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"Resemblance of Neutrinos with Different Quantum–Oscillating Flavor and Mass"

by Imrich KRIŠTOF

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Abstract: This presented tech–science paper is focused on main themes of evolution and history of research of neutrinos – elusive elementary particles.

The highlights is dedicated to the scheme of born and reborn and cascade decay hierarchic high energy particles, called hyperons (lambda, sigma, xi, epsilon, omega) and main position particles called mezons (mion, pion, kaon, rhó meson, éta meson, phí meson, omega meson, J/Ψ (J-Psí meson), h_1 meson, a_0-meson f_1, f_2 meson).

This Sun or starshowers fall in energetic clusters and clouds on each cm^{-2}, of Earth's surface (ϕ average flux of neutrinos 10 billions neutrinos on cm^2/sec. (10^{10} $cm^{-2}.s^{-1}$) for $E_v > 7$ MeV →~ 10^6 $cm^{-2}.s^{-1}$).

Cross section of neutrinos is very small $\sigma_{vN} = 10^{-42}\ m^2 - 10^{-48}\ m^2 = 10^{-19}$ barn, 1 barn is an unit of cross section.

In the Ending part of starshowers the photons, phonons and electron, mion, and tauon are detected in photomultipliers and scintillators, like a Cherenkov radiation – hyperrelativistic electrons, photons and mions and tauons, visually Fig. 4 Neutrino Detector SUDBURY(SNO) Canada.

The main part of paper is focused on NEUTRINO FLAVOR AND MASS. According Pauli and Fermi–Dirac and Bose–Einstein Statistical Laws each particle is conjugated with its own antiparticles: electron (e^-) and positron (e^+), electron neutrino (ν_e) and electron antineutrino ($\overline{\nu_e}$), quark beauty / bottom (b) and antiquark beauty / bottom ($\overline{b}$).

In the text is not forget the facts about 11 NOVEMBER 1974 – particles J/Ψ REVOLUTION MESONS J/Ψ consist of beauty quark and beauty antiquark.

The Pioneer work of Clyde L. Cowan, Jr. and Frederick Reines in Hanford and Savannah River Plant lead to fundamental discovery and detection of neutrinos. On Fig. 7 is described Cowan–Reines Neutrino Experiment.

In the End of this text is situation of Neutrinos and The Standard Model of particles.

The goal of this work is clarified the evolution and theoretical background of elementary particles – neutrinos.

Keywords: Neutrinos, Scintillators, Photomultiplier, hyperons, mesons, Sun – starshowers, detection of antineutrino, particles, antiparticles, neutrino flux, neutrino mass and flavor, cross–section of neutrinos, Sudbury, Savannah River.

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1. Introduction

I met with Neutrino, already in 1993, when I was sixteen, I hold in my hands the A. C. CLARKE Publication: “The Song of Distant Earth” a superknown space opera, the soundtrack music composer was multi–instrumentalist Mike Oldfield. In this book I was registered at the first in my life word neutrino and neutrino oscillation, deficit of Solar Neutrinos.

The first my scientifically experience was a contact with Associate–Professor doc. RNDr. Petr Burcev, CSc. (*1932) from Theoretical Physics and Astrophysics Department of Masaryk University Brno, who integrated me with physics celebrities like Prof. RNDr. Michal Lenc, Ph.D., Associate–Professor doc. RNDr. Jan Celý, CSc., Associate–Professor doc. RNDr. Miroslav Pardy, CSc. and superknown RNDr. Jiří Grygar, CSc.

Until these times Neutrino Physics and Astrophysics attracted me with a powerfull force. On these days was very popular Japanese Project Superkamiokande and Bruno Pontrecorvo Oscillation of Neutrinos. More detail science picture of these days till the Project SNO (Sudbury Neutrino Observatory) and F. Reines and C. L. Cowan, Jr. illustrated this paper.

