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Attempt on Detection of Natural Neutrinos by a Simple and Compact Apparatus

by

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Abstract

A simple and compact apparatus was developed for detection of natural neutrinos on the basis of a new hypothesis. The experimental apparatus consisted of two electrodes, fiber material and purified water. Fiber materials such as raw silk, nylon and polyester were tested in measuring the output voltage generated between two electrodes. The apparatus utilizing the raw silk produced an appreciably high output voltage. After it was irradiated with intense flux of reactor neutrinos, its output voltage became higher than that of the non-irradiated one. The experimental results suggest that the voltage appears as the interaction between the natural neutrinos and the purified water: raw silk induces non vector-axial interaction. The reactor neutrinos are considered to make the non vector-axial interaction field active. Very-low energy neutrinos of 1 to 10 keV may be existed in nature.

Keywords: Natural neutrinos, Raw silk, Non vector-axial interaction field, Reactor neutrinos irradiation, Very-low energy neutrinos

1. Introduction

Neutrinos, being neutral particles, make the weak interaction with matter. Since the coupling constant of the weak interaction is quite small, neutrinos seldom interact with matter. In order to detect neutrinos, it is necessary to utilize a huge apparatus in underground[1)-9)]. The weak interaction works in a special field, which is called the vector — axial vector (V-A) interaction field while the electromagnetic interaction has the type of the vector (V) field. According to the electroweak unification theory, the weak interaction has a property similar to the electromagnetic one. If there exists some materials that have the function for the weak interaction between neutrinos and the other matters to own non V-A type interaction field, the coupling constant may increase to a level comparative to the

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magnitude of the electromagnetic interaction, and neutrinos may be detected easily. On the basis of this hypothesis, several kinds of fiber materials have been selected for making an attempt to detect natural neutrinos in this study. In this paper, simple and compact apparatus was devised for detection of neutrinos and its preliminary results will be discussed.

2. Experimental Apparatus

Figure 1 illustrates the cross section of experimental apparatus. The apparatus contains purified water of 50 ml in its lower half region, where gold and glassy carbon plates are immersed. Their thicknesses are 0.1 mm and 1.0 mm for gold and glassy carbon plates, respectively, and both of the plates are 20 mm×50 mm in dimension. Fiber of 0.5 g is set on each side of the gold plate. These are placed in a container made of Teflon. Raw silk, nylon and polyester are chosen as fiber materials. A voltmeter with a large input impedance of 1 MΩ is connected between the two electrodes to readily measure the output voltage for a long time.

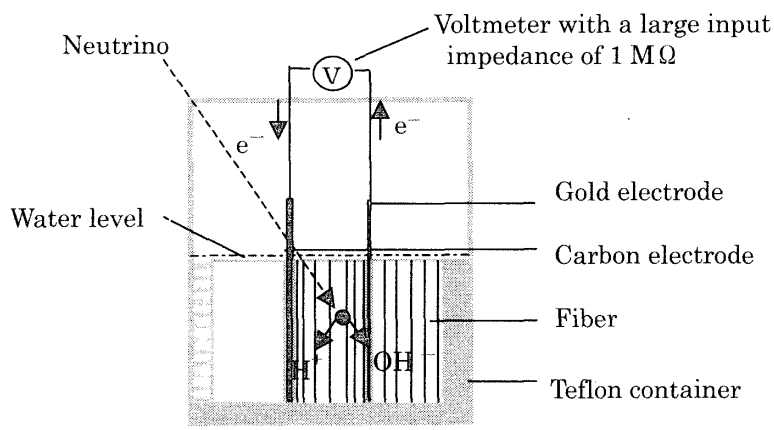

Fig. 1 Sketch of the experimental apparatus.

3. Experimental Results

Raw silk, nylon, and polyester were tested in the experiment. Each kind of fiber was set around the gold electrode. The experimental apparatus was placed in a temperature-controlled incubator. A temperature of 27℃ (300K) was chosen in this study. The output voltage was measured for each fiber. The results are shown in **Fig. 2**. It clearly shows that the output voltage in the case of raw silk increases after 7 days. The value reaches 53 mV in maximum at 30 days. In contrast, the voltage is close to zero in the case of either nylon or polyester. The raw silk is considered different from nylon and polyester in aspect of producing the output voltage of experimental apparatus.

