MESON-EXCHANGE CURRENTS OF 1^{RST}-FORBIDDEN β DECAY

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An important part of nuclear physics is devoted to study "exotic nuclei" characterized by a high excess of protons or neutrons according to the stable nuclei. The studies of these exotic nuclei enable a deeper understanding of nuclear structure, astrophysics (via p, s, r-processes) or fundamental interaction.

The weak interaction is responsible of the nuclear β decay. In the case of neutron rich nuclei, the β^- process corresponds to a transformation of a neutron to a proton. This process feeds levels of the daughter nucleus located in the available energy window, Q_β. If some populated states are located at an excitation energy above the neutron separation energy, S_n, a neutron emission can occur. This process is called neutron β-delayed decay (β-n).

The β transitions between 0^+ and 0^- states are particularly interesting because an enhancement of the β-decay rate by mesonic exchange currents (MEC) is predicted and explained as a contribution of meson exchange to the weak axial current.

The β transition rate to a given final state is characterized by the "*ft* value" where *f* is the Fermi function and *t*, the partial lifetime ($t = T_{1/2} / I_\beta$, I_β is the branching ratio).

The experimental measurement of *ft* enables to determine the transition strength of the first-forbidden β decay and an experimental matrix element, M^{exp}, is deduced. From this result, the equality between the M^{exp} and the theoretical calculation of β-decay matrix element is obtained by introducing an enhancement factor, ε_{MEC}.

The ε_{MEC} values obtained in the A = 16, 50 and 96 regions are all of the same order of magnitude around $\varepsilon_{MEC} = 1.64$. However, studies in lead region have established a larger enhancement factor which is explained by extra meson exchange contributions coming from ρ and Δ mesons.

Previous experimental results around ^{132}Sn give ε_{MEC} values between 1.74 ± 0.07 and 2.16 ± 0.29. Extra measurements are needed to conclude to a discrepancy with the predicted value especially for the ^{134}Sn(0^+) $\rightarrow$ ^{134}Sb(0^-) transition for which the ε_{MEC} factor has a poor accuracy.

The goal of this study is to measure the direct β branching ratio of the ^{134}Sn(0^+) ground state to its daughter ^{134}Sb(0^-) ground state. The direct feeding of the ground state will be inferred from observable activities in β-γ, β-n and β-n-γ channels. The ion beam of ^{134}Sn, produced at ALTO facility, will be directed to the collection point surrounded by a detection station allowing the counting of the β by plastic scintillators, the counting of the γ by Ge detectors and the counting of the neutrons by TETRA.

The PhD student will contribute to the experiment carried out at the ALTO facility in Orsay (BEDO, TETRA and COeCO), analyze data collected on lifetime (τ_β) and β-n decay probability (P_n) measurements using the neutron detector, TETRA, and interpret these results.

The PhD student will also participate in the physics campaigns with the European AGATA gamma-ray spectrometer at Legnaro (Italy).