This Paper Presents the Objective and Empirical Truth about the Hypothetical Solar Neutrino Problem

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ABSTRACT

An objective and empirical analysis of the data collected from different detectors over four decades reveals that the so-called solar neutrino problem is far from being solved. Contrary to the assessment of the Nobel Committee, the experimental results from the Sudbury Neutrino Observatory cannot be regarded as a confirmation of the Standard Solar Model. However, the obsolescence of the current model (SSM) has recently been exposed by so much observational data, for instance, the crisis in solar abundance. Furthermore, using images obtained by the Solar Dynamics Observatory, researchers found the convective motions (the motions within the Sun's interior) to be nearly 100 times smaller than current theoretical expectations. This is a clear verdict on the notion of thermonuclear reactions that are supposed to be the processes that generate solar neutrinos.

INTRODUCTION

Based on the hypothesis of the standard solar model, the number of neutrinos produced by the Sun per second is approximately 1.8 x 10^{38}, which means 400 trillion neutrinos pass through our bodies every second. The model also assumes that the absolute majority of neutrinos are generated from the P-P reaction, and 99.99% of solar neutrinos have energies far too low for detection. Solar neutrinos with higher energy are considered rare, making up merely 0.01% of the total. These high-energy neutrinos come from a side reaction involving 3He and 4He particles that form a beryllium nucleus (7Be), which then captures a proton to form a boron nucleus (8B). This nucleus subsequently breaks up into Beryllium (8Be), a positron, and a neutrino. Furthermore, just two of these reactions are supposed to be produced out of 10,000 completions of the P-P reaction.

In order to detect these high-energy neutrinos, Raymond Davis Jr. first proposed placing a vessel—about the size of a large swimming pool (400 cubic meters) filled with a chlorine-based cleaning fluid (perchloroethylene)—underground in a gold mine in South Dakota, USA. Raymond Davis Jr. used a chlorine solution as a target for inverse β-interactions, $\nu_e + {}^{37}Cl \rightarrow {}^{37}Ar + e^-$. The radioactive ${}^{37}Ar$ could be extracted from the target and the decay could be detected with proportional counters. It is believed only a small number of the Chlorine-37 (37 Cl) will react with the neutrinos to form **Argon-37** and an electron, which then reverts to **Chlorine-37 and neutrino.** **(37Ar + e– → 37Cl + ν e)** The **37Ar** atoms are purged with helium gas and the decay is counted. The Homestake Solar Neutrino Detector was only sensitive to neutrinos with energy higher than **~0.8 MeV**. The first results of Ray's experiment were announced in1968 (1). The detector should have measured 8 x 10^{36} interactions per second per atom or **8SNU**, with an error rate of 33%.

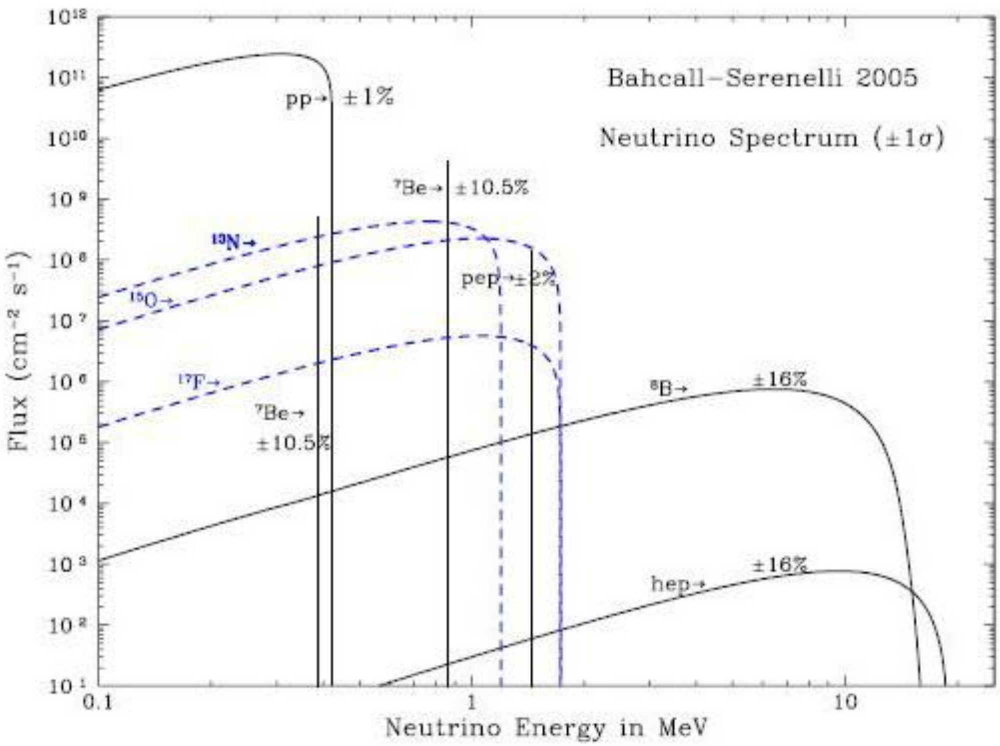


Figure 1.0 **Calculated energy spectrum of the solar neutrinos (with 1 standard deviation uncertainty) according to the Standard Solar Model [1]**

However, the neutrino detector had averaged just 2.0 SNU with a deviation of 0.3 SNU. This represented about one-third as many radioactive argon atoms as predicted. This discrepancy, which soon became known as "the solar neutrino problem" or "the mystery of the missing neutrinos," was well outside both the uncertainty of the calculations and the experimental deviations. In the beginning, two different explanations were given to solve this problem, but no question was raised about the validity of the thermonuclear powered Sun. The first explanation suggested that the theoretical calculations might be wrong, while the second suggested that the experimental setup could be flawed. For the following two decades, the sensitivity of the experiment was increased, and the theoretical calculations were refined and checked many times. In spite of that, the discrepancy between the theory and experimental results persisted.

