

Rocks Surroundings of Neutrino Detectors

Author: Imrich Krištof^a

^aInstitute of Theoretical Physics and Astrophysics, Faculty of Science, Masaryk University, Kotlářská 2, 611 37 Brno, Czech Republic, e-mail: IMRIK@atlas.cz

Abstract:

There have been a spontaneous oscillations of elementary particles, called Neutrinos, observed during the last few decades.

The results in the many types of research suggest the non-zero masses of the neutrinos. The possibility of neutrino oscillations and transformation-stabilizations number in three or four types of them, according to Italian scientist Bruno Pontecorvo's (1946) research and theory, has not been eliminated until these days.

Keywords:

oscillations, neutrinos, non-zero masses, stabilization number, Pontecorvo.

1. Historical and Recent Neutrino Research Projects and the Most Known Neutrino Scientists in the World.....	1
2. Many materials like the Neutrino Detector Minerals (Crystals)	8
3. Results from measurements on different detectors	10
4. Measurements in Homestake (South Dakota) by John Bahcall and Raymond Davis, Jr.....	11
5. Solar Neutrino Unit (SNU)	12
6. Neutrino positions in the Solar Standard Model	13
7. Applications of Results in the Laboratory (Practical) Research and Model (Theoretical) Research	15
8. Conclusions	16
9. References	18

1. Historical and Recent Neutrino Research Projects and the Most Known Neutrino Scientists in the World

Neutrino oscillations – this phenomenon is most evident in the Physical Detection Project Superkamiokande in Japan, Dumand in Hawaii, Los Alamos in the U.S.A., CERN-GRAN SASSO in Europe, SAGE in CAUCASUS-BAKSAN in Russia, Sudbury (SNO) in Canada, AMANDA in the Antarctica, NESTOR and ANTARES in Mediterranean Sea in the South of Europe, Lake BAIKAL in Russia, HOMESTAKE in the South Dakota and SOUDAN (Both in the U.S.A.).

Superkamiokande (Hyperkamiokande 2010-2014)

Observatory with 50,000 tons of pure water with 13,000 photomultipliers is hidden 1,000 metres (3281 feet) beneath KAMIOKAKÓ. Detector located at a depth of 2,700 metres water

equivalent in the Kamioka Mozumi mine in Japan, beneath the mount IKENA JAMA. Kamioka is an old zinc mine and deposits of Ag-Zn-Pb-Cu SKARN.

The Kamioka consists of uplaining limestone lenses deposits of clinopyroxen-rich SKARNS, paleozoic metabazit and early Funatsu granitic rocks and minerals pyromorphite, hemimorphite and andradite. The density of rocks surrounding in Kamioka is approximately $3.8 - 4.1 \text{ g/cm}^3$.

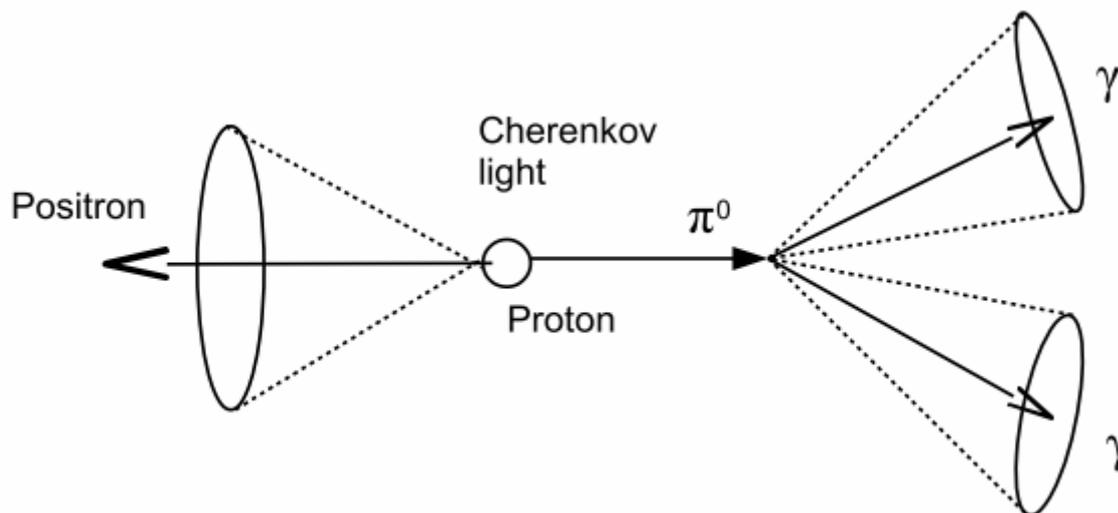


Figure 1. Scheme of Detector Superkamiokande.

Detector is transparent nylon sphere of diameter 13 m submerging in oil tank of diameter 18 m where 13,000 photomultipliers are.

The name of site is Mozumi Mine of Kamioka Mining and Smelting Company near the village of Higashi-Mozumi, Gifu, Japan.

SAGE (Soviet-American Gallium Experiment) (BNO Baksan Neutrino Observatory)

Located in the Baksan River in the Caucasus mountains in Russia, it started in 1977, becoming the first such observatory in the USSR.

Underground Scintillation Telescope located 300 m below the surface.

Gallium-germanium neutrino telescope SAGE located 3,500 m deep.