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2. Highlights Sketches

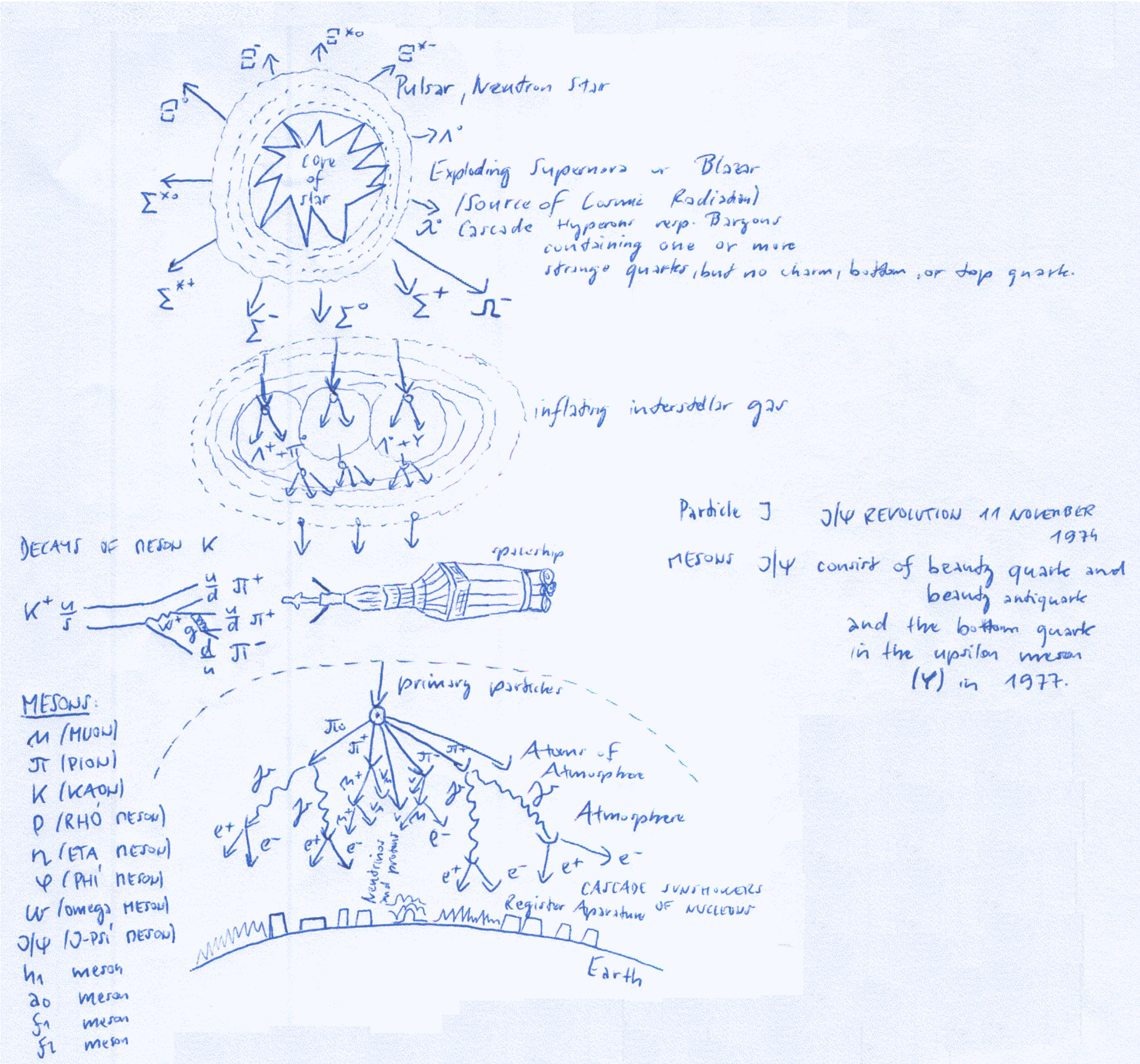

Fig. 1. Common Origin (Resemblance) of Different Neutrinos. Author: Imrich KRIŠTOF, M.Sc.