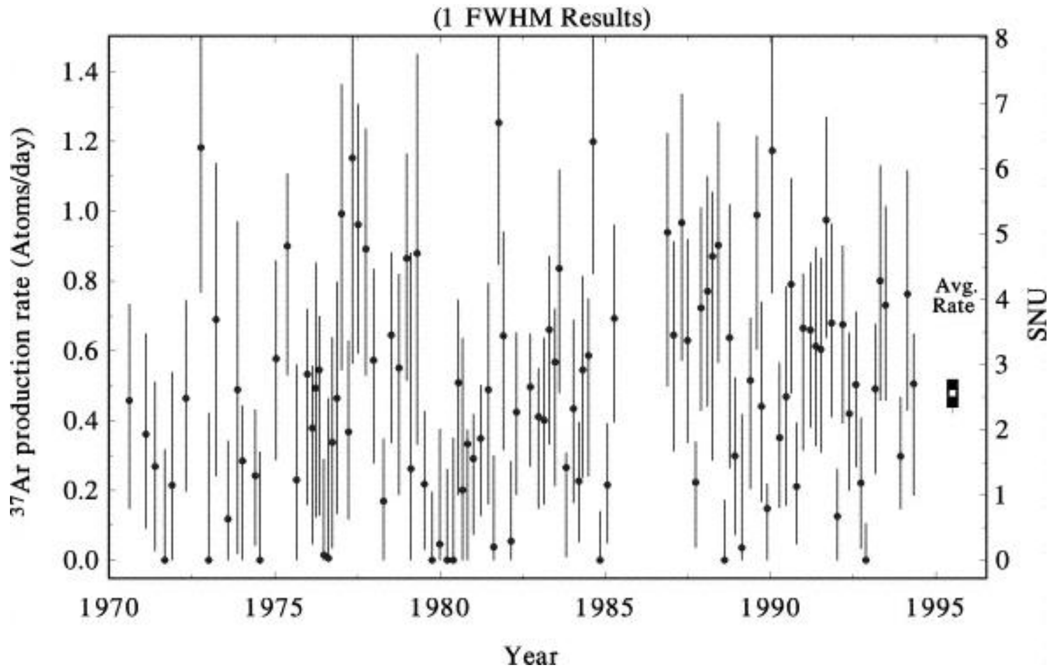
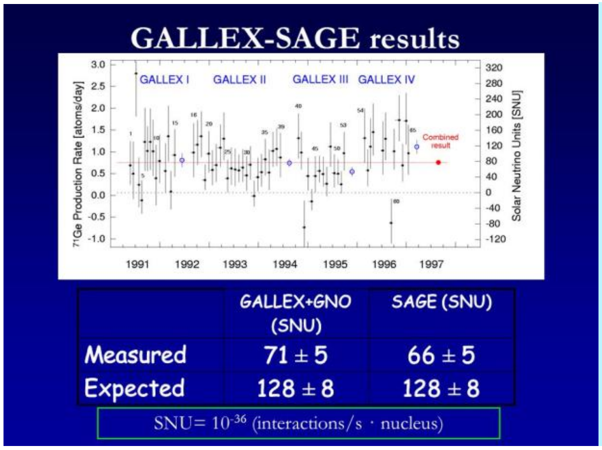


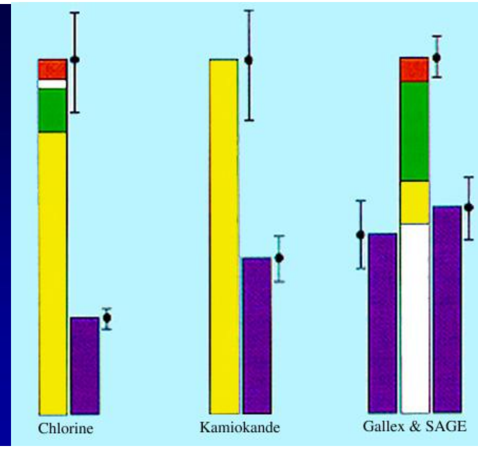
Figure 2.0 the measured flux of solar neutrinos by Homestake Solar Neutrino Detector (1970-1995)

Twenty-one years after the results of Davis's experiment were announced, a new experimental group called Kamiokande—led by Japanese physicists Masatoshi Koshiba and Yoji Totsuka—constructed a large, pure water detector. This was built to measure the rate at which electrons in the water scattered the higher-energy neutrinos expected to be emitted from the Sun, which are considered rare in the solar energy production cycle.

The results of Kamiokande also showed that the observed neutrino events were far fewer than those predicted by the theoretical model. While the discrepancy between theory and experiment remained, it was slightly less pronounced in the Kamiokande experiment than in Ray Davis's chlorine detector.

In the 1990s, three other massive detectors were built, which confirmed these findings. Two of these detectors utilized gallium and were constructed in Russia and Italy. The SAGE detector was led by Russian physicist Vladimir Gavrin, and the GALLEX detector was led by German physicist Till Kirsten (4). The results from both detectors demonstrated that lower-energy neutrinos were also missing. In addition to SAGE and GALLEX, a much larger version of the Japanese water detector, Super-Kamiokande (directed by Totsuka and Suzuki), measured higher-energy neutrinos and confirmed the deficit previously found by Kamiokande and Ray Davis's detector (5).