The results for three sets of the same combinations of purified water and the raw silk are shown in **Fig. 3**. The three experiments were made in the same condition to check the reproducibility of the experimental performance. As three curves are overlapping one another, the reproducibility of the experiments is good, and accordingly the experimental data are considered to be reliable.

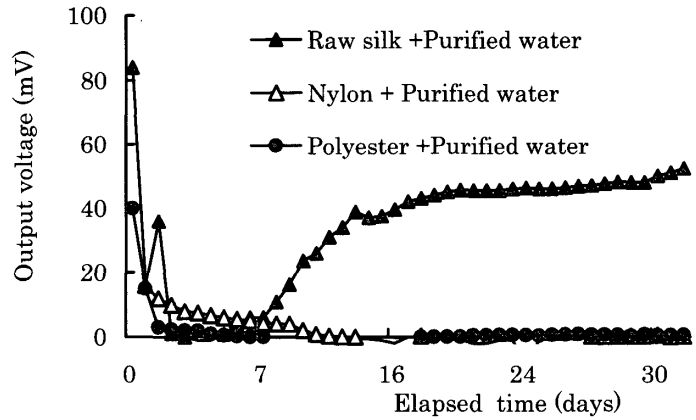

Fig. 2 Output voltages of apparatuses in three kinds of fibers.

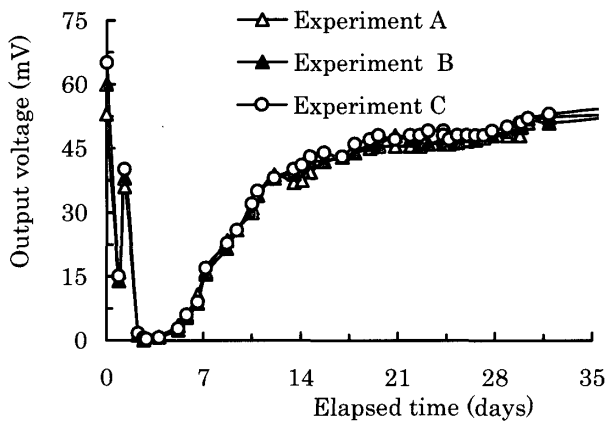

Fig. 3 Reproducibility of the experiment for the raw silk in purified water.

4. Analysis Result

4.1 Effect of the purified water itself on the output voltage of experimental apparatus

As seen in **Fig. 2**, the apparatus installed raw silk and the purified water produces appreciable output voltage. The voltage may results from the purified water itself. In order to find out the affection of purified water itself to the experimental result, we made an apparatus consisted of only the purified water, and measured the output voltage of it. The result is shown in **Fig. 4**.

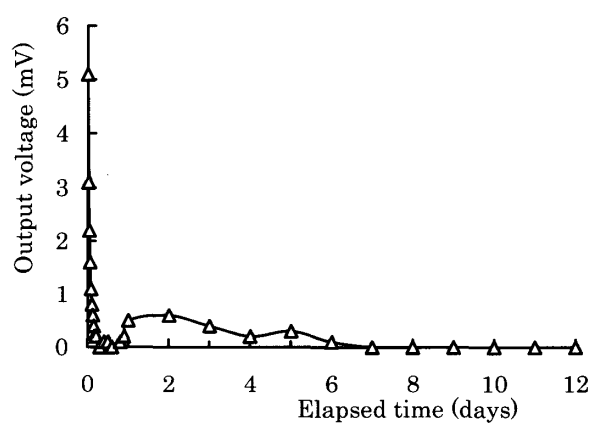

Fig. 4 Output voltage for experimental apparatus with electrodes and purified water alone

Figure 4 shows the influence of the purified water itself on the output voltage of experimental apparatus. Output voltage of several mV appears at the beginning of measuring, and decreases to be less than 1 mV quickly. After 7 days, it is close to zero. If the influence of purified water exists, it is only in the period of 7 days. Thus, this influence can be ignored.

