Experimental Evidence for Physical Reality of Theta Wave by Change in Radionuclide Decay Rates

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By analysis performed on two independent experiments on radionuclide decay rates, we inferred the physical reality of de Broglie waves. The unexpected result of a variation of decay rates of 32Si and 226Ra with Earth-Sun inverse squared distance, clearly related with solar neutrino flux, is accounted here as a physical action of de Broglie empty waves. The highly illusive neutrino could not account for that rate change unless we consider them as a quantum particle in the causal and non-linear quantum physics framework. Other experiment here studied relating solar flares and changes in 54Mn decay rate reinforce the assumption that the solar neutrino flux is the reason for that variation, with neutrino as a quantum particle in de Broglie framework. In addiction, over and above of discuss further possibilities to confirm, or not, ours conclusions, we report some experimental setups which is

only possible of interpretation if we consider the reality of Theta waves.

Keywords: neutrino solar flux; nuclides decay rates; de Broglie wave's reality; quantum particle; modern causal and non-linear quantum physics; Theta wave.¨

1 Introduction

Style Recently has been reported [1] a periodic change in time decay rates in 32Si and 226Ra nuclides, intimately related with Earth-Sun inverse squared distance characteristic of a flux. This unexpected outcome require a new insight on the possible solar neutrino's flux as the source for these results.

Decay rates of radioactive nuclides has known to be constant over time [2]. The well established characteristic Poisson distribution that describe the radioactive decay rate is independent both of the particular decay process, such as alpha or beta decays branches, as of the nature of the emitted particle. Moreover is well settled the independence of nuclides decay rate from thermodynamic variables such as pressure or temperature as well from electromagnetic fields [1]. Those rates are time independent and uncorrelated although there are two exceptions related to decays resulting from K-capture and for beta-decays in very strong electromagnetic fields [3].

Although the relation between observed variation in time decay rates and the solar neutrino flux has not been fully settled [1], is not known other permanent annual modulated flux from the sun able to induce decay rate variation in nuclides.

In the analyzed experiments was used tiny amounts of nuclides such as few millimeters cubic of aqueous solution in one of them [4]. So, as a highly elusive particle, the neutrino's flux only could influence decay rates of nuclides if we consider them as de Broglie

quantum particles with an extended Theta wave, which by some mechanism yet unknown interfere with decay process.

In the conceptual framework of modern causal and non linear [5] development of de Broglie double-solution theory [6] we find evidence for the physical activity of neutrino's theta wave.

2 Experiment Analysis¨

In Jenkins, et al. [1] was analyzed two sets of data from two independent experiments. They obtained the raw data both of Alburger, et al. [7] experiment from the Brookhaven National Laboratory (BNL) and of H. Siegert, et al. [4] experiment in Physikalisch-Technische Bundesandstalt (PTB), Germany, and submitted that data to robust statistical tests.
Both experiments take place for several years. The BNL experiment range to 4 years and the PTB range for 15 years, allowing the study for eventually long unexpected time correlation.

The initial motivation behind BNL group experiment was the great uncertainty in 32Si half life witch in the beginning of the experiment range from 60 to 700 yr hence the need for a multiyear experiment to obtain a measurable slope. Otherwise for PTB group was the study of long-term stability of detectors as the main motivation for their work.

We must stress that the two experiments take place in very different spots both gathering data in unequal climate conditions with different electronics and apparatus. Moreover 32Si decay by beta emission while 226Ra decay by alpha emission.

The PTB group measured the half-life of 152Eu against the long-lived comparison standard 226Ra. In Jenkins, et al. [1] was used 226Ra raw data of PTB experiment instead of 152Eu since the later was submitted to some corrections that turns out deconvolution process more difficult [12]. The 32Si half-life was measured by BNL

group against the long-lived comparison standard 36Cl (T1/2=301,000 yr.)

As is well known the nuclide decay rate is described by the exponential decay law

$$N(t) = N_0 e^{-\lambda t}$$

where N(t) denotes the number of surviving atoms starting from an initial population N_0 at t=0. So we define activity as the quantity

$$\frac{dN}{dt} \equiv \dot{N} = -\lambda N_0 e^{-\lambda t}$$

where

$$\lambda = \frac{\ln 2}{T_{1/2}}$$

is the slop of a plot of $\ln \dot{N}(t)$. From λ we obtain the half-life $T_{1/2}$.

