Implications of Li to O data of AMS-02 on our understanding cosmic-ray diffusion

Michael Korsmeier

in collaboration with Alessandro Cuoco

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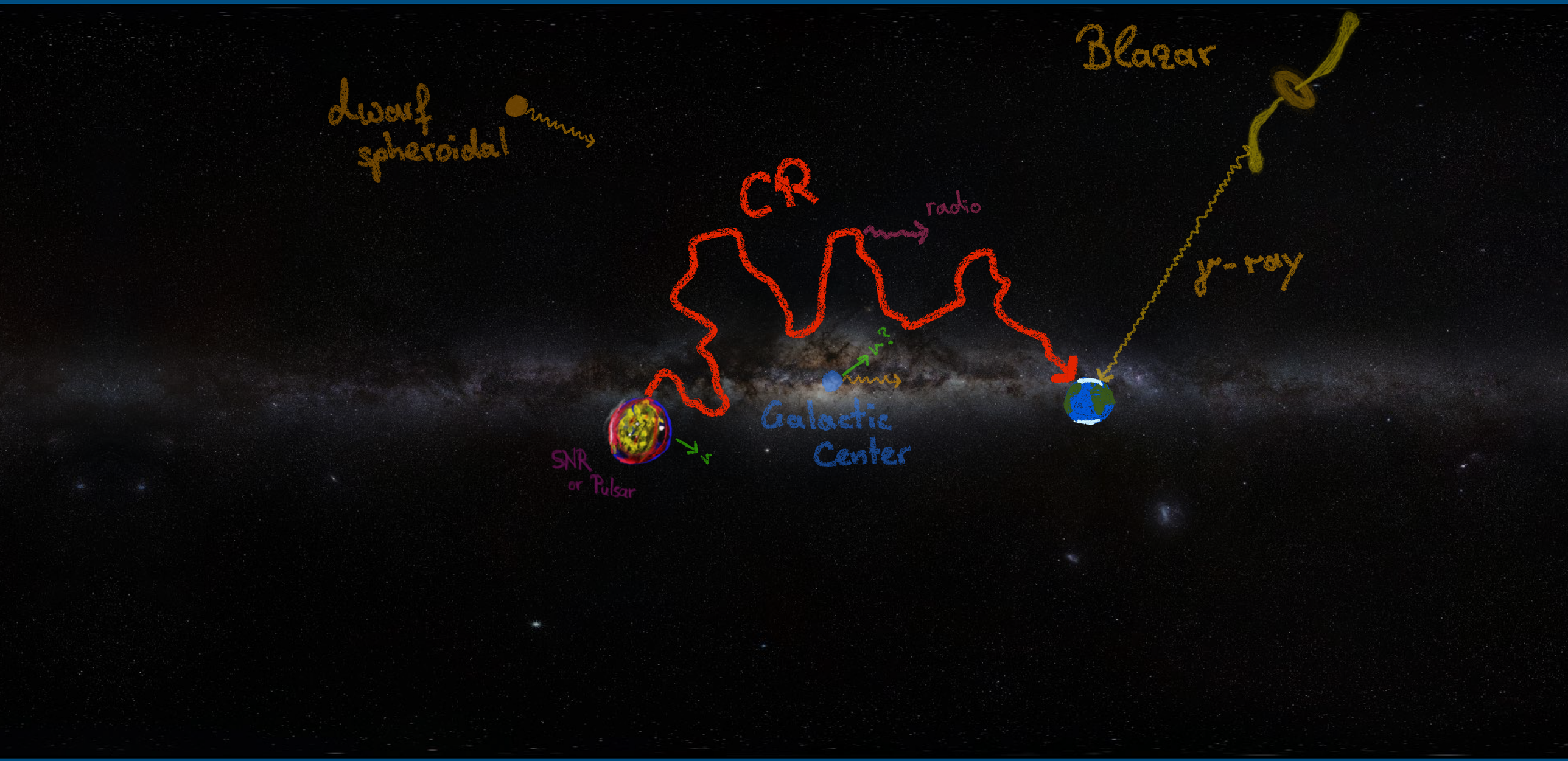
Astroparticle messenger



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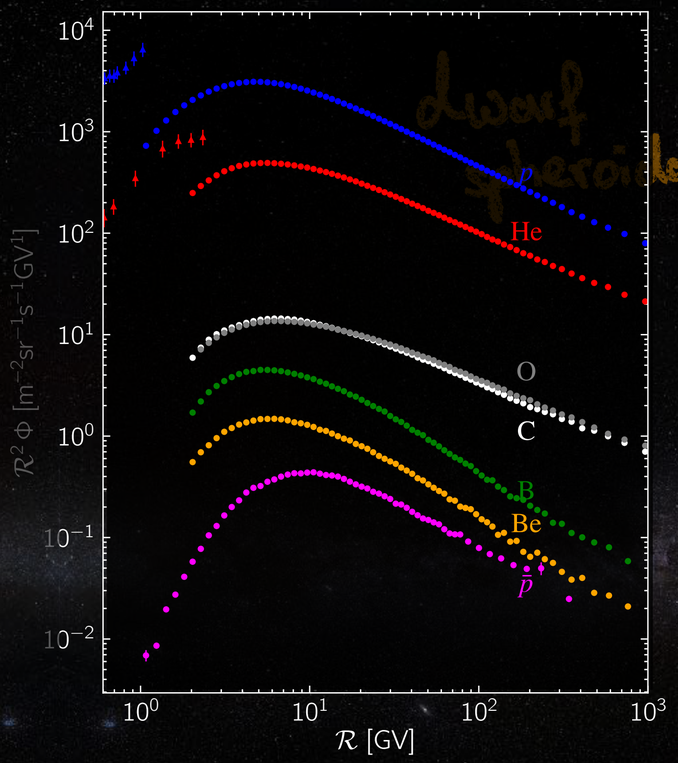
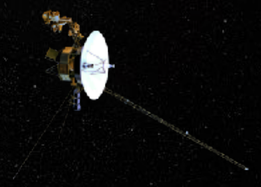
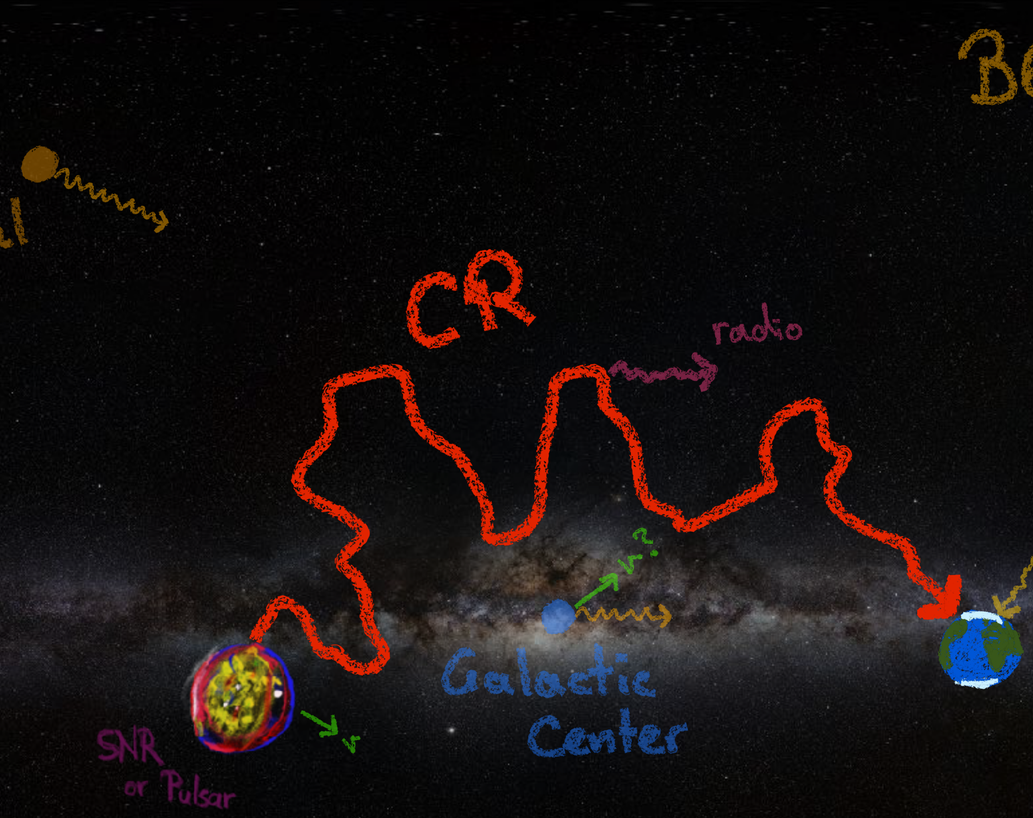


