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# Production of a 4.4-MeV gamma ray from NC neutrino-oxygen reaction in a water Cherenkov detector for supernova neutrino bursts and the isospin mixing of the 2^- states (12.97 MeV and 12.53 MeV) of O

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We first discuss and determine the isospin mixing of the two $2^-$ states (12.53 MeV and 12.97 MeV) of $^{16}$O nucleus using the inelastic electron scattering data. We then evaluate the cross section of 4.4-MeV $\gamma$ rays produced in the neutrino neutral-current (NC) reaction $^{16}$O($\nu$, $\nu$')$^{16}$O$(12.97\mathrm{MeV}, 2^-)$ with a water Cherenkov detector at the low energy below 100 MeV. We have made the shell-model calculation of this NC neutrino-$^{16}$O$(12.97\mathrm{MeV}, 2^-)$ cross section as accurate as possible by calibrating both the vector form factor (or spin g-factor $g_s$) and the axial coupling constant ($g_A$), using real data of the (e,e') cross section, muon-capture of $^{16}$O(12.97MeV,$2^-$), and $^{16}$N $\beta$-decay from the $2^-$ analogue state to the $^{16}$O ground state. We compare the $\gamma$-ray production rate from this process with that from the excited states ($E_x$>16 MeV), which was discussed previously by many authors. In this talk, we discuss a new NC reaction channel from $^{16}$O(12.97 $\mathrm{MeV}, 2^-$) producing a 4.4-MeV $\gamma$ ray, the cross section of which is more robust and even larger at the low energy ($E_\nu$ <25 MeV) than the NC cross section from $^{16}$O$(E_x > 16\ \mathrm{MeV}, T = 1)$. We also evaluate the number of such events induced by neutrinos from supernova explosion which can be observed by the Super-Kamiokande, a 32 kton water Cherenkov detector in the Earth.

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