Particle J – J/Ψ REVOLUTION 11 NOVEMBER 1974. MESONS J/Ψ consist of beauty quark and beauty antiquark and the bottom quark in the upsilon meson (Y) in 1977.

Tab. 1. Species of Neutrinos

FERMION	**SYMBOL**	**MASS**
FAMILY OF ELECTRON		
ELECTRON NEUTRINO	ν_e	< 2,5 eV
ELECTRON ANTINEUTRINO	$\bar{\nu}_e$	< 2,5 eV
FAMILY OF MUON		
MUON NEUTRINO	ν_μ	< 170 keV
MUON ANTINEUTRINO	$\overline{\nu_\mu}$	< 170 keV
FAMILY OF TAUON		
TAU NEUTRINO	ν_τ	< 18 MeV
TAU ANTINEUTRINO	$\bar{\nu}_\tau$	< 18 MeV

Tab. 2. Hyperons.

Particle	Symbol	Make Up	Spin (Parity)	Mean lifetime / s	Commonly decays to
Lambda	Λ^0	uds	1/2 + J[e]	$2{,}60 \times 10^{-10}$	$p^+ + \pi^- \ or \ n^0 + \pi^0$
Sigma	Σ^+	uns	1/2+	$(8{,}013 \pm 0{,}026) \times 10^{-11}$	$p^+ + \pi^0 \ or \ n^0 + \pi^+$
Sigma	Σ^0	uds	1/2+	$(7{,}4 \pm 0{,}7) \times 10^{-20}$	$\Lambda^0 + \Upsilon$
Sigma	Σ^-	dds	1/2+	$(1{,}479 \pm 0{,}011) \times 10^{-10}$	$n^0 + \pi^0$
Xi	Ξ^0	uss	1/2+	$(2{,}90 \pm 0{,}09) \times 10^{-10}$	$\Lambda^0 + \pi^0$
Xi	Ξ^-	dss	1/2+	$(1{,}639 \pm 0{,}015) \times 10^{-10}$	$\Lambda^0 + \pi^-$
Omega	Ω^-	sss	3/2+	$(8{,}21 \pm 0{,}11) \times 10^{-11}$	$\Lambda^0 + \kappa^- \ or$ $\Xi^0 + \pi^- \ or$ $\Xi^- + \pi^0$

Clyde Lorrain Cowan, Jr.
(*6.12.1919 Detroit – +24.5.1974 Bethesda, Maryland, U.S.A.)
Was an American physicist, discover of neutrino together with Frederick Reines, Nobel Prize Winner in 1995.

Frederick Reines
(*16.3.1918 Paterson, New Jersey, U.S.A.– +26.8.1998 Orange, California, U.S.A.)
NOBEL PRIZE FOR PHYSICS 1995 FOR DETECTION OF NEUTRINOS together with Martin Lewis Perl.

Martin Lewis Perl
(*24.6.1927 Manhattan, New York, U.S.A. – +30.9.2014 Palo Alto, California, U.S.A.
An American physicist, Nobel Prize winner from 1995 for contribution to lepton physics, namely for discovery lepton – tau.

Fig. 2. C. L. Cowan, Jr. and Frederick Reines photo in Hanford.

3. Methods

Cowan and Reines made use of five tanks of water 6¼ feet long by 4½ feet wide, but varying in thickness (see Fig. 2.). Two of the tanks were thin “target tanks” only three inches high. They were arranged in a “two–decker sandwich”: detector / target / detector / target / detector. The water in the target tanks contained a small quantity of a dissolved chemical, cadmium chloride.