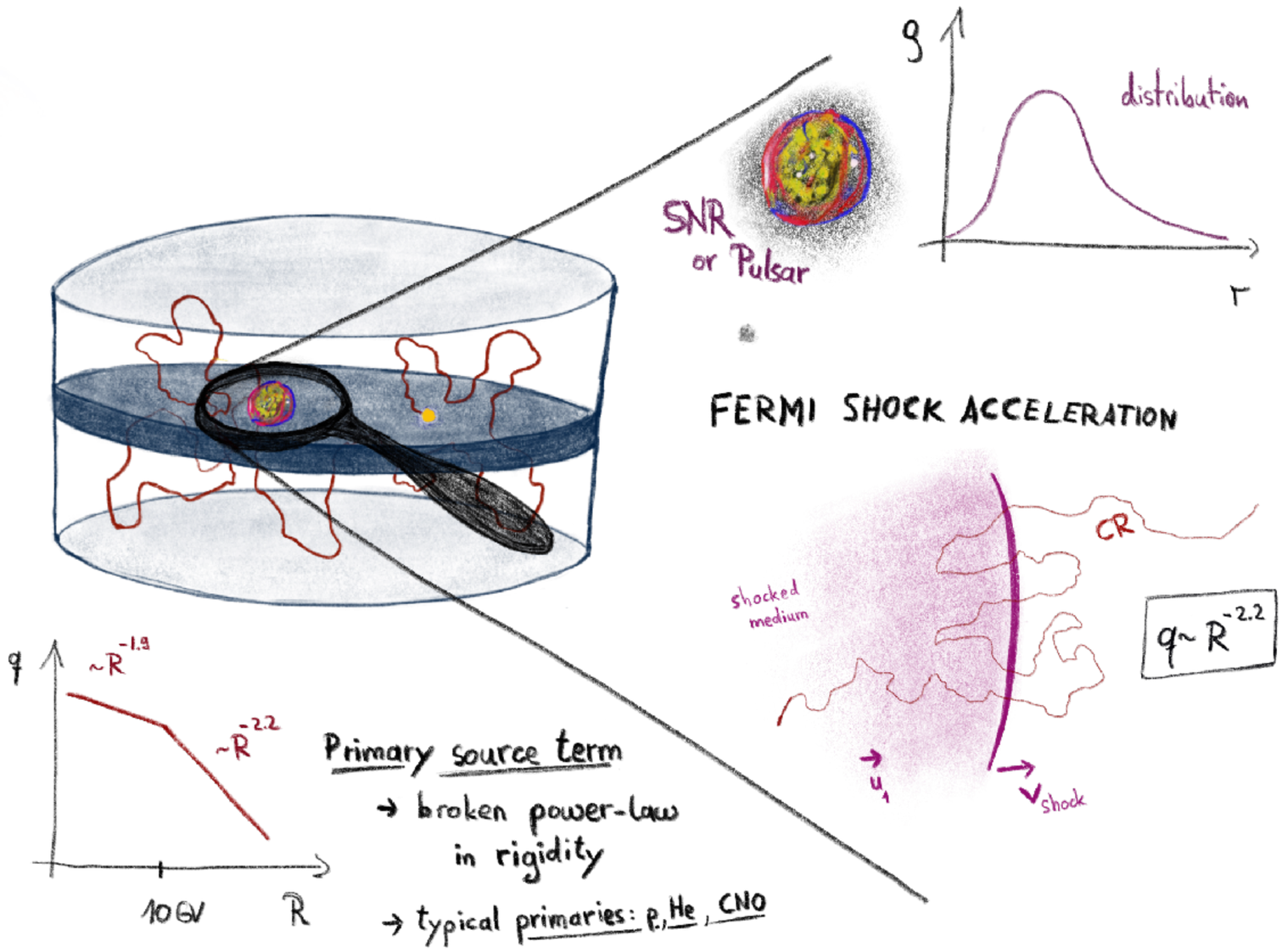


Voyager

AMS-02



Modeling cosmic-ray propagation



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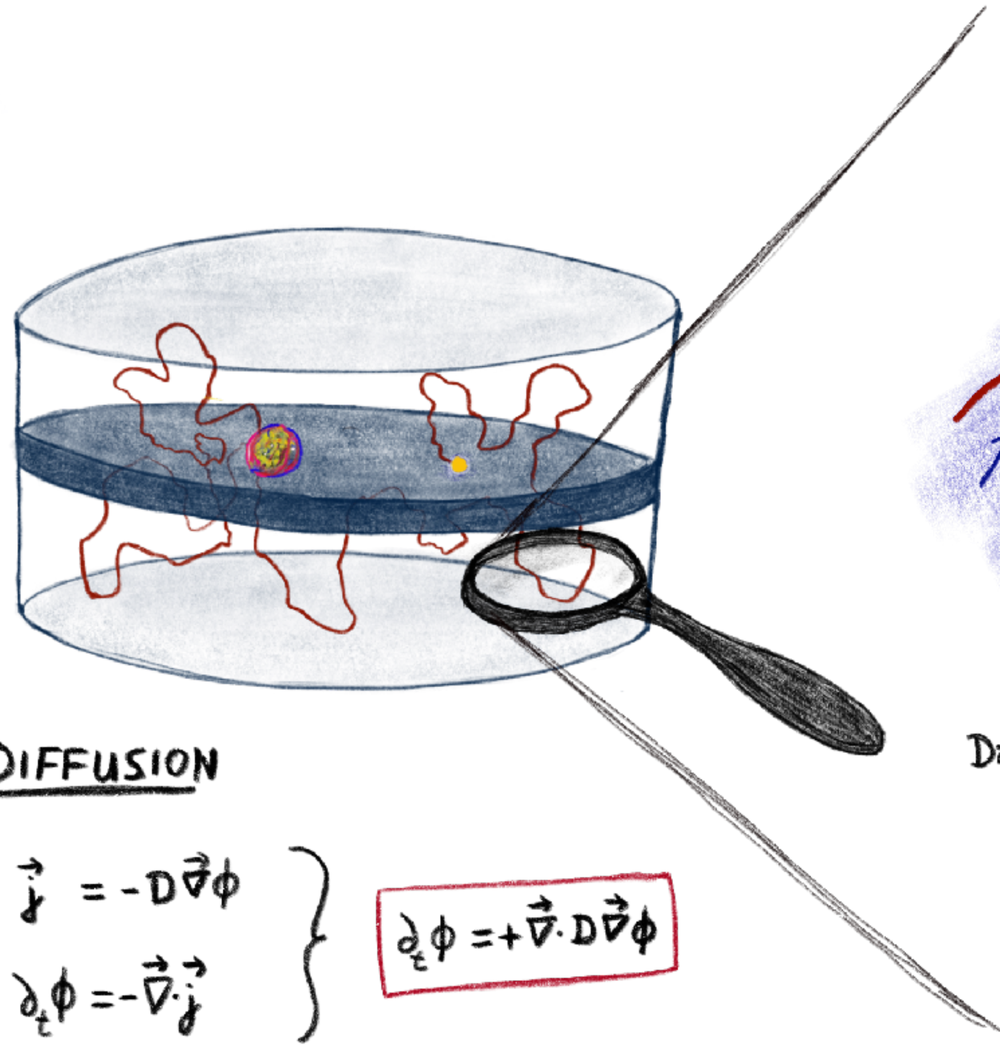
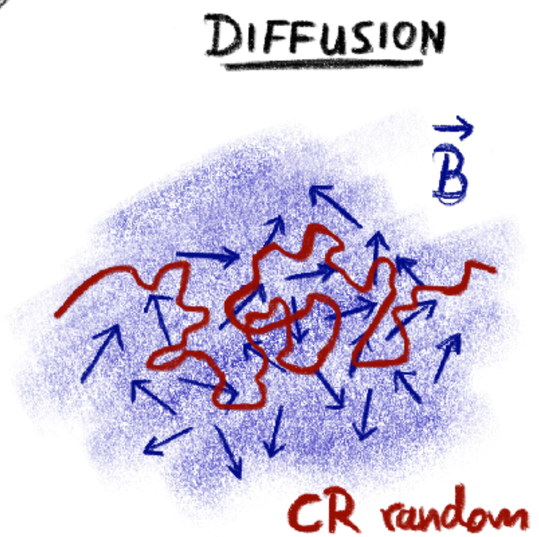