The rock surrounding of SAGE is built Pb-rich BAKSANIT, which was recovered in a magnetit SKARN from W-Mo deposit in the Northern Caucasus, Baksan River Valley. Associated minerals such as bismuthinite, tetradymit, calcite and andradite are there.

Plumbian baksanit is dark steel-grey, shows a black streak and has a perfect basal cleavage. The Baksanit rock surrounding is about 7.44 g/cm^3 . The mineral is grayish-white in reflect light, bireflectant, nonpleochroic, faintly anisotropic in yellowish-grey tints.

HOMESTAKE (South Dakota Gold Mine, U.S.A.)

The first detector of neutrinos built in 50's. This detector has twenty-six years continuous of measurements (exactly from 1967 till 1993). It was located in abandoned Au mine, is fold up with horizontally placed cylinder vessel refill with 615 tons of tetrachlorethylene. With this detector are connected names of two scientists: John Bahcall – astrophysics expert in calculating and improving neutrino fluxes and spectra with Standard Solar Model. Raymond Davis, Jr. controlled all possibly sources of inexact and background. Neither big nor small effort not lead to change of difference between theory and experimentally observations.

Development of Helioseismology, which studies seismic waves on the surface of the Sun, in 90's led to confirm the right of Solar Models.

Typical auriferous greenschist gold ore is from the Homestake Mine.

Until it was closed in 2002 it was the largest and deepest gold mine in North America. The mine produced more than 40 million ounces (approximately 1.25 million kilograms) of gold during its lifetime.

Homestake rock surrounding consists of iron-formation gold depositions.

Proterozoic erosion removed approximately 30,000 feet of rock from the Earth's crust.

On the regolith surface forming very high-grade gold paleoplacer deposits.

Homestake Paleoplacer deposit is characterized by gold bearing quartz pebble conglomerates, similar to the Jacobina Conglomerate gold deposits of Bahia, Brasil.

Rock surrounding of Homestake achieves these density values – ranged from 2.66 g/cm³ to 2.85 g/cm³.

SUDBURY (Ontario Canada, SNO)

Sudbury neutrino observatory was built 6,800 feet underground near Sudbury, Ontario, Canada, excavated from NORITE ROCK, located in the deepest part of the mine. Detector itself has been selected to have minimal radioactivity.

The first co-spokesmen for the SNO collaboration when it was established in 1984, were Professor Herb Chen from University of California, Irvine and Professor George Ewan, Queen's University.

The SNO will use 1,000 tones of heavy water (D₂O) to detect elusive particles called neutrinos emitted from the centre of the Sun and from remote exploding stars-supernovas like SN 1987A/Sanduleak. SN 1987A was a supernova in the outskirts of the Tarantula Nebula in the Large Magellanic Cloud. It occurred approximately 51.4 kiloparsecs from Earth, approximately 168,000 light-years.

From this event is dated establishing of NEUTRINO PHYSICS according author of this article NEUTRINICS.

Rock surrounding of SNO is built by Sudbury NORIT – density between 2.78 and 3.0 g/cm³, it's correlated with REKEFJORD EAST NORIT density: 3.15 g/cm³. Norit is mafic intensive eruptive rock, which is one of species of gabbro. It consists of namely from basic feldspars, bytovnit and labradorite, the part is created from pyroxens. The name Norit is from the name of the Northern Europe state – Norway – according norwegian geologist Jens Esmark.

SOUDAN, SOUDAN 2 (University of Minnesota, Duluth, U.S.A.)

Iron mine and physics lab is the oldest and deepest, is situated in Vermilion Range in depth about 2.5 km. SOUDAN'S rock surrounding creates gabbro with olivine, subophitic augit and troctolite. Minos cavern is 82 meters long, 15 meters wide and 13 m high.

The Soudan2 / CDMS2 is similar in shape, but only 70 m long.

Surrounding rock formation is not iron ore but actually Ely Greenstone, about 2.7 billion years old.

Ely Greenstone is a belt of rocks, consisting chiefly of metamorphosed volcanic rocks and PILLOW LAVA extremely rich veins of hematite at this site, often containing more than 65% iron.

The Animikie Group is a geologic group composed of sedimentary and metasedimentary rock, having been originally deposited between 2.5 and 1.8 million years ago within Animikie Basin.

GABBRO of the Duluth complex is one of the largest intrusion of gabbro on Earth.

Rock density increases with depth from 2.76 to 3.21 g/cm³ with a mean of 2.98 g/cm³. The Duluth complex is a composite body of anorthositic, troctolitic, gabbroic, granodioritic units.

LOS ALAMOS (est. 1943)

Los Alamos is located in the northern part of New Mexico. Most of the town is situated on the top of the mesas, at an elevation around 7,500 feet above sea level. The White Rock sits at the base of mesas, around 7,000 feet (2,200 m).

Los Alamos is built on the Pajarito Plateau between White Rock Canyon and the Valles Caldera, part of Jemez Mountains.

Jemez Mountains are predominantly formed by the 18.7 Ma to approximately 50 ka Jemez volcanic field.

LANL (Los Alamos National Laboratory)

The most known scientist connected with this worldwide known site is Robert Oppenheimer (Manhattan Project).

