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Possible Detection of Natural Neutrinos by Use of Small Apparatus

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A simple and compact apparatus was developed for detection of natural neutrinos on the basis of a new hypothesis in this study. 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 the two electrodes. The apparatus utilizing raw silk produced an appreciable high output voltage. After this kind of apparatus was irradiated with intense flux of reactor neutrinos, its output voltage became higher than that of the non-irradiated one. Moreover, the electrochemical interaction of the materials dissolved from the raw silk to the purified water was not confirmed to be attributed to the output voltage in the apparatus. Thus, the output voltage of experimental apparatus using the raw silk was regarded as a result from the interaction between the natural neutrinos and the purified water. This interaction, which was induced by the raw silk, is defined as non-standard vector-axial vector interaction. The reactor neutrinos are considered to make the non-standard vector-axial vector interaction field active. Very-low energy neutrinos of 1 to 10 keV may experimentally be testified to exist in nature.

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

I. Introduction

Neutrinos, being neutral particles, are subject only to the weak interaction. Due to work in the vector-axial vector (V-A) interaction field, the weak interaction has a quite small coupling constant, which results in difficulty in detection of neutrinos. Generally, a huge apparatus in underground is employed to detect the natural neutrinos[1)-9)]. If neutrinos are not a point-like particle, they are supposed to have an internal structure based on the V-A type weak-magnetic field[10)]. The internal structure may have properties to be unstable under existence of weak-electric scalar potential that is generated by some leptonic particles in materials. On the basis of this hypothesis, several kinds of fiber materials have been selected in detecting natural neutrinos in this study. One of these fiber materials was placed around two electrodes in purified water, forming a simple and compact experimental apparatus. Preliminary experimental results and discussions will be presented.

II. Experiment

1. Experimental Apparatus

Figure 1 illustrates the cross section of experimental apparatus. Teflon container contains purified water of 50 ml in its lower half region, where gold and glassy carbon plates are inserted. Their thicknesses are 0.1 mm and1.0 mm for gold and glassy carbon plates, respectively, and both of the plates are 20 mm × 50 mm in dimension. Fiber of 0.5 gram is set on each side of the gold plate. 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. The experimental apparatus was placed in a temperature-controlled incubator of 27 ℃ (300K). The output voltage of experimental apparatus is measured for a long time.

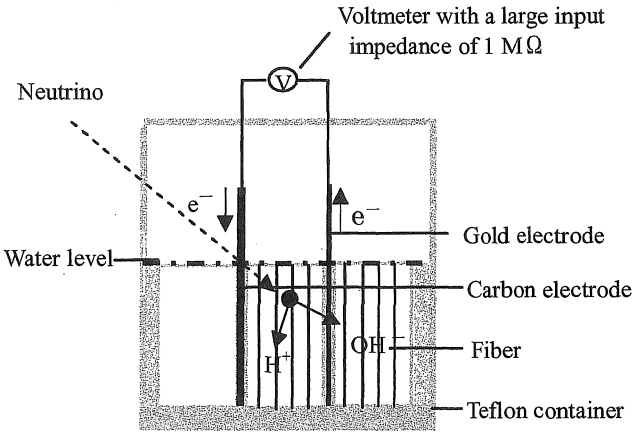

Fig. 1 The schematic view of the experimental apparatus.

2. Experimental Results

Raw silk, nylon, and polyester were tested in the experiment. The results are shown in **Fig. 2**. The output voltage in the case of raw silk increases after 7 days, and the stable value reaches approximate 50 mV in 20 days. In contrast, it 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

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experimental apparatus. The raw silk may induce the interaction between natural neutrinos and the materials in the experimental apparatus.