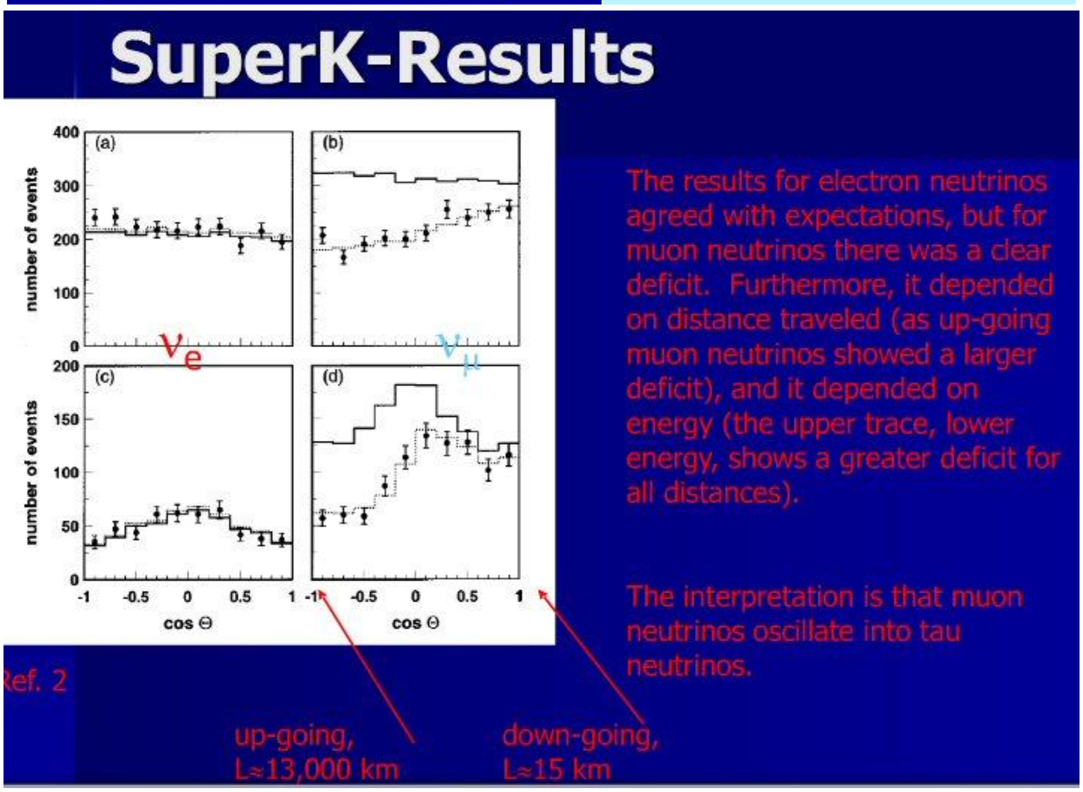
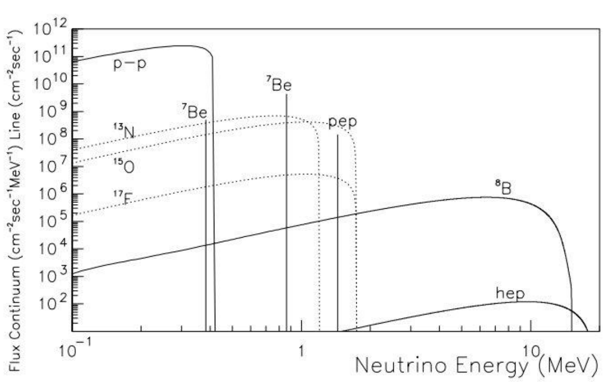


Figure 3.0 on the upper right. SOLAR NEUTRINO FLUXES observed (purple) by the four first-generation detectors show large deficits when compared with standard solar-model predictions. The different predicted total fluxes, normalized here to unity, comprise various individual solar processes, indicated by colors: white for pep fusion (with and without electron assistance); green for electron capture by 7Be; yellow for 8B decay; and red for the stellar carbon-nitrogen-oxygen cycle, which is calculated to play only a small role in the Sun neutrinos so energetic that Kamiokande can see them. The monoenergetic line fluxes are shown in cm-2·s-1. The second-generation water-Cerenkov experiments hope to have neutrino-energy detection thresholds of about 5 MeV. **(Credit: John N. Bahcall, Frank Calaprice, Arthur B. McDonald and Yoji Totsuka, Physics Today, Volume 49, No. 7, July 1996, pp. 30-36)**

DISCUSSION & ANALYSIS

It is abundantly clear from the results of the above-mentioned detectors that the expected number of both high- and low-energy neutrinos was absent. The huge discrepancy between the expectations of the model and the experimental results remained in spite of decades of trying with different detectors. In other words, all detectors showed that the number of neutrinos was far too small to account for the Sun's presumed thermonuclear energy output. Theoreticians had to find a solution to save their model, because they could not contemplate trashing the theory that resides at the heart of astrophysics and cosmology. Therefore, the problem had to be with the neutrinos themselves. As expected, theoreticians created a hypothetical problem for solar neutrinos, but this time the Standard Model of particle physics had to be sacrificed, yet the model is supposed to be verified by so many experiments that took enormous amounts of time and money (2, 3). However, theoretical physicists proposed that solar neutrinos exhibit a multiple personality disorder, much like many politicians. This notion assumes that neutrinos are created as electron neutrinos in the Sun but change their type during their journey to Earth. Naturally, this theoretical concept had to be supported by some type of experimental evidence to make it valid. On June 18, 2001, a collaboration of Canadian, American, and British scientists, directed by Canadian scientist Arthur B. McDonald, announced that the solar neutrino mystery had been solved. They used a detector containing 1,000 tons of heavy water (D_2O), called the Sudbury Neutrino Observatory (SNO), located in a nickel mine in Sudbury, Ontario, Canada. The researchers stated that they studied the same higher-energy neutrinos previously investigated in Japan with the Kamiokande and Super-Kamiokande detectors. The first measurement was performed using the heavy-water detector in a mode sensitive only to electron neutrinos, which yielded around one-third as many neutrinos as the standard solar model predicted. By combining their results with the previous findings from the Kamiokande and Super-Kamiokande detectors, the researchers announced that the solar neutrino problem had been resolved