4.2 Influence of the materials dissolved from raw silk to purified water on the output voltage of experimental apparatus

The raw silk is produced by boiling cocoon filament. The cocoon filament is comprised of the proteins silk fibroin and sericin, which account for approximately 97% of the total composition, and a small fraction of the others including carbohydrate, coloring matter, and minerals[10]. During the boiling cocoon filament, most of sericin dissolves into warm water and is discarded from the raw silk; the silk fibroin leaves in the raw silk[10]. The main minerals in raw silk fiber are calcium (Ca), magnesium (Mg) and sodium (Na)[11]. When the raw silk is soaked in water, the silk fibroin remains in the raw silk without any variation in its chemical structure; the main minerals dissolving into purified water become to be positive ions as Ca^{2+}, Mg^{2+}, Na^{+}. These ions move in the purified water, and they may induce a current to some extent. For examining this possibility, the variation of contents of ions escaped from raw silk to purified water was measured. A glass bottle of 1-liter was prepared, in which 800-gram purified water was poured following about 100-gram raw silk being putting in. The bottle was placed in an temperature-controlled incubator of 27℃ for one month. The ingredient of the dissolved water was analyzed with Inductively Coupled Plasma Mass Spectroscopy (ICP-MS). **Figure 5** shows the analytic results.

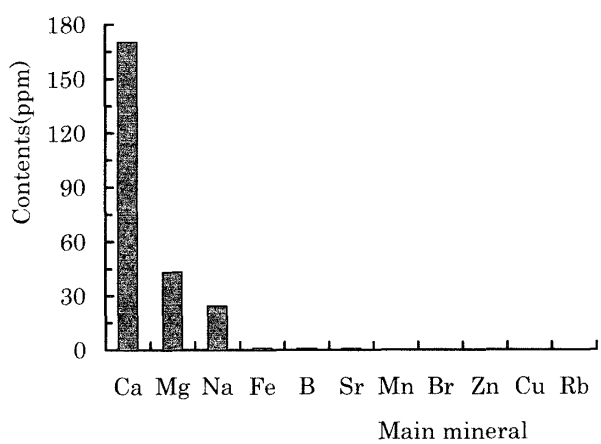

Fig. 5 Analysis results of the raw-silk-immersed water by ICP-MS.

Figure 5 shows that the inorganic materials escape from the raw silk into the purified water, and contents of minerals such as Ca, Mg, Na are 10-100 times much more than the other ones. In accordance with requirement of the experiment, we put 1.0-gram raw silk in 50-gram purified water for different periods to do the same immersion test as above. Regarding Ca, Mg, and Na as the main mineral in the dissolved water, we analyzed these mineral contents, whose results are shown in **Fig. 6**.

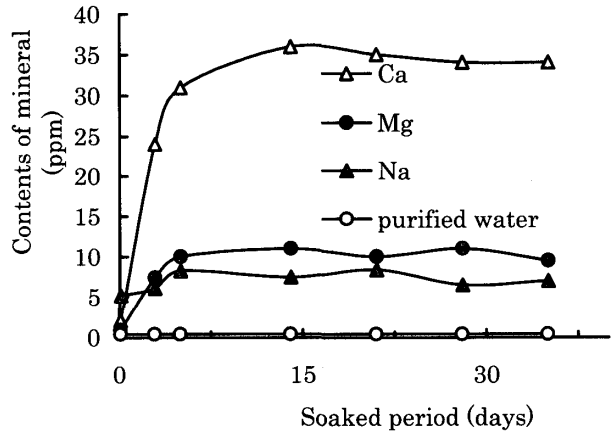

Fig. 6 Variation of contents of main minerals in the raw-silk-immersed water.

The three curves in **Fig. 6** get approximately constant in 15 days after the raw silk being put in the purified water: all of minerals may dissolve into the water in 15 days after the raw silk is soaked in water. Variation of the relative contents of minerals is given in **Fig. 7**.