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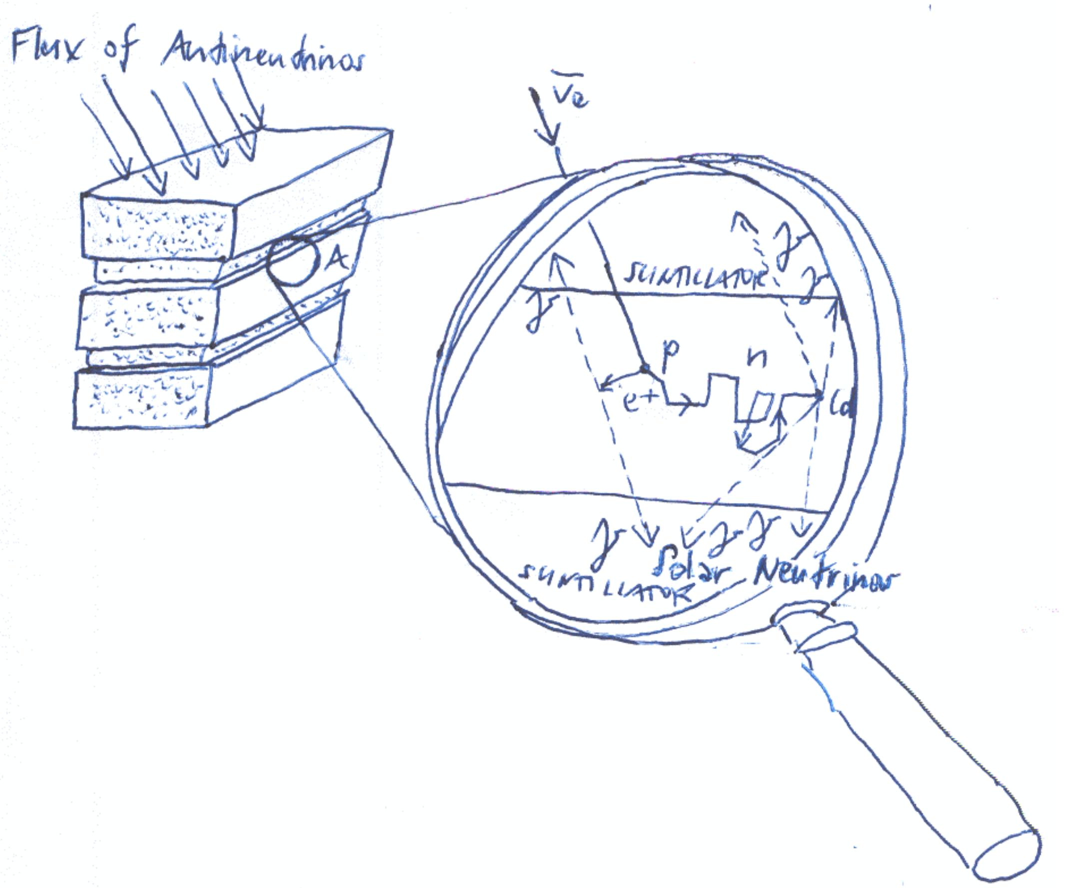

Fig. 3. Detection of Antineutrino. Author of the Sketches: Imrich KRIŠTOF, M.Sc. According I. Asimov.