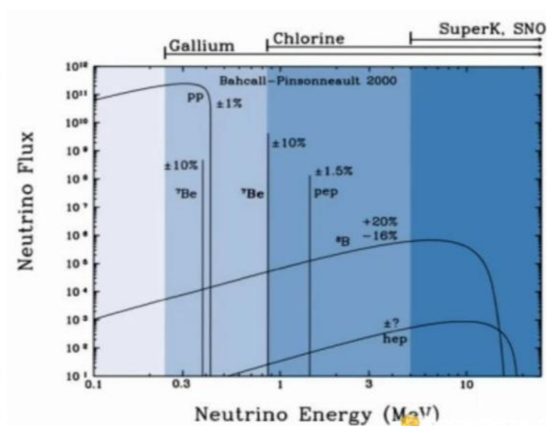


Figure 4.0 Solar neutrino fluxes --- pp chain (solid lines) (dotted lines are CNO neutrinos, which is less than 2% of total). right -- superimposes the neutrino detection threshold of the major neutrino detectors (source left) - http://www.slac.stanford.edu/econf/C990809/docs/suzuki.pdf) (source right) -- screen capture from 2002 Davis Nobel lecture)

Based on their assessment, the combined measurements of the SNO and the two Japanese detectors agreed with the prediction of the standard solar model. In their first measurement, which is supposed to be sensitive only to electron neutrinos, the SNO researchers said they observed approximately one-third as many electron neutrinos as the model predicted. They concluded that since the Super-Kamiokande detector... observed about half as many events as were expected, **"the smoking gun has been found".**

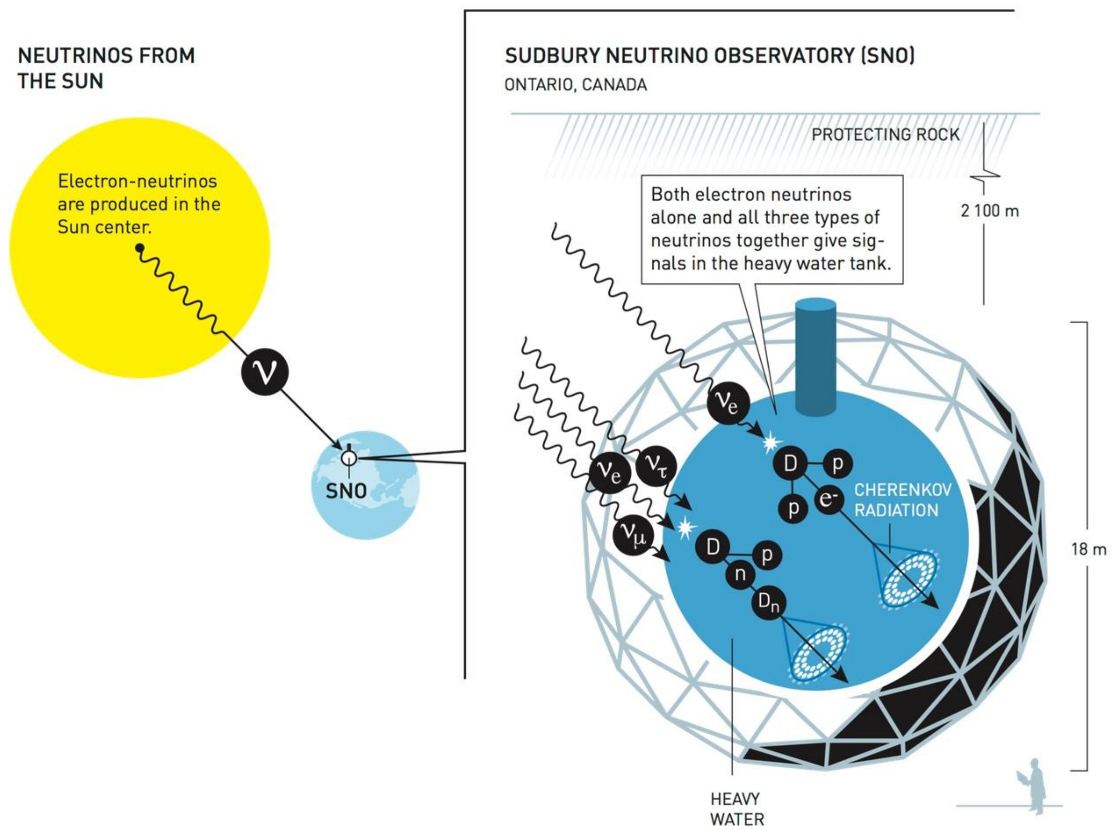


Figure 5.0 Credit: Johan Jarnestad/the Royal Swedish Academy of Sciences.