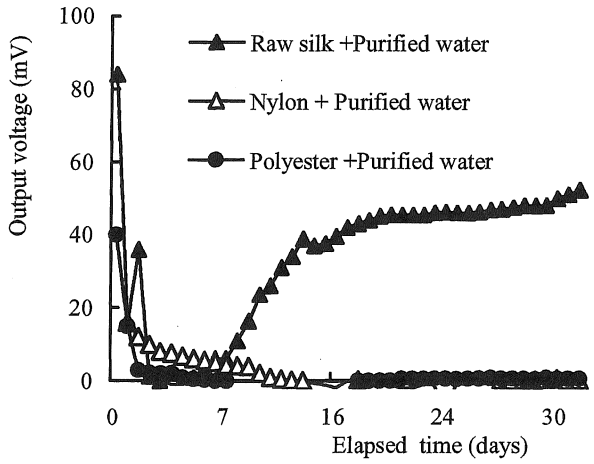

Fig. 2 Output voltages of apparatuses in three kinds of fibers.

III. Analysis Result

1. 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 of 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[11]. 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[11]. The main minerals in raw silk fiber are calcium (Ca), magnesium (Mg) and sodium (Na)[12]. 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, firstly, a glass bottle of 1-liter was prepared, in which 800-gram purified water was poured following about 100-gram raw silk being put in. The bottle was placed in an temperature-controlled incubator with 27℃ for one month. The ingredient of the dissolved water was analyzed with Inductively Coupled Plasma Mass Spectroscopy (ICP-MS). The analytic results are presented in **Fig. 3**.

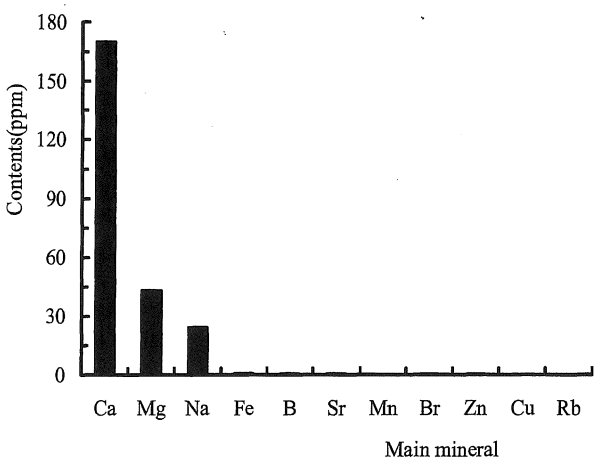

Fig. 3 Analysis results of the raw-silk-immersed water by ICP-MS (Ca : ^{40}Ca; Mg: ^{24}Mg; Na: ^{23}Na).

Figure 3 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 as high as the other ones. Secondly, in accordance with requirement of the experiment, we put 1.0-gram raw silk in 50-gram purified water for different periods to make the same immersion test as above. The minerals such as ^{40}Ca, ^{24}Mg, and ^{23}Na were analyzed. Their results were shown in **Fig. 4**.

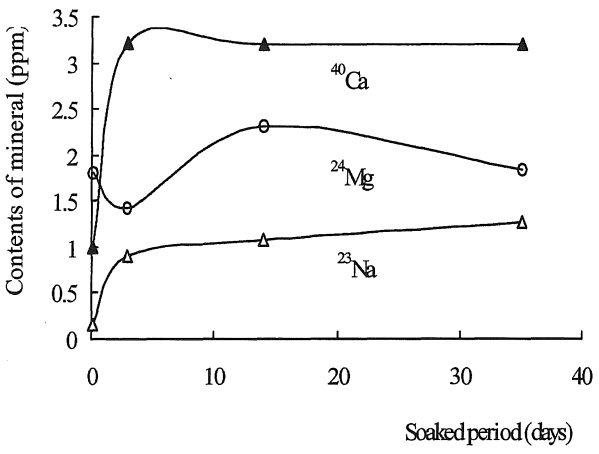

Fig. 4 Variation of contents of main minerals in the raw-silk-immersed water.