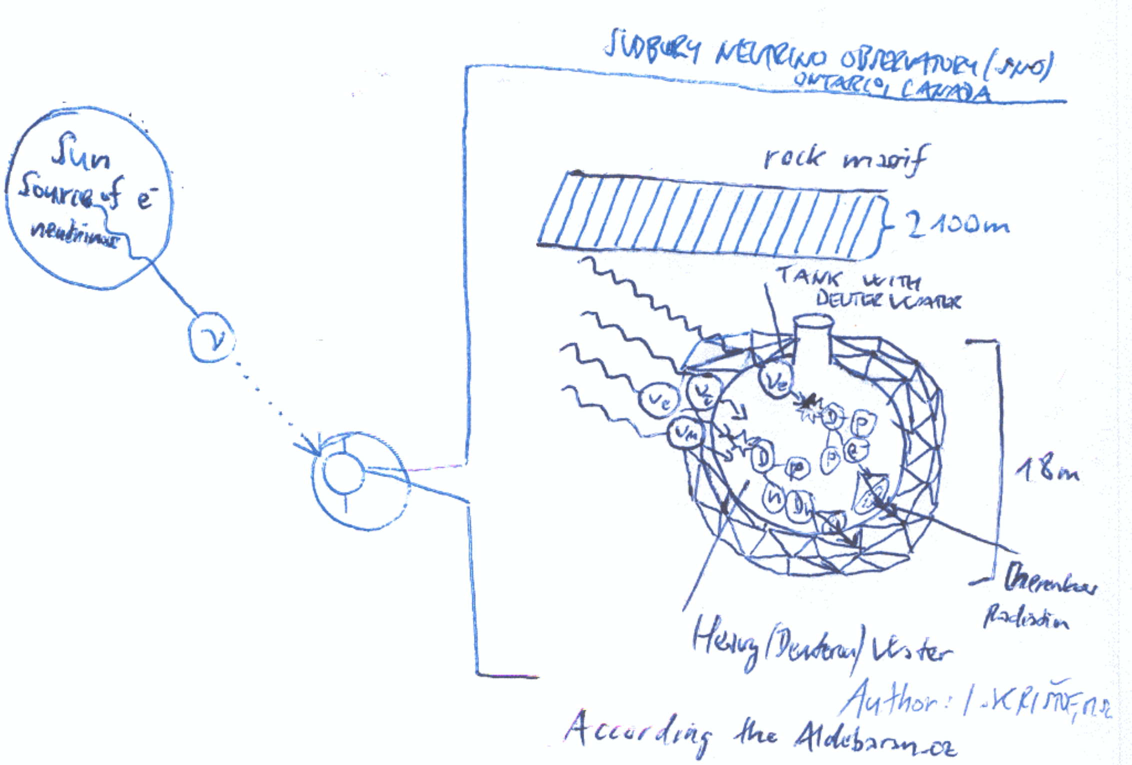

Fig. 4. Neutrino Detection (SNO) Sudbury Neutrino Observatory.

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4. The Neutrino

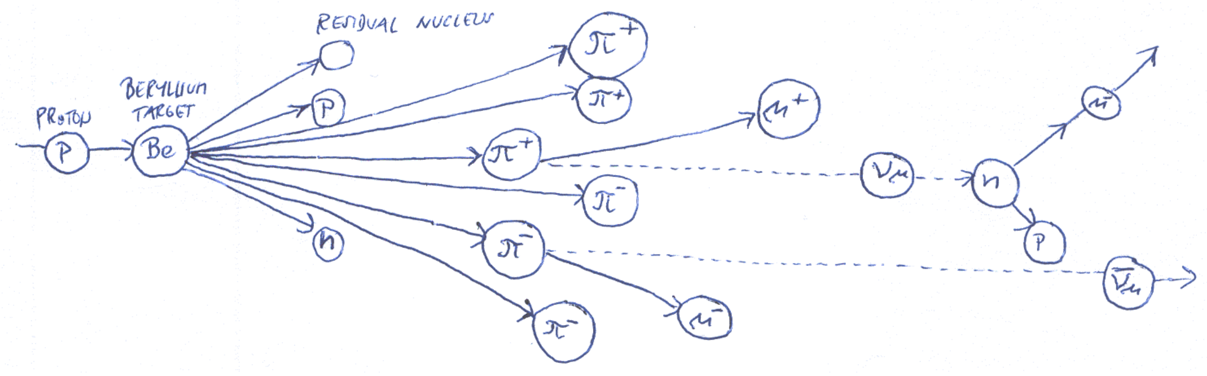

Fig. 5. Production of Neutrinos in Two–neutrino Experiment. Author: Imrich KRIŠTOF, M.Sc. According I. Asimov.

