

Study on Output Current Behavior of Electrochemical Apparatus Sensitive to Antielectron Neutrinos

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論 文 要 旨

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<p>論文題名</p> <p>Study on Output_Current behavior of Electrochemical Apparatus Sensitive to Antielectron neutrinos (反電子ニュートリノに有感な電気化学装置の出力電流波形の研究)</p>			

論 文 内 容 の 要 旨

As one of leptons, neutrinos commonly fill the whole universe. After postulation of the existence of neutrino in 1930, neutrinos have attracted considerable interests of scientists. Especially, in the past decade, some neutrino oscillation experiments have revealed that neutrinos should own a quite small mass in relation to the oscillation phenomena, which are inconsistent with the standard model for weak interaction. Our group detected the output current for irradiation of nuclear reactor neutrinos by the use of electrochemical apparatus. The apparatus was also understood to be sensitive to natural neutrinos on the earth. The experimental current was understood to be ascribed to formation of considerably large mass in neutrino system. Although the signal generation scenario was proposed, quantitative analysis was not performed for the output current of the apparatus. In addition, a poor reproduction of current peak at initial period of a few days was not understood.

In this study, a half-cell model with assistance of weak interaction is proposed to numerically calculate the output current of the apparatus, and the reason is experimentally studied for the poor reproduction of initial peak.

Chapter 1 explains the discovery of neutrinos, neutrino sources, weak-interaction theory and several experiments for low-energy solar neutrinos. Following these, the objective in this study is stated.

Chapter 2 describes the electrochemical detector. Some physical and chemical properties of water, the selection criteria of working electrodes, and electrode treatment procedure are summarized. The proposed basic scenario of output current generation is described: A neutrino consists of boson and fermion particles as $\nu_b\nu_f$. When neutrinos are incident into auxiliary field generated from a

biological material, they will obtain mass and tend to separate into boson ν_b and fermion ν_f particles. The particles may break water molecule into hydrogen and hydroxide ions. The boson combines with hydrogen ion as $H^+ \nu_b$ and fermion will react with hydroxide one as $OH^- \nu_f$. The repulsive properties of ν_b and ν_f at rest do not allow $H^+ \nu_b$ and $OH^- \nu_f$ to be recombined. The hydroxide ions with fermion ($OH^- \nu_f$) may diffuse to a gold plate, and hydrogen ions with boson ($H^+ \nu_b$) may diffuse to a carbon one. The output current is obtained in the experiment.

Chapter 3 presents the electrochemical analysis of output current by using a half-cell model with assistance of weak interaction. The time evolution of output current is solved with the half-cell model under the consideration of weak interaction effect. The reduction current density j_{H^+} of hydrogen ions is given by the Butler-Volmer equation. The reaction of hydroxide ions is endothermic one; the reaction is assumed to be promoted with assistance of weak interaction between the fermion particle and the auxiliary field. The activation energy is obtained from experimental data at different temperatures as $\Delta = 0.65$ eV. The hydrogen ions are treated to disappear in the rate of I/F as the current I flows where F is the Faraday constant. The oxygen concentration was taken to be consistent to experimental data. The positive ions like Ca^{2+} and Mg^{2+} in the solution are treated to produce current as reduction of impurities. For reproduction of experimental current, however, time parameters t_d and t_r were required for expressing the delay and rising times, respectively, for initiation of weak interaction assistance. The values of t_d and t_r of few days were treated as adjustable parameter. The comparison between the experiments and calculations suggested that the half-cell model works well for the environmental experiment. The same electrochemical parameters were applied to reactor-neutrino irradiation experiment. By the use of estimated antielectron neutrino flux, the output current was twice as large as the experiment. The larger signal is successfully suppressed by setting limited value of hydrogen ion concentration of 9.27×10^{-7} mol cm^{-3} . Thus, the use of basically the same electrochemical parameter leads to reproduction of the experimental data.

Chapter 4 describes the experiments on the poor-reproductive initial peak at a few days. The output current of electrochemical detector under environmental condition gives an initial peak around 2 days and an equilibrium value in 2-3 weeks under environmental conditions. At early stage of our experimental study, a tendency of positive correlation was observed between the initial peak and solar activity, namely, solar wind velocity. To make clear the situation, further experiments were carried out during the period for two years. For the later experiments, no clear correlation was found. It was concluded that the former positive correlation in the early stage was the accidental result.

Finally in Chapter 5, the conclusion of whole study is given.