UNIVERSITAT DE VALÈNCIA
DEPARTAMENTO DE FÍSICA ATÓMICA, MOLECULAR Y NUCLEAR
INSTITUTO DE FÍSICA CORPUSCULAR (UV - CSIC)

Programa de Doctorado en Física

Beta Spectrum Shapes Study for the Prediction of Reactors' Antineutrino Spectra

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Analysis of the I233 Experiment
for the e-shape Collaboration

By **Gustavo Adolfo Alcalá Escalona**
Supervised by **Dr. Alejandro Algora**

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INFORME FAVORABLE PARA EL DEPÓSITO DE LA TESIS DOCTORAL

Alejandro Algora, Investigador Científico del IFIC (CSIC - Universitat de València), y **Juan Zúñiga Román**, Catedrático de la Universitat de València,

como director y tutor de tesis, respectivamente,

CERTIFICAN:

Que la presente memoria, *Beta spectrum shapes study for the prediction of reactors' antineutrino spectra*, ha sido realizada bajo la dirección de ambos en el Instituto de Física Corpuscular, centro mixto de la Universitat de València y del Consejo Superior de Investigaciones Científicas, por **Gustavo Adolfo Alcalá Escalona**, y constituye su Tesis para optar al grado de Doctor por la Universitat de València una vez cursados los estudios en el Doctorado en Física.

Y para que así conste, en cumplimiento de la legislación vigente, presenta en el Departamento de Física Experimental la referida Tesis Doctoral, y firman el presente certificado.

València, a 26 de junio de 2024,

Alejandro Algora

Juan Zúñiga Román

"Science, my lad, is made up of mistakes, but they are mistakes which it is useful to make, because they lead little by little to the truth."

Jules G. Verne, Journey to the Centre of the Earth (1864).

Abstract

Predictions of fluxes and energy spectra of nuclear reactors' electron antineutrinos do not coincide with the measurements [1]. These differences are the "Reactor Antineutrino Anomaly" and the spectral "bump" [2]. The e-shape collaboration looks for solutions for these problems via the improvement of relevant nuclear models used in the calculation of antineutrino spectra of reactors [3]. It has been proposed that using improved models for the forbidden beta spectra of reactors' fuel fission products could solve the spectral "bump" [4, 5].

The collaboration uses the Summation method [6] to calculate predictions of reactors' antineutrino spectra due to its improved results over other methods, and electron telescopic detectors to measure the beta spectra of relevant contributors to the antineutrino spectra [7]. These detectors are used to validate the best beta feedings and the real shapes of the energy beta spectra of the measured beta decays.

Measurements of beta shapes were conducted at IGISOL-4 because the facility has a double Penning trap (JYFLTRAP) that produces isotopically clean radioactive beams of the isotopes of interest. This work presents the analysis of the ^{92}Rb, ^{142}Cs, and ^{86}Br beta spectra measured at the facility during the I233 experiment. Comparisons to previous experiments [8] are made.

Key words: Reactor antineutrino anomaly, reactor antineutrino spectrum, summation method, beta decay, beta feeding, TAGS, shape correction factors, first forbidden transitions, telescopic detectors.