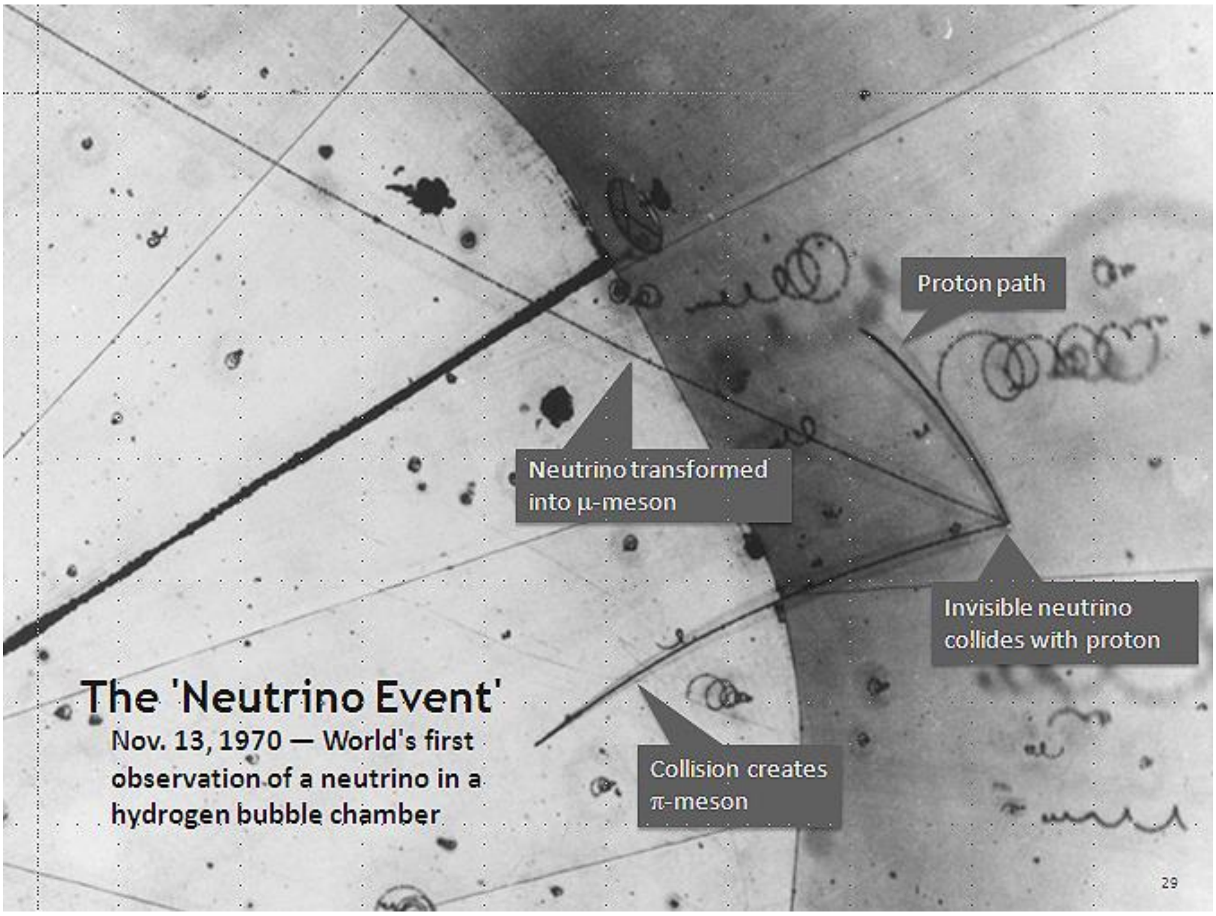

Fig. 6. “The Neutrino Event”, Nov 13, 1970. World’s first observation of a neutrino in a hydrogen bubble chamber. On 11 November 1974 with RAPID CHANGES IN HIGH–ENERGY PHYSICS AT THE TIME HAVE BECOME COLLECTIVELY KNOWN AS THE “NOVEMBER REVOLUTION”.

The (J/Ψ) meson or psion is a subatomic particle a flavor neutral meson consisting of a charm quark and a charm antiquark, generally known as “charmonium”$(c\bar{c})$. Has a rest mass of 3,0969 GeV/c^2 and a mean lifetime of 7,2×10^{-21} s. Interactions strong, weak, electromagnetic force, gravity; mass 5,5208×10^{-27} kg; 3,096916 GeV/c^2, electric charge 0e, spin 1.