The Sedimentary Rocks, Volcanic – volcanoclastic, basalt flow are typical for Los Alamos Canyon and Rhyolites (1.23 – 1.59 Ma) are typically for Cerro Toledo. White Rock Canyon lavas and tuffs, Quaternary pyroclastic deposits, interactions between magma and surface water, lacustrine sedimentary sequences. High proportion of Tschicoma andesite to dacite clasts, Precambrian clasts. Rocks of Rio Grande depression, Santa Fe Group, Old alluvium, Volcano Rocks Tschicoma, Formation Pyroxen-Andezit-Rhyolit. Los Alamos NL is situated on carbonate rocks with density about 2.65 g/cm³.

CERN – GRAN SASSO

Name of project is devised from French Conseil Européen pour la recherche nucleaire. Gran Sasso's dolomite rocks are very poor in uranium and thorium, the main sources of natural radioactivity. G.S. mountains is in the highest peak in Apennines with height about 2,912 m,

north-east of Rome. CERN is situated near Geneva in Switzerland, OPERA - oscillation neutrino project with apparatus including photo/watch emulsion is experiment which testing oscillation of these elementary particles called neutrinos.

Captured neutrinos from bunch of mion neutrinos made in CERN flowing in distance of 730 km to Italian Gran Sasso.

Gran Sasso's dolomite and limestone rock is very poor in uranium and thorium.

Gran Sasso's Large Volume Detector (LVD) searches for neutrino bursts from supernovae. Lying under 1,400 metres of rock, it offers silence – not an absence of sound, but of cosmic ray noise, the rain of particles constantly bombarding Earth's surface from space.

Scheme of cosmic ray bombarding Earth's surface:

$$\pi^{\pm} \rightarrow \mu^{\pm} + \nu, \quad \pi^0 \rightarrow 2\gamma$$

$$\mu^{\pm} \rightarrow e^{\pm} + 2\nu$$

where π – pions, ν – neutrinos, γ – gamma photon, μ – mu – meson (muon).

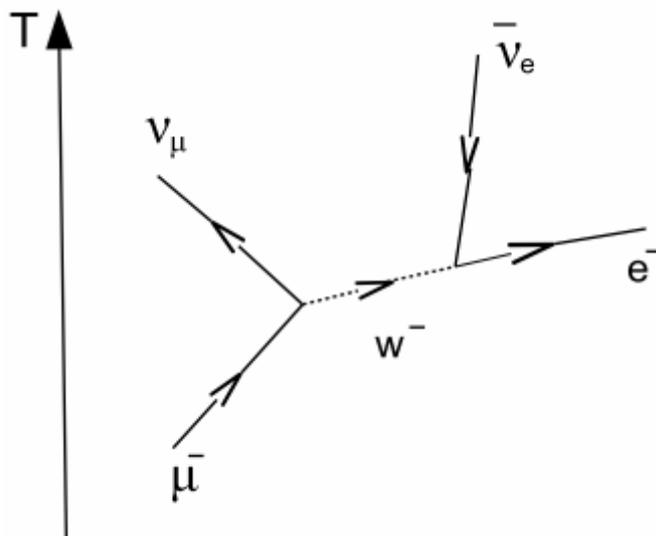


Figure 2. The most common decay of the muon.

The muon decay (M_d) width is from Fermi's golden rule:

$$M_d = \frac{G_F^2 m_\mu^5}{192\pi^3} I\left(\frac{m_e^2}{m_\mu^2}\right)$$

where $I(x) = 1 - 8x - 12x^2 \ln x + 8x^3 - x^4$

and G_F is the Fermi coupling constant

and $x = \frac{2E_e}{m_\mu c^2}$ is the fraction of the maximum energy transmitted to the electron.

Density-neutron log porosity:

Limestone: 2.71 g/cm³

Dolomite: 2.87 g/cm³

Matrix density value: 2.87 g/cm³

The most Known Neutrino Scientists in the World

History of discoveries of neutrinos:

Prediction and fundamental or basic “stones” of Neutrino Physics (Neutrinics) were based in 30’s. The most known scientist from this period is Bruno Pontecorvo, exactly Akademik Pontekorov, Russia, U.S.A., Canada - Chalk River, Italy. Pontecorvo was the first scientist who described and defined “neutrino oscillations” and detection and scintillation substances or matters.

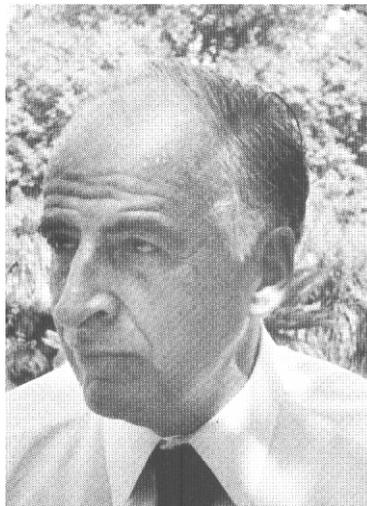


Figure 3. Bruno Pontecorvo (1913 – 1993) in (Veltman, 2007).

The name neutrino was created by Enrico Fermi. Fermi is author of the first theory, which describes a “behaviour” of neutrinos. It’s principally a “word game”, in Italian language it signed neutrone (name for neutron), it’s big and neutral, but neutrino signed small and neutral.

