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Recent ALICE results on antinuclei inelastic cross sections and the implications for antinuclei fluxes near Earth

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The presence of antinuclei in cosmic rays remains one of the most intriguing questions of modern physics, with several ongoing or planned experiments looking for traces of antinuclei in space near Earth. An observation of antideuteron or antihelium nuclei in cosmic rays would most probably mean a breakthrough in searches for "new physics", as the antinuclei production from ordinary collisions between cosmic rays and interstellar medium is expected to be very low, especially in the low kinetic energy range. However, to correctly interpret future results, one needs to know as precisely as possible both the antinuclei production mechanism and their nuclear inelastic cross sections. The latter defines the probability that antinuclei produced in the Galaxy can reach the detectors near Earth. Unfortunately, these inelastic cross sections are known very poorly from the experiment, which hampers precise calculations of expected antinuclei fluxes.

The ALICE collaboration has recently performed several measurements of antideuteron and antihelium-3 inelastic cross sections, providing the first experimental information of this kind. The antideuteron inelastic cross sections have been measured for the first time in the low momentum range $0.3 < p < 4$ GeV/c using collisions at the LHC as a source of antideuterons and the material of ALICE experiment as a target. The method has been later extended to antihelium-3 nuclei in the momentum range of $0.85 < p < 10$ GeV/c. The results are compared to the parameterisations used in Geant4 toolkit, and in the case of antihelium-3 a much steeper rise of the inelastic cross section is observed at low momentum.

We show how the measurement of antinuclei inelastic cross section with ALICE provides one of the necessary constraints for the study of antinuclei in space. To this purpose, the impact of ALICE results on the antinuclei fluxes near Earth has been studied using a state-of-the-art propagation model implemented in GALPROP framework. The fluxes of antihelium-3 nuclei near Earth have been calculated for typical dark matter scenarios and for collisions of cosmic rays with the interstellar medium. We show that in the case of antihelium-3 stemming from dark matter one loses around half of the antinuclei due to annihilations in collisions with interstellar gas. As for the background antihelium-3 flux, this loss is strongly energy-dependent, ranging from 75% at low energies down to around 10% at high energies.

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