ANTIPROTONS PRODUCTION IN COSMIC RAYS AND IMPLICATIONS FOR THE DARK MATTER RESEARCH

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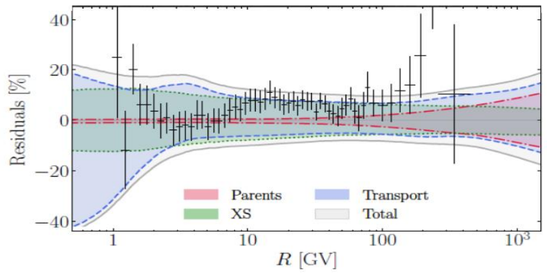
UNCERTAINTIES ON COSMIC ANTIPROTONS

The uncertainties about the production and the propagation of cosmic antiprotons are due to solar modulation, nuclear cross sections and uncertainties on the parameters of propagation of cosmic rays. The first ones dominate at energy less than 10-30 GeV and are determined by the model used to describe CR in Heliosphere. The second ones arise from collider experiments and are related to the production of antiprotons in pp, Ap, pA and AA collisions. These uncertainties are dominant between 10 and 100 GeV. The last ones are related to the model used to describe production and propagation of CR in the galaxy and are dominant at energy higher than 100 GeV.



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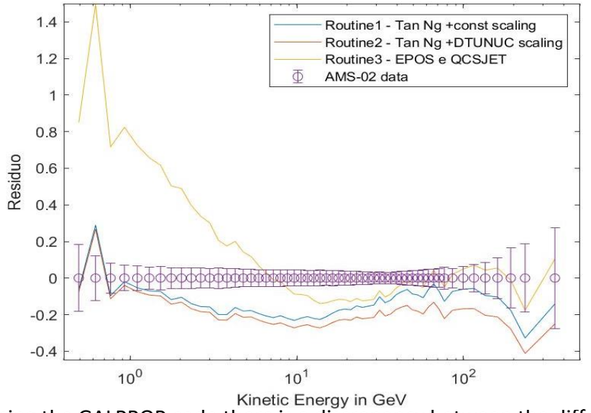
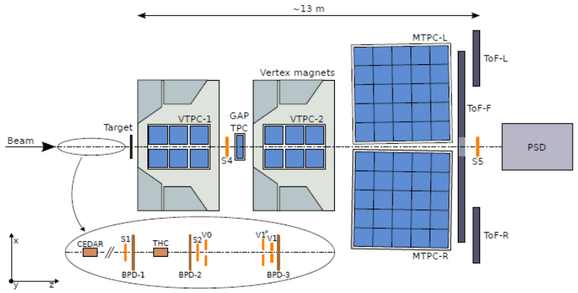
THE DIFFERENT GALPROP MODELS



Using the GALPROP code there is a discrepancy between the different models used to describe the production of secondary antiprotons. If we use the parametrizations, we will see an underprediction of antiprotons that can be fitted with a DM signal compatible with the GeV excess in the galactic centre.
Differently, if we use the tables yielded by the MC simulators, we will predict an enhancement in the signal compared to the flux detected by AMS-02.

THE CROSS-SECTION PROBLEM

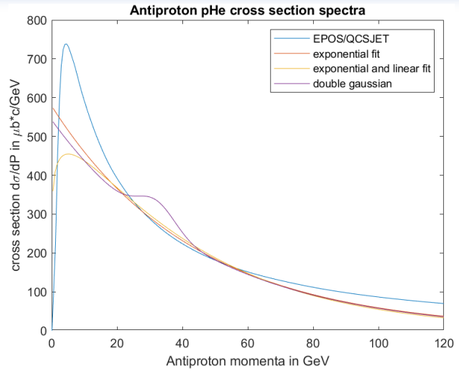
Until 2017 there were very few data about the production of antiprotons in nuclear collisions and the avaiable set had high uncertainties because they are obsolete.
In the recent years, two experiments took data about antiprotons production in pp and pHe collisions: NA61/SHINE [1] at SPS and SMOG at LHC [2].
Many people are proposing experiments to help fill the data gap in the future (see COMPASS/AMBER for an example).

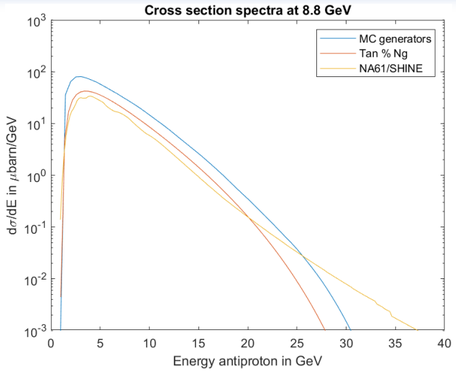


The NA61/SHINE experiment

COMPARISON OF MODELS WITH CERN DATA

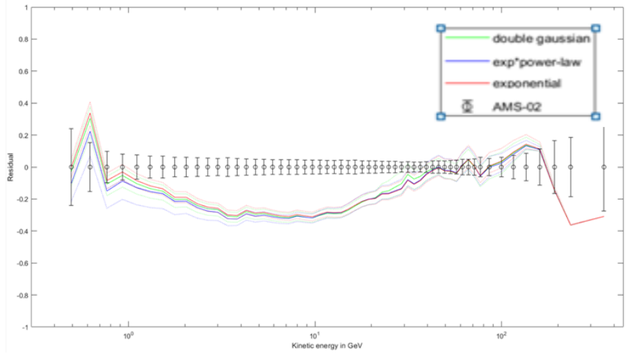
The different models that GALPROP uses to describe the antiprotons production have been compared with the results of the NA61/SHINE and SMOG experiments.
The SMOG experiment reveals a higher production of antiprotons in pHe collisions than expected one.
The NA61/SHINE dataset is in better agreement with the parametrization of Winkler and Tan & Ng with respect to the tables of the MC simulators.





NEW PARAMETRIZZATIONS FOR PHE COLLISIONS

I wrote a new GALPROP routine to calculate the production of antiprotons in pHe collision. This routine is based on three different parametrizations fitted on SMOG data. The results are shown with the only uncertainties related to pHe collisions at 95% C.L.



REFERENCES: [1] arXiv:1705.02467, [2] arXiv:1808.06127