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## alpha-cluster structures in 14C and 16O

Well-bound spherical nuclei can be considered as closed quantum systems that can be described by state-ofthe-art versions of the shell model, where nucleons occupy well-localized single-particle states. However, when we move towards the dripline or inject enough excitation energy into the system, the coupling to the continuum and reaction channels becomes more important, forcing the nucleus to behave like a many-body open quantum system. This complex interplay between reaction and structure leads to intriguing phenomena, where weakly bound or unbound systems exhibit features such as halos, particle emission near decay thresholds, and alpha clustering. Inferring the relevant observables to investigate such phenomena requires the use of efficient detection systems for experiments in inverse kinematics. Solenoidal spectrometers are precisely engineered to effectively analyze various reactions resulting in the formation of clustered states. SOLARIS [1], a next-generation solenoidal spectrometer, offers versatile functionality with its two distinct modes of operation: Si-array and Active Target mode.

In this talk, we will discuss the cluster structure of <sup>14</sup>C and <sup>16</sup>O, as explored through various experiments conducted using SOLARIS in Active Target mode with the Active Target Time Projection Chamber (AT-TPC). For the <sup>14</sup>C, some of the states within the two rotational bands ( $\pi$ -bond and  $\sigma$ -bond) of the linear-chain cluster state (LCCS) remain unresolved [2-7]. We have used resonant scattering of <sup>10</sup>Be + <sup>4</sup>He as the reaction to explore this nucleus. We present the cross sections, the angular distributions and the spin-parity of several <sup>14</sup>C resonances, including states belonging to the rotational bands. In the case of the <sup>16</sup>O, we aim to search for resonances near the 4- $\alpha$  emission threshold, where the  $\alpha$  condensate states are more likely to manifest [8], with an <sup>16</sup>O + <sup>4</sup>He reaction. We also calculate the branching ratios of the <sup>12</sup>C + <sup>4</sup>He and <sup>12</sup>C(0<sub>2</sub>+) + <sup>4</sup>He exit channels.

[1] https://www.anl.gov/phy/solaris.

[2] H. Morinaga, Interpretation of some of the excited states of 4n self-conjugate nuclei, Phys. Rev. 101 (1956) 254-258.

[3] T. Suhara, Y. Kanada-En'yo, Cluster structures of excited states in C 14, Physical Review C 82 (2010) 044301.
[4] M. Freer et al., Resonances in 14C observed in the 4He(10Be,4He)10Be reaction, Physical Review C 90 (2014) 054324.

[5] A. Fritsch et al., One dimensionality in atomic nuclei: A candidate for linear-chain alpha clustering in C 14, Physical Review C 93 (2016) 014321

[6] H. Yamaguchi et al., Experimental investigation of a linear-chain structure in the nucleus 14C, Physics Letters, Section B: Nuclear, Elementary Particles and High-Energy Physics 766 (2017) 11-16.

[7] J. Han et al., Nuclear linear-chain structure arises in carbon-14. Commun Phys 6, 220 (2023).

[8] S. Ohkubo, Y. Hirabayashi, Phys. Lett. B 684 (2010) 127

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