The three curves in **Fig. 4** get approximately constant in 15 days after the raw silk being put in the purified water: All of minerals dissolve into the purified water after the raw silk is soaked in water for 15 days.

Thirdly, raw silk was immersed in purified water for 15 days. After the raw silk was taken out, only the purified water was fed into the experimental apparatus. The output voltage of the experimental apparatus is shown in **Fig. 5**.

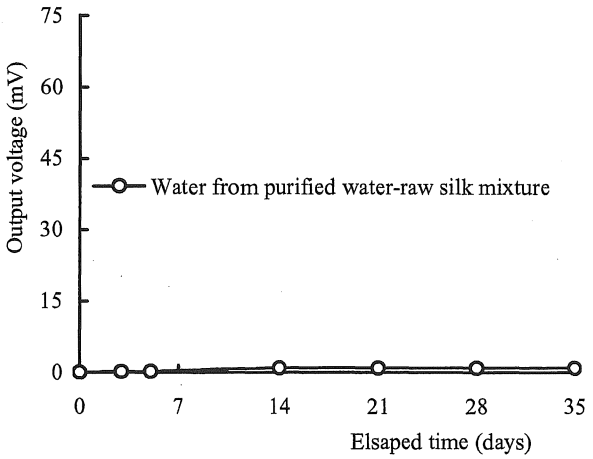

Fig. 5 Influence of the materials dissolved from raw silk to purified water on the output voltage of experimental apparatus.

The output voltage in **Fig. 2** appeared in the situation of minerals in **Fig. 4**. If the output voltage in **Fig. 2** only came from these materials escaped from the raw silk, the curve in **Fig. 2** should be the same as that in **Fig. 5**. However, the former is much higher than the latter in 7 days; and the latter is approximately zero. The materials dissolved from the raw silk to the purified water alone were incapable of generating appreciable current.

2. Response of the output voltage of 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**. If the interaction, between natural neutrinos and materials in the experimental apparatus, results in the output voltage of experimental apparatus, the output voltage of the experimental apparatus should respond to neutrino variation. The nuclear reactor is capable of producing intense flux of neutrinos, so that we set the apparatus near a nuclear reactor. An apparatus was placed outside a container vessel of FUGEN nuclear power station with electric power of 165 MW. 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 7.4×10^{11} $cm^{-2}s^{-1}$. After neutrino irradiation, the apparatus was carried back to our laboratory of Kyushu University. The output voltage was continuously measured during all procedures. The results are shown in **Fig. 6**.

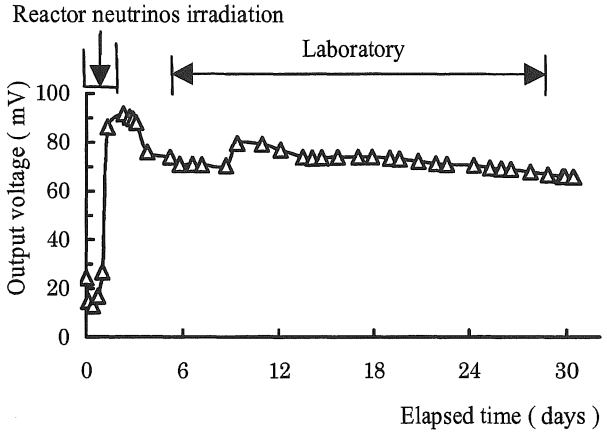

Fig. 6 Response of output voltage to reactor neutrinos irradiation.