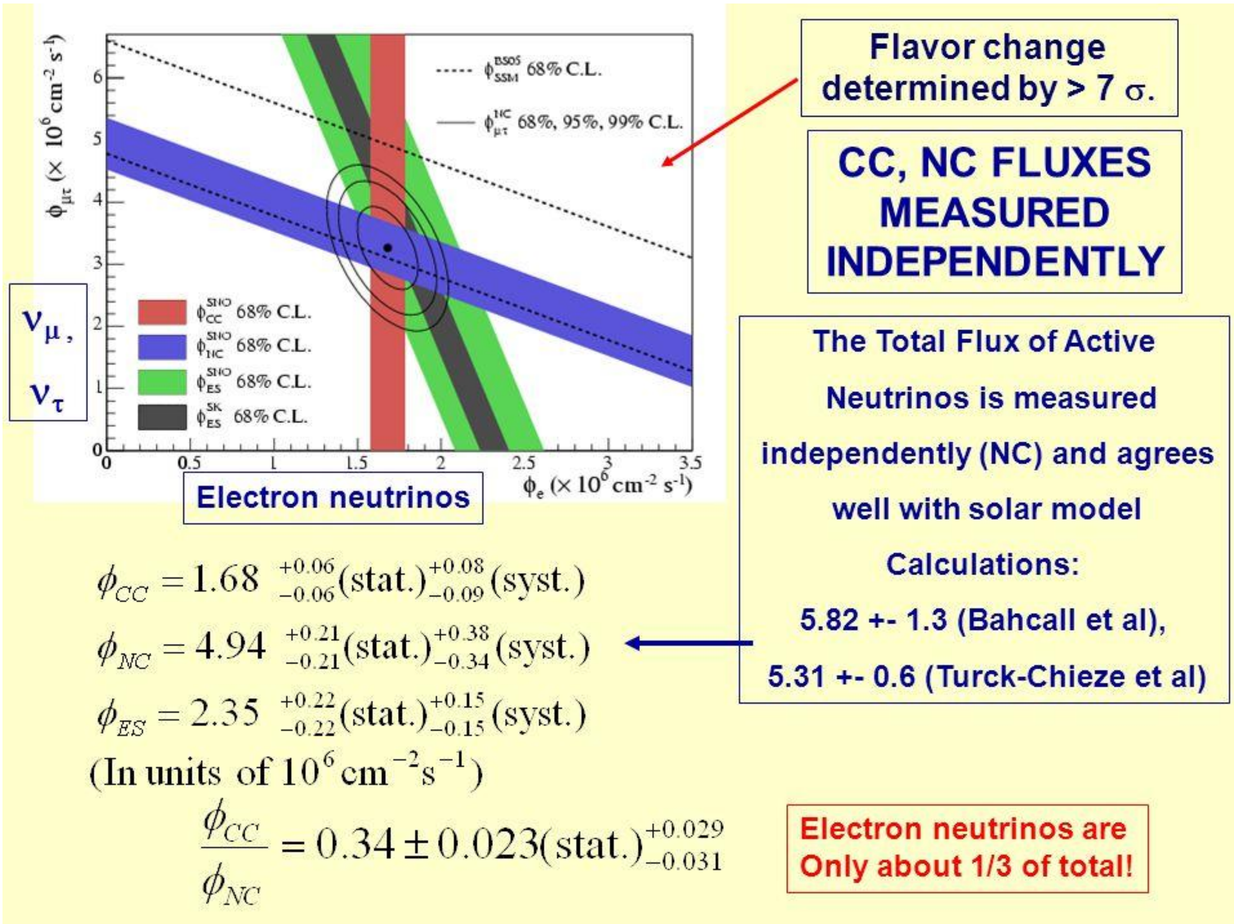


Figure 6.0 Credit: Arthur B. McDonald, Queen's University, Kingston, Ontario, Canada

In the above figure obtained from the research team of SNO, the x-axis represents electron-neutrino flux, while the y-axis represents the flux of the other types. Yet, it is not possible to distinguish muon neutrinos from tau neutrinos. The red band shows the result of the charged-current analysis, which is sensitive only to electron-neutrinos. The blue band represents the neutral-current analysis, which is supposed to be sensitive to the three types. The green band is elastic electron-neutrino scattering, which also has some sensitivity to tau and muon neutrinos. The brown band represents the result from Super-K. The band between the dotted lines is the total neutrino flux as expected from the standard solar model. However, Bahcall and his colleagues announced that particle physics must be wrong concerning neutrinos. They claimed that if particle physics were correct, then the fraction measured by SNO and the fraction measured by Super-K should be the same, and all neutrinos should be electron neutrinos. Therefore, since the fractions were different, it means that electron neutrinos produced in the core of the Sun change into muon and tau neutrinos by the time they reach the Earth. In other words, the missing neutrinos were actually present, but they were more difficult to detect since they became muon and tau neutrinos.

