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Antiproton production cross sections for dark matter search at the AMBER experiment @CERN

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Multiple evidence reveals that the vast majority of the matter content of the universe is non baryonic and electrically neutral. This component is usually called Dark Matter (DM), for its lack of electromagnetic interactions, and is measured to constitute about 25% of the energy density of the Universe. The most common hypothesis is that it consists of weakly interacting massive particles, supposed to be cold thermal relics of the Big-Bang.

The indirect detection of DM is based on the search of the products of DM annihilation or decay. They should appear as distortions in the gamma ray spectra or in anomalies in the rare Cosmic Ray (CR) components. In particular, antimatter components, like antiprotons, antideuterons and positrons, promise to provide sensitivity to DM annihilation on top of the standard astrophysical production.

The interpretation of galactic CR data requires the correct modeling of their source terms and the turbulence spectrum of the galactic magnetic field, in addition to the knowledge of the cross sections that regulate the production of CR interacting with the interstellar medium.

After PAMELA detector results, the antiprotons flux has been measured with an accuracy of a few percent by AMS-02 over an energy range from below 1 GeV up to a few hundreds of GeV. However, the only currently measured production cross section is the proton-proton one, while all the reactions involving helium have no laboratory data in the phase space covered by AMS-02 (only LHCb, but with incident proton energy of 6.5 TeV). This requires a scaling of the pp channel to pA interaction through approximation and modeling.

The AMBER fixed target experiment at the M2 beam line at CERN will contribute to this fundamental DM search, performing a unique and complementary measurement of the double differential antiprotons production cross-section with a proton beam ranging from 60 to 250 GeV/c impinging on a liquid He target.

The data taking for the experimental determination of the cross-section in p+He scattering is scheduled for May-June 2023. This result from AMBER will directly pin down the production of anti-protons in the relevant kinematical region covered by AMS-02.

Category

Experiment

Collaboration (if applicable)

AMBER

Author: Mr GIORDANO, Davide (Università degli Studi di Torino / INFN Torino (IT))

Presenter: Mr GIORDANO, Davide (Università degli Studi di Torino / INFN Torino (IT))

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