Rather than $\dot{N}(t)$, was used the function

$$U(t) \equiv \frac{\dot{N}(t)}{\dot{N}_0} \exp(\lambda t)$$

which is time-independent for all nuclides.

Jenkins, et al. [1] obtained a strong correlation between U(t) and R^{-2}, where R stands for distance between Earth and Sun, with a almost non-existent probability of being uncorrelated.

The Earth-Sun distance R was obtained from U.S.Naval Observatory (USNO) and the fractional change both in 32Si and 226Ra counting rates between perihelion and aphelion is approximately 0,003.

The statistical data analysis reveal a probability of only 6×10^{-18} of the two data sets (BNL raw data and R^{-2}) were uncorrelated. This probability turns out to be even more vanishingly small (2×10^{-246}) in PTB raw data. Moreover, both BNL and PTB are correlated with each other, with a probability of this correlation arise from uncorrelated data of 4×10^{-12} .

A possible phase shift between R^{-2} and both BNL and PTB data is noted. The efect, if real, "could also arise from smaller contributions to periodic variations in neutrino flux." [1]

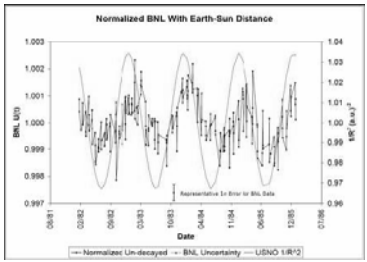

Fig.1: Plot of U(t) for the raw BNL 32Si/36Cl ratio along with R^{-2} were R is the Earth-Sun distance in units of 1/$(a.u.)^2$. $U(t)$ is obtained by multiplying each data point by $\exp(\lambda t)$ where $\lambda = \ln(2/T\,1/2)$ and $T_{1/2} = 172$ yr for 32Si. The left axis gives scale shows normalized $U(t)$, and the right axis denotes the values of R^{-2} in units of 1/$(a.u.)^2$ [published with the permission of J. H. Jenkins, et al. [1]]

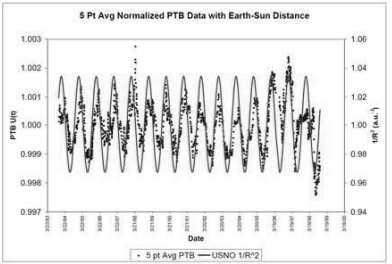

Fig.2: Plot of U(t) for the PTB 226Ra data along with R^{-2}. See caption to Fig. 1 for further details. [published with the permission of J. H. Jenkins, et al. [1]].

3 Causal and Non-Linear Quantum Physics

The progress of a causal and non-linear Quantum Physics has been developed by Croca and his co-workers [5]. From de Broglie's original ideas and studies in the beginning of the quanta to their development in the early sixties, we have since been able to build a new framework based on a new ontology. These efforts were carried out mostly with the help of a recent mathematical tool, the wavelet analysis, developed precisely to overcome some limitations of the Fourier non-local analysis. We have departed from the infinite and non-local Fourier analysis to the finite and local wavelet [13] analysis.

Following de Broglie's original ideas [6], any quantum particle is a complex entity [Fig. 3] with a localized singularity, where almost all energy is confined to a small area, the corpuscle, and an extended part, the Theta wave, with almost non-existing energy and responsible for guiding the singularity through a non-linear process. That guidance occurs to the points with great intensity of Theta wave. This basic property of Theta wave was named by de Broglie as the guiding principle.

With this framework, any quantum particle, like for instance the neutrino, can be described, in the first instance, by a full wave

ϕ composed of an extended yet finite region, the wave θ, described mathematically by a Morlet gaussian wavelet plus a singularity, now named as Acron, ξ immersed in the wave so that we have [8]:¨

$$\phi = \theta + \xi$$

In the linear approximation, the wave devoid of a singularity, the θ wave is the solution to the usual Schrödinger equation, while at the non-linear approach, the function ϕ representing the quantum particle, is the solution of the non-linear master equation:

$$-\frac{\hbar^2}{2m}\nabla^2\phi + \frac{\hbar^2}{2m}\frac{\nabla^2(\phi\phi^*)^{1/2}}{(\phi\phi^*)^{1/2}}\phi + V\phi = i\hbar\frac{\partial\phi}{\partial t}$$

Fig. 3: Plot of the real part of the quantum particle.

