ID de la contribución : **930** Tipo : **no especificado**

Cluster structure in 14C

miércoles, 20 de noviembre de 2024 9:30 (15)

Cluster-like structures are often present in atomic nuclei and significantly influence their structural and dynamical properties. More precisely, Morinaga [1] proposed a particular alpha cluster configuration known as the linear-chain cluster state (LCCS), in which the alpha particles are arranged in a linear sequence. In this configuration, the neutron excess appears to play a significant role in stabilizing the structure. Suhara and Kanada-En'yo [2] were the first to predict the existence of the LCCS in ^{14}C using antisymmetrized molecular dynamics (AMD). However, it was not until 2014 that the first experimental evidence was obtained by Freer *et al.* [3], supporting the idea of the LCCS in ^{14}C by identifying the prolate band ($J^\pi = 0^+, 2^+, 4^+$). Two years later, Fritsch *et al.* [4] observed the 2^+ and the 4^+ states, but the position of the band head (0^+) remained unknown. Recently, Yamaguchi *et al.* [5] reported having identified this 0^+ state at 3 MeV, however, a recent work has challenged this finding [6].

The alpha-cluster structure of ^{14}C has been investigated through the resonance scattering in the ^{10}Be(^{4}He,^{4}He)^{10}Be reaction. The experiment was conducted using an active target time projection chamber (AT-TPC) filled with pure He, placed inside the solenoidal spectrometer SOLARIS [7]. The standalone ^{10}Be beam was injected into the ReA6 accelerator at the Facility for Rare Isotope Beams (FRIB), where it was accelerated and subsequently delivered to SOLARIS. Different gas pressures inside the AT-TPC and different beam energies were used in order to extract as much information as possible about the different LCCS bands: the π-bond and the σ-bond. Both bands will be studied using a new observable: the three-particle decay inelastic channel branching ratio.

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This work is supported by the Xunta de Galicia (CIGUS Network of Research Centres) and the European Union.

Abstract

Primary author(s) : PALACIOS SUÁREZ-BUSTAMANTE, David (IGFAE - Universidade de Santiago de Compostela); Dr. AYYAD, Yassid (IGFAE - Universidade de Santiago de Compostela); Dr. OLAIZOLA, Bruno (IEM - CSIC)

Co-author(s) : Dr. ANTHONY, A. (High Point University); ARDELEAN, C. (FRIB - Michigan State University); BAZIN, D. (FRIB - Michigan State University); BECEIRO-NOVO, S. (Universidade Da Coruña); CABO, C. (IGFAE - Universidade de Santiago de Compostela); CHEN, J. (Southern University of Science and Technology); DOPFER, J. (FRIB - Michigan State University); GAI, M. (University of Connecticut); HUNT, C. (FRIB - Michigan State University); MACCHIAVELLI, A. O. (Oak Ridge National Laboratory); MCCANN, G. (FRIB - Michigan State University); MITTIG, W. (FRIB - Michigan State University); PAINTER, S. (FRIB - Michigan State University); SERIKOW, Z. (FRIB - Michigan State University); TANG, T. (FRIB - Michigan State University); TURI, N. (FRIB - Michigan State University); WEGHORN, L. E. (FRIB - Michigan State University)

Presenter(s) : PALACIOS SUÁREZ-BUSTAMANTE, David (IGFAE - Universidade de Santiago de Compostela)

Clasificación de la sesión : Red FNUC (Red Temática de Física Nuclear)

Clasificación de temáticas : Red Temática de Física Nuclear (FNUC)