The second scientist, who predicted electron neutrino (ν_e) was in 1930 Wolfgang Pauli. Neutrino was first predicted by W. Pauli in 1931, when he explained spectrum β -decay – decay of neutron to proton and electron. Pauli predicted formation non detected particle with energy and momentum of mobility, equal to observed decrease of these values by products opposite to original particles.

Expression of this theory about their existence to their experimental verification sustains in considering to little reactivity of neutrinos about 25 years



Figure 4. Enrico Fermi (1901 – 1954) in (Veltman, 2007).

In 1956 Clyde Cowan, Frederick Reines, F.B. Harrison, H.W. Kruse and A.D. McGuire published an article in journal *Science*: “Detection of free neutrinos: confirmed”. This research was lately rewarded by Nobel Prize for Physics (1955). Discovery of electron neutrino (ν_e), in Savannah River (1956).

In 1962 Leon Lederman, Melvin Schwartz and Jack Steinberger proved an existence of many types of neutrinos, so that they detected muon neutrino (ν_μ).



Figure 5. Melvin Schwartz (1932 – 2006) in (Veltman, 2007).

When he was in SLAC (Stanford Linear Accelerator) in 1975 at first observed the third lepton (τ – tauon), began supposed an existence of complementary neutrino. The first evidence of existence of the third neutrino (ν_τ) was observation of missing particle energy and momentum of mobility by TAU (τ) – DECAy, similar the β -decay.

About the first observation of interaction of Tau (τ) neutrino informed the project DONUT in Fermilab, with this gone to discovery the last particle of Standard Model, which interaction before this was not observed.

The first man, who measured the neutrino fluxes was Raymond Davis, Jr. and John Bahcall, who defined so-called Standard Model of Solar Neutrinos, and they defined the Solar Neutrino Unit, too. Raymond Davis, Jr., Masatoshi Koshiba, and Riccardo Giacconi shared the Nobel Prize for Physics in the year 2002.

Well-known all over the world is the physicist Prof. Joseph Weber from Maryland University, U.S.A., “the pioneer of neutrino telecommunication” and builder of gravitational waves detector.

Technicians of Milano’s Pirelli holds a sapphire piezoelectric crystals used in an experimental neutrino detector built by Joseph Weber in the 1980s.

2. Many materials like the Neutrino Detector Minerals (Crystals)

For example minerals Crystals Sapphire (Al_2O_3) piezoelectric crystal – isotropy and homogeneity. (Prof. Joseph Weber → Pirelli, Milano)

ROCKS – inhomogeneity mineral association, created by more than one mineral, chemical formula absent, for example: limestone, gabbro, basalt, skarn.

SCINTILLATION SURROUNDINGS: Ultra pure water (H_2O), heavy water (D_2O), crystals of salt (NaCl – Halite, KCl – Sylvite), ^3He , $^4\text{He} \rightarrow ^7\text{Be}$, Titanite, Rutile (TiO_2), Biotite (Melanic mica) – isomorphic row Flogopit – Annit – Pseudohexagonal Barytes (BaSO_4) – Stone Pit by Tisnov / Tišnovské Brunidy – Štěpánovice above river Svratka near Brno – South Moravia (Europe), Molybdenite (Mo^{100}) Mokrý Mount near Brno, Limestones CaCO_3 , CaMgCO_3 , Dolomite, Basalts, Diorites, Grandiorites, Gabbro, CCl_4 (perchloroethylene), $\text{Ga}^{71} \rightarrow \text{Ge}^{71}$, SiGe^{71} , and Permafrost, Lead Perchlorate $\text{Pb}(\text{ClO}_4)_2$.

GAS: (Cl^- , Ar^* , Rn^* , ^3He , ^4He).

LIQUID: D_2O , H_2O , $\text{H}_2\text{O} + \text{Ca}^{2+} + \text{Mg}^{2+} + \text{HCO}_3^{2-}$, karst water, CdCl_2 .

Supposed localities with special types of rock surroundings for detector of neutrinos

- using of artificial or natural cavities or caverns / cave domes, underground spaces, caverns in the wide numerous of types of rocks.

Examples of localities with suitable rocks surroundings

- Tisnov’s Brunids
 - o Cavita – Králova jeskyně (Carl Cave)
 - o Květnice (Be and SiO_2 crystals)
- Petrov (Brno – City): 725 million years old Proterozoic Basalts, type of Genesis-MORB (Middle Ocean Ridge Basalts)