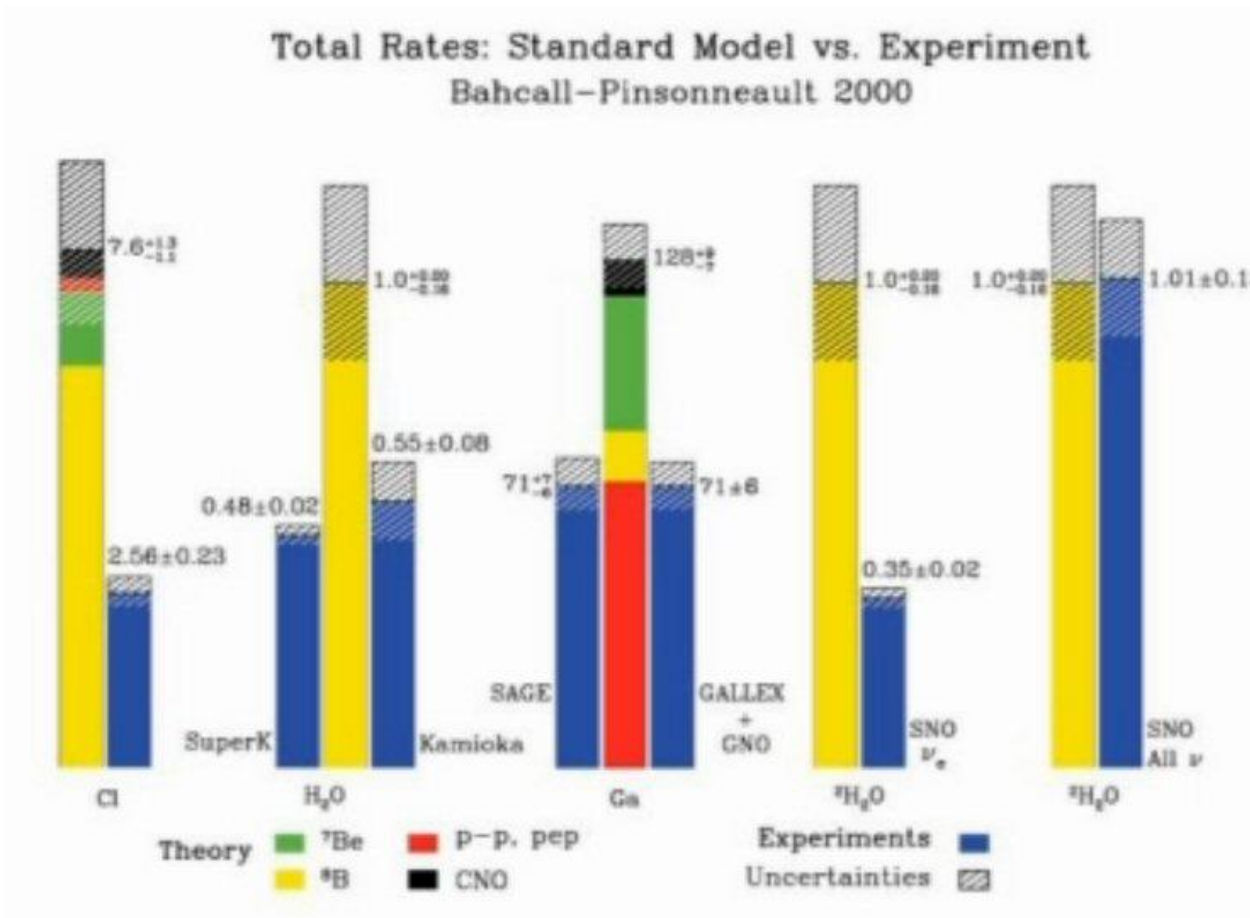


Figure 7.0 Measured (blue) vs calculated (yel) neutrino rates for all major neutrino detectors up to year 2000. Only Sudbury (SNO) in its deuterium fission mode (right) is "supposed" to show the measured rate matching the calculated rate. (screen capture from Davis Homestake 2002 Nobel lecture)

A report in Physics Today, March 2003, stated: "After 36 years of solar neutrino experiments, the inescapable conclusion is that a large fraction of the electron neutrinos produced by nuclear processes in the Sun's core are metamorphosing into other neutrino varieties somewhere en route to the detectors on Earth." The best comment on this report came from Wal Thornhill, an advocate of the Electric Universe. He said, "The report came to the conclusion that neutrinos were not undergoing any significant change of flavor in the vacuum of space between the Sun and Earth. Instead, they were performing an irreversible flavor change that takes place in high-density regions of the Sun. So, not only does the Sun need a hypothetical hot, high-density core to have any hope of generating thermonuclear energy, it now needs a hypothetical critical-electron-density region as well, to fudge the neutrino results." On October 11, 2002, a few days after Ray Davis and Masatoshi Koshiba were awarded the Nobel Prize, Chen-Ning Yang, the late Chinese physicist who received the 1957 Nobel Prize in Physics, said that he did not believe in neutrino oscillations even after Davis's painstaking work and Bahcall's careful analysis. The oscillations were, he believed, uncalled for. Sidney Drell, an American theoretical physicist and former arms control expert, who was also professor emeritus at the Stanford Linear Accelerator

Center (SLAC), who died on December 21, 2016, wrote a letter to late John N. Bahcall, who worked on the solar neutrino problem for years and supported neutrino oscillations. The success of the Standard Model of Particle Physics (SMPP) was too dear to give up. The SMPP is a beautiful theory that has been tested and found to make correct predictions for thousands of laboratory experiments. The standard solar model involves complicated physics in unfamiliar conditions and had not previously been tested to high precision. Moreover, the predictions of the standard solar model depend sensitively on details of the model, such as the central temperature. No wonder it took scientists a long time to blame the SMPP rather than the standard solar model".

However, according to Pontecorvo and Gribov—who were the first to come up with the idea of neutrino oscillation—lower energy solar neutrinos switch from an electron neutrino to another type as they travel in the vacuum from the Sun to the Earth. Meanwhile, Stas Mikheyev, Alexei Smirnov, and Lincoln Wolfenstein proposed that interactions with electrons in the Sun affect high-energy neutrinos (6), with matter causing them to oscillate more vigorously between types. The standard model of particle physics asserts that there are three massless, left-handed neutrino types and three right-handed antineutrinos traveling near the speed of light while interacting very weakly with matter. This raises the question of why neutrinos change types when propagating from the Sun to the Earth, presenting a serious contradiction. In other words, why does neutrino change its characteristic completely by converting to different types when it propagates from the core of the Sun to the surface of the Earth? This is a serious contradiction.

