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Simulation of the background from (α, n) reactions in the JUNO scintillator

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The Jiangmen Underground Neutrino Observatory (JUNO) experiment is a new generation neutrino project. Its main and ultimate goal is to determine the neutrino mass ordering. To achieve this fundamental milestone, the precise reactor neutrino spectroscopy based on the Inverse Beta Decay reaction will be applied. The approach implies detailed knowledge of all relevant backgrounds in the liquid scintillator target of the detector. One significant background are (α, n) reactions, which occur on ^{13}C nuclei and are possible due to the presence of residual radio-impurities, mainly, ^{238}U , ^{232}Th and ^{210}Pb . This work describes the simulation of this background, performed using open source Geant4-based software called SaG4n, a new event generator and the dedicated JUNO detector response simulation package. All stages of the reaction were considered, including, in particular, the α particle propagation in the medium before the interaction and emission of a neutron and de-excitation particles from the excited states of the final nucleus. The total and partial (α, n) background event rates and the respective shapes of the energy spectra have been obtained within the expected radioactivity concentration. The simulation pipeline and its outcomes are relevant for other neutrino experiments using organic liquid scintillator and may be useful for dark matter search projects.

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