTELLIGENT MOTHER FOR HER EXTRAORDINARY PATIENCE AND FOR HER LOVE TO LIFE.

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10. References

- [1.] Hořejší, J., (2019), TAJEMNÝ MIKROSVĚT (STRUČNÁ HISTORIE STANDARDNÍHO MODELU), Mafyz Press, Praha, 119p. [In Czech]
- [2.] <http://www-ucjf.troja.mff.cuni.cz/>
- [3.] Wagner, V., (2014): OSEL.CZ – JAK SE VYZNAT V PŘEHRŠLI RŮZNÝCH ČÁSTIC, [In Czech] <http://www.osel.cz/7744-jak-se-vyznat-v-prehrsli-ruznych-castic.html>
- [4.] Sean Carral, (2019): Částice na konci vesmíru (Kterak nás honba za Higgsovým bosonem zavedla až na práh nového světa). [In Czech]
- [5.] Aldebaran.cz. <https://www.aldebaran.cz/astrofyzika/interakce/standard-model.php>