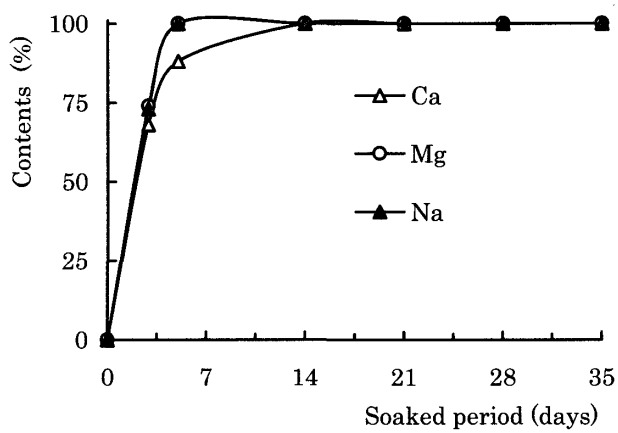

Fig. 7 Relative increase in mineral contents in dissolved water.

It is interesting to know the influence of the dissolved materials alone on the output voltage of experimental apparatus. Raw silk was immersed in water for 15 days. After the raw silk was taken out, only the water was fed into the experimental apparatus. The output voltage of the experimental apparatus is shown in **Fig. 8**.

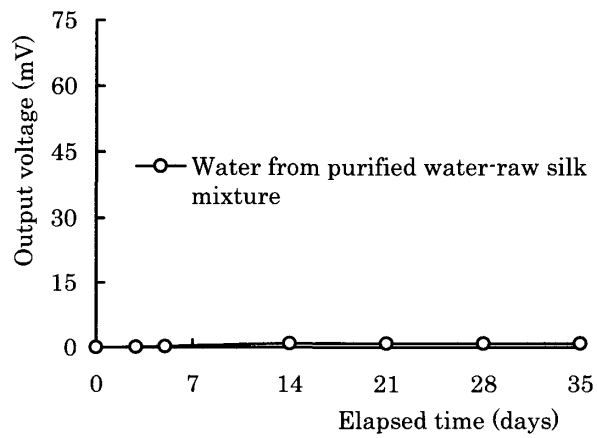

Fig. 8 Influence of the materials dissolved from raw silk to purified water on the output voltage of experimental apparatus.

The output voltage in **Fig. 3** appeared the situations of minerals in **Fig. 6** and **Fig. 7**. If the output voltage in **Fig. 3** only came from these ions escaped from the raw silk, the curve in **Fig. 3** should be the same as that in **Fig. 8**. However, the former is much higher than the latter in 7 days; and the latter is approximately zero. Only the ions in the purified water were incapable of generating appreciable current.

4.3 Response of the apparatus to reactor neutrinos

Natural radiations exist in our laboratory of Kyushu University. The radiations mainly consist of photons, neutrinos and other rays. Neutrinos may interact with the materials in our experimental apparatus, and induce the output voltage like **Fig. 2** and **Fig. 3** through the weak interaction different from V-A type. The nuclear reactor is capable of producing intense flux of neutrinos, so we set the apparatus near a nuclear reactor to see the response of the experimental apparatus to reactor neutrinos. In the experiment, the apparatus was placed outside a container vessel of FUGEN nuclear power station, electric power of 16.5 GW. Irradiation was made for 3 days in a non-radiation control area, where neutrons and gamma rays were well shielded to the conventional circumstance level. Irradiation gave a reactor neutrino flux of 3×10^{12} $cm^{-2}s^{-1}$, After neutrino irradiation, the apparatus was carried back to our laboratory of Kyushu University, and the output voltage was continued to be measured. The results are shown in **Fig. 9**.

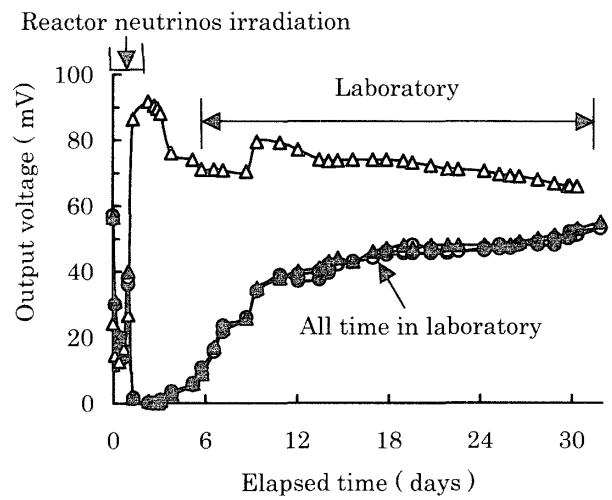

Fig. 9 Response of output voltage to reactor neutrinos irradiation.