- Moravian Karst and its limestones – 380 Ma years old Paleozoic Sediments rich of: Ca, C, Mn, Mg, Fe, H₂O, Rn.
- Brno – Stránská Rock – 235 – 135 Ma years old crinoid limestones, island of Jurassic Limestones with caves and underground Karst Small Lake and Stratigraphic Geologic Layer Oxford-Kellway, locality of Homo Erectus.
- Brno-Massif (Granodiorit) – many types of rocks – Granodiorite, Type Blansko (Titanit), Granodiorite Type Královo Pole, includes: pseudo-hexagonal vertical Biotite (Mafic Mica), Granodiorite Type Olbramovice.
- Molybdenit – near Brno – Mokrý Hora, Mo¹⁰⁰
- Precious Rock Surroundings
 - o Třebíč Massif – Syenite and Durbachyt,
 - o Želešice Hornblendite
- Special Soils with Enriched Horizons:
 - o Cl⁻ (Chloric)
 - o K⁺, Na⁺ (Natric)
- Solanchaks, Solonetz Soils
 - o Rich concentrations of Cl⁻ ions in surface horizons
 - o Cl⁻¹⁷ → Ar^{+18*} original equation for Determination Number or Neutrinos for defining SNU (Solar Neutrino Unit)
 - o Locality Sedlec (Břeclav, South Moravia)
 - o Evaporites – sea littoral-lacustrine bottoms with evaporation soils with rich contains of Na, K, Cl, BaSO₄
- H₂O Like A Detector Medium
 - o SPS – DUMAND (Deep Underwater Muon And Neutrino Detector) in Hawaii
 - o ANTARES AND NESTOR – both in Mediterranean Sea in the South of Europe
 - o NESTOR in Greece near the Pylos Island, in deep about 5 km
 - o ANTARES in France-Italy in deep 2.5 km and 25 km near the Toulon
 - o ANTARES - “Astronomy with a Neutrino Telescope and Abyss Environmental Research”. The largest submarine detector of neutrino in the world.
 - o BAIKAL - Lake in Russia, Siberia, 3.6 km from shore at a depth 1.1 km. BNP – The Baikal Neutrino Project.
 - o AMANDA and ICE CUBE in the Antarctica. The Antarctic Muon And Neutrino Detector Array) at the South Pole.

3. Results from measurements on different detectors

DAYA BAY (China)

Mixing angle θ_{13} (théta)

Energy spectrum to improve the bounds on the mixing angle:

$$\sin^2(2\theta_{13}) = 0.090^{+0.009}_{-0.009}$$

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

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

Daya Bay Collaboration China (JUNO)

Neutrino point sources search (AMANDA)

A search for point sources of high energy astrophysical neutrinos was performed by looking for excess of events from the directions of 32 pre-selected objects using a sample of 4282 up-going muon tracks collected during 2000 – 2004, with a live time of 1001 days.

Neutrino and anti-neutrino:

$$\Phi \nu_{\mu} + \nu_{\tau}$$

Figure 6. Selected results of the pre-selected point source searches.

Source	n_{obs}	n_{b}	$\Phi^+ \nu_{\mu} + \nu_{\tau}$	$\Phi^{+\frac{+}{+}} \nu_{\mu} + \nu_{\tau}$
Markarian 421	6.0	7.4	7.4	51
Markarian 501	8.0	6.4	14.7	102
M87	6.0	6.1	8.7	134
NGC 1275	4.0	6.8	5.0	31
Cygnus X-1	8.0	7.0	13.2	96
Cygnus X-3	7.0	6.5	11.8	80
SGR 1900-14	5.0	5.7	7.8	127
Geminga	3.0	6.2	3.5	38
Cassiopeia A	5.0	6.0	8.9	41
Crab Nebula	10.0	6.7	17.8	192
PSR J0205+6449	1.0	4.7	3.1	11

+ and $\frac{+}{+}$ for indices $\gamma = 2$ and $\gamma = 3$ (Amanda)

The NEMO-3 Tracking Detector

The NEMO-3 tracking detector is located in the Fréjus Underground Laboratory. It was designed to study double β -decay in a number of different isotopes ^{100}Mo and ^{82}Se .

Decay of ^{100}Mo ($T_{1/2} > 2.7 \times 10^{22}$ yr) and ^{82}Se ($T_{1/2} > 1.5 \times 10^{22}$ yr).

Figure 7. Limits on $T_{1/2}$ at 90% CL for decays with majoron emission.

Spectral index	^{100}Mo	^{82}Se
n = 1	$> 2.7 \times 10^{22}$	$> 1.5 \times 10^{22}$
n = 2	$> 1.7 \times 10^{22}$	$> 6.0 \times 10^{21}$
n = 3	$> 1.0 \times 10^{22}$	$> 3.1 \times 10^{21}$
n = 7	$> 7 \times 10^{19}$	$> 5.0 \times 10^{20}$

Figure 8. The number of heavy neutrino capture events for three different reactions and a given amount of the daughter isotope. Three different masses of heavy neutrino m_h are considered. $E^{\text{thresh.}}$ is the threshold energy of the reaction and $B(A,Z)$ is the strength of the allowed β -transition.

Nuclear transition	$E^{\text{thresh.}}$ (MeV)	Mass (kg)	$B(A,Z)$
$^3\text{He} \rightarrow ^3\text{H}$	1.04	1	5.65
$^{106}\text{Cd} \rightarrow ^{106}\text{Ag}$	1.22	10	< 2.34
$^{100}\text{Mo} \rightarrow ^{100}\text{Th}$	0.19	10	1.05

Nuclear transition	$m_h = 1 \text{ MeV}$	$m_h = 5 \text{ MeV}$	$m_h = 10 \text{ MeV}$
$^3\text{He} \rightarrow ^3\text{H}$	—	1.5×10^4	7.3×10^4
$^{106}\text{Cd} \rightarrow ^{106}\text{Ag}$	—	$< 7.0 \times 10^2$	$< 3.5 \times 10^3$
$^{100}\text{Mo} \rightarrow ^{100}\text{Th}$	1.3×10^2	4.1×10^4	1.6×10^4

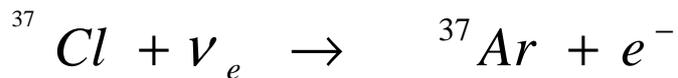
The possibility of detection of relic neutrinos in KATRIN and MARE experiments via neutrino capture on tritium and rhenium.

