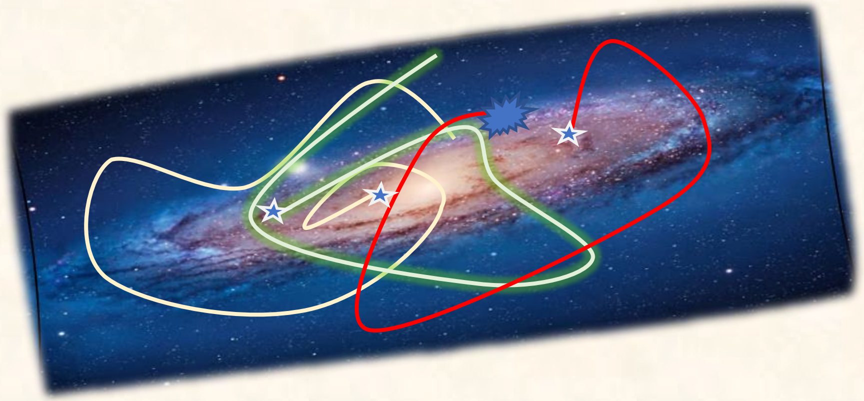
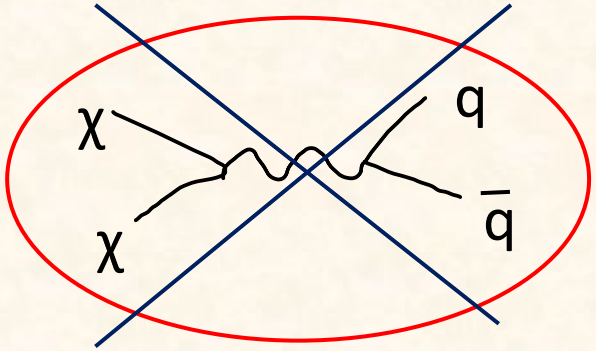
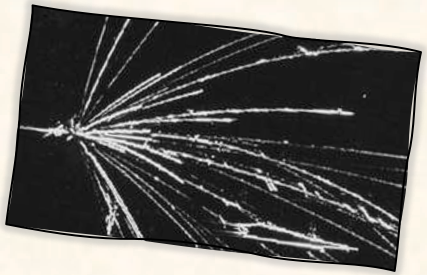
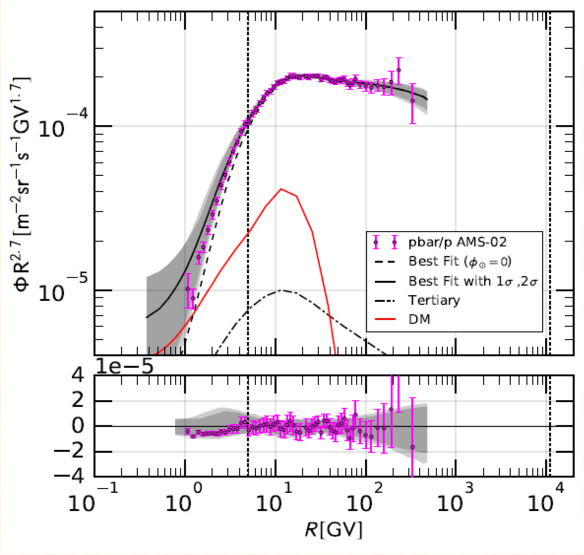
Antiproton production from cosmic-ray interactions and its compatibility with AMS-02 data