DIFFUSION

$$\vec{j} = -D\vec{\nabla}\phi$$

$$\partial_t\phi = -\vec{\nabla}\cdot\vec{j}$$

$$\partial_t\phi = +\vec{\nabla}\cdot D\vec{\nabla}\phi$$

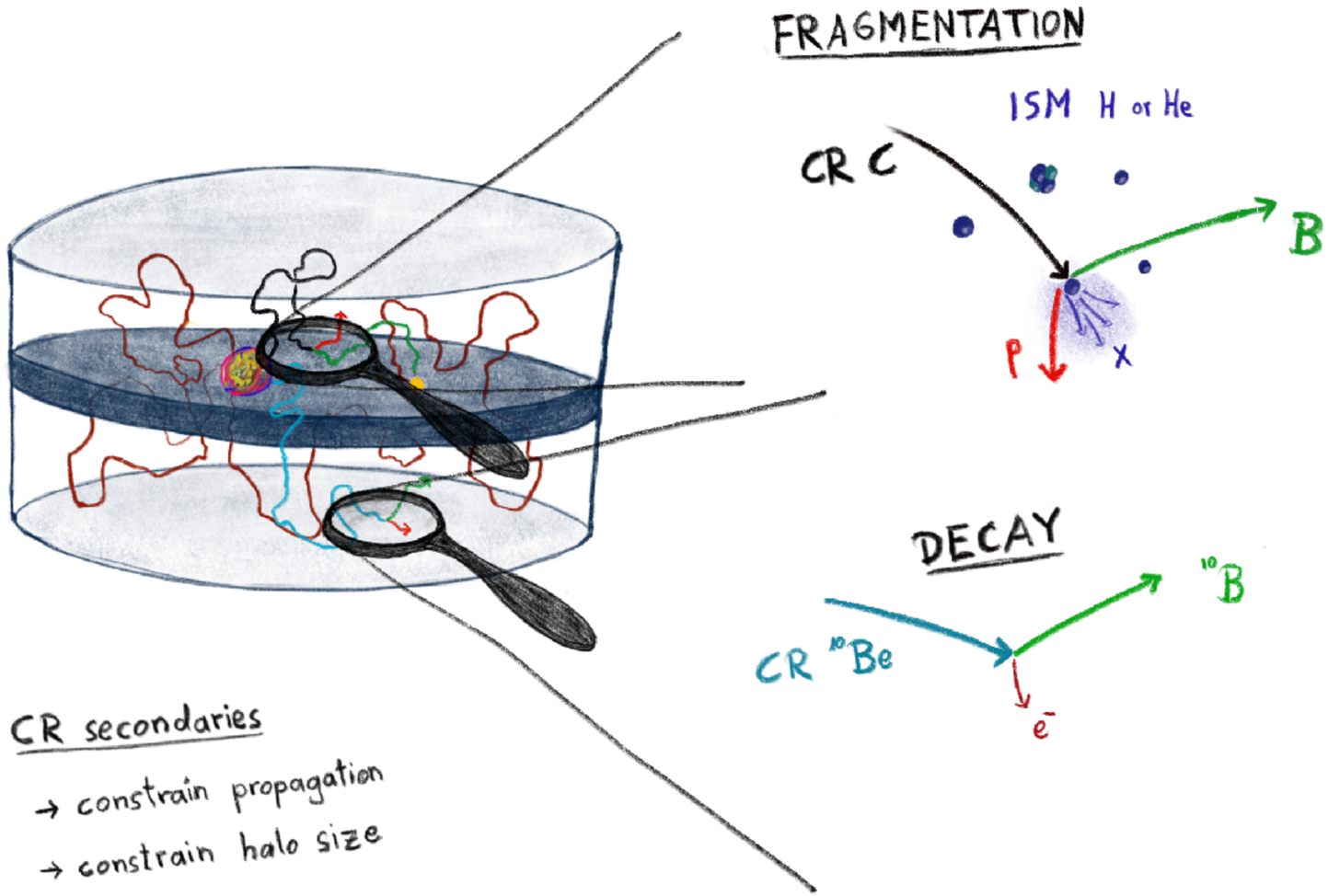


DIFFUSION

Diffusion constant is energy-dependend

$$D = \beta D_0 R^{+\delta}$$

Modeling cosmic-ray propagation



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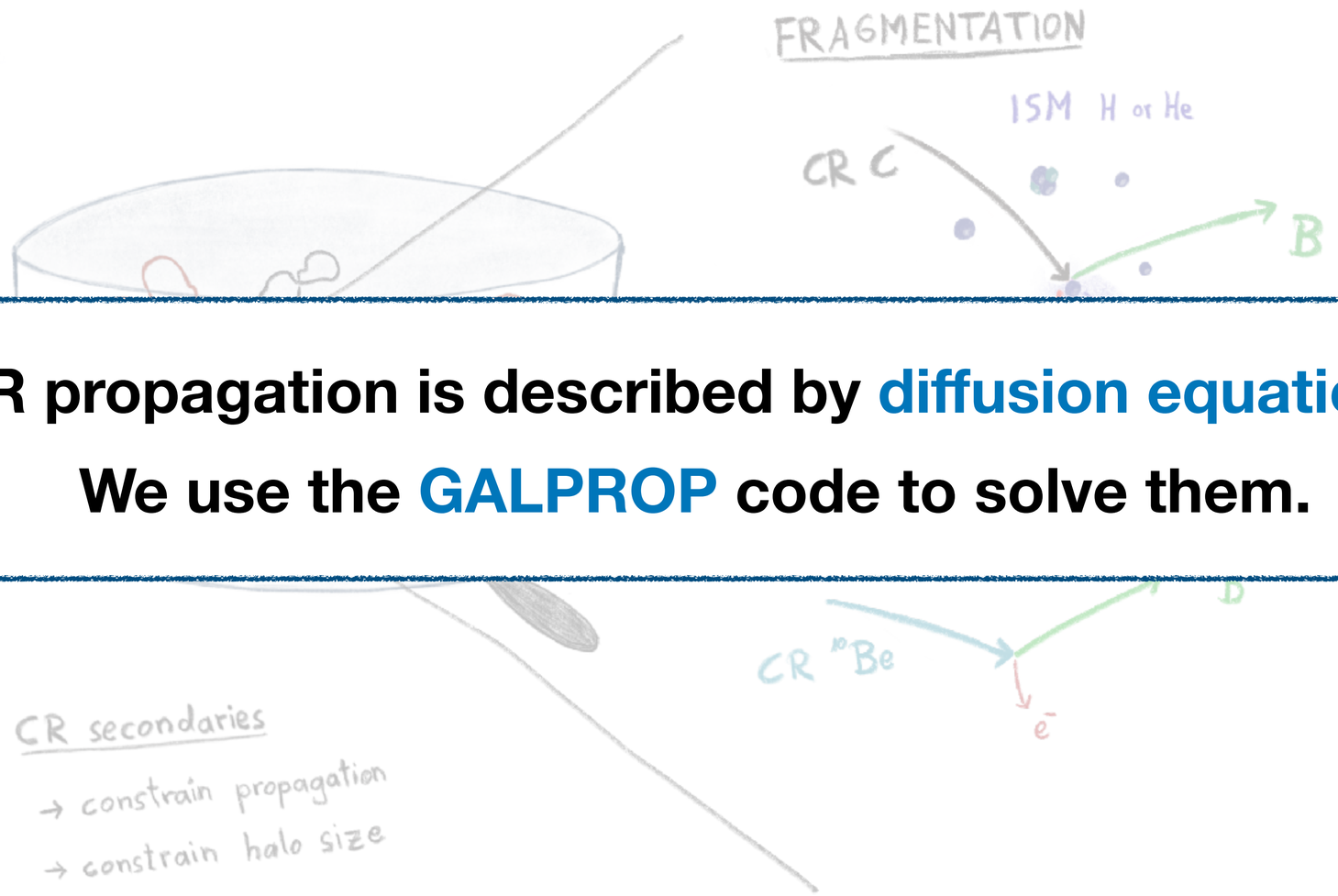


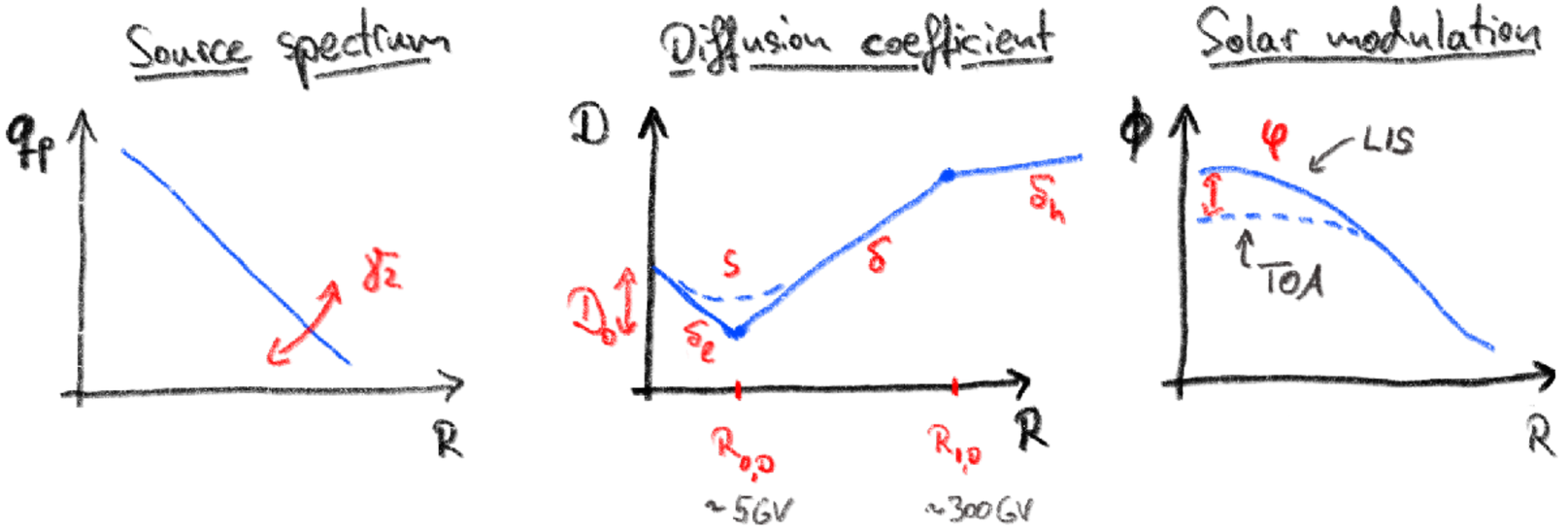
CR propagation is described by diffusion equations.

We use the GALPROP code to solve them.

