

# Importance of $\gamma$ -ray production in neutral-current neutrino-oxygen and -carbon interactions

M. Sakuda\*

*Department of physics, Okayama University, Okayama 700-8530, Japan.*

## Abstract

The neutrino-oxygen or -carbon elastic (coherent) and quasi-elastic interactions are the most fundamental and important interactions in the neutrino experiments. The coherent scattering dominates for  $E_\nu < 200$  MeV, while the quasi-elastic interactions dominates for  $E_\nu > 200$  MeV. We would like to point out that for both reactions, the  $\gamma$ -ray emission ( $E_\gamma > 5$  MeV) from excited nuclei is associated at the level of 30-40% and that those events will play an important role in the detection of neutrinos from supernova explosion and Neutrino Oscillation experiments [1,2].

We explain the calculation of  $\gamma$ -production from the neutral-current neutrino-oxygen quasi-elastic interaction. This cross section is dominated by  $p_{3/2}$ -hole state of  $^{15}\text{N}$  and  $^{15}\text{O}$  and the branching ratio of  $\gamma$ -emission ( $E_\gamma > 6$  MeV) amounts to 40% and the contribution of s-hole state to the branching ratio of the  $\gamma$ -ray emission is about 2% or less [2].

We plan an experiment to measure  $\gamma$ -rays in  $^{16}\text{O}$ ,  $^{12}\text{C}$  (p,p') and (He,t) reactions at RCNP. We measure both the excitation energy ( $E_x$ ) and the energy of  $\gamma$ -rays ( $E_\gamma$ ) in the experiment at  $\sim 0$  degrees, and thus we will measure the branching ratios of  $\gamma$ -ray emission as functions of  $E_x$  from giant resonances for  $E_\gamma > 5$  MeV [3]. This experiment is a natural extension of the previous RCNP E148 experiment [4].

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\*sakuda@fphy.hep.okayama-u.ac.jp