4. Measurements in Homestake (South Dakota) by John Bahcall and Raymond Davis, Jr.

The Sun produces many of neutrinos $1.8 \times 10^{39} / \text{sec.}$, even on the Earth, 150 million km remote from the Sun, impacting each second on the surface of size like human finger (approx. 1 cm^2) about 100 milliards neutrinos.

In 1951 Raymond Davis, Jr. began working on radiochemical experiment with detection of neutrinos by method, which was designed by B. Pontecorvo:

Capture of neutrinos according the reaction:



The message from Pontecorvo was from Laboratory in Chalk River in Canada.

Luis Alvarez (Nobel Prize winner in 1968) suggested detection of solar neutrinos according chlor-argon reaction in big reservoir filled by saturated solution of NaCl.

In Pontecorvo's methodic with capture of neutrino change ${}^{37}\text{Cl}$ in ${}^{37}\text{Ar}$ with half-time 35 days.

Threshold of capturing reaction is 0.814 MeV, what signed, that neutrinos around energy smaller than 0.814 MeV will not be captured.

In the first Davis experiment he utilized reaction ${}^{37}\text{Cl} \rightarrow {}^{37}\text{Ar}$, he efforted to detect of neutrinos from split reactor with tetrachlorocarbon (CCl_4) like a material of the target. Tank included 3800 litres of tetrachloridcarbon and was exposed to radiation in Brookhaven's graphite research reactor for a month till two months, then eliminated argon and measured with small Geiger counter.

5. Solar Neutrino Unit (SNU)

R. Davis and J. Bahcall determinated the upper limit of flux of solar neutrinos on 40000 SNU, 15000x more than Davis finally result. 2.56 SNU. SNU (Solar Neutrino Unit) is defined like 10^{30} captures by atom ${}^{37}\text{Cl}$ per second. Bahcall and his cooperators shows a prediction from Standard Model of the Sun approximately 7.5 ± 3 SNU.

Nowadays value from Homestake's experiment with chlorine is 2.56 SNU and recent prediction os Standard Model of the Sun is 7.6 SNU.

The Sun has produced only one third of expected numerous of neutrinos. So that formulated in 1967 "a problem of solar neutrinos", which persisted until the end of century. A problem of solar neutrino's sustained from the year 1967 till the year 2001. Measured, but neither predicted value of flux is not changing during this time.

All data from experiment in Homestake completed Cleveland et al.

During 25 years of measuring Davis and Bahcall determined flux of solar neutrinos on 2.56 ± 0.19 (statistic error) ± 0.16 (systematic error) SNU. Recent prediction of Standard Model of the Sun is $7.6_{-1.1}^{+1.3}$ SNU.

Neutrino's oscillation proposed Gribov with Pontecorvo and Wolfenstein and this theory more extended Mikheyev and Smirnov in an image, which is today known like a MSW effect.

Libby with Thomas and Salpeter proposed that be played a self role, so-called catalysis of quarks.

Bahcall with cooperators proposed, that neutrinos could be disintegrated.

Prentice suggested, that the Sun is in the late stadium of evolution of stars, so that, hydrogen is already fired and solar core consists of helium. Clayton et al suggested, that an energy of

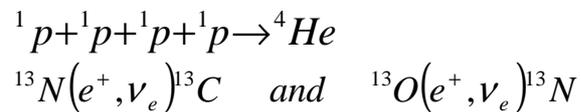
the Sun has not been coming from fusion reactions, but from an energy released by accrecy into the Black Hole in the Center of the Sun.

6. Neutrino positions in the Solar Standard Model

Figure 9. Reactions producing neutrinos in solar core

	Reaction	Relative Intensity (%)	Energy (MeV)	Name
PPI	$p + p \rightarrow {}^2\text{H} + e^+ + \nu_e$	99.75	0.0 – 0.42	pp
	$p + e^- + p \rightarrow {}^2\text{H} + \nu_e$	0.25	1.44	pep
	$2\text{H} + p \rightarrow {}^3\text{He} + \gamma$	100		
	${}^3\text{He} + {}^3\text{He} \rightarrow {}^4\text{He} + 2p$	85		
PPII	${}^3\text{He} + {}^4\text{He} \rightarrow {}^7\text{Be} + ?$	15		
	$e^- + {}^7\text{Be} \rightarrow {}^7\text{Li} + \nu_e$	99.99	0.86; 0.38	${}^7\text{Be}$
	$p + {}^7\text{Li} \rightarrow {}^4\text{He} + {}^4\text{He}$	100		
PPIII	$p + {}^7\text{Be} \rightarrow {}^8\text{B} + \gamma$	0.01		
	${}^8\text{B} \rightarrow {}^4\text{He} + {}^4\text{He} + e^+ + \nu_e$	100	0 – 14.1	${}^8\text{B}$

CNO cycle:



Holmgren and Johnston:

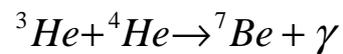
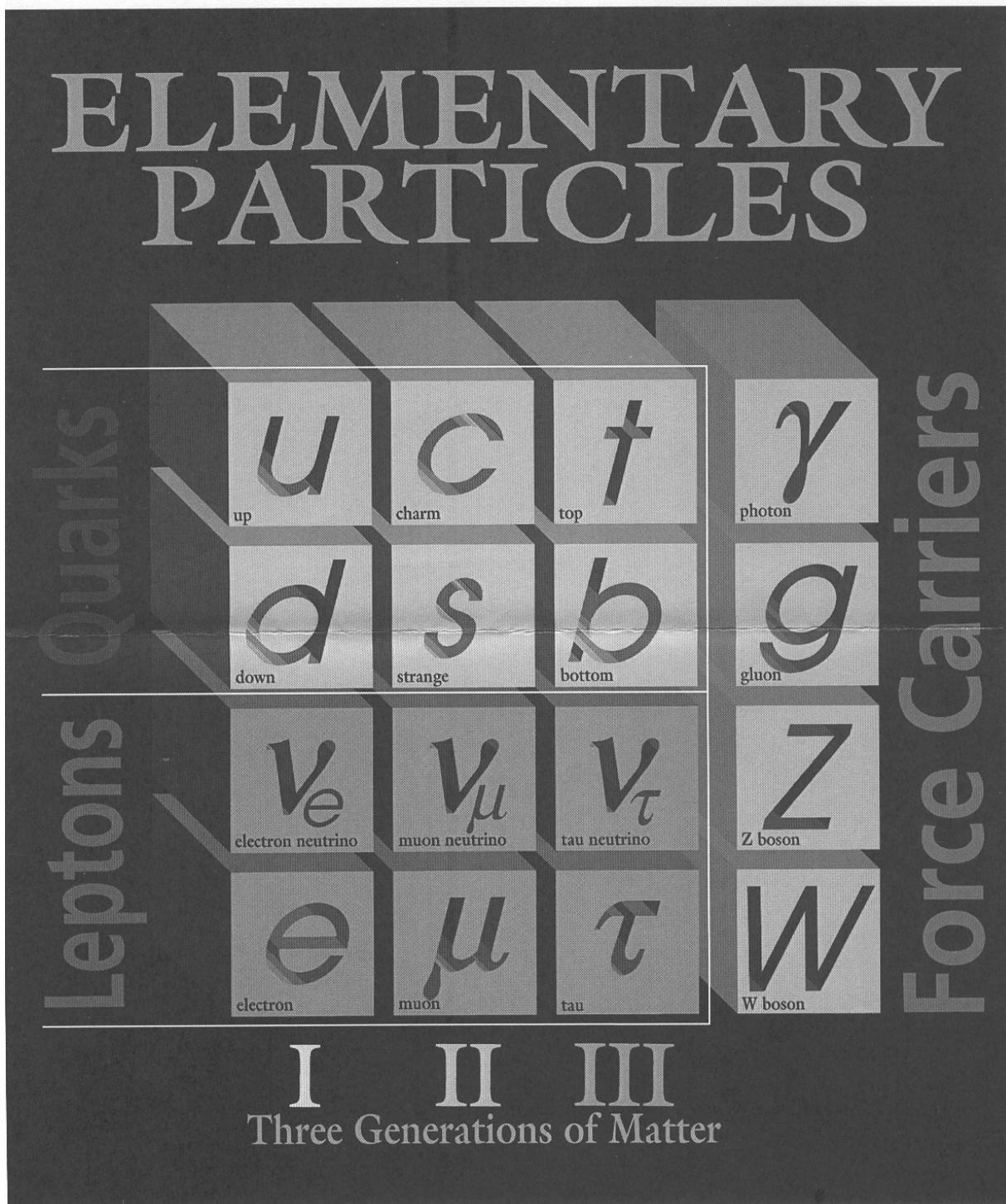


Figure 10. Elementary Particles, Standard Model of Elementary Particles (Fermilab)



7. Applications of Results in the Laboratory (Practical) Research and Model (Theoretical) Research

- Maps of Neutrino Fluxes,
 - in different detectors (scintillators),
- Medicine Applications,
 - Noninvasive operations and diagnostics,
 - Neutrino laser,
- Communications (Telecommunications) – Prof. Joseph Weber,
 - Neutrino laser – sapphire piezocrystals, ICT,
- Technics,
 - Neutrino LED diode,
 - Neutrino-Spintronics,
- Establishment of new science discipline respectively new technical branch – successorist of Electronics according the author of this article NEUTRINICS.
- Cosmologically and Astrophysically Applications,
 - Dark Matter,
 - Surface of Cosmos,
 - Inflations and Inflation Theory of Expanding Universe,
- Radioastronomy and Neutrinos,
 - “Tones of Oscillations”
 - “Music of the Spheres”
- SETI (Searching for Extraterrestrial Inteligence)
 - Puerto-Rico-Arecibo (305 m big diameter or radiotelescope)
 - Prof. Carl Sagan
- ART (Optoacustics)
 - Lissajus Curves
- Theoretical and Cosmological Models, Neutrinos in String and Gate Theories From Thermodynamics and Relativistic Perspectives
 - Cygnets, Nuggets, Linear Strings and String Loops → Strangelets resp. Neutrinos and Vortex Whirlpools and Microscopic Black Holes – Tunnel Phenomenon And Fractal Theories (Benouit Mendelbrot),
- Antropic princip