The searches of physical evidences for the reality of Theta wave has greatly progressed with several experimental setup proposals [15,16].

By Franco Selleri in 1982 [10] and later in 1989 [9] it was pointed out, in a discussion related to stimulated emission, that "one does not only measure energy changing processes but probabilities as well: the [Theta] wave could therefore reveal its presence by modifying decay probabilities for an unstable system."[9] Furthermore, Selleri

presented a plausible hypothesis of the same nature of Theta waves regardless of the associated singularity.

Therefore, one possible experiment designed to reveal the physical reality of de Broglie's waves, was the use of neutrinos and their very highly elusive feature "*to see whether the waves associated with a beam of neutrinos […] are by any chance capable of modifying transition probabilities of unstable systems.*"[9].

4 Discussion

The main result of the analysis performed by Jenkins, et al. [1] – the Earth-Sun inverse square distance dependence of nuclides decay rates – was reinforced by yet another experiment.

Using data obtained during the solar flare of 13 December 2006, J. H. Jenkins and E. Fischbach [10] were able to "suggest that neutrinos from the flare were detected via the change they induced in the decay rate of 54Mn."

As a result of data analysis and from experimental setups, they were able to discard other hypothesis e.g. possible effects due to the change in the electromagnetic field on Earth during the solar flare or any other known charged particles.

For the sake of our discussion, it is important to point out that the only variation in the flux of neutrinos on the Earth's surface is the one due to the eccentricity of the orbit. This result [11] was established while searching for periodicities on solar neutrino measurements released by the Super-Kamiokande and SNO collaboration. A wavelet approach [13] to seek regular as well transient modulations was carried on. The major result was the confirmation of the "*expected annual modulation variation due to the eccentricity of the Earth's orbit*" [11] and the demonstration that no other reliable time variation

signals within current experimental sensitivity, in the measured solar neutrino flux.

From the above discussion, we must also point out that the proven correlation between the variation on the flux of solar neutrinos and the variation of nuclides decay rates with time and also, the almost inexistent interaction of neutrinos with matter. However, if we take neutrinos as de Broglie's quantum particles, we must consider its extended property, its Theta waves. The greatest of the neutrino's flux and Theta wave superposition, both between each other and with nucleons, Theta waves will eventually stress the nucleus to decay.

5 Conclusion

Within the framework of the causal and non-linear Quantum Physics, the Theta wave, the wave that is devoid of corpuscular entity, is a real physical system that can be detected by actual experimental setups.

The experiments by Jenkins, et al. [1], revealed a new physical phenomenon: the change on nuclides decay rates with time and the undeniably strong correlation with the inverse square Earth-Sun distance. That analysis was reinforced by the induced change in decay rates of ^{54}Mn during a solar flare [10]. Solar neutrinos flux is the main candidate responsible for this new physical phenomenon for its variation with inverse squared distance from Earth to Sun. Nevertheless, the vanishingly small cross section of neutrinos, is well recognized

The hypothesis presented here is that the Theta wave associated with the solar neutrinos is responsible for the change in probability rates and, following earlier suggestions by F. Selleri [14], that the experiments describe here, are a physical manifestation of their physical reality.

Further observation and confirmation, or not, of this new and unexpected outcome of neutrino's influence in decay rates of radionuclide, can be achieved by reviewing raw data from earlier experiments [1].

Using already existing technical facilities on neutrino production, the Nuclear Reactors, a long term experiment on nuclides decay rates could be performed nearby such facilities. A typical nuclear reactor with a thermal power of 4,000 MW and an electrical power generator of 1,300 MW, corresponding to a total power production of 4,250 MW, 250 MW of which is radiated away as anti-neutrino radiation. Other interferences besides solar and reactor neutrinos could be cancelled out using a lead box.

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