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Richter and Ting were rewarded for their shared discovery with the 1976 Nobel Prize in Physics. In 2016 at University of Honolulu, Hawaii was detected a psion like a PSIONIC POWER.

5. F. Reines and C. L. Cowan, Jr. Neutrino Experiment

$$n + {}^{108}Cd \rightarrow {}^{109}Cd + \gamma$$

^{108}Cd produces an excited state of ^{109}Cd which subsequently emits a gamma ray. The Gamma pair in coincidence plus another gamma within 5 µs.

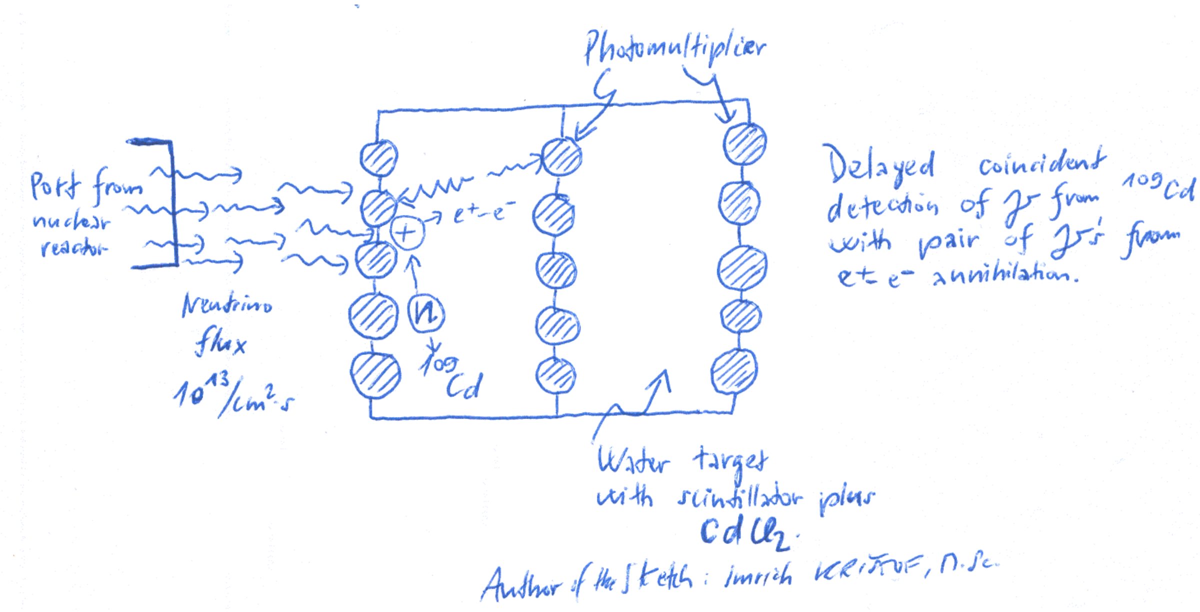

Fig. 7. Cowan and Reines Neutrino Experiment.

After a preliminary experiment at Hanford, Reines and Cowan moved the experiment to the Savannah River Plant near Augusta, Georgia where they had better shielding against cosmic rays. This shielded location was 11 m from the reactor and 12 m underground.

In the 1956 experiment they used two tanks with a total of about 200 liters of water with about 40 kg of $CdCl_2$ dissolved in it. The water tanks were sandwiched between three scintillator layers which contained 110 5–inch photomultiplier tubes.

Fig. 8. Savannah River Atomic Plant Photo.