CR propagation models

We explore 5 different setups for CR propagation:

BASE BASE+v_A BASE+inj BASE+inj+v_A BASE+inj+v_A-diff.brk



+ convection $v_{0,c}$

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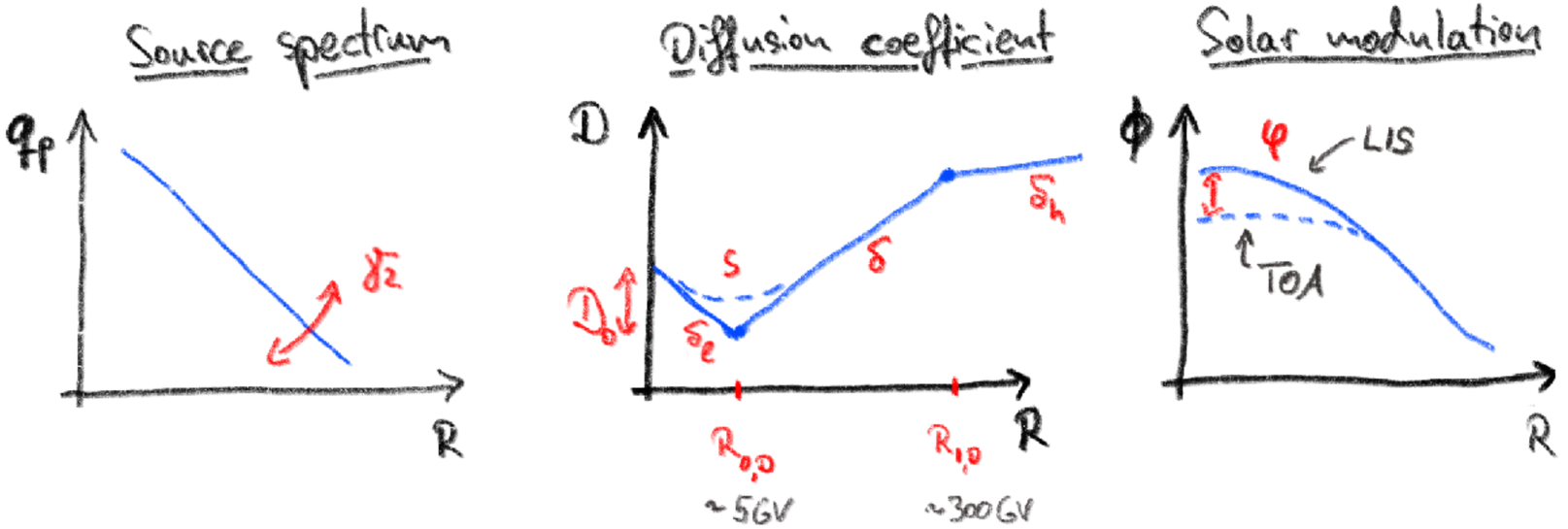

+ Convection $v_{0,c}$
+ reacceleration v_A

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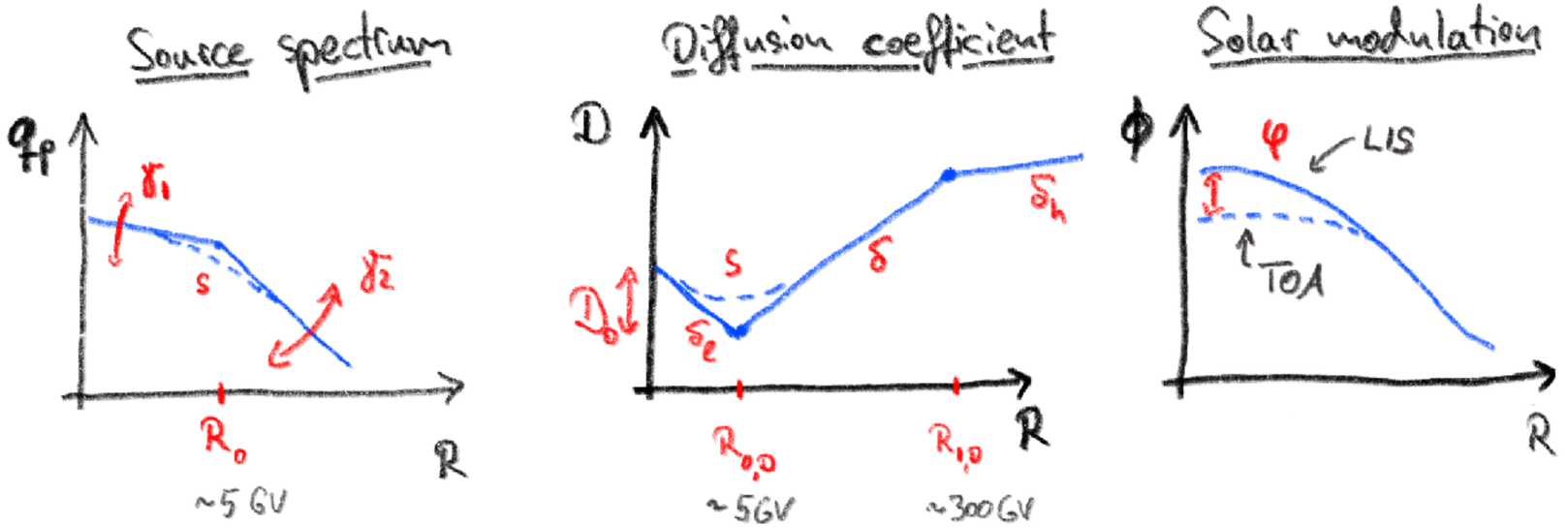

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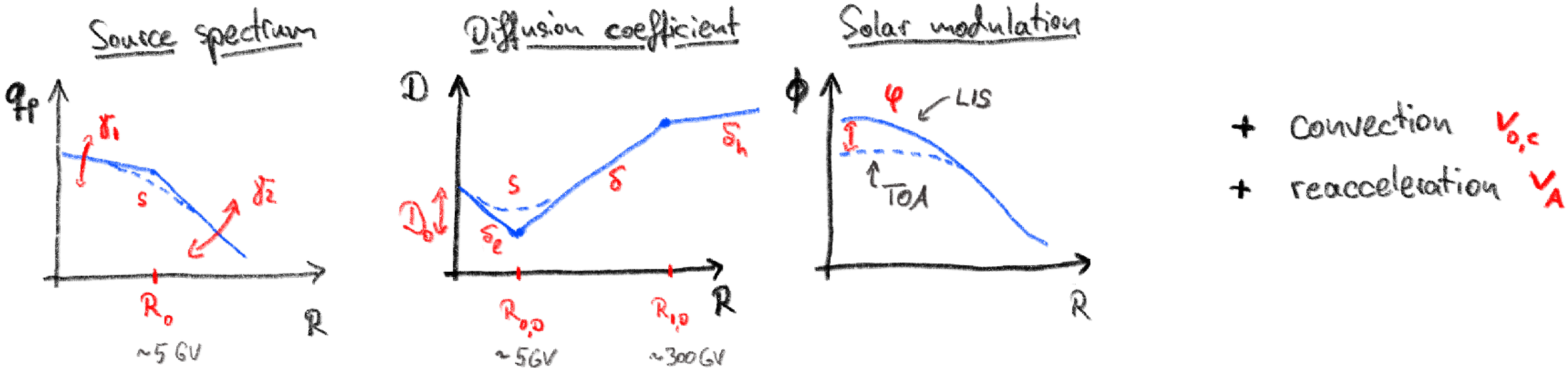

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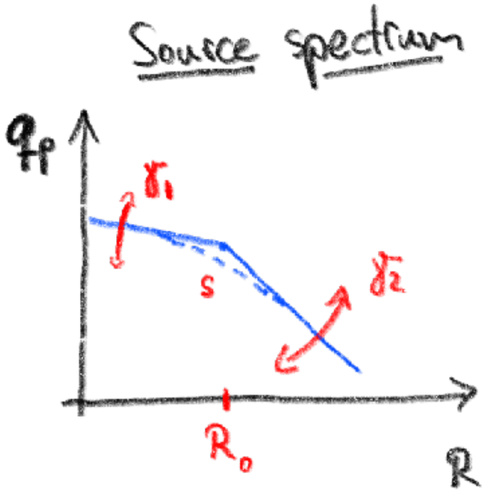
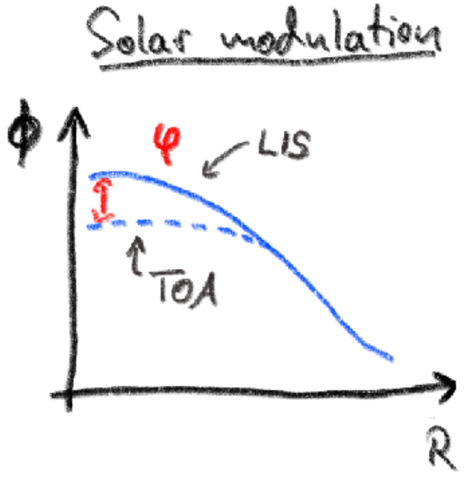


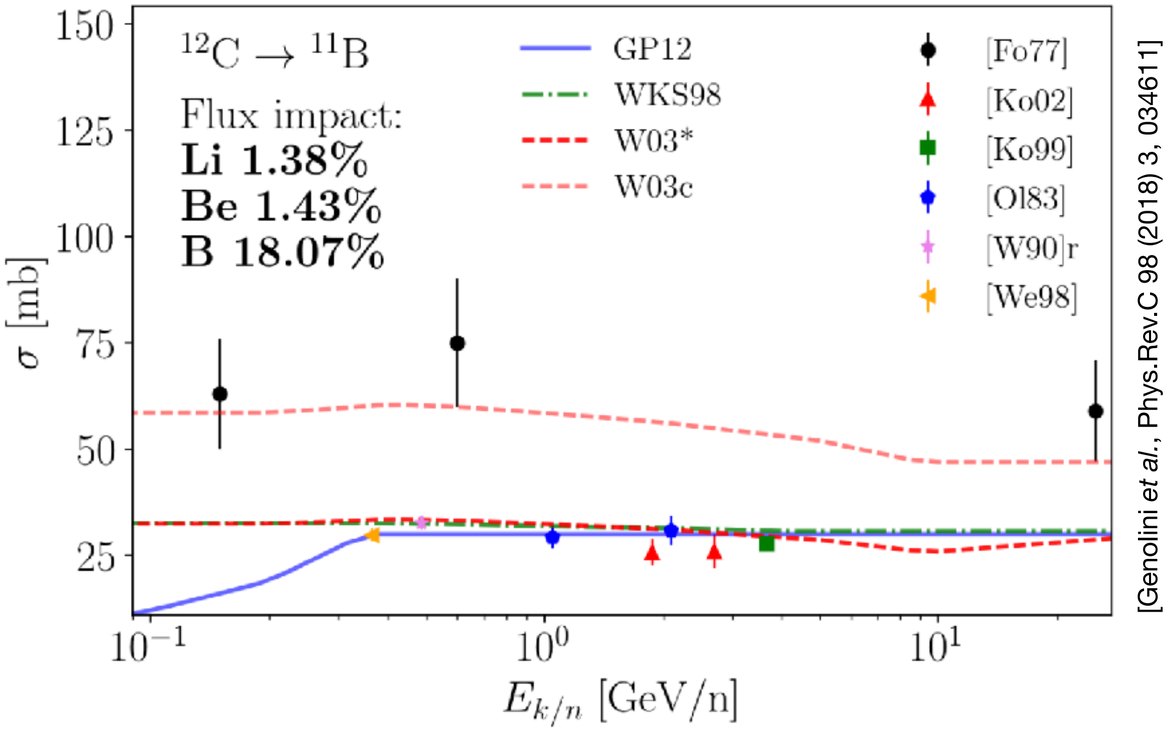


\+ convection $V_{0,c}$

\+ reacceleration V_A

Systematic uncertainty: fragmentation cross sections

Example: Fragmentation of ^{12}C to ^{11}B

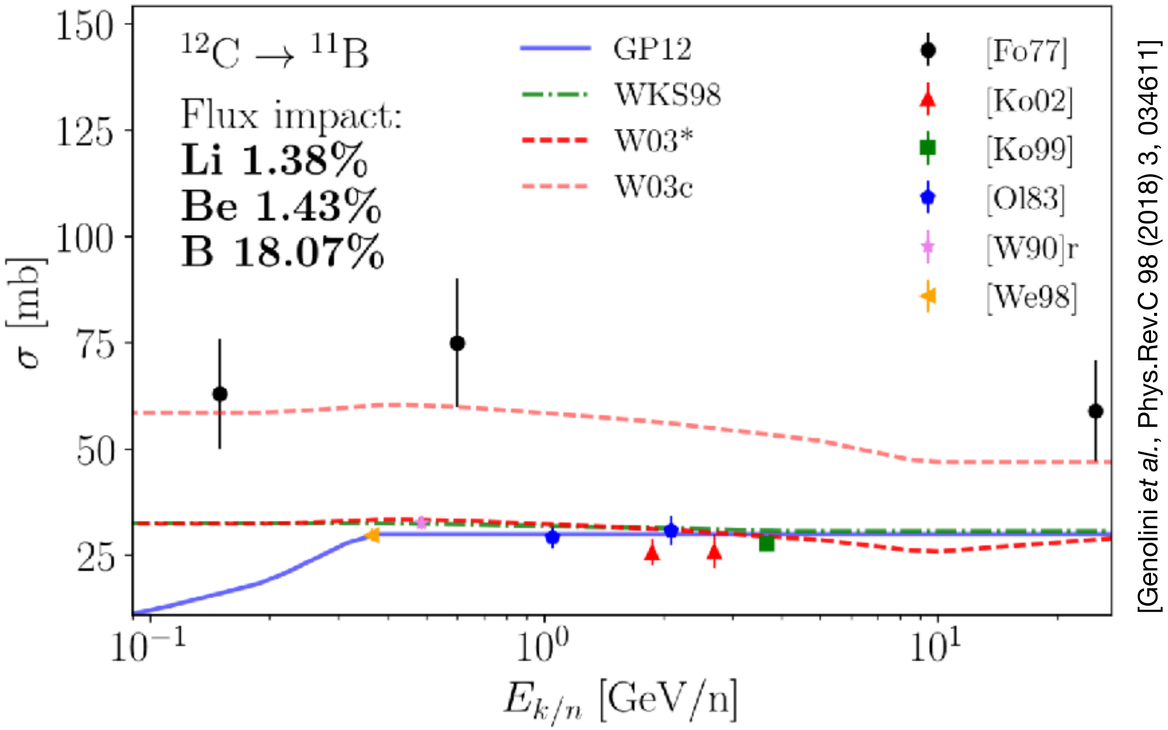


[Genolini *et al.*, Phys.Rev.C 98 (2018) 3, 034611]

Systematic uncertainties in the fragmentation cross sections are larger than those in the measured CR spectra!

Systematic uncertainty: fragmentation cross sections

Example: Fragmentation of ^{12}C to ^{11}B



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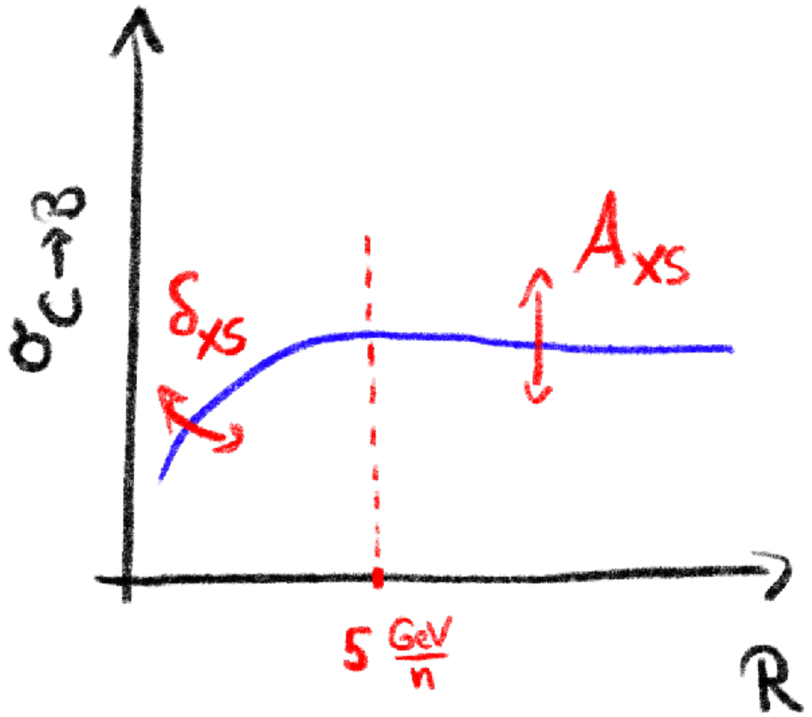
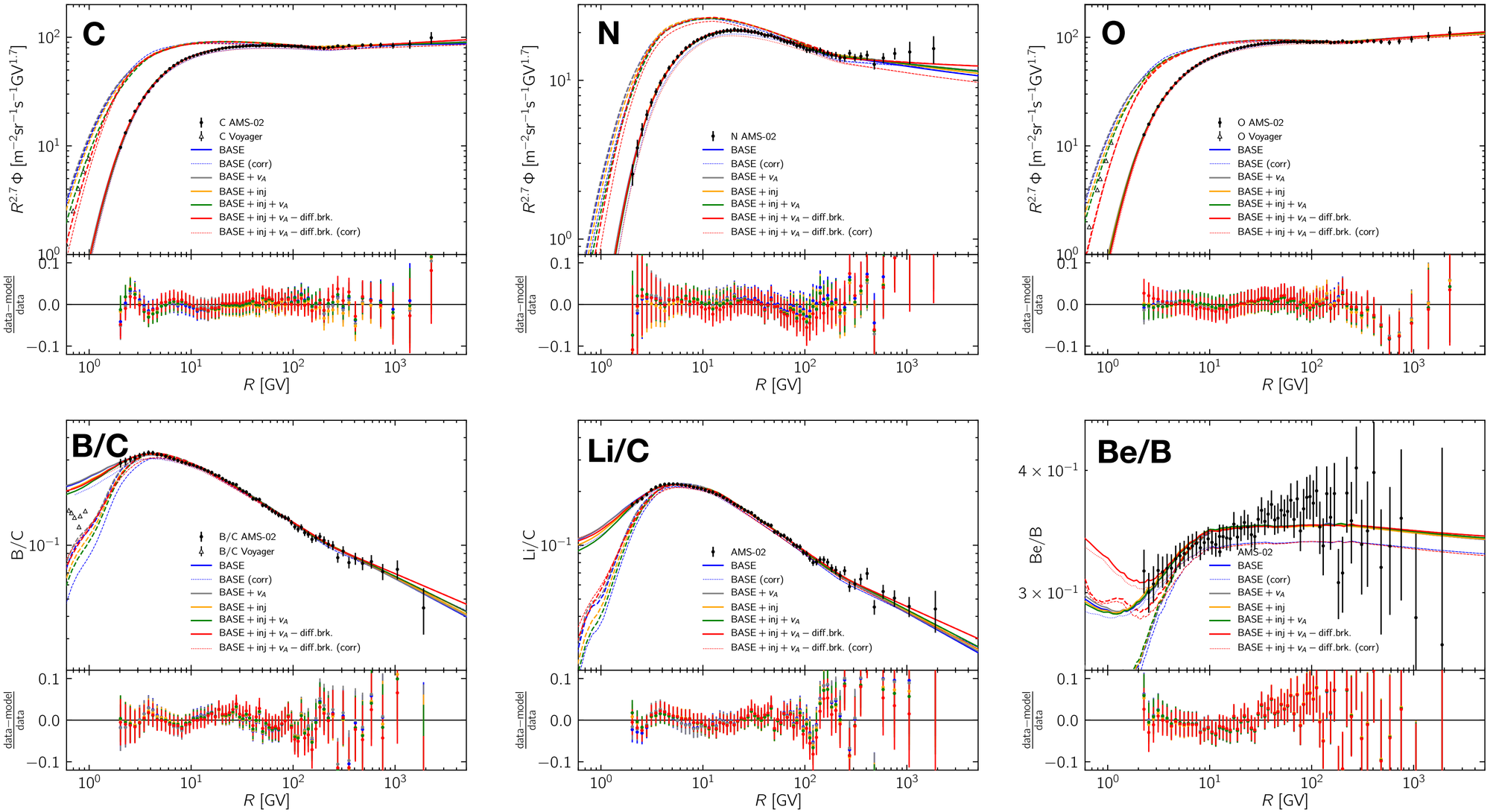


Systematic uncertainties in the fragmentation cross sections are larger than those in the measured CR spectra!

We perform a global fit and profile over nuisance parameters in the 10 most relevant fragmentation cross sections.

Results of the global fits



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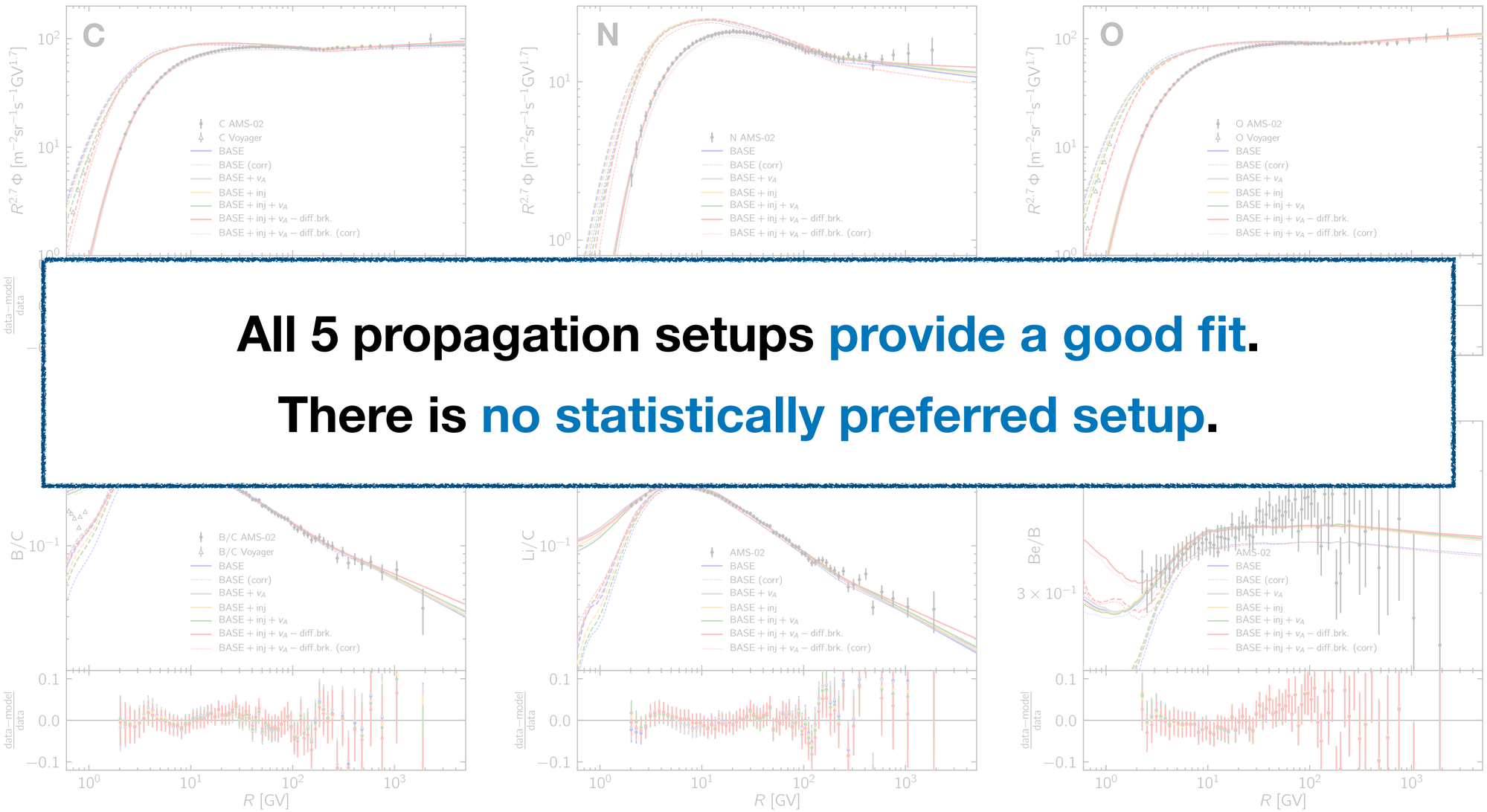
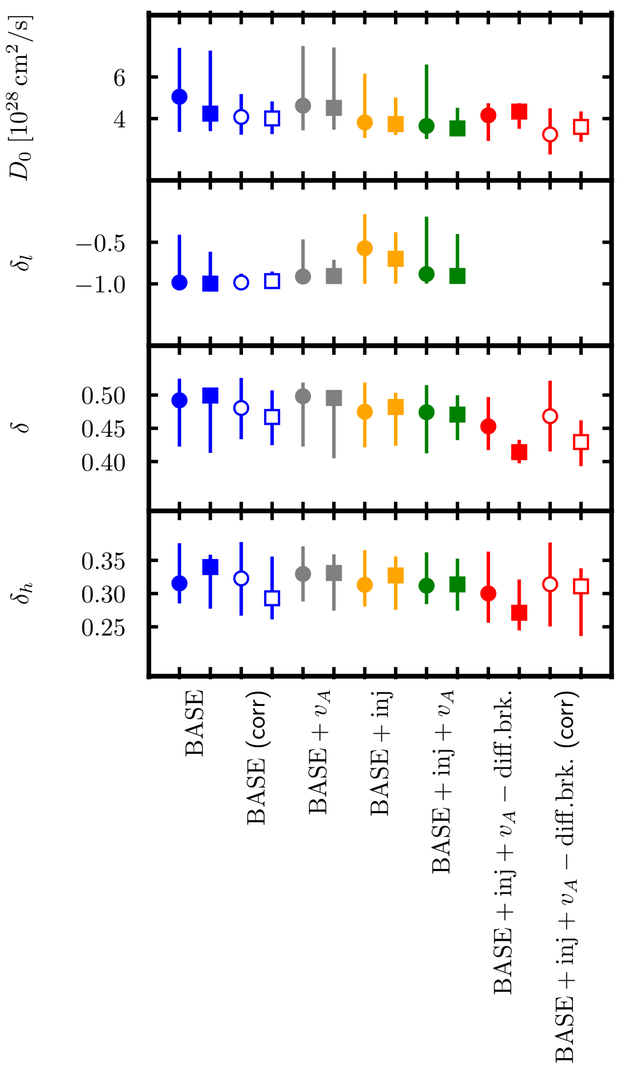
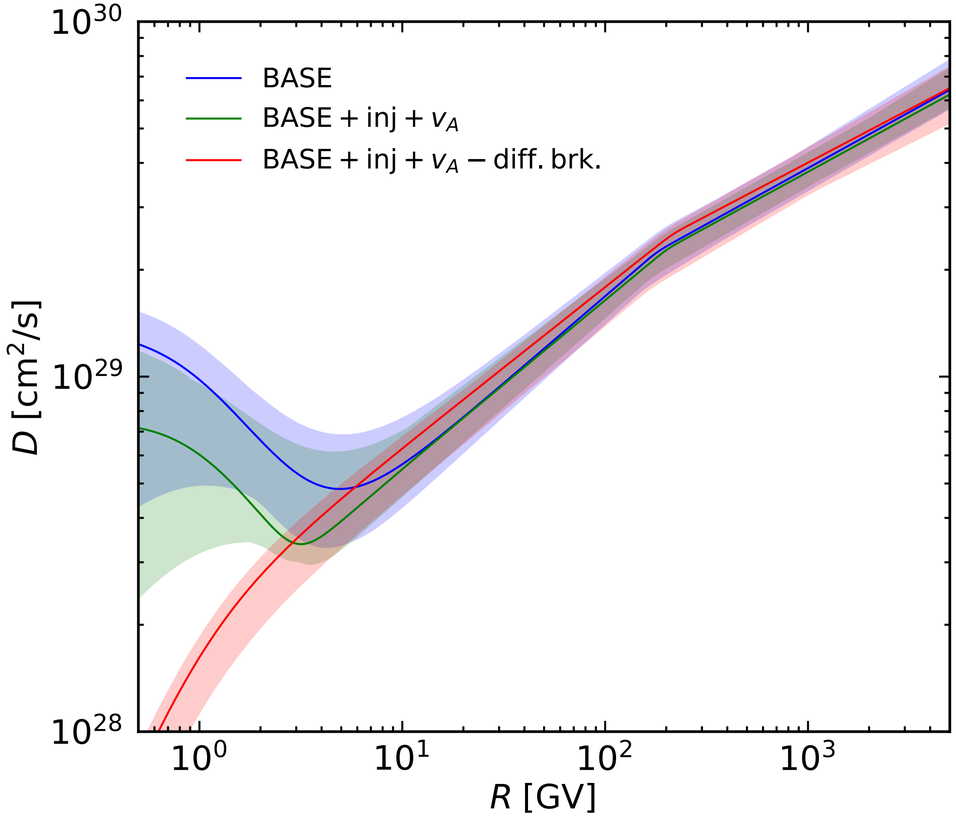


All 5 propagation setups provide a good fit.

There is no statistically preferred setup.

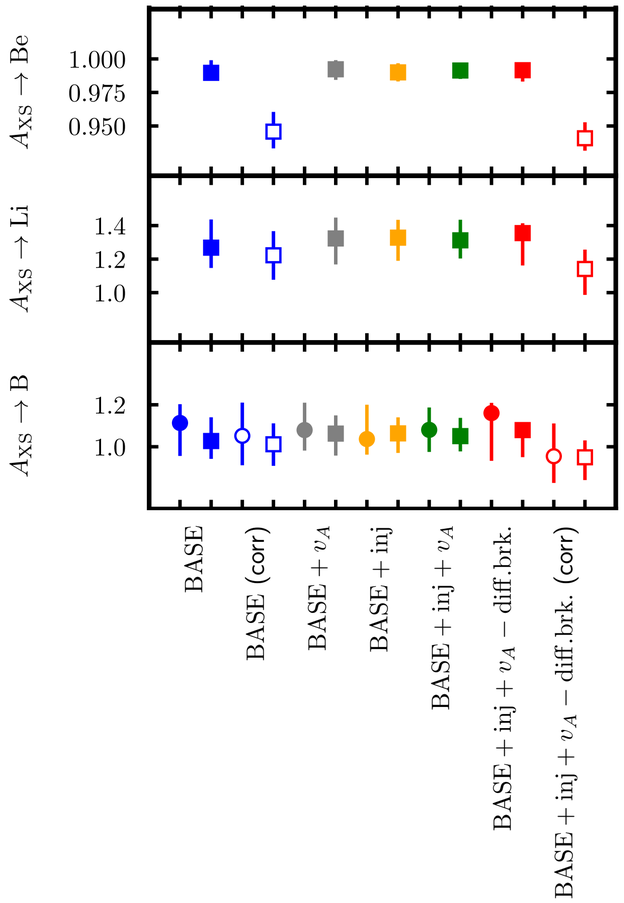
Parameter constraints

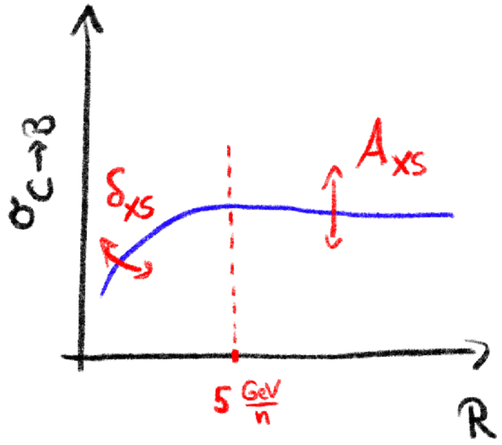


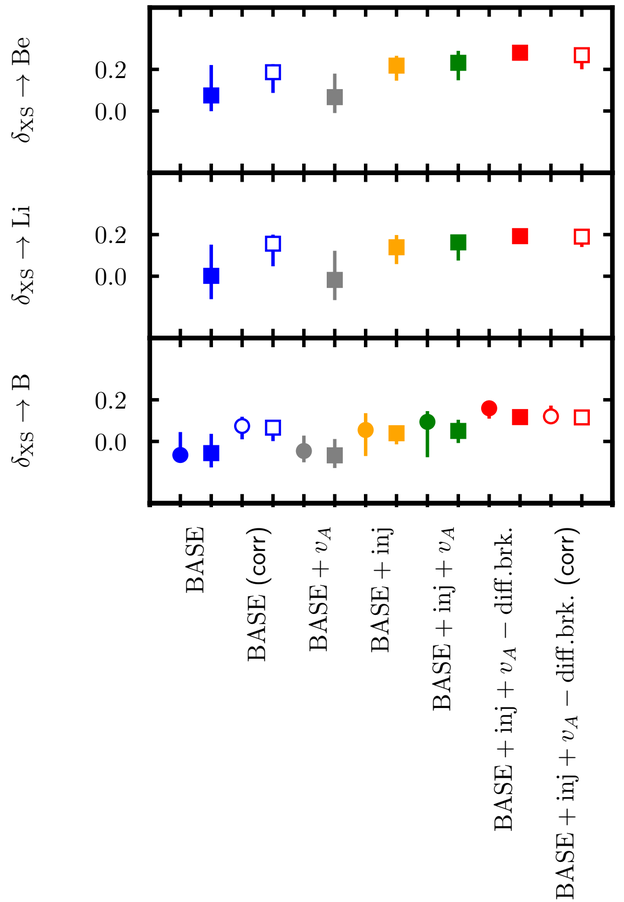


The diffusion coefficient is well constrained above 10 GV

Impact of cross section uncertainties







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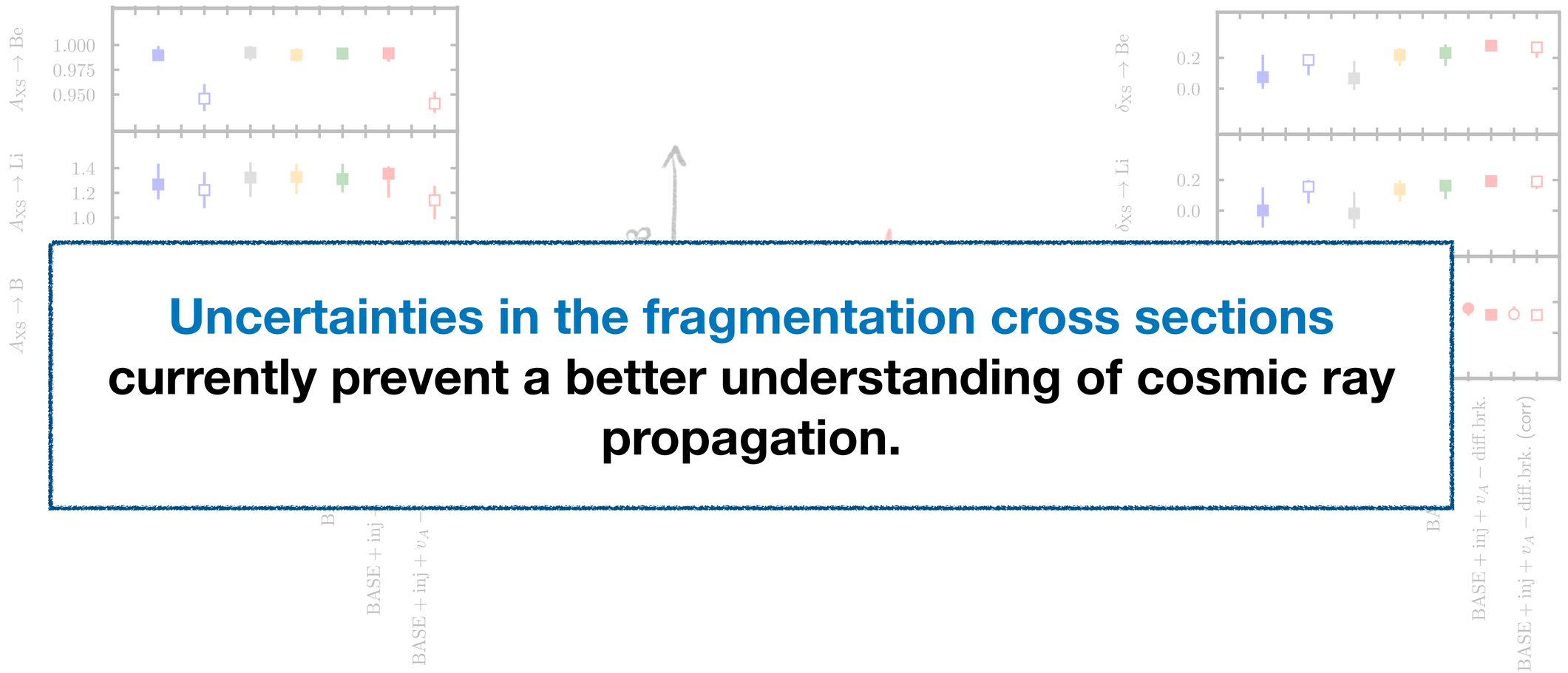
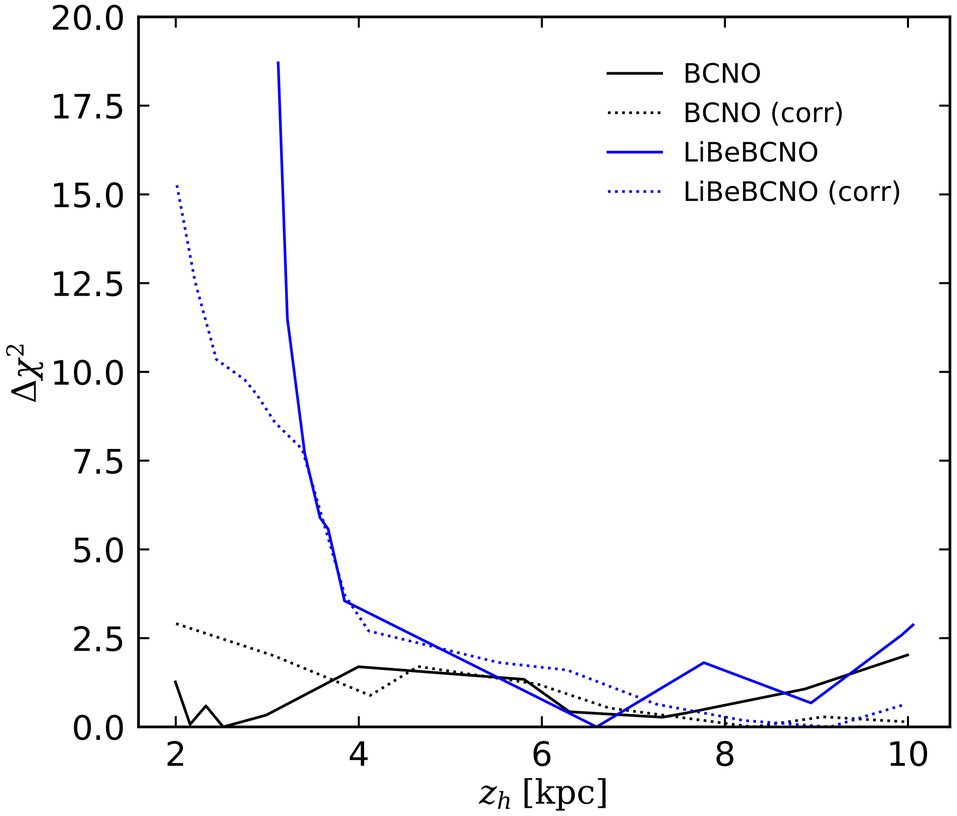
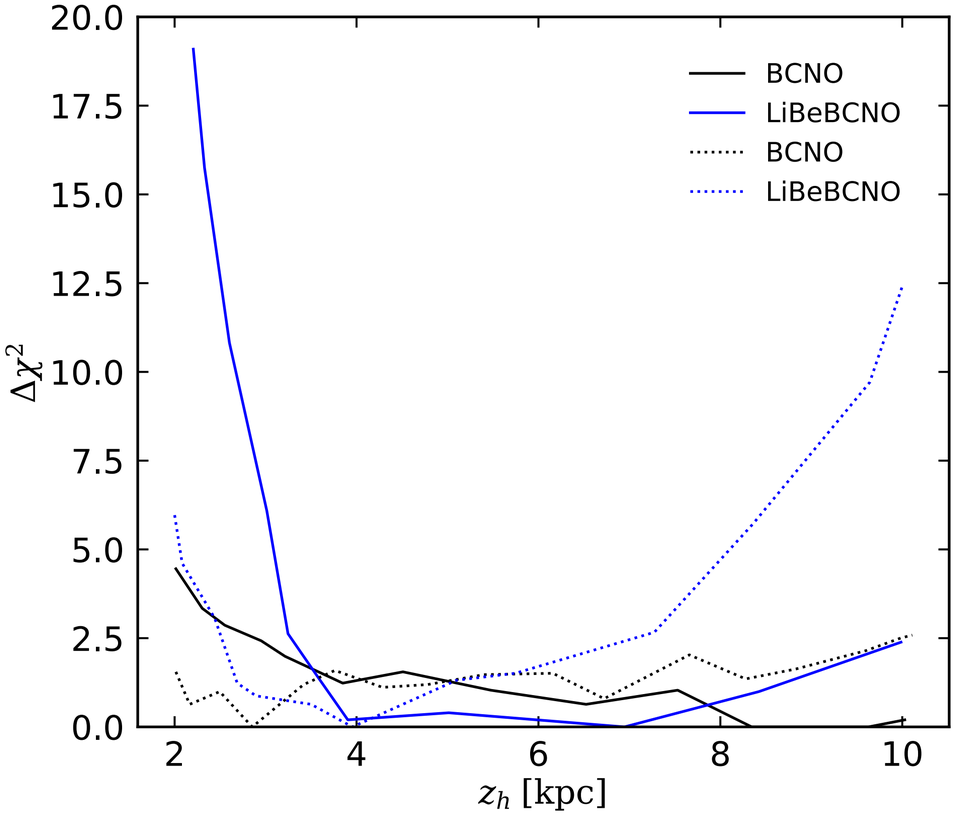


Uncertainties in the fragmentation cross sections currently prevent a better understanding of cosmic ray propagation.

Parameter constraints





The combination of B and Be data allows to constrain z_h

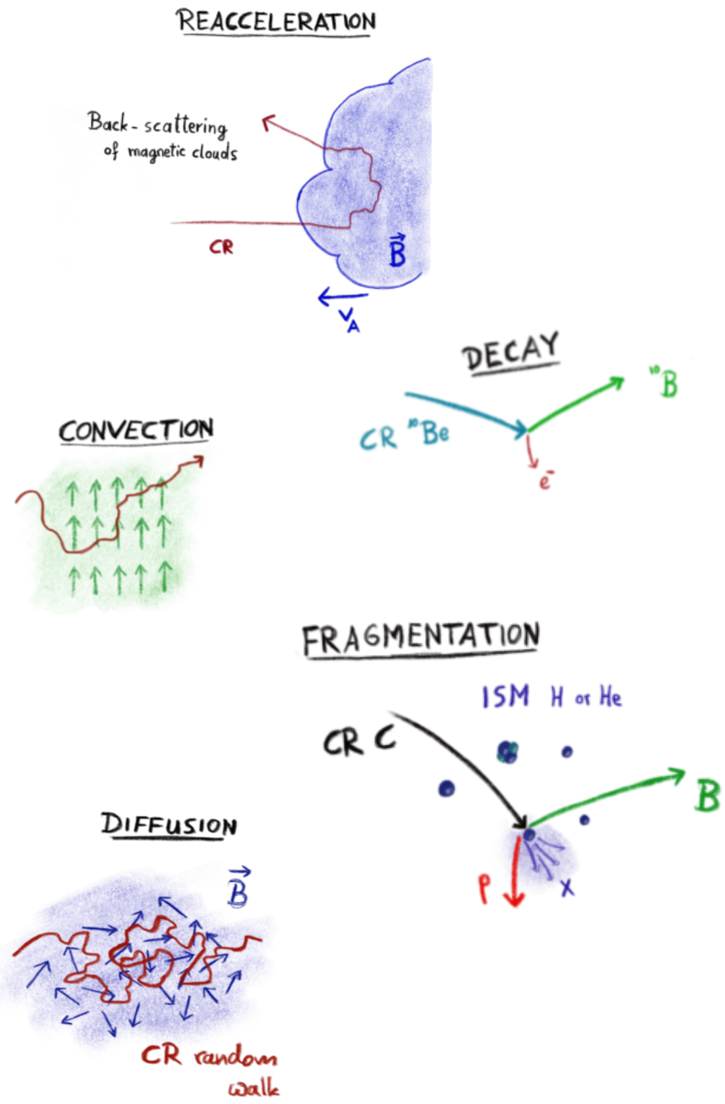
Conclusions

CR nuclei from Li to O are consistent with the traditional CR diffusion models

There is no clear preference for one CR propagation model because of uncertainties in the secondary fragmentation cross sections

Small halo heights of $z_h < 3$ kpc are excluded

The diffusion coefficient is well constrained above 10 GeV



See you at the discussion session!

Discussion time slot: July 19th 2021 - 12:00
URL: https://desy.zoom.us/j/91896950007
ZOOM-Meeting ID: 91896950007
Passcode: ICRC2021

Constraining CR diffusion with AMS-02 data from Li to O

We use GALPROP to perform global fits of CR propagation and profile over nuisance parameters for fragmentation cross sections.

We test 5 different propagation scenarios!

Conclusions

- **AMS-02 data of CR Li to O is fitted well by the traditional diffusion models**
- **Cross section uncertainties prevent better understanding of CR propagation**
- **Small half-heights of the halo $z_h < 3$ kpc are excluded**
- **Diffusion coefficient is well constrained above 10 GV**