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Is ^{14}C nuclear chain puzzle solved?

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Some nuclear properties can be understood by modeling nuclei as loosely interacting clusters. Among the various cluster phenomena observed in light unstable nuclei, particularly neutron-rich ones, is a unique form of clustering where an alpha-cluster structure is held together by neutron exchange, akin to covalent bonding in molecules. In the case of neutron-rich nuclei, theoretical predictions by Suhara and Kanada-En'yo [1-3] using antisymmetrized molecular dynamics (AMD) suggest the existence of a linear chain configuration in ^{14}C, where α-particles are bound by neutrons. This configuration is expected to be associated with a rotational band (J = 0^+, 2^+, 4^+) appearing a few MeV above the ^{10}Be+α threshold.
The spectroscopy of ^{14}C has been extensively investigated and, specifically, studies have been conducted to search for the alpha-chain structure by measuring the ^{10}Be+^{4}He elastic scattering excitation function [4-6] and, more recently, ^{14}C breakup reaction [7]. These publication do suggest that states which may be associated to a linear chain configuration of ^{14}C are, indeed, being observed. These claims, however, suffers, on one hand of a poor time resolution that does not allow the separation of the elastic from the inelastic scattering [4,6], on the other, of a poor energy resolution of the ^{14}C excitation energy spectrum [7]. As reported in [8], in fact, ^{14}C posses a large number of states in the excitation energy region of interest.
In this presentation we will report on the results of an elastic scattering ^{10}Be+^{4}He excitation function experiment, performed at INFN-Laboratori Nazionali del Sud using the most intense ^{10}Be radioactive beam available worldwide (10^9 pps). In this measurement the limitations of the previous experiments have been overcome. The elastic scattering excitation function is unambiguously measured in a broad ^{14}C excitation energy region (13 MeV-23 MeV) and large c.m. angular range (90° -180°), with a c.m. energy resolution of about 50 keV. The inelastic scattering channels to both, the 2_1^+ and 0_2^+ states in ^{10}Be, have also been measured. The theoretical analysis has been performed using R-matrix. The possible evidence (or lack of) linear chain in ^{14}C will be critically discussed.
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