



Ordinary Muon Capture for Double Beta Decay and Anti-Neutrino Nuclear Responses

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This is a brief review on ordinary muon capture (OMC) experiments at Research Center for Nuclear Physics (RCNP) Osaka University relevant for the study of double beta decays (DBDs) and astro anti-neutrinos (neutrino) nuclear responses. OMC usually leaves the nucleus in highly excited unbound state. OMC is a charge exchange reaction via the charged weak boson as given by $(\bar{\mu}, \nu_\mu)$ reactions with μ and ν_μ being the muon and muon neutrino. Subjects discussed include 1) unique features of OMC for studying DBDs and astro anti-neutrino (neutrino) nuclear responses, 2) experiments of OMCs on ^{100}Mo and ^{102}Mo to study neutrino nuclear responses for DBDs and astro anti-neutrinos, 3) impact of the OMC results on neutrino nuclear responses for DBDs and astro anti-neutrinos. Remarks and perspectives on OMC experiments for neutrino nuclear responses are briefly described.

Keywords: ordinary muon capture, muon charge exchange reaction, neutrino nuclear response, double beta decay, supernova neutrino, nuclear matrix element, neutrino mass

1 INTRODUCTION

Double beta decays (DBDs) and astro (solar and supernova) neutrinos and anti-neutrinos are of current interest. Neutrino-less DBDs are used to explore the fundamental neutrino properties such as the Majorana nature, the absolute mass scale, the mass hierarchy and the CP phases beyond the standard electroweak model. The zero-neutrino (0 ν) DBD rate is given by $R^{0\nu} = G^{0\nu} \times |M^{0\nu}|^2 \times |\alpha^{0\nu}|^2$, where $G^{0\nu}$ is the phase space volume, $\alpha^{0\nu}$ is the effective neutrino mass and $M^{0\nu}$ is the zero-neutrino DBD nuclear matrix element, whose squared value is the nuclear response, i.e. $R^{0\nu} = |M^{0\nu}|^2$. Here we consider the ground state (0^+) to ground state (0^+) transition $^A_Z X \rightarrow ^A_{Z+2} X$. The DBD nuclear matrix element (NME) $M^{0\nu}$ is given by the coherent sum of the individual matrix elements $M^{0\nu}_i$ which connect the initial and final ground states via the i th intermediate nucleus $^A_{Z+1} X_i$, where these extend up to about 100 MeV.

The supernova nucleosynthesis rates induced by neutrinos and anti-neutrinos are proportional to the respective nuclear responses

$$R^{n,\nu} = \frac{1}{2J_A + 1} |M^{n,\nu}|^2 \quad (1)$$

where $M^{n,\nu}$ are the NMEs, and $(2J_A + 1)$ is the spin factor for the initial nucleus. Note that the NMEs $M^{n,\nu}$ are the coherent sums of individual NMEs $M^{n,\nu}_i$

$$M^{n,\nu} = \sum_i M^{n,\nu}_i \quad (2)$$

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Beta Decay And Muon Capture

Herwig F. Schopper



Beta Decay And Muon Capture:

Beta Decay and Muon Capture Masato Morita,1973 **Induced Effects in Beta Decay and Muon Capture** J. N. Huffaker,C. E. Laird,ALABAMA UNIV UNIVERSITY DEPT OF PHYSICS.,1967 In order to facilitate analysis of muon capture in ^{16}O results are presented of a shell model calculation of low lying odd parity states of ^{16}O and ^{16}N including the effects of a two particle spin orbit interaction Calculated energy levels and rates for various beta decay and muon capture transitions are given as functions of the spin orbit interaction strength Formulas are obtained for single level muon capture rates for the following transitions $^{12}\text{C} 0 \rightarrow ^{12}\text{B} 1$ $^{16}\text{O} 0 \rightarrow ^{16}\text{N} 0$ $^{16}\text{O} 0 \rightarrow ^{16}\text{N} 1$ and $^{16}\text{O} 0 \rightarrow ^{16}\text{N} 2$ The formulas include effects of finite nuclear size and relativistic treatment of the muon and are presented in a form showing explicit dependence on induced form factors and on configuration mixing coefficients for the various nuclear levels Electron radial wave functions suitable for beta decay calculations involving light elements Z **Neutrino nuclear responses for astro-particle physics**

by nuclear reactions and nuclear decays Hiroyasu Ejiri,Francesco Cappuzzello,Theocharis S. Kosmas,2023-07-05

Weak and Electromagnetic Interactions in Nuclei Hans Volker Klapdor,2012-12-06 Nuclear physics is presently experiencing a thrust towards fundamental physics questions Low energy experiments help in testing beyond today's standard models of particle physics The search for finite neutrino masses and neutrino oscillations for proton decay rare and forbidden muon and pion decays for an electric dipole moment of the neutron denote some of the efforts to test today's theories of grand unification GUTs SUSYs Superstrings complementary to the search for new particles and symmetries in high energy experiments The close connections between the laws of microphysics astrophysics and cosmology open further perspectives This concerns to mention some of them properties of exotic nuclei and nuclear matter and star evolution the neutrino and the dark matter in the universe relations between grand unification and evolution of the early universe The International Symposium on Weak and Electromagnetic Interactions in Nuclei W E LN 1986 held in Heidelberg 15 July 1986 in conjunction with the 600th anniversary of the University of Heidelberg brought together experts in the fields of nuclear and particle physics astrophysics and cosmology Invariance Principles and Elementary Particles Jun John Sakurai,2015-12-08 J J Sakurai's treatment of various elementary particle phenomena is written for those not completely familiar with field theory who wish to gain insight into theoretical problems Since the manuscript for his book was completed a very important development has taken place in particle physics the discovery of the p_w and n mesons in view of this development the author has added a new section devoted exclusively to these new mesons and resonances Originally published in 1964 The Princeton Legacy Library uses the latest print on demand technology to again make available previously out of print books from the distinguished backlist of Princeton University Press These editions preserve the original texts of these important books while presenting them in durable paperback and hardcover editions The goal of the Princeton Legacy Library is to vastly increase access to the rich scholarly heritage found in the thousands of books published

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