Cuoco et al. 2017



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ICRC 2021 – 12/07/2021

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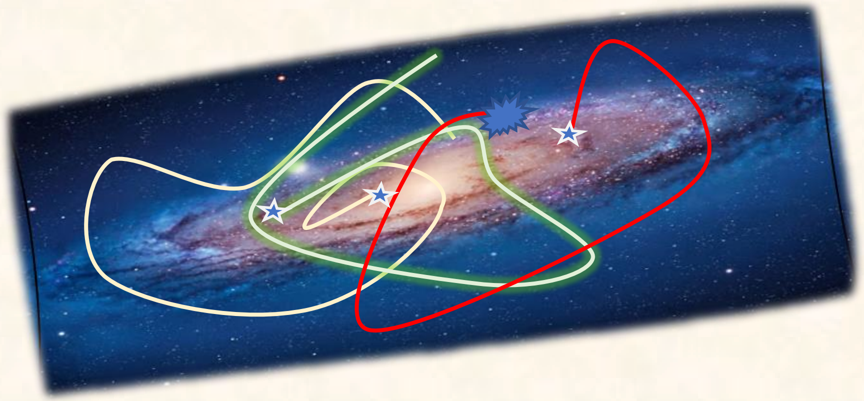
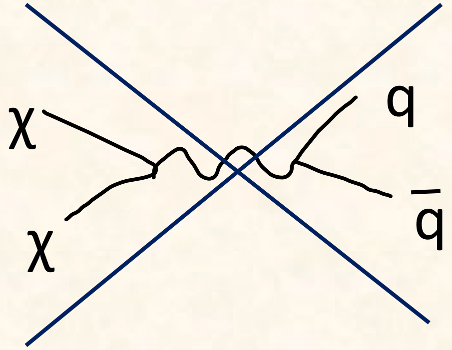
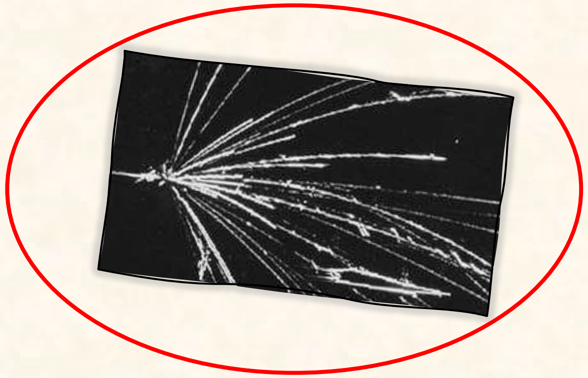
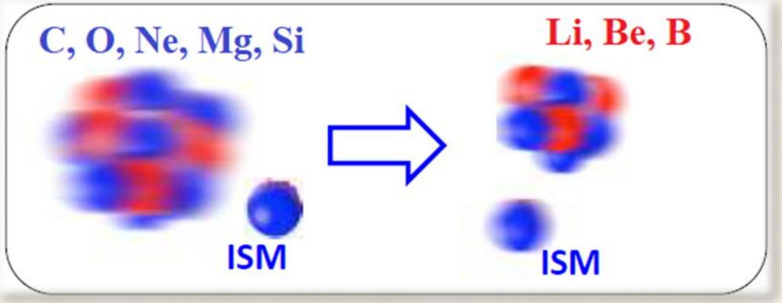




$$\mathrm{CRs} + \mathrm{ISM} \longrightarrow \bar{p} + X$$





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Diffusion-reacceleration model (no convection) → *DRAGON2 code*

$$D(R) = D_0 \beta^{\eta} \frac{(R/R_0)^{\delta}}{\left[1 + (R/R_b)^{\Delta\delta/s}\right]^{s}}$$

$R_0 = 4$ GV
$R_b = 312$ GV
$\Delta\delta = 0.14$

Fit to experimental data from a **Markov-Chain Monte Carlo (MCMC) procedure** based in ArXiv:2102.13238.

$$\ln \mathscr{L}^{Total} = \sum_{F}^{Li,Be,B/(C,O,Li,Be,B)} \ln(\mathscr{L}(F)) + \sum_{X}^{B,Be,Li} \mathscr{N}_X$$

Scale factors are incorporated in the code as nuisance parameters **to renormalize the cross sections parametrizations of B, Be and Li production** allowing us to adjust the grammage (propagation parameters) in order to improve the predicted *$\bar{p}/p$ ratio*.