- Sensu Lato and Sensu Stricto or Intelligent Design and Neutrinos
- Neutrinos And Paraversum (Parallel Universum),
 - Multiversum, Universum or Metaversum (Superantropic Princip), Cosmos
- Neutrino: Like Tachyons – Yes or No?
 - Particles with imaginat mass,
- Neutrinos and Standard Model and GUT (Grand Unified Theory), TOE (Theory of Everything) and SUSY (Super Symmetry), SUGRA (Super Gravity Theory),
- Applied Physics,
 - Geophysics – Seismics (Physics of the Earth),
 - Heliophysics – Helioseismology (Physics of the Sun),
 - Selenophysics (Physics of the Moon),
 - Biophysics,
 - Medicine Physics,
 - Astrophysics (Physics of the Stars),
- “Neutrino Tomography”,
 - Earth, Sun, Moon and objects of Solar System – Galilelo Moons of Jupiter – Ganymed, Callisto, Europa, Io,
- Utilization of Neutrinos in “Terraforming Moon and Mars”.

8. Conclusions

It's most evident in many different geological localities of neutrino detectors and many different states of matter, that these conditions formed rock surrounding and chosen detection or scintillation medium. Very relevant is density of rock or minerals and many significant properties like chemical composition, half-time decay, oscillations of neutrinos, colors of detector and radioactivity of rocks surrounding of detectors.

Like a detection medium (detector) is possibly to choose many materials in many states of matter from onefold: H₂O, D₂O, NaCl, CCl₄, ⁷¹Ga, ⁷¹Ge, ¹⁰⁰Mo to difficult detection materials SiGe⁷¹, permafrost, CdCl₂, Pb(ClO₄)₂, Karst Water,

According this article neutrinos could have oscillated in their trajectories from the core of the Sun to underground or underwater detectors on the Earth. They had have three “flavors“ or “colours” – electron neutrino ν_e , muon neutrino ν_μ and tauon neutrino ν_τ and maybe next unknown type or types of neutrino.

The goal of this work is effort to built a neutrino detector on the South of Moravia in The Czech Republic in the Central Europe. This detector will be applied to many disciplines or branches of human activity and mainly for scientific research.

Author of this text thanks to:

Masaryk University in Brno – Faculty of Science, Institut of Theoretical Physics and Astrophysics. Concretely Prof. Dr. Michal Lenc, PhD., Associate-Professor Dr. Miroslav Pardy, CSc. For precious advices and extraordinary intuition in Physics.

Department of Analytical Chemistry. Concretely Prof. Dr . Josef Havel, DrSc. for exclusive scientific intuition and many experiences.

Thanks to Associate-Professor Dr. Zdeněk Losos, CSc. for precious advices in Mineralogy and Petrology.

Special thanks to engineer Ing. Josef Pokorný for ICT support and stimulating intelectual background and My Mum Yvonna Krištofová for her patienty and her love without it will be very difficult to form this publication.

9. References

- [1] M. Veltman, Facts and Mysteries in Elementary Particle Physics (2007), Academia, Praha.
- [2] M. Durrani, From tyres to neutrinos, New Scientist vol. 182 issue 2443 – 17 April 2004.
- [3] R. Hodák et al., Towards the detection of light and heavy relic neutrinos, Progress in Particle and Nuclear Physics 66 (2011), 452-456, Elsevier.
- [4] X.W. Xu, Results Achieved with AMANDA, Nuclear Physics B (Proc. Suppl.), 175-176 / 2008, 401-406 Elsevier, www.icecube.wisc.edu.
- [5] R. Arnold et al., Limits on different majoron decay modes of ^{100}Mo and ^{82}Se for neutrinoless double beta decays in the Nemo-3 experiment, Nuclear Physics A 765 (2006), 483-494, Elsevier.
- [6] L.C. Stonehill et al., Lead perchlorate as neutrino detection medium, Nuclear Instruments and Methods in Physics Research A 492 (2002), 43-48, Seattle, Elsevier.
- [7] R. Davis, jr., Half-Century with Solar Neutrinos, Department of Physics and Astronomy, University of Pennsylvania, Philadelphia, Pennsylvania 19104, U.S.A. and Department of Chemistry, BNL, Upton, New York 11973, U.S.A., (2002), The Nobel Foundation.
- [8] V. Wagner, Introduction in Subatomic Physics /online/, ÚJF AV ČR (2010), (cit. 2011-10-02), Presentation n. 10, Particles and their interaction. (<http://hp.ujf.cas.cz/~wagner/prednasky/subatom/powerpoint/castice.ppt>)
- [9] D. Nosek, Cores and Particles, Solution Examples (2005) Matfyzpress, Praha, 306 p.
- [10] L.D. Landau, E.M. Lifšic, Quantum Mechanics vol. 2, (1972), Nauka, Moscow, 368 p.
- [11] J. Horský et.al., Introduction in Physical Cosmology (2004), Academia, Praha, 219 p.
- [12] Czechslovak journal for Physics, FZÚ AV ČR, v.v.i., Praha, <http://ccf.fzu.cz>.
- [13] Kozmos, popular-science journal, SÚH Hurbanovo and kozmos@nextra.sk.

And these servers:

- [14] www.elsevier.com/locate/nima
- [15] www.sciencedirect.com
- [16] <http://technet.idnes.cz>
- [17] <http://en.wikipedia.org/w/index.php>