For the experimental apparatus always laid down in our laboratory, its output voltage was shown in **Fig. 2**. After an experimental apparatus in the same composition of 50 g-purified water plus 1.0 g-raw silk was irradiated with intense flux of reactor neutrinos for 3 days, however, its output voltage in **Fig. 6** was different from that in **Fig. 2**. Because all radiations from the nuclear reactor are shielded except for neutrinos, the additional increase of output voltage around 3 days should be attributed to the intense neutrino flux from the nuclear reactor. It suggests that neutrinos from the nuclear reactor interact with the mixture of purified water and the raw silk. Since only 50-gram water is used to interact with reactor neutrinos, this interaction is not ascribed to the ordinary vector-axial vector (V-A) one at all. It is considered as the result of non-standard V-A interaction, which may be induced by the raw silk. 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 decrease quickly and at least coincide to values shown in **Fig. 2** after 3 days. Comparison of **Fig. 6** with **Fig. 2** indicates that the irradiated apparatus in 3 days appears higher output voltage than the non-irradiated one does. This phenomenon may be explained as follows: When the mixture of the raw silk and purified water is irradiated by the reactor neutrinos, the non –standard V-A interaction field in the mixture is enhanced. The enhanced non-standard V-A interaction field is supposed to make active the interaction between natural neutrinos and the mixture of the purity water and raw silk, and the output voltage of the irradiated apparatus after 3 days is regarded as the interaction between the natural neutrinos and the mixture under the enhanced non-standard V-A interaction field. Therefore, the output voltages of experimental apparatus with raw silk after 7 days in **Fig. 2** may also be considered to result from the interaction

between natural neutrinos and the mixture in ordinary non-standard V-A interaction field.

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

The reaction mechanism in the apparatus is not clearly known. One of possible speculations is as follows. We suppose that neutrinos are not a point-like particle, but they have an internal structure based on the V-A type weak-magnetic field[10]. The internal structure has properties to be unstable under existence of weak-electric scalar potential. This weak-electric scalar potential may initially be supplied by some leptonic particles in the silk, and be strengthened by the apparatus operation under neutrinos. Neutrinos that are made in the unstable condition may easily couple with oxygen in some manner as non-standard V-A interaction, and the oxygen takes electron of hydrogen atom in water molecule, giving rise to dissociation of water molecule.

For the speculated reason, the water molecule may separate into OH^- and H^+ ions ($H_20 \rightarrow OH^- + H^+$), as shown in **Fig. 1**. The OH^- ions may move to the gold electrode where electrons are produced ($4OH^- \rightarrow 2H_20 + O_2 + 4e^-$) while the H^+ ions diffuse to the glassy-carbon electrode in which they combine with an oxygen molecule absorbing electrons to form water molecules ($4H^+ + O_2 + 4e^- \rightarrow 2H_20$) [13]. A small amount of current is induced in the closed circuit of electrodes and purified water. Consequently, the output voltage of the apparatus experimentally appears.

In our experiment, if the secondary reaction is neglected, a simple consideration on current I leads to

$$I = \phi \sigma n e ,$$

where ϕ is the flux of natural neutrinos, σ the interaction cross section between natural neutrinos and water molecule, n the number of water molecules in the cell, and e the electric charge. The cross section itself cannot be estimated due to lack of knowledge on magnitude of ϕ. The product of $\phi\sigma$ is evaluated as $\phi\sigma \approx 2 \times 10^{-13} s^{-1}$ with use of current $I = 50 \times 10^{-3} / 10^6$ A and water of 50 grams.

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 1 eV. Some kinds of low energy neutrinos are supposed to exist in nature[14]. In fact, 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. Although such neutrinos have not been experimental identified up to now, the present experimental results suggest that some kind of low energy neutrinos may exist in nature.

IV. Conclusion

The apparatus utilizing raw silk produced an appreciable high output voltage. The electrochemical interaction of the materials dissolved from the raw silk to the purified water was not confirmed to attribute to the output voltage in the apparatus. After irradiation with intense flux of reactor neutrinos, the output voltage of the apparatus became higher than that of the non-irradiated one. The output voltage of experimental apparatus using the raw silk was considered to result from the interaction between the natural neutrinos and the purified water.

Water of 50 grams 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. The experimental results suggest that non-standard V-A interaction should occur between natural neutrinos and the mixture of raw silk and purified water.

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