Secondary $\bar{p}$ production from CR interactions

$$q_{\mathrm{CR+ISM}\to\bar{p}}(T_{\bar{p}}) = \int_0^{\infty} dT\, 4\pi n_{\mathrm{ISM}} \Phi_{\mathrm{CR}}(T) \frac{d\sigma_{\mathrm{CR+ISM}\to\bar{p}}}{dT_{\bar{p}}}(T, T_{\bar{p}})$$

$$\mathrm{CRs} + \mathrm{ISM} \longrightarrow \bar{p} + X$$

Contribution to the $\bar{p}$ spectrum

pp channel	(50% - 60%)
*p*He channel	(15% - 20%)
He*p* channel	(10% - 20%)
HeHe channel	few percent

Korsmeier, Donato, Di Mauro, 2018; arXiv:1802.03030

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$$\ln \mathscr{L}^{Total} = \sum_{F}^{Li,Be,B/(C,O,Li,Be,B)} \ln(\mathscr{L}(F)) + \sum_{X}^{B,Be,Li} \mathscr{N}_X$$

- **B/C, B/O, Be/C, Be/O, $\bar{p}/p$** allow us to determine D/H
- **^{10}Be/^{9}Be, ^{10}Be/Be flux ratios** allow us to constrain the height of the magnetized halo (H)
- **Be/B, Li/B, Li/Be ratios** offer a sensitive tool to account for cross sections uncertainties

