NPAC course on Astroparticles

CONCLUSIONS

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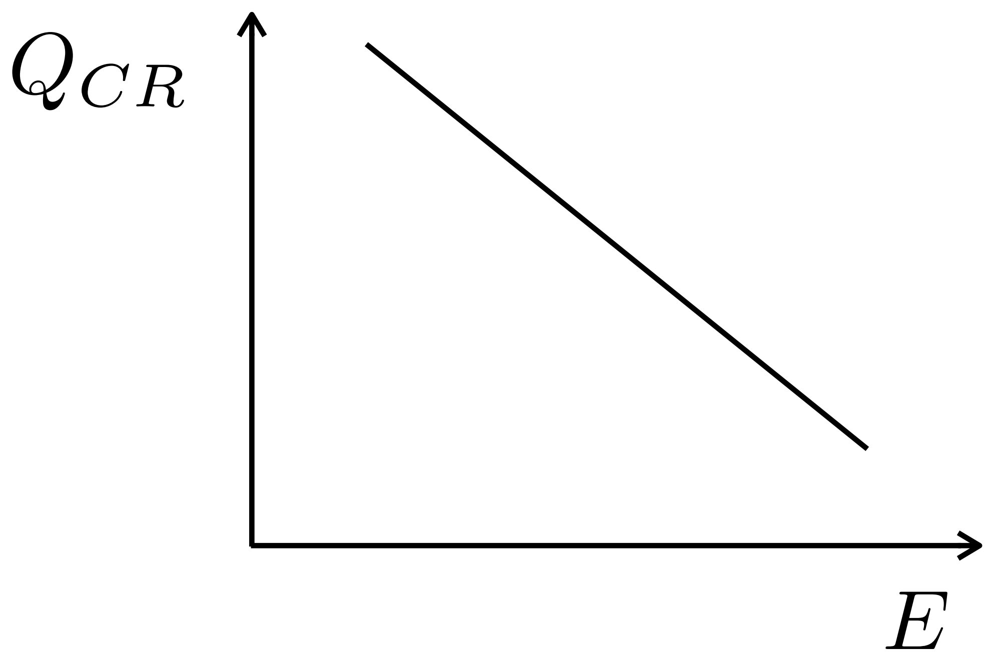
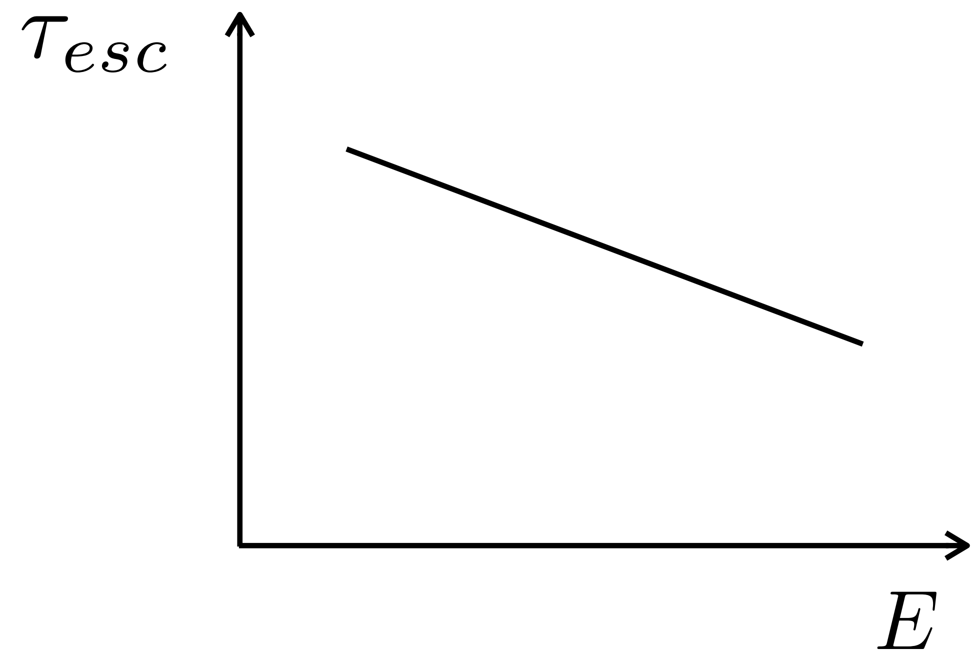
(incomplete list of) PROBLEMS...

The two-power-laws scenario

$$Q_{CR}(E) \propto E^{-\delta}$$

$$\tau_{esc}(E) \propto E^{-\alpha}$$





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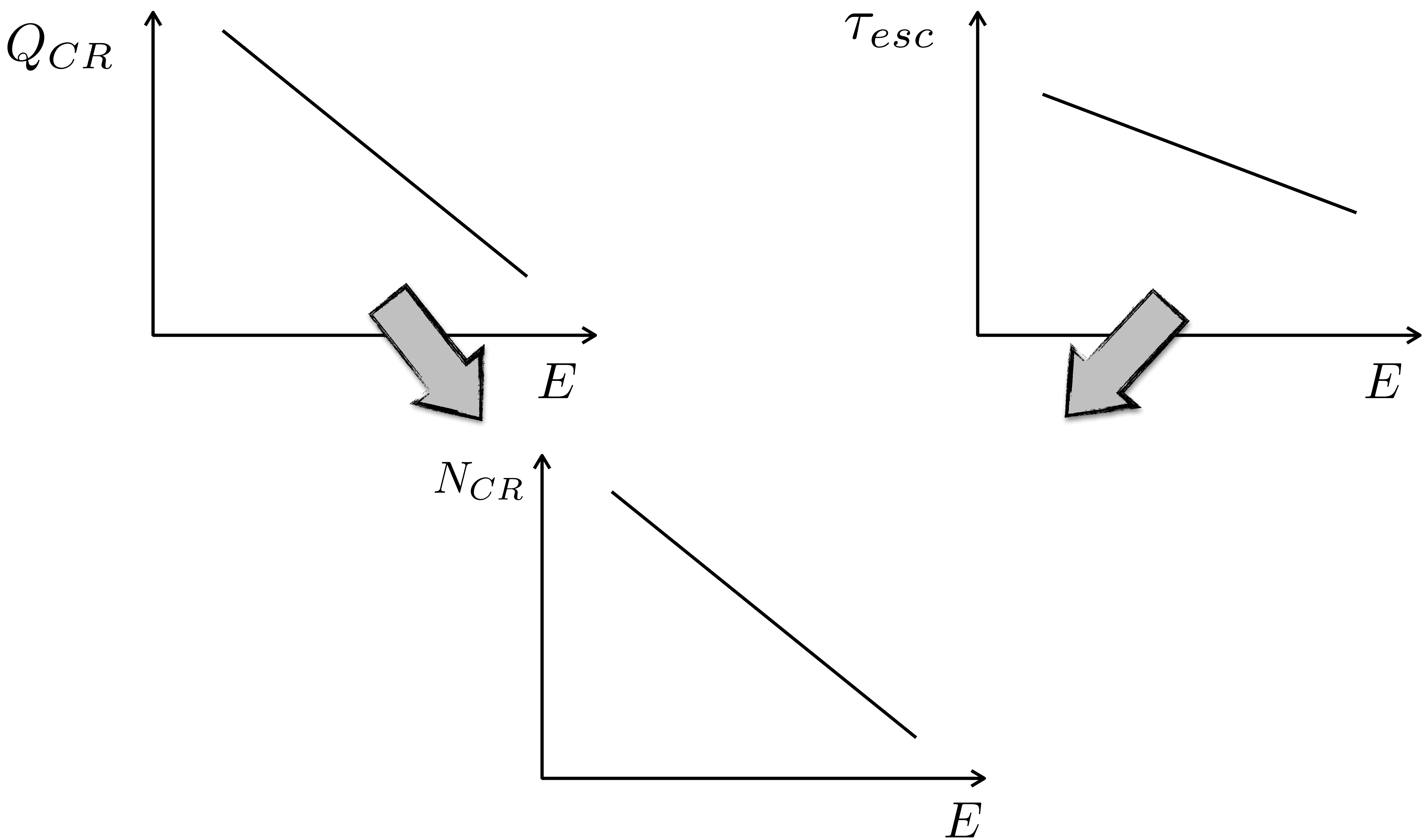

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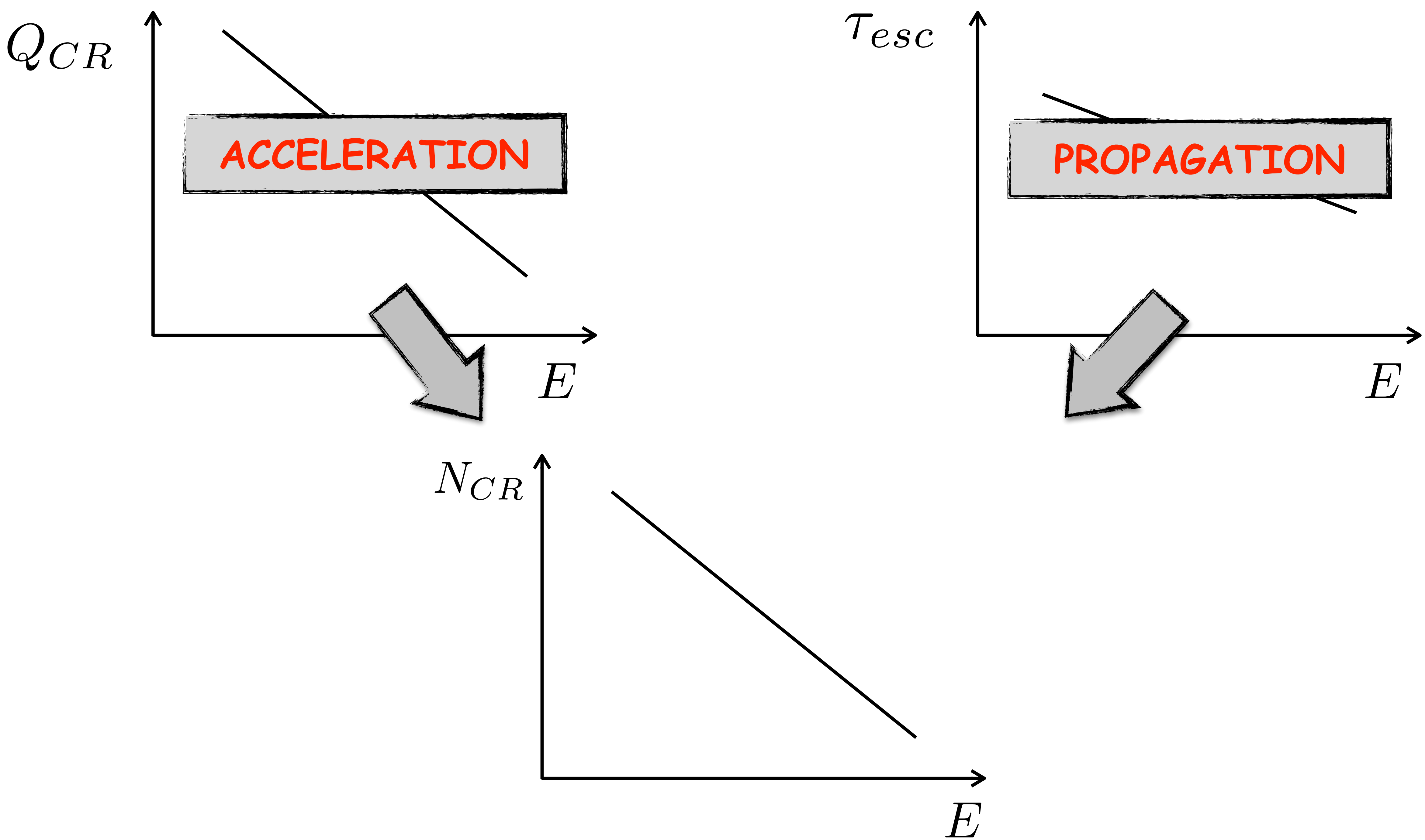

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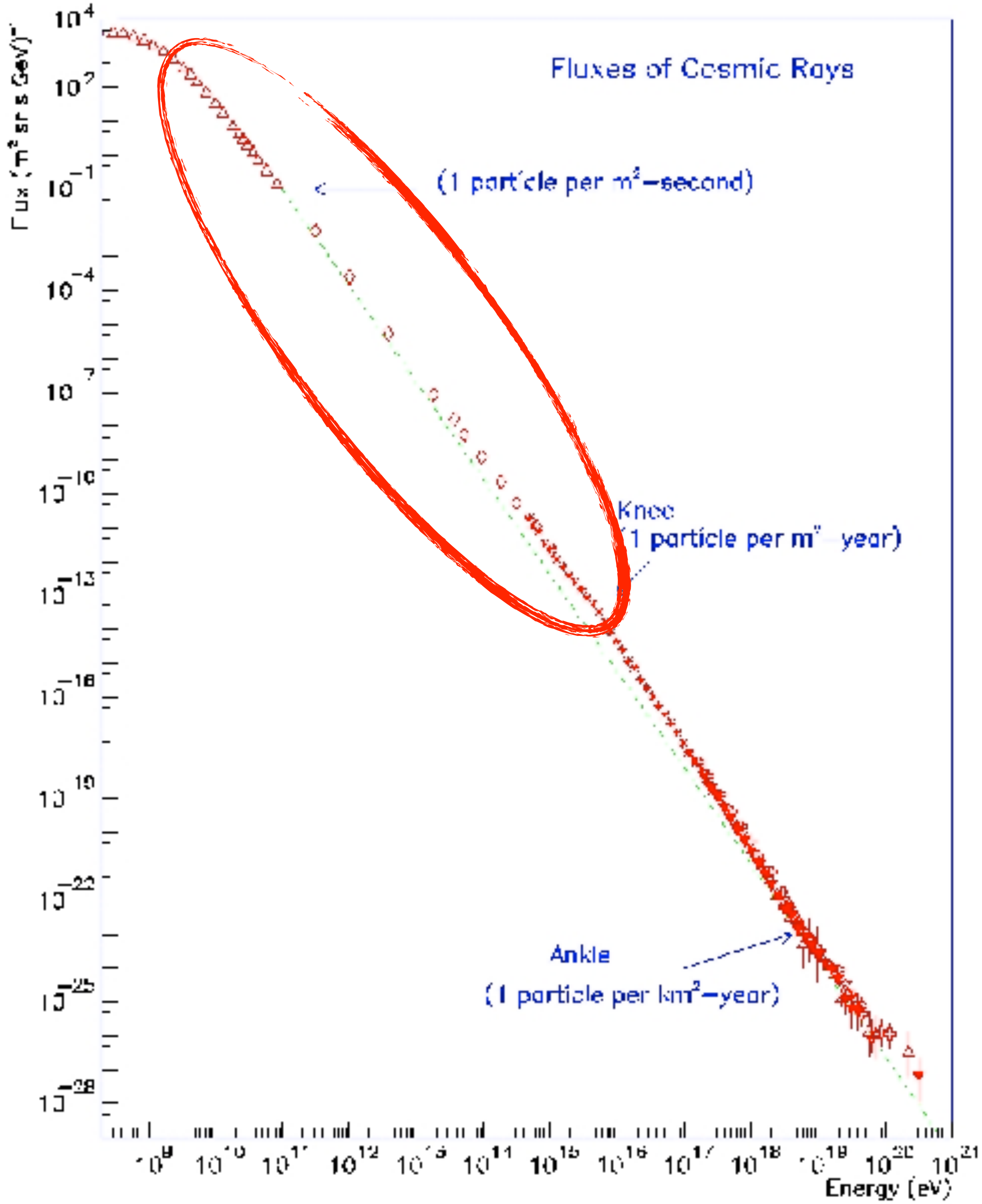
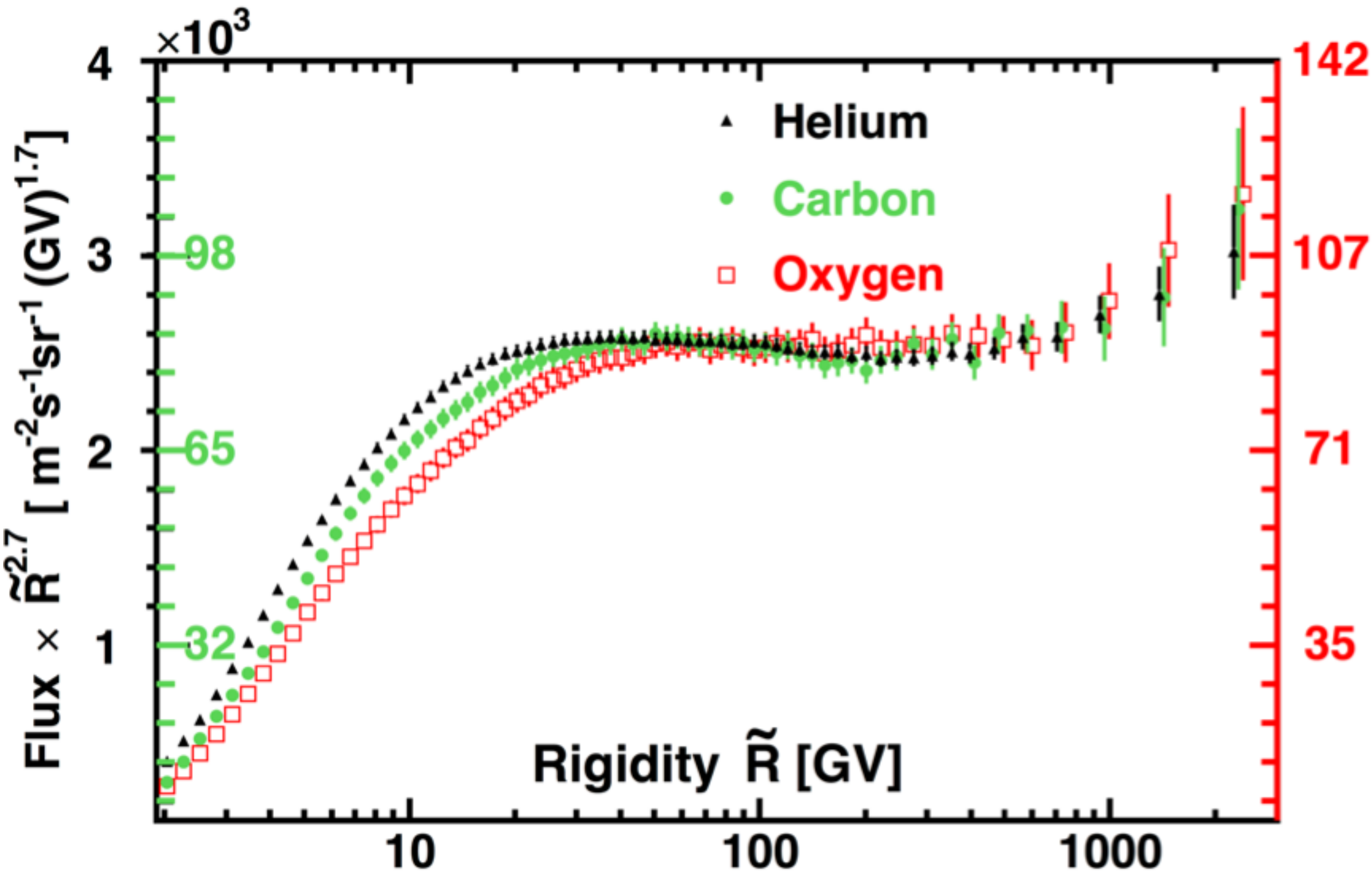
The observed cosmic ray spectrum



Real life is much harder than that…

PAMELA and AMS-02

Spectral breaks at 300 GV



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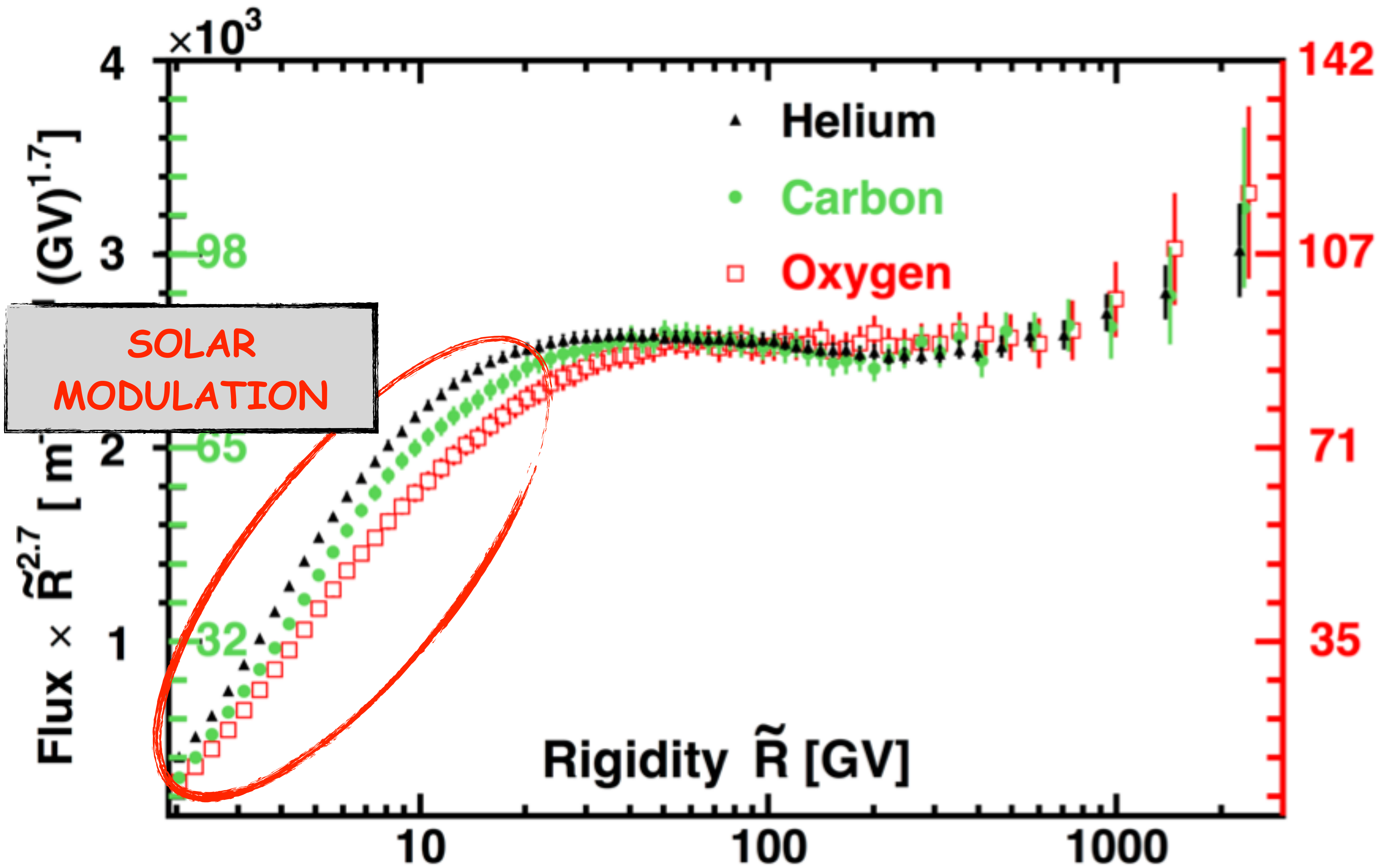

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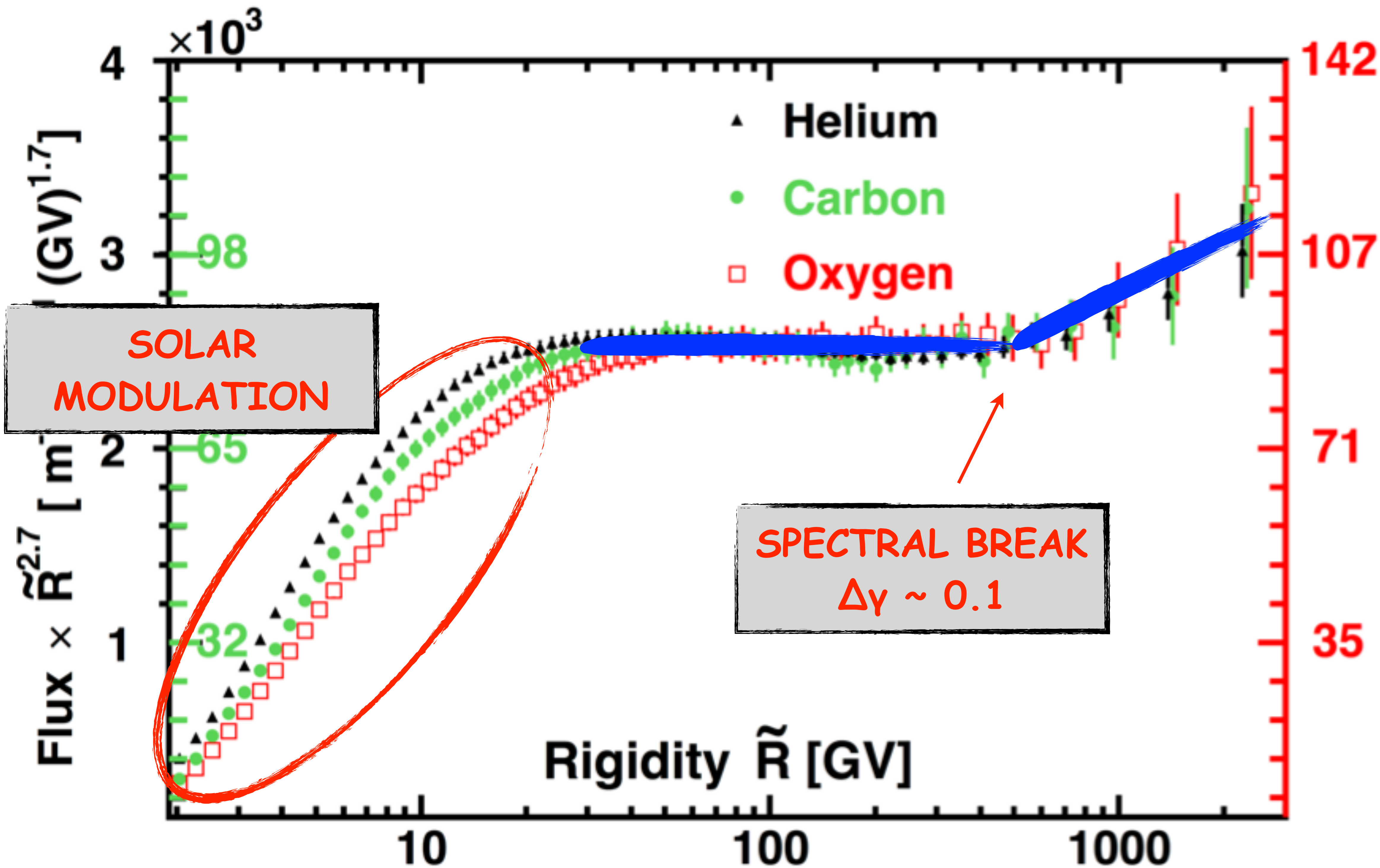
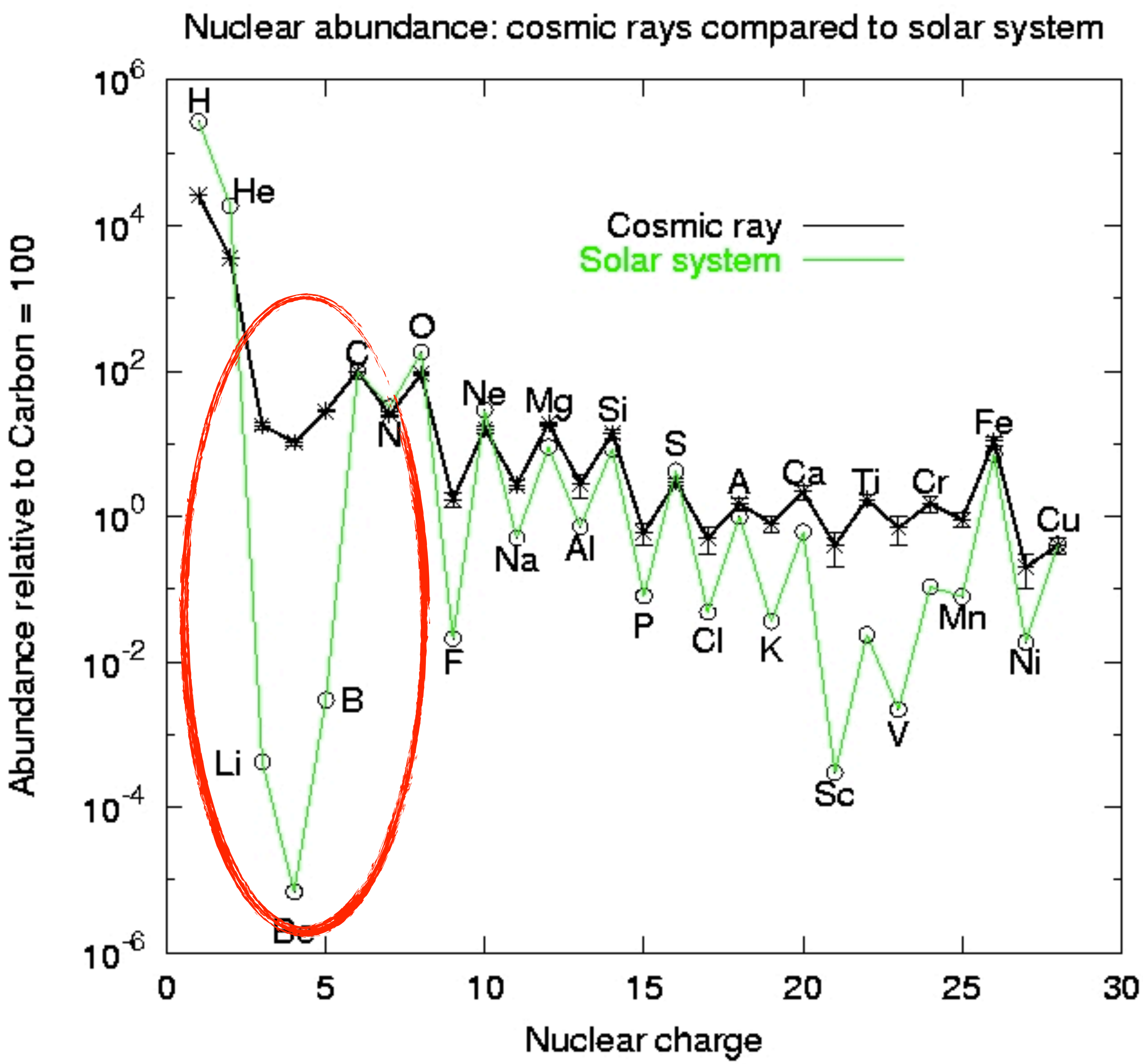
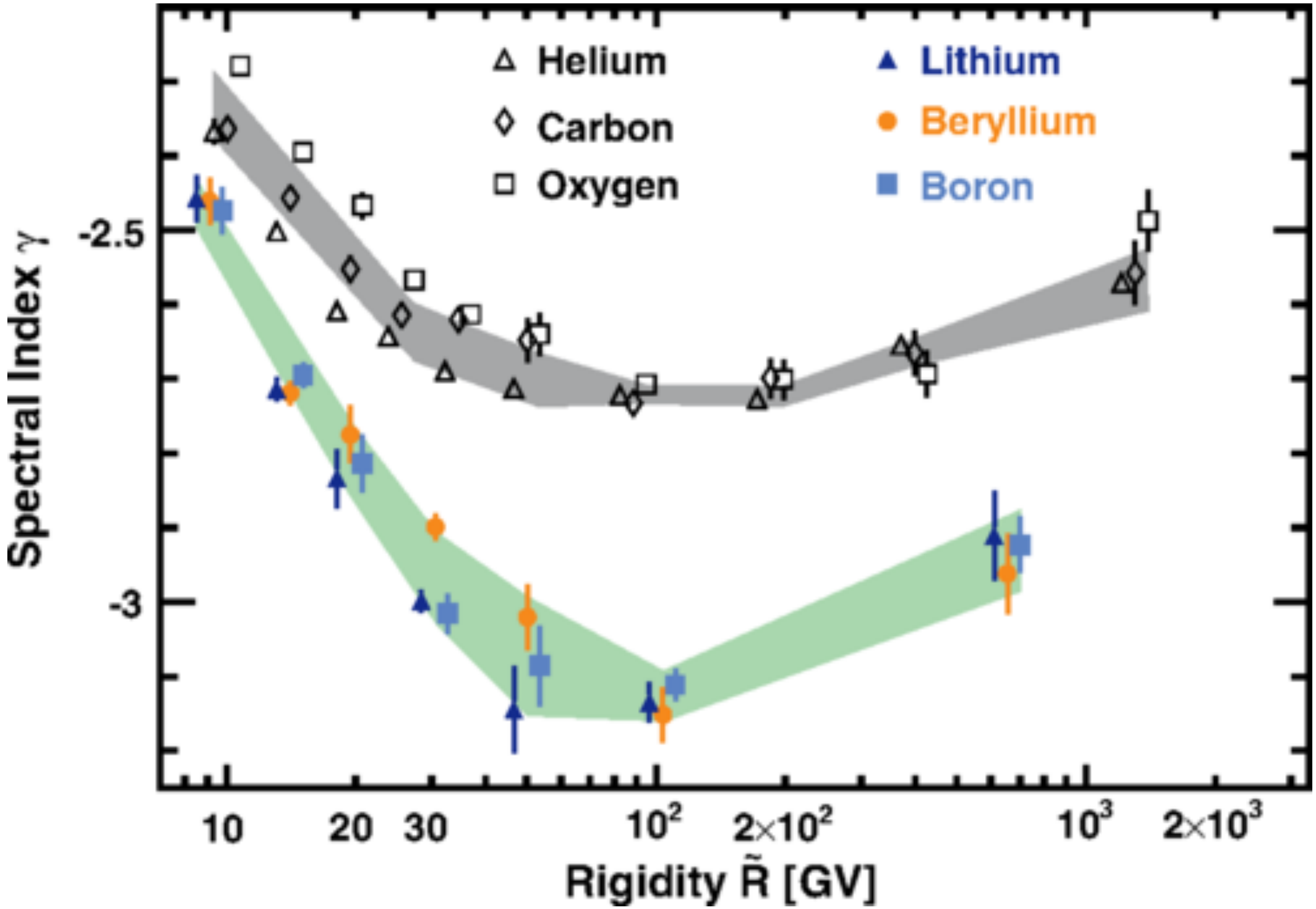


Acceleration or propagation?

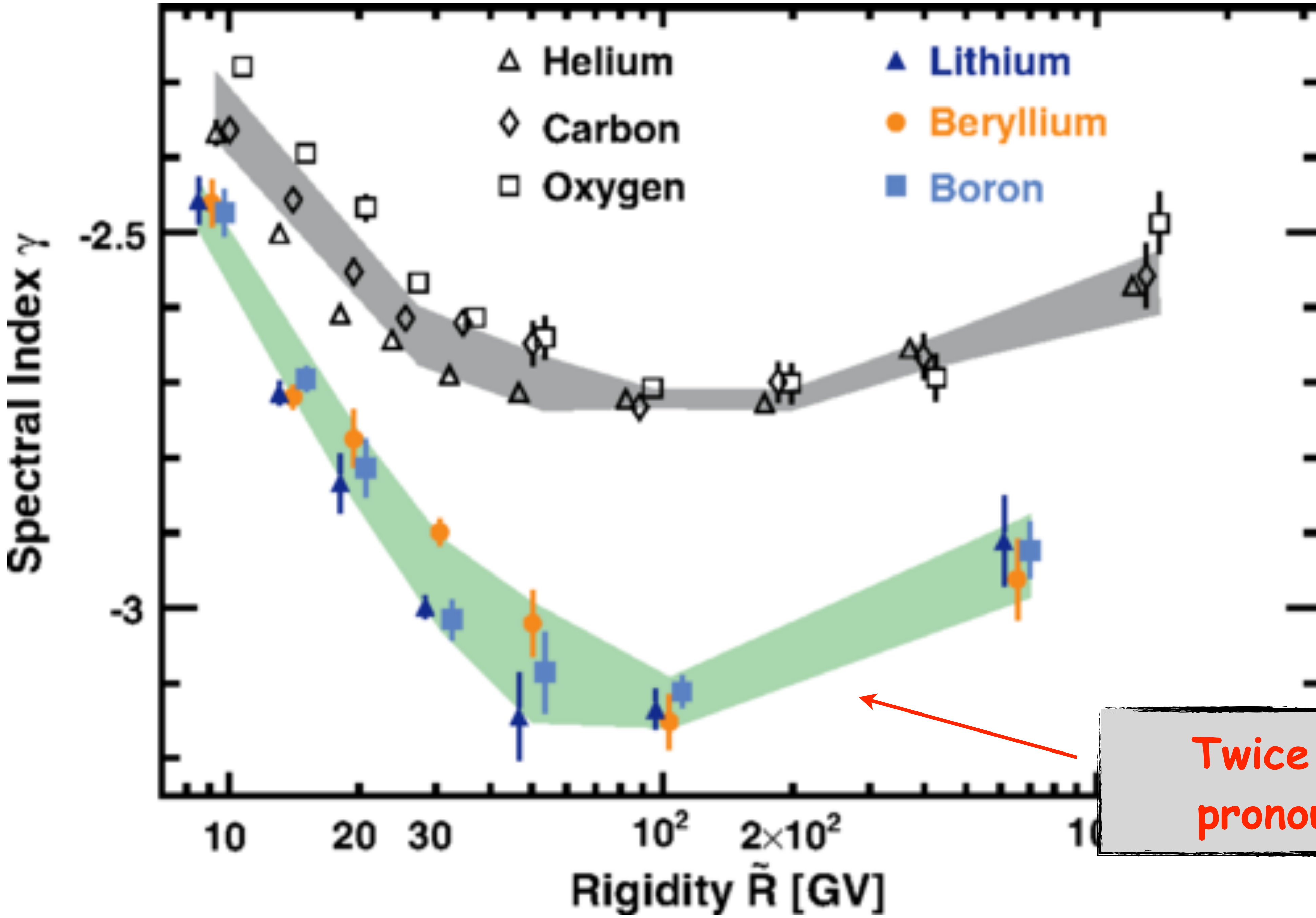


Propagation!



What happens at 300 GV?

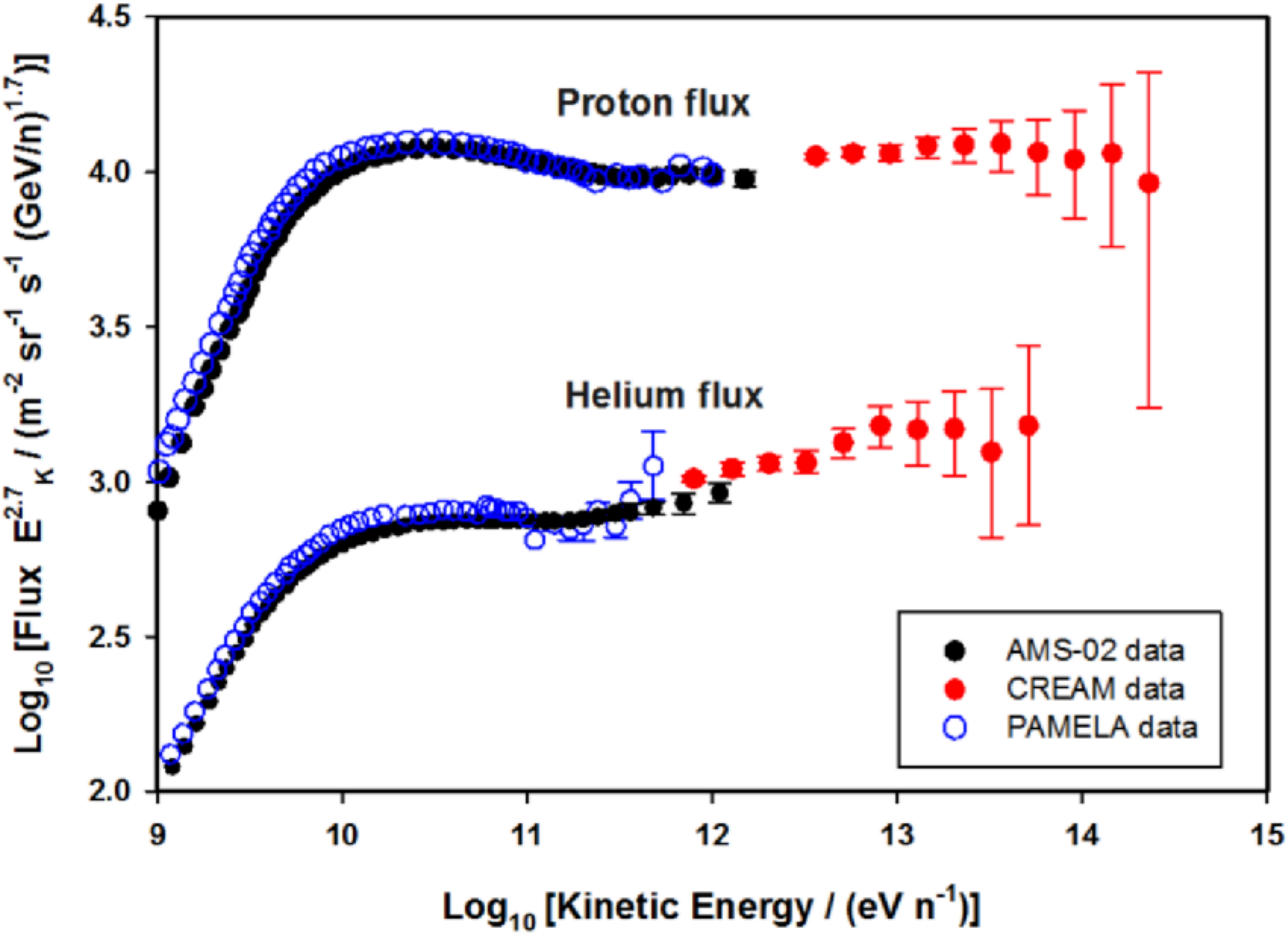
Propagation!



Twice more pronounced

What happens at 300 GV?

H spectrum is softer than He… (?!?!)



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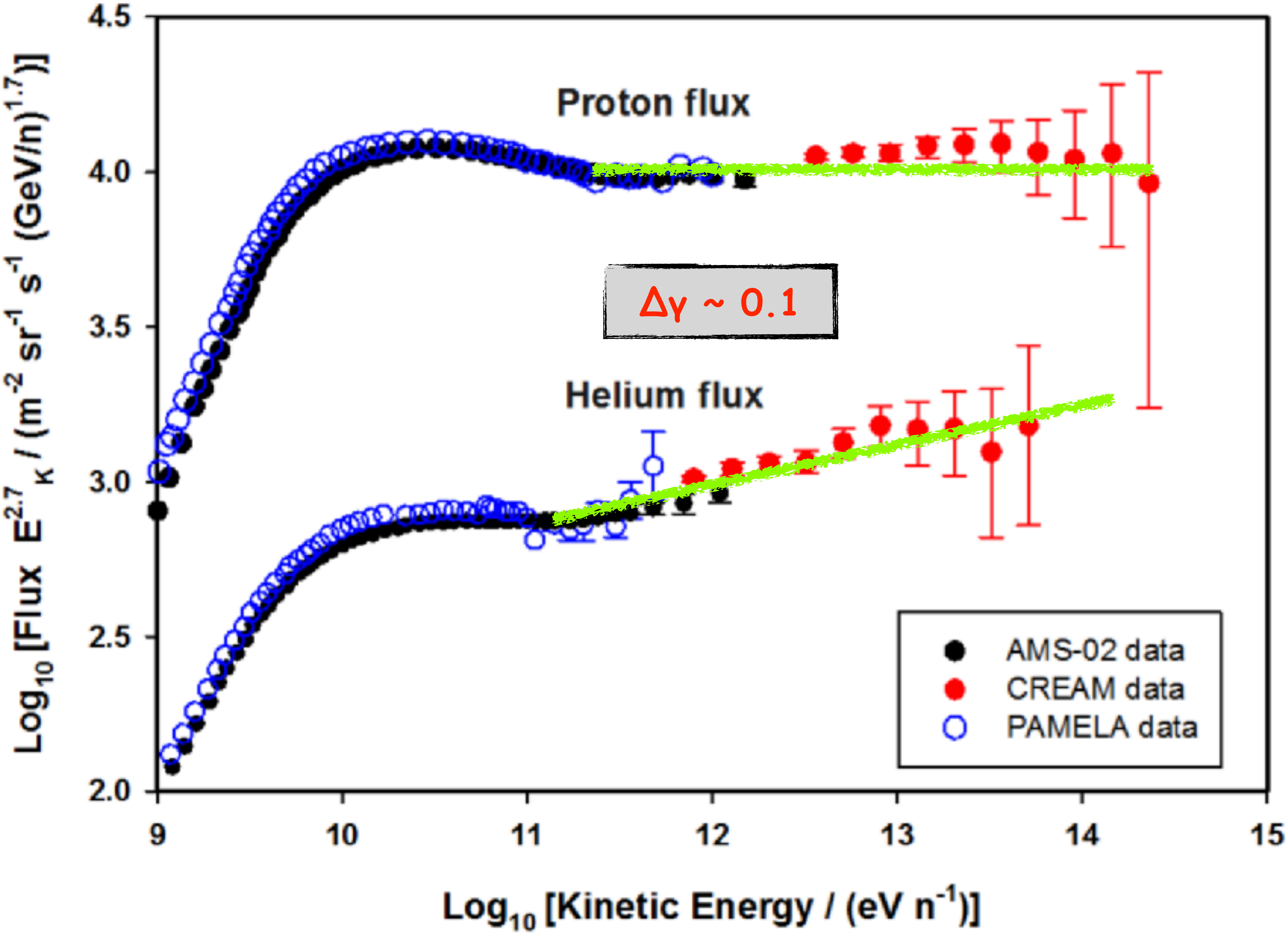
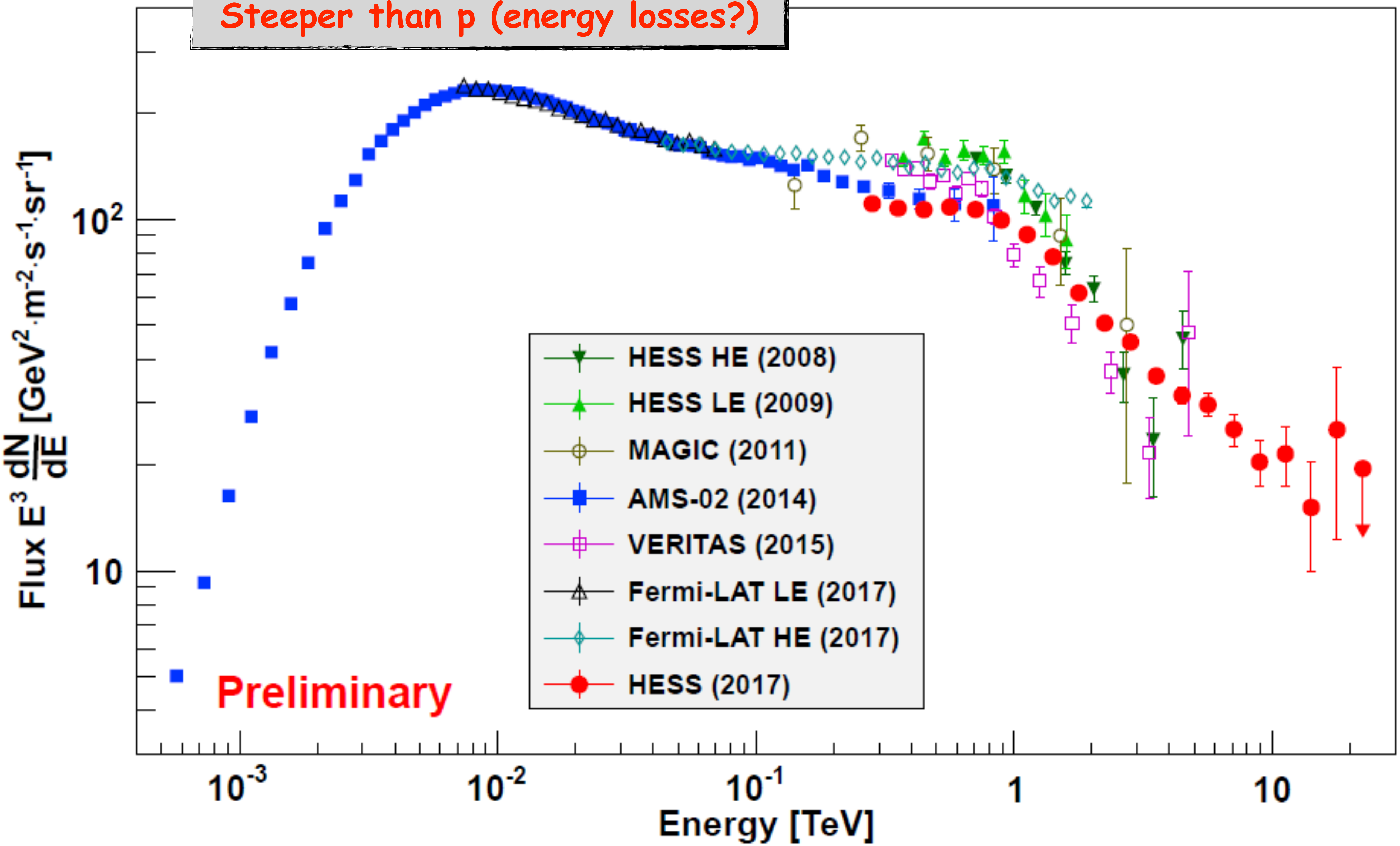


Electron spectrum

Steeper than p (energy losses?)



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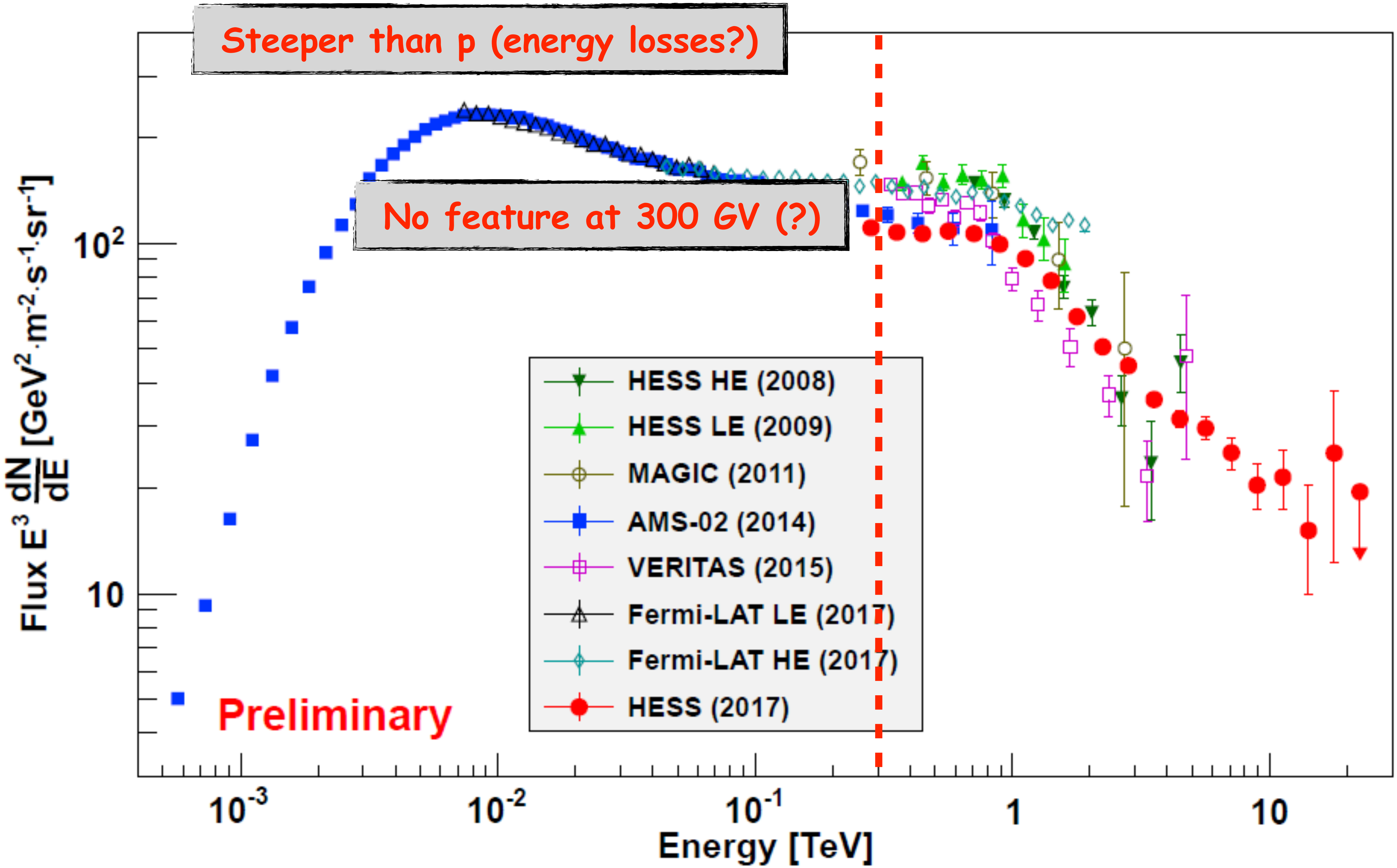

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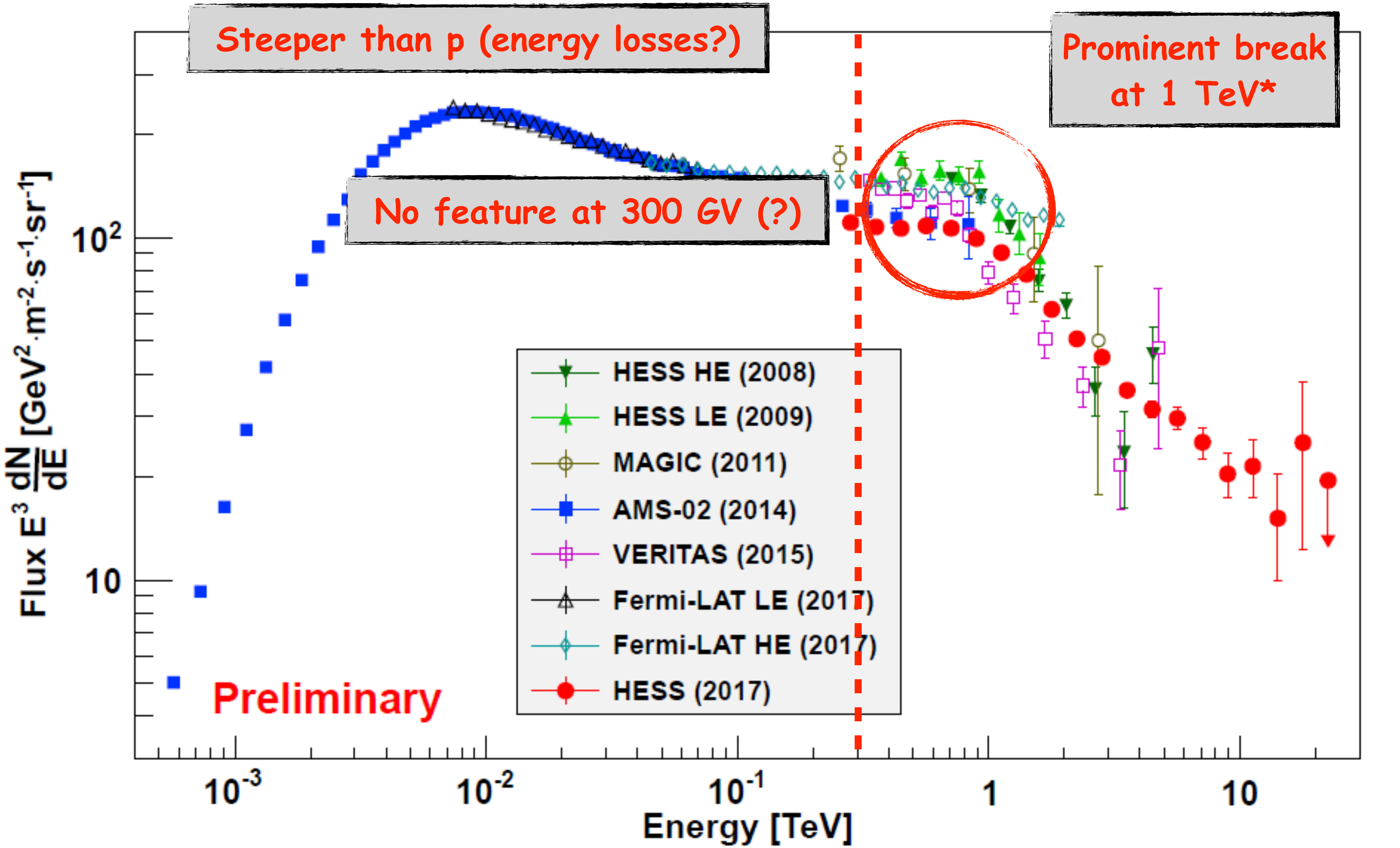

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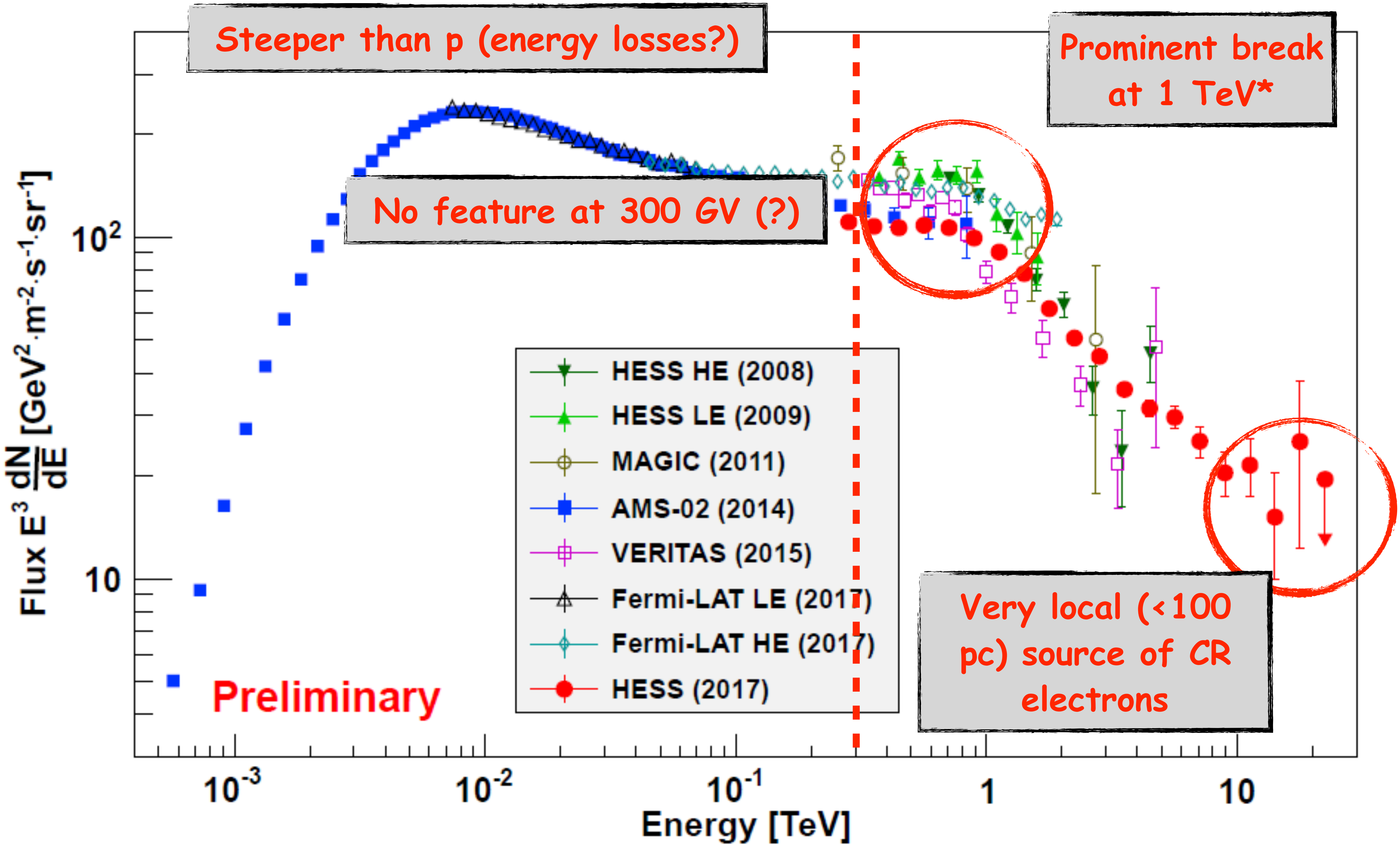

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Positrons

Neutrinos/antineutrinos & electrons/positrons are also produced in pp interactions

$$p + p \rightarrow p + p + \pi^0 + \pi^+ + \pi^-$$

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Final products of proton-proton interactions are not only **gamma ray photons** but also **neutrinos**, **anti-neutrinos**, **electrons** and **positrons**

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neutral and charged pions produced with the same probability (1/3,1/3,1/3)

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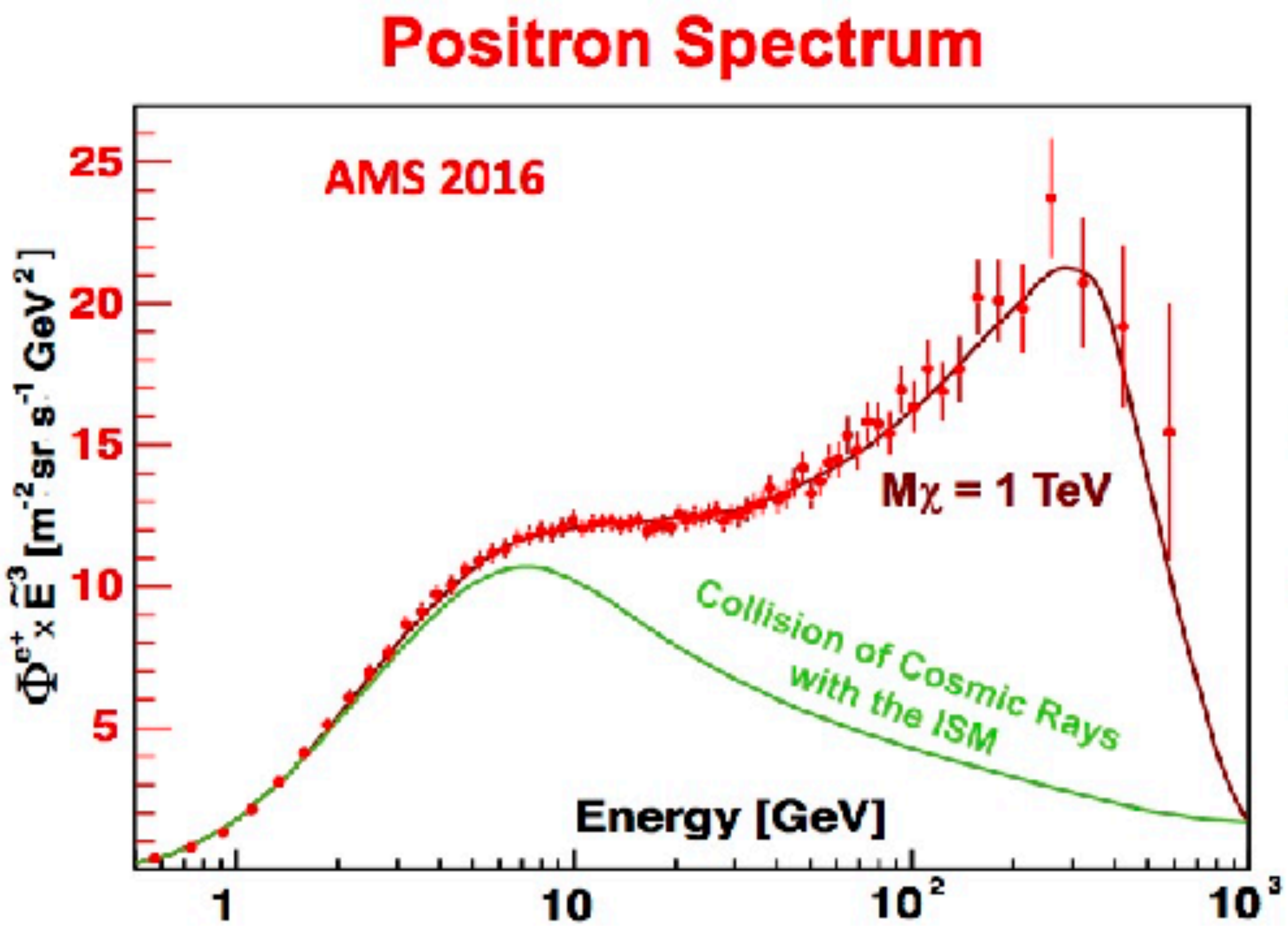
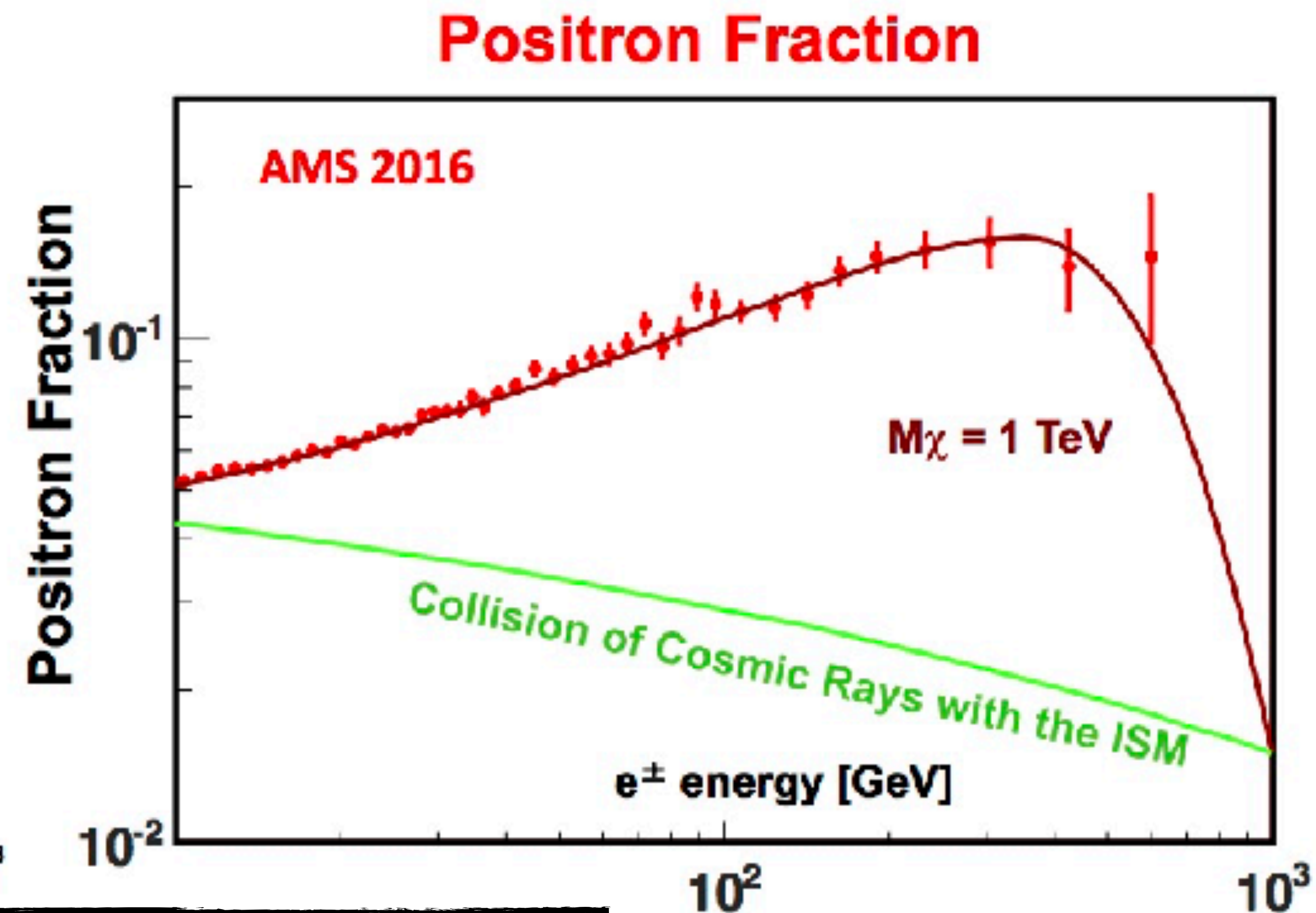
Positrons and electrons behave in the same way ->

$$\frac{N_{e^+}(E)}{N_{e^-}(E)} = \frac{Q_{e^+}(E)}{Q_{e^-}(E)} \propto E^{-\alpha}$$

Positron fraction





Nearby source of CR positrons? (pulsars?)

Dark matter decay?

Anisotropy

isotropic part

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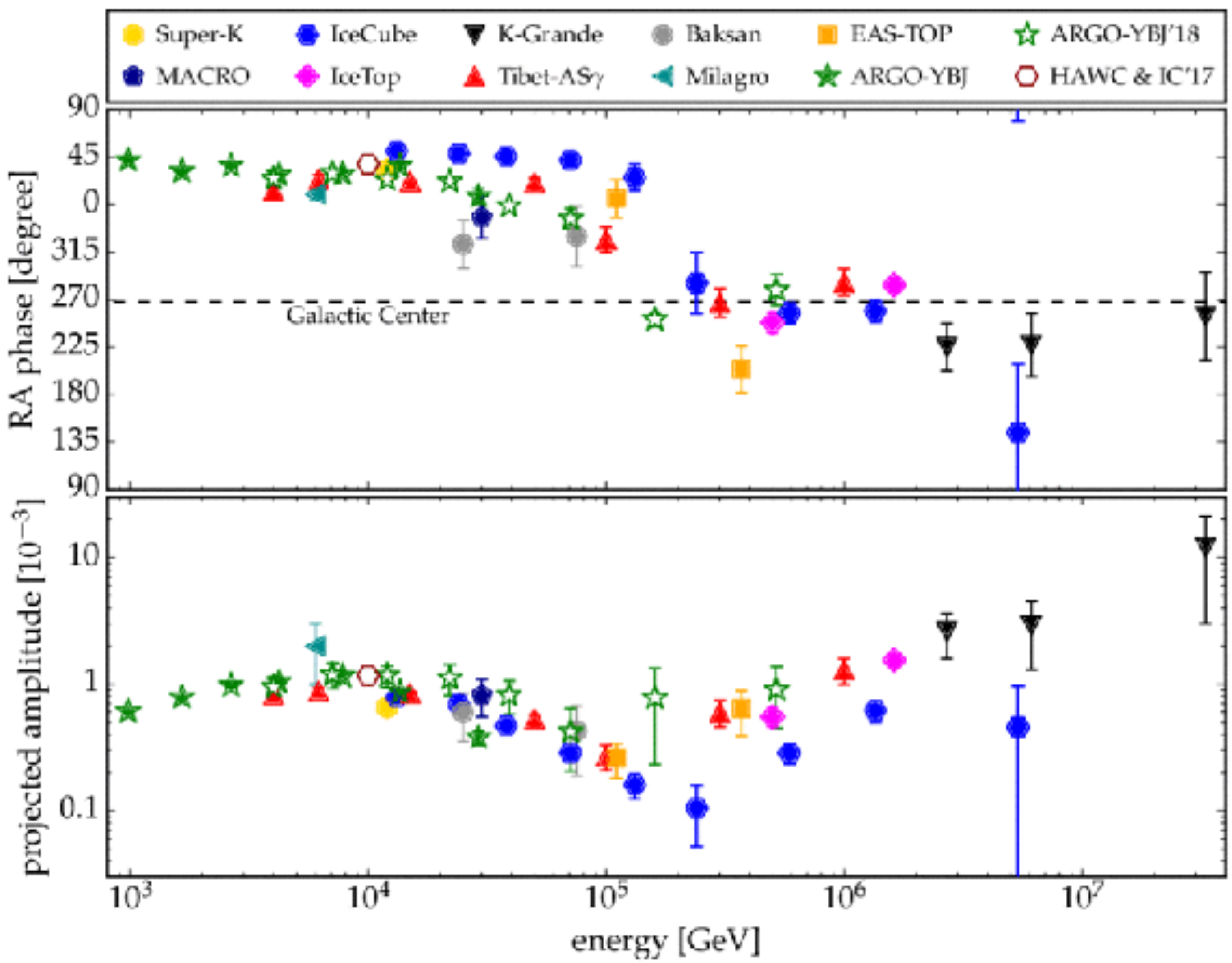

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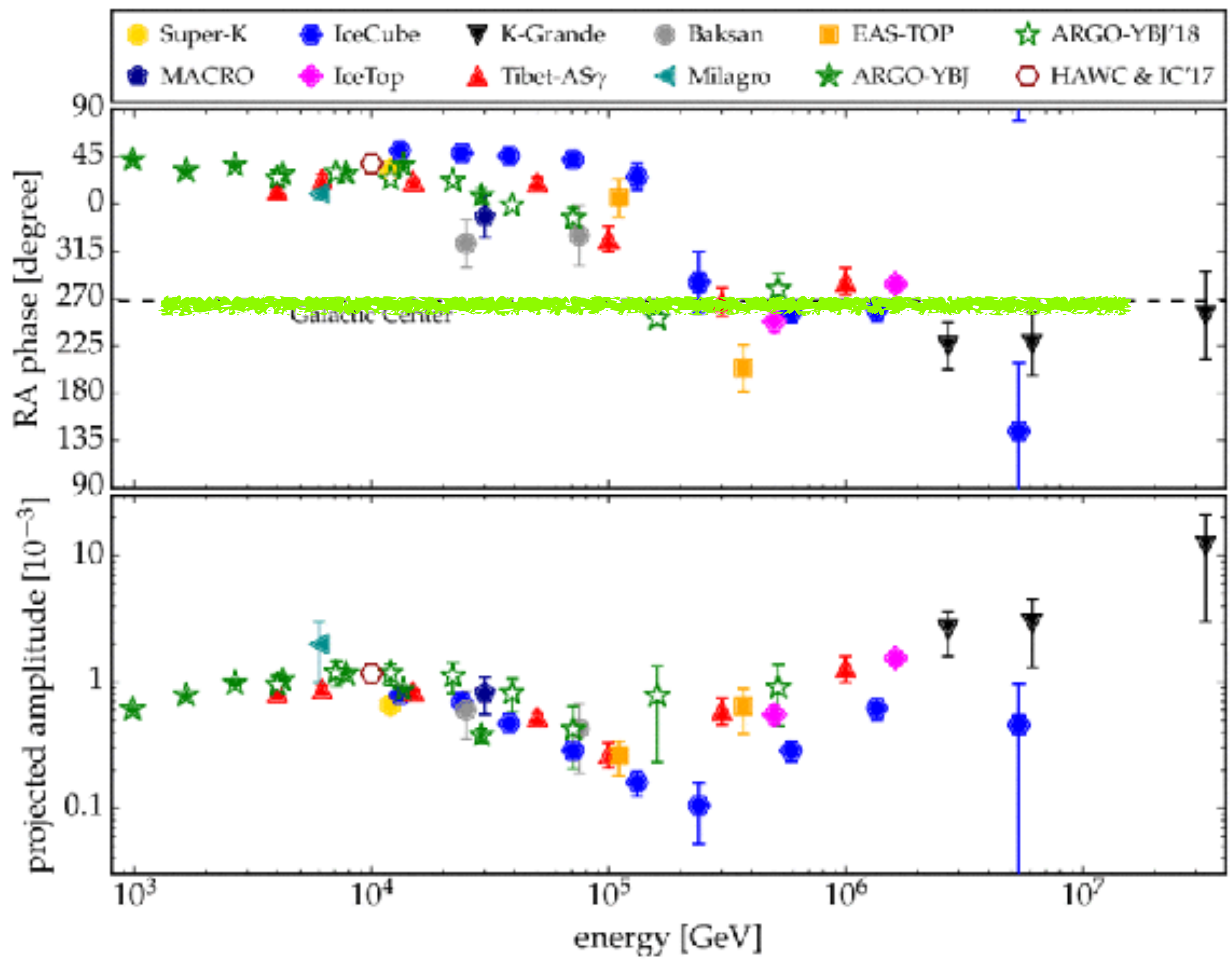

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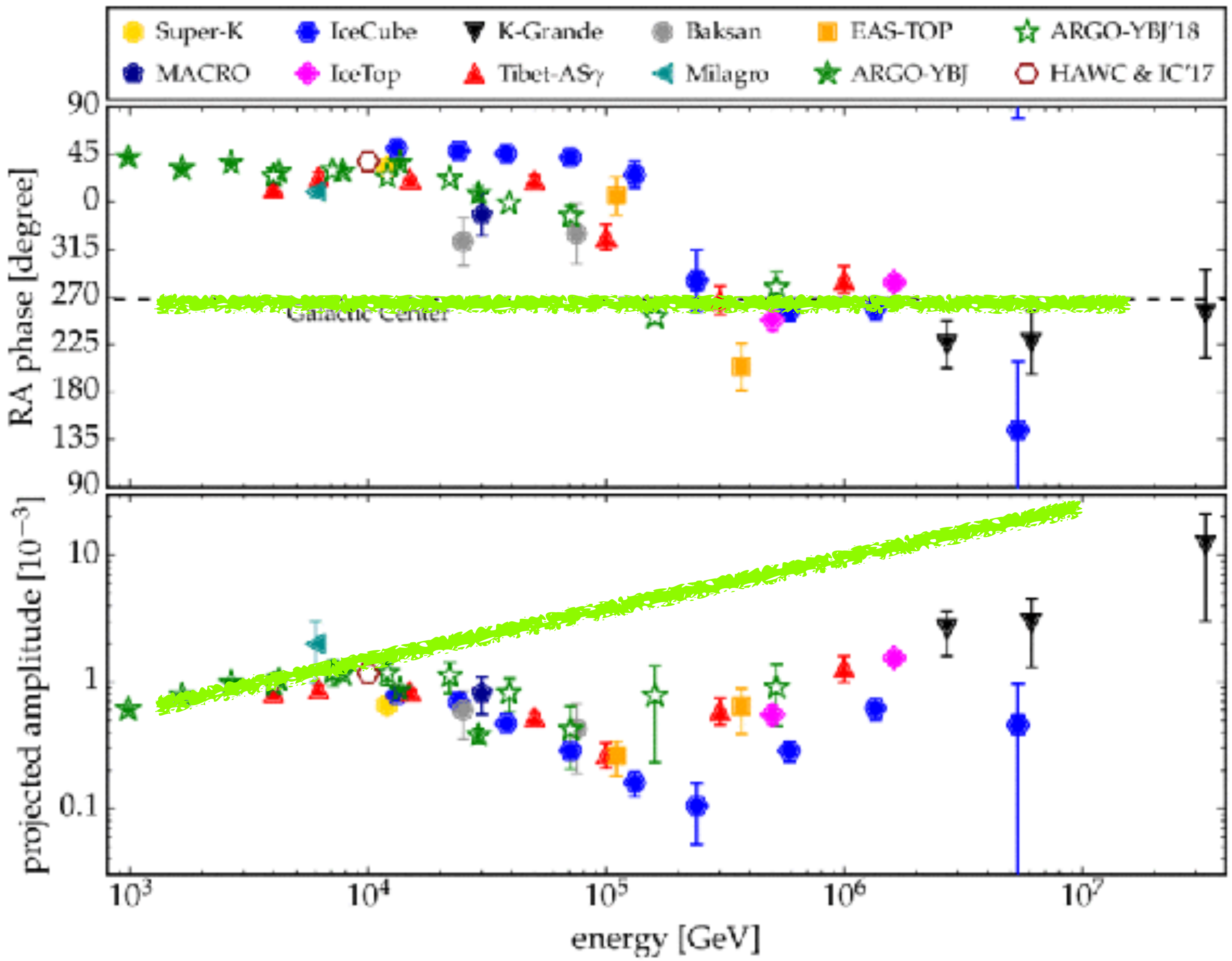
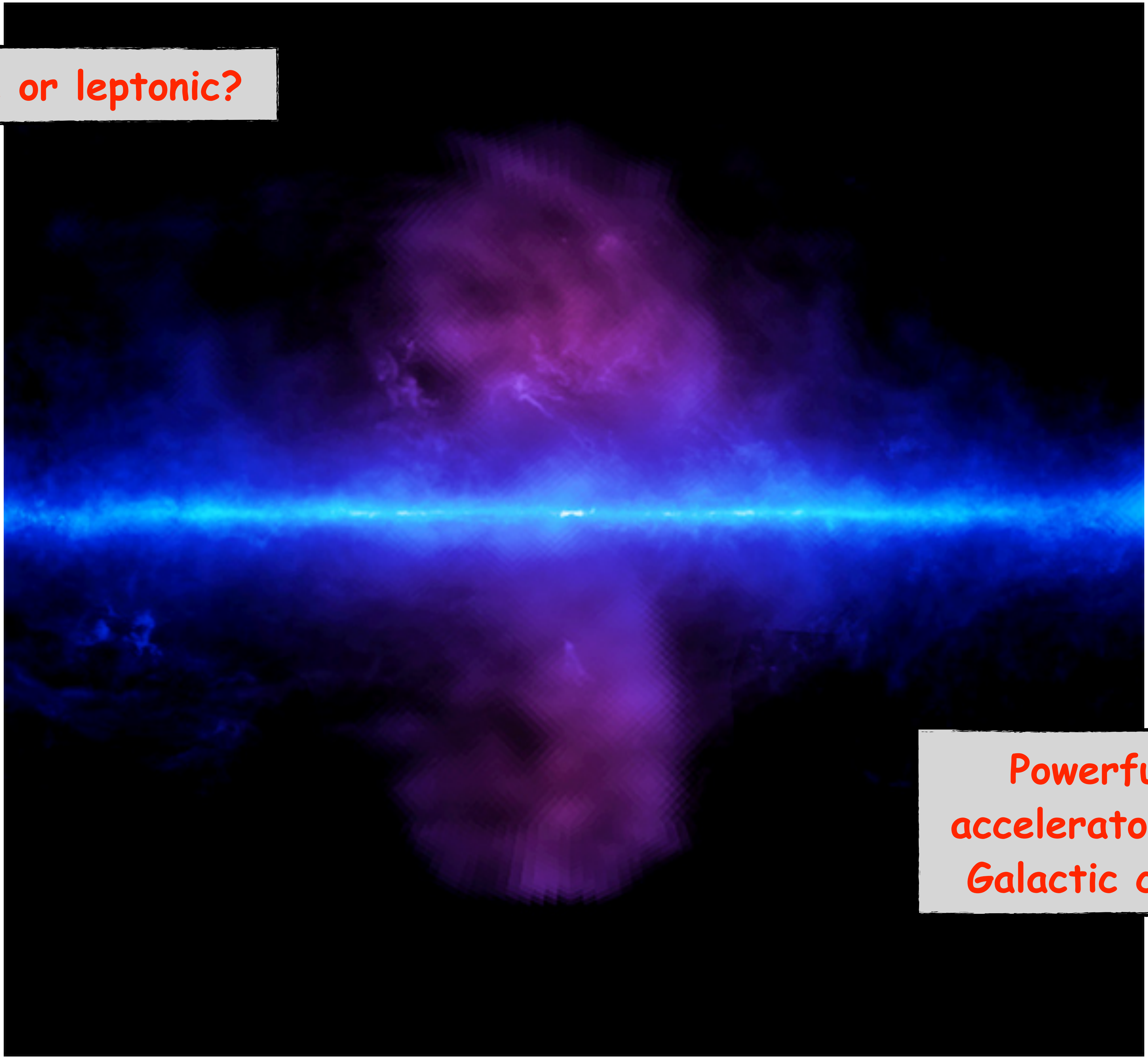


Fermi bubbles