More importantly, in experimental science, one has to carry out measurements without making a prior hypothesis. There can be no confirmation of neutrino oscillation between the Sun and the Earth without simultaneous neutrino measurements being made near the Sun or at least somewhere between the two celestial bodies. In fact, even if one uses the arguments of those theoreticians who came up with the idea of neutrino oscillation, the solar neutrino problem is far from being solved. First of all, the mass of any particular neutrino is not specified, but only the sum of the masses of the three neutrinos is assumed to be less than 1.5 electron Volts. Neutrino oscillation requires that the three neutrinos have finite and different masses, which is still unverified. Secondly, the claim of neutrino oscillation is not backed up with any evidence showing that neutrinos oscillate routinely into any specific alternative flavor.

Neutrino oscillation is based only on a theoretical hypothesis that assumes upper limits on the oscillation rate via the so-called mixing angles. Besides that, theoreticians cannot decide whether neutrinos are Majorana particles or Dirac particles, nor why only neutrinos oscillate among leptons. On top of all that, even if one accepts for the sake of argument that neutrinos oscillate and change flavors, this still cannot be a confirmation of the Standard Model. Water detectors are sensitive only to higher-energy neutrinos (with energies > 5 eV). These neutrinos are supposed to make up only 0.01% of the neutrinos emitted by the Sun. That means 99.99% of the neutrinos generated by the Sun—according to the SSM—have not been detected yet. So, how can one draw a conclusion from these results, not to mention proclaiming that these results agree with the theoretical predictions of the model? Precise measurements of the rate of low-energy solar neutrinos remain the critical test of the Standard Solar Model and the theory of stellar evolution in general.

Nevertheless, from the analysis of data collected by different detectors for more than three decades, it is obvious that—just like the case of quantum tunneling, which is supposed to remove the hurdle facing thermonuclear reactions—neutrino oscillations (a notion also based on quantum mechanics) were shoved down our throats with the help of quasi-experiments to serve as a solution to one of the most obvious defects of a major theoretical paradigm in astrophysics. It is noteworthy, however, that the rate of neutrino production is directly related to the notion of Quantum Tunneling (QT). This is because the number of charged particles (P-P) that must collide to generate the reaction is small compared to the total number of protons. In other words, only a tiny fraction of the nuclear collisions in the sun can overcome the potential barrier and cause the reactions. This fraction is highly sensitive to temperature; a mere 1% error in the temperature corresponds to about a 30% error in the predicted number of neutrinos, and a 3% error in temperature results in an error by a factor of two. Recent observations using sensitive imaging devices on board an advanced space telescope, the Solar Dynamics Observatory (SDO), have shown that the motions of the solar material within the interior of the Sun are around two orders of magnitude slower than what theoretical models predict. This recent observational data provides a clear verdict on the real temperature range within the core of the sun, meaning that hypothetical QT cannot possibly take place under such conditions. Unexpectedly slow motions below the Sun's surface | Max-Planck-Gesellschaft

Solar Physics is Missing, not Solar Neutrinos

In physical reality, any type of particle—whether charged or neutral—possesses mass, including the photon. The details of this argument are explained in the Helical Universe Model, with its basic concept of the magnetic structure of matter that I introduced in 2013. Nevertheless, all types of solar neutrinos are generated on the surface of the Sun and within its atmosphere. They are produced due to the interactions of cosmic rays with the atomic nuclei of the elements that make up the surface and atmosphere of the Sun. Moreover, neutrinos do not need to oscillate on their way to Earth to make up for an imagined deficit. In fact, the number of solar neutrinos detected from the above-mentioned experiments is more or less the actual rate of solar neutrinos. There is no solar neutrino problem to start with. What is really missing is not neutrinos, but rather real solar physics. Actually, this argument is valid and obvious just by considering the fact that a clear correlation exists between the neutrino count and the surface activities of the Sun, such as sunspot numbers and the strength of solar flares. These are surface effects that have no connection with what is happening in the interior of the Sun. The establishment is totally silent about the observed correlation between solar surface activities and neutrino count. One can understand the silence. There are already serious gaps to cover in the current model, and any measurement that shows a correlation between sunspot numbers, solar flares, and neutrino counts would be a devastating blow that no theoretical notion could cover.

Nonetheless, solar neutrinos must be classified into primary and secondary categories. Primary neutrinos are generated in the core of the Sun and on its surface as a result of condensed-matter nucleosynthesis, while secondary neutrinos are high-energy solar neutrinos produced by interactions between galactic and extragalactic cosmic rays and the composition of the upper layers of the Sun's atmosphere. These interactions produce secondary particles that are mainly unstable, such as mesons and certain baryons. Most of these particles decay, while the remainder undergo secondary interactions, producing new particles that further contribute to the development of a cascade. The decays of these secondary particles produce neutrinos as well as muons, which subsequently decay into additional neutrinos.