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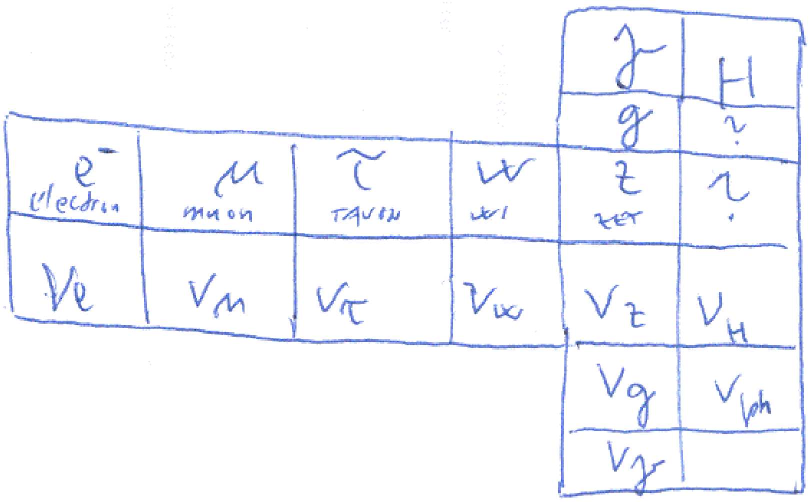
6. Neutrinos and Standard Model of Particles

Neutrino oscillation:

- is a quantum mechanical phenomenon whereby a neutrino created with a specific lepton family number ("lepton flavour": electron neutrino, muon neutrino, or tau neutrino) can later be measured to have a different lepton family number.
- arises from mixing between the flavor and mass eigenstates of neutrinos. That's, the three experiments confirmed neutrino states, probably also next further the fourth or fifth neutrinos associated by intermediary boson W and Z (GAUGE BOSONS) or Higgs particle of foton, respectively phonon or gluon or gravitino. The position of Higgs boson in Standard Model of particles says, that elementary particles would be exist in much number more than many Theoreticists expect. For example, situation with oscillation and flavor of neutrino, could illustraded this fact:

Masses and flavors
of oscillating neutrinos



Author of highlights sketches: Imrich KRIŠTOF, M.Sc.

Fig. 9. New neutrino flavor and oscillation objects ν_W → WION NEUTRINO (WIINO), ν_Z → ZION NEUTRINO (ZIINO), ν_g → GLUON NEUTRINO (GLUIINO), GRAVI NEUTRINO (GRAVITINO), ν_γ → FOTI NEUTRINO (FOTINO), ν_H → HIGGSINO (NEUTRINO HIGGS), ν_{ph} → PHONINO.

That's, the three neutrino states that interact with the charged leptons in weak interactions are each a different superposition of the three (propagating) neutrino states of definite mass. Neutrinos are created (and absorbed) in weak processes in their flavor eigenstates.

As a neutrino superposition propagates through space, the quantum mechanical phases of the three – or nine mass states.

The idea of neutrino oscillation was first put forward in 1957 by Brnuno Pontecorvo, who proposed that neutrino – antineutrino transitions may occur in analogy with neutral kaon mixing (KAON = MEZON K).

7. Conclusion

The Scheme of born of Neutrinos resp. cascade hyperons in the core of the star / supernovae illustrated, what's happened with neutrinos through distance of 1 AU (ASTRONOMICAL UNIT = 15×10^{7} km) till these elusive elementary particles are registered in photomultipliers and scintillators. The Neutrino flux ($6{,}6\times10^{10}$ cm^{-2}.s^{-1}) also shown are the atmospheric neutrino background, the Projects: IceCube 5 year sensitivity limits, the ARIANNA 6 month values limits and the ANITA II 45 day limits. Because the lower luminosity leads to a γγ compactness too low to lead to significant thermalization. The high significant are High Energy Neutrino Emissions from the earliest Gamma–Ray Bursts. Very important is that, the mass of all neutrinos could open / close our Universe. With respect to Cosmological Models could be our Universe eternaly open and expand and endless or could be oscillating and leads from Big–Bang to Big Crunch, or extremely could be in big freeze (entropian scale). The most probably, our Universe is eternal, open and expand, it's probably too, that Universes like our are milliards like the grains of a sand. The billion and billion stars could significantly described the hurry up life of each atom, quark, neutrino, photon in the context with whole Multiversum.

8. Acknowledgements

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