In **Fig. 9**, the upper curve represents the output voltage of the apparatus, which was irradiated with reactor neutrinos for 3 days and then carried back to our laboratory of natural radiation circumstances. The output voltage was measured during all the period. The lower curve stands for the results of the experiment that was made in our laboratory in the completely the same period as in the experiment of reactor neutrino irradiation. All radiations from nuclear reactor are shielded except for neutrinos. The additional increase around 3 days is attributed to the intense neutrino flux from the nuclear reactor. It suggests that neutrinos from the nuclear reactor interact with the purified water with existence of the raw silk. In contrast to the weak interaction theory, this interaction may not be the ordinary V-A one. It is considered as non V-A interaction. Our experimental laboratory is 50 km far from the nearest nuclear reactor, so that the influence of reactor neutrinos on the output

voltage of this apparatus can be ignored after this apparatus was taken back to our experimental laboratory. If only the reactor neutrinos interact with the apparatus, the output voltage of this apparatus should be decreased quickly and at least coincides to the lower curves after 3 days. However, it is still higher after 3 days than that of the experiment that were always made in our laboratory. This phenomenon is explained as follows. The raw silk, which may induce the non V-A interaction, is considered to be one of a special material. When the mixture of the raw silk and purified water is irradiated by the reactor neutrinos, the non V-A interaction field in the mixture is enhanced. The enhanced non V-A interaction field is supposed to make active the interaction between natural neutrinos and the purity water, the output voltage of the irradiated apparatus after 3 days is described as the interaction between the nature neutrinos and the purified water under the enhanced non V-A interaction field. Therefore, the output voltages after 7 days in **Fig. 2** and **Fig. 3** are also considered to result from the interaction between natural neutrinos and water in ordinary non V-A interaction field.

The mechanism of voltage generation is explained as follows. As shown in **Fig. 1**, if natural neutrinos interact with a water molecule, the water molecule may separate into OH^- and H^+ ions ($H_2O \rightarrow OH^- + H^+$). The OH^- ions move to the gold electrode where electrons are produced ($4\ OH^- \rightarrow 2H_2O + O_2 + 4e^-$), while the H^+ ions diffuse to the glassy-carbon electrode, where they are combined with an oxygen molecule absorbing electrons to form water molecules ($4\ H^+ + O_2 + 4e^- \rightarrow 2H_2O$)[12]. Then current can be induced in the outer circuit.

Summing the discussions above, it is considered that the output voltage shown in **Fig. 2** and **Fig. 3** results from the interaction between natural neutrinos and purified water when the raw silk existing. The natural neutrinos are detected by our compact apparatus in this study.

5. Discussion

Low energy neutrinos far below 0.1 MeV are supposed to exist in nature[13]. However, they have not been experimental identified by now. The present experiment is based on the interaction between natural neutrinos and purified water. The energy required for separating the water molecule into OH^- and H^+ is less than 5 eV. If neutrinos in the region of 1-10 keV make elastic scattering with electrons, the scattering gives the energy of the order of eV to electrons. The present experimental results suggest that the low energy neutrinos of 1-10 keV may exist in nature. Water of 50 g is sufficient to detect the natural neutrinos; this is not explained by the conventional weak interaction theory based on the V-A interaction with the small coupling constant. It is reasonable to consider that the raw silk induces non V-A interaction, and this non V-A interaction field facilitates the reaction of natural neutrinos with the water molecules. In addition the non V-A interaction can be activated with irradiated by intensive reactor neutrinos.

6. Conclusion

The experimental results suggest the following conclusions.

(1) Raw silk is the material inducing non V-A interaction.

(2) The non V-A interaction field becomes stronger by irradiation of intense reactor neutrinos.

(3) Neutrinos with low energies exist in the nature.

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