The process of secondary particle production in the solar atmosphere resulting from cosmic-ray bombardment is identical to the cascades produced by cosmic rays in Earth's upper atmosphere. This latter process has been studied extensively over the last few decades. Yet, one must keep in mind that cosmic rays bombarding the Sun have a much higher energy intensity than those hitting Earth. Additionally, the density of the solar atmosphere is much lower than that of Earth. Ingelman and Thunman (7) studied the fluxes of high-energy muon and electron neutrinos produced from the interactions of cosmic rays with solar material. The results of their calculations—which are based on Monte Carlo models—regarding muon neutrino flux agree in principle with the results obtained by Seckel et al. (8), though their specific values differ substantially. They found that solar neutrino fluxes produced from interactions within the solar atmosphere are at least two orders of magnitude higher than those resulting from cosmic-ray interactions in Earth's atmosphere.

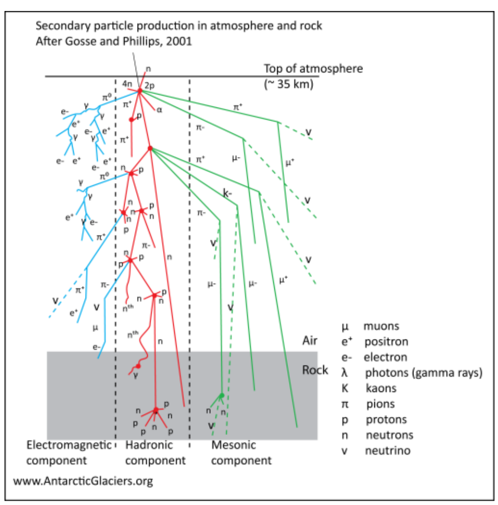


Figure 8.0 Process of secondary particles production in Earth's Atmosphere

CONCLUSION

Our star is misunderstood, and the SSM, which is supposed to represent its physical mechanism, is not even wrong. I have been living in a state of permanent shock for more than two decades. How can the world's leading scientific institutions still believe in the concepts of the SSM? The Sun is a complete mystery based on its concepts. Yet, a well-known physicist who considers himself an authority said in an interview that the current model made predictions that agreed with essentially all the observations to a pretty high level of accuracy. Absolutely ridiculous! In reality, none of the basic features of the sun, without exception, can be explained by the current model. The neutrino puzzle, which is still alive, is just one serious problem facing it. Furthermore, there is a long list of recent observations that have entirely exposed the dogmatic nature of the notion of a thermonuclear furnace. Nonetheless, the decisive evidence that would settle all disputes about the Sun can be presented if the proper arrangements can be made. Specifically, a correct, practical model of how fusion reactions occur can be provided.

REFERENCES

1- Experiments by R. Davis et al: see October 1990 Physics today, p 17.
2- Solar neutrino reviews: J. N. Bahcall and M. Pinsonneault, Reviews of Modern Physics, vol 64, p 885, 1992; S. Turck-Chieze and I. Lopes, Astrophysical Journal, vol 408, p 347, 1993. See also J. N. Bahcall, *Neutrino Astrophysics* (Cambridge, 1989).
3- Bahcall arguing for new physics: J. N. Bahcall and H. A. Bethe, Physical Review D, **47**, p 1298, 1993; against new physics: J.N. Bahcall et al., *Has a Standard Model Solution to the Solar Neutrino Problem Been Found?*, preprint IASSNS-94/13 received at the National Radio Astronomy Observatory, 1994. J. Bahcall et al. Phys. Rev. Lett. **78**, 171 (1997)
4- First results from the ^{51}Cr neutrino source experiment with the GALLEX detector, Physics Letters B, Volume 342, Issues 1–4, 12 January 1995, Pages 440-450, GALLEX Collaboration, P Anselmann, R Fockenbrock, W Hampel, G Heusser, J Kiko, T Kirsten, M Laubenstein, E Pernicka, S Pezzoni, U Rönn, M Sann, F Spielker, R Wink, M Wójcik, R.v Ammon, K.H Ebert, T Fritsch, D Heidt, E Henrich, C Schlosser, et al.
5- Constraints on Neutrino Oscillations Using 1258 Days of Super-Kamiokande Solar Neutrino Data, *S. Fukuda* et al. *(Super-Kamiokande Collaboration) Phys. Rev. Lett. 86, 5656 – Published 18 June 2001*
6- Mikheyev-Smirnov-Wolfenstein enhancement of oscillations as a possible solution to the solar-neutrino problem S. P. Rosen and J. M. Gelb Phys. Rev. D 34, 969 – Published 15 August 1986
7- High Energy Neutrino Production by Cosmic Ray Interactions in the Sun, G. Ingelman and M. Thunmana https://arxiv.org/pdf/hep-ph/9604288.pdf
8- Signatures of Cosmic-Ray Interactions on the Solar Surface - Astrophysics Data System

BIBLIOGRAPHY

1- Are the experiments in error? Is our model of the solar interior wrong?
http://helas.astro.uni.wroc.pl/data/jc/BS_neutrino.ppt

2- Did the Nobel committee get the physics wrong? http://www.sciencemag.org/news/2016/12/did-nobel-committee-get-physics-wrong

3- The Sudbury Neutrino Observatory, https://arxiv.org/pdf/1602.02469.pdf

4- Sudbury Neutrino Observatory. https://en.wikipedia.org/wiki/Sudbury_Neutrino_Observatory

5- A half century with solar neutrinos. Nobel Lecture, December 8, 2002, by Raymond Davis, JR. https://www.nobelprize.org/nobel_prizes/physics/laureates/2002/davis-lecture.pdf

6- Review of solar neutrino experiments. A. Bellerive. Ottawa-Carleton Institute for Physics, Department of Physics https://arxiv.org/pdf/hep-ex/0312045.pdf

7- John Bahcall's web site, http://www.sns.ias.edu/~jnb

31.08.2026