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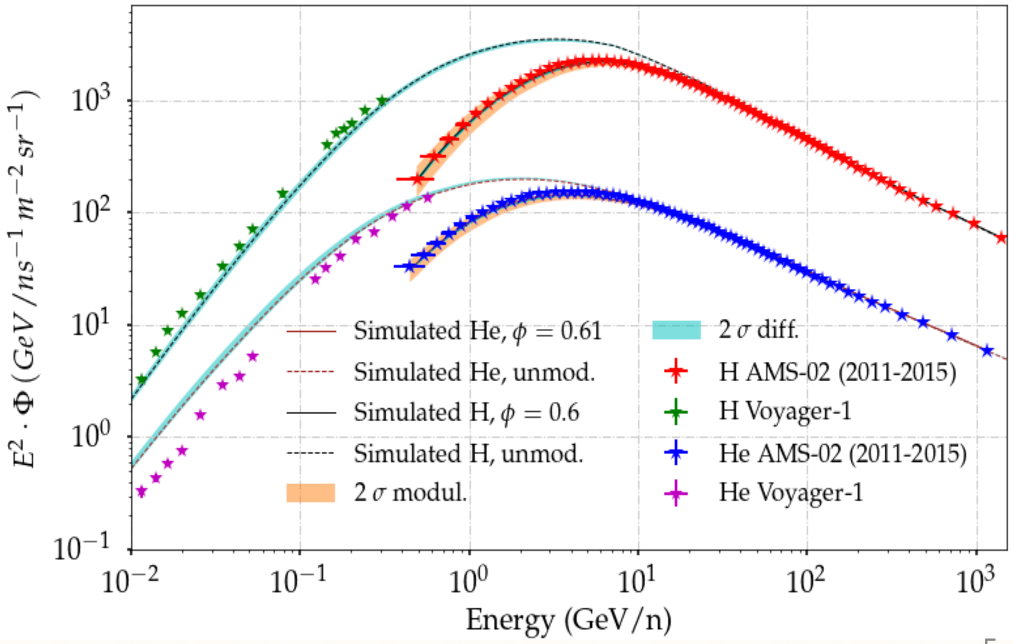
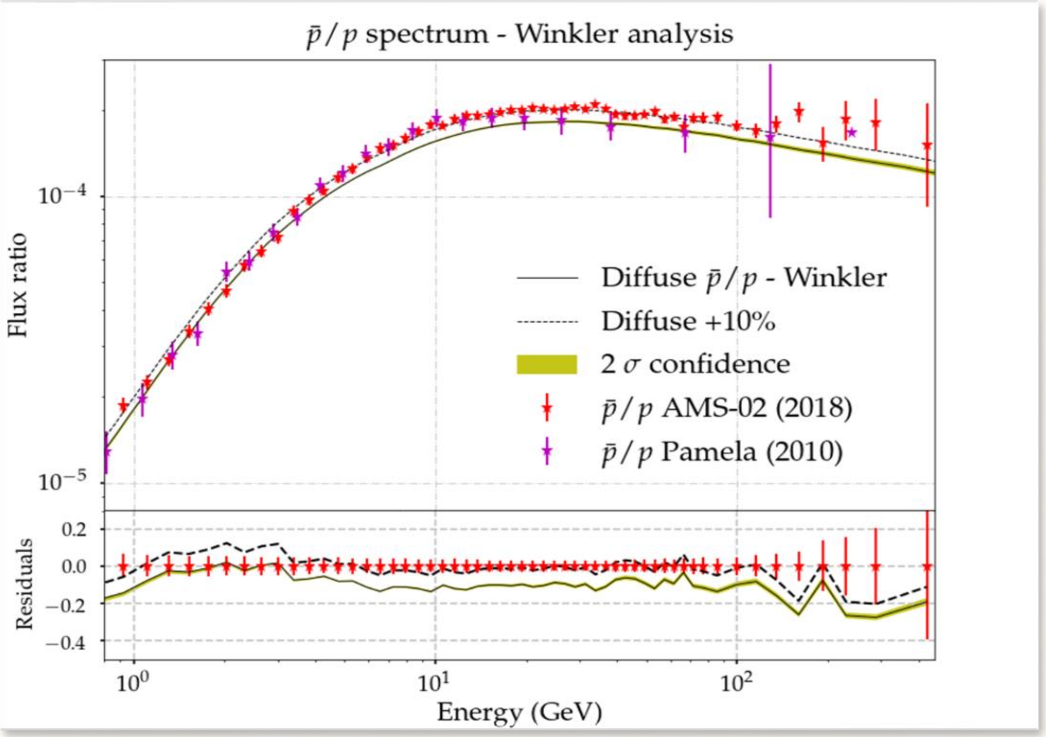
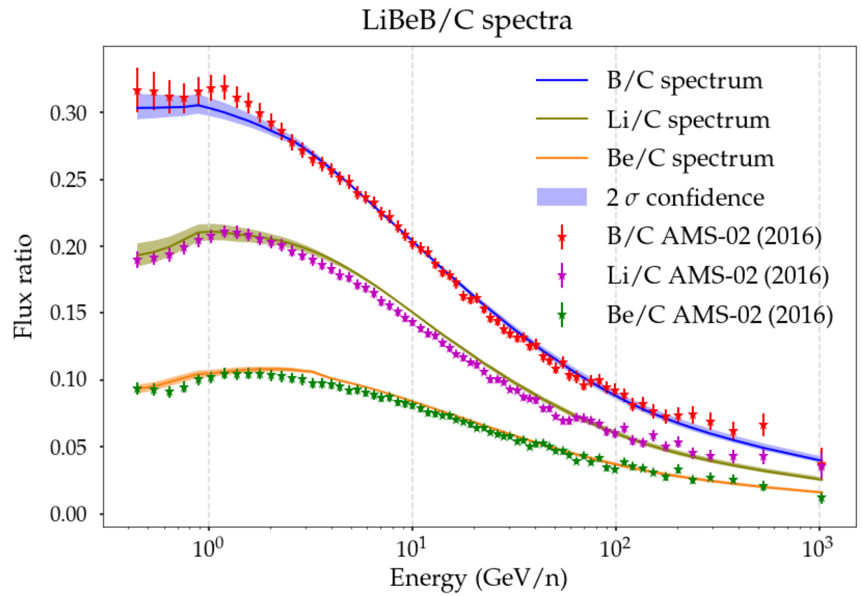
Injection parameters adjusted until reaching convergence

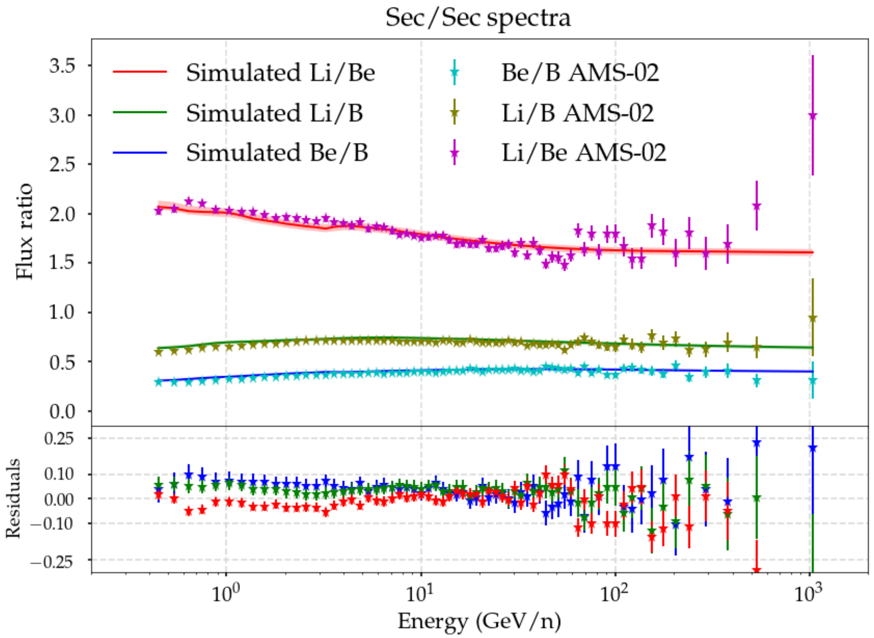


Winkler cross sections used in the evaluation of $\bar{p}$



Propagation parameters				
H (kpc)	D_0 (10^{28} cm^2/s)	v_A (km/s)	η	δ
6.07 ± 0.11 [5.82, 6.27]	4.79 ± 0.1 [4.59, 5.01]	0.28 ± 1.25 [0., 2.8]	-1.57 ± 0.08 [-1.75, -1.39]	0.49 ± 0.01 [0.46, 0.51]





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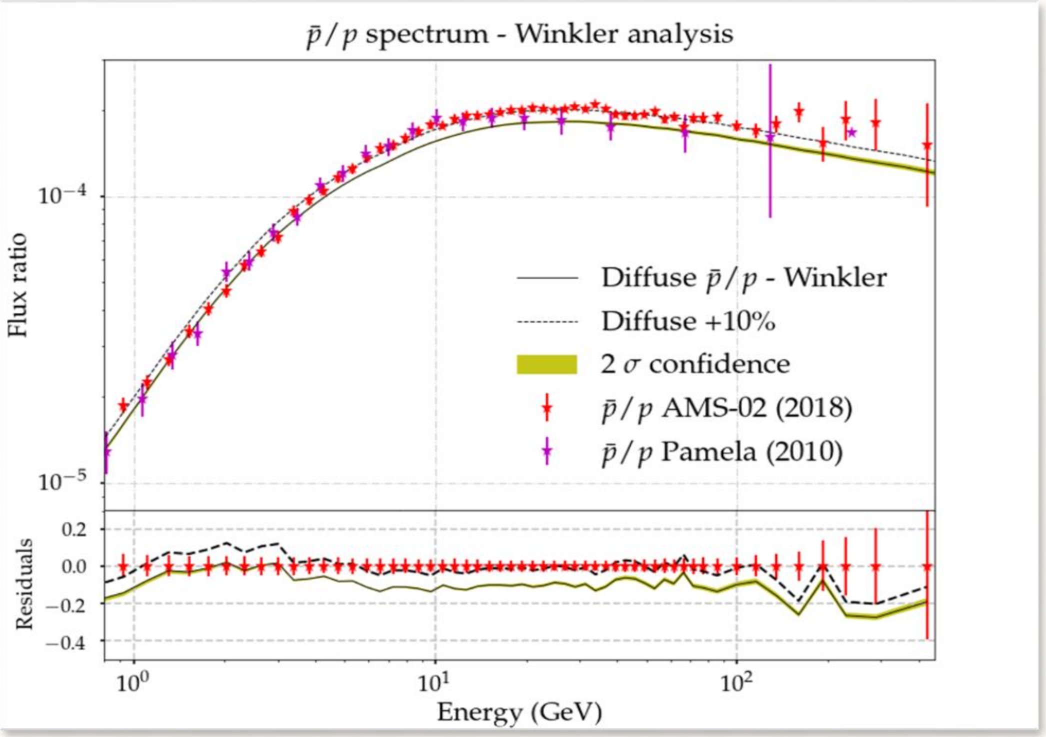
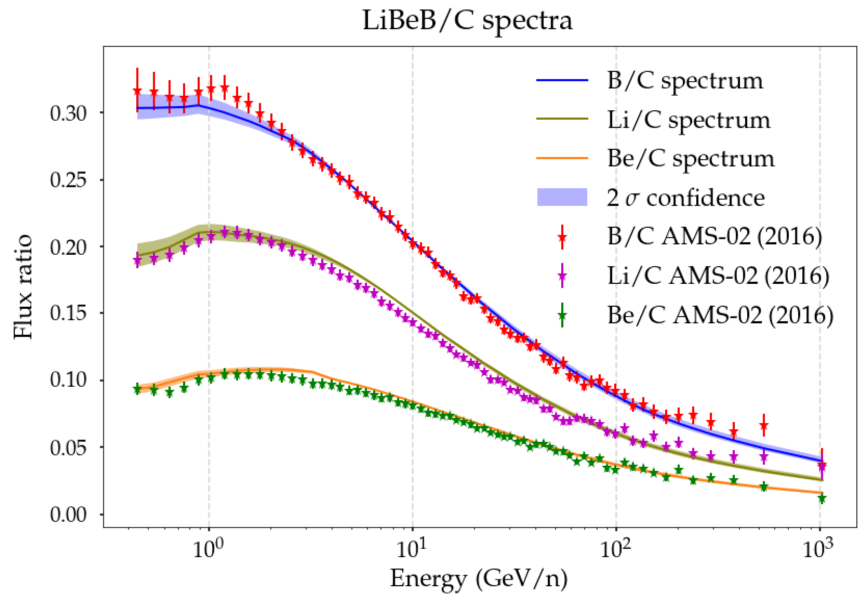
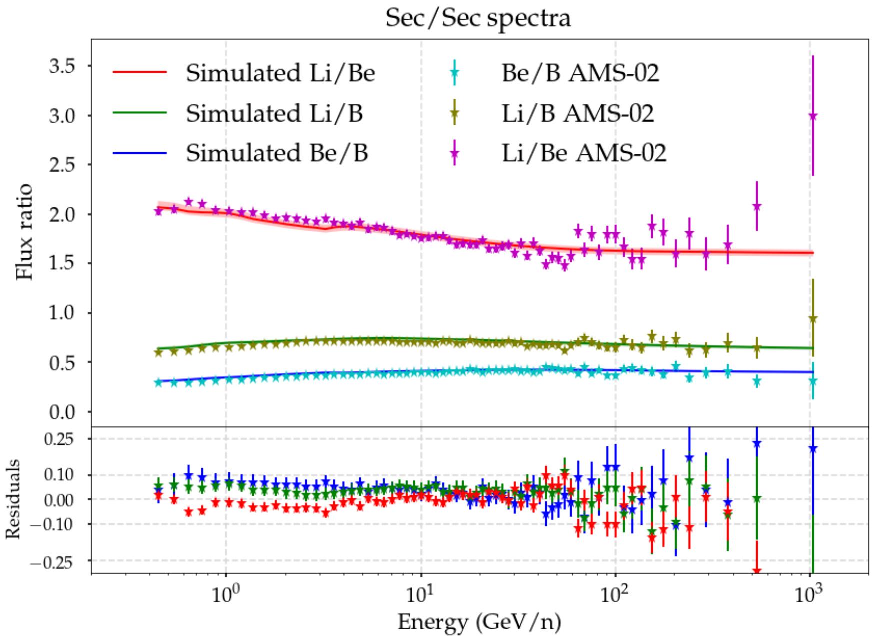


- **Energy dependence predicted** by the analysis is in **great agreement with AMS-02 data** → constant 10% underestimation above 3 GeV
- **Discrepancy** can be **well explained taking into account the antiproton cross sections uncertainties** (~ 20%)





In conclusion:

From the predictions reached here, the experimental $\bar{p}/p$ ratio seems to be **compatible with a pure secondary origin of the antiprotons**