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Study of the excited 8.1 MeV state of ^{11}C

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The ^{11}C nucleus is a proton-rich nucleus with intriguing exotic features. Unlike the neutron-rich ^{11}Be nucleus, isobar analog with a confirmed neutron halo, ^{11}C does not form a pronounced proton halo due to the Coulomb barrier.

The results of an experimental study of the structure of ^{11}C using the transfer reaction $^{10}\text{B}(^7\text{Li}, ^6\text{He})^{11}\text{C}$ at a beam energy of 58 MeV, carried out at the U400 cyclotron at JINR, are presented. The main focus is on a detailed analysis of the excited state with an energy of 8.1 MeV. Using a multi-stage identification procedure and kinematic calculations, it was possible to reliably separate the peak under study from the contributions of parasitic impurities ^{12}C and ^{16}O in the operating angle range, ensuring high purity of experimental data.

The distorted waves method was used to interpret the obtained angular distributions of differential cross sections. The analysis showed that the radial dependence of the form factor for the 8.1 MeV state decreases significantly more slowly (has a longer “tail”) compared to the ground state. This directly indicates an abnormally large root mean square radius of this level. The obtained results became the first experimental evidence of the increased size of the 8.1 MeV state in the ^{11}C nucleus. Its spatial dimensions turned out to be comparable to the radius of the Hoyle state in ^{12}C and the mirror level in ^{11}B . This is consistent with the theoretical predictions of the antisymmetrized molecular dynamics (AMD) model and confirms the presence of an exotic three center cluster structure $2\alpha + ^3\text{He}$, which allows us to confidently assign this level to the class of “size isomers”.

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