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Constraining the formation mechanisms of light (anti)nuclei at the LHC and applications for cosmic ray physics

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The formation mechanism of light (anti)nuclei produced in high-energy hadronic collisions is an open question that is being addressed both theoretically and experimentally. Moreover, the study of (anti)nuclei production at particle accelerators is relevant to model the flux of antinuclei produced in cosmic ray interactions, which represents the dominant background for dark matter searches. In fact, according to the most accredited theoretical models, dark matter particles present in the galactic halo could annihilate and produce ordinary matter-antimatter pairs.

At LHC energies, the same amount of matter and antimatter are produced, which makes this facility suited for detailed studies of (anti)nuclei production. ALICE, thanks to its excellent particle identification capabilities, measured (anti)nuclei in all the collision systems and energies provided by the LHC. Measurements of transverse momentum distributions, ratios of integrated yields, and coalescence probabilities are discussed in comparison with two phenomenological models used to describe the production of nuclei.

During the LHC long shutdown 2, the ALICE apparatus underwent a series of major upgrades to take advantage of the luminosity increase of the LHC Run 3. These upgrades will allow the collection of an unprecedented amount of data, opening new paths to probe the formation mechanisms of nuclei with A = 3 and A = 4 with unprecedented precision.
The performance of the upgraded ALICE detector during the Run 3 pp data taking will be discussed together with perspectives for new measurements with applications to searches for antinuclei in cosmic rays for indirect dark matter searches by the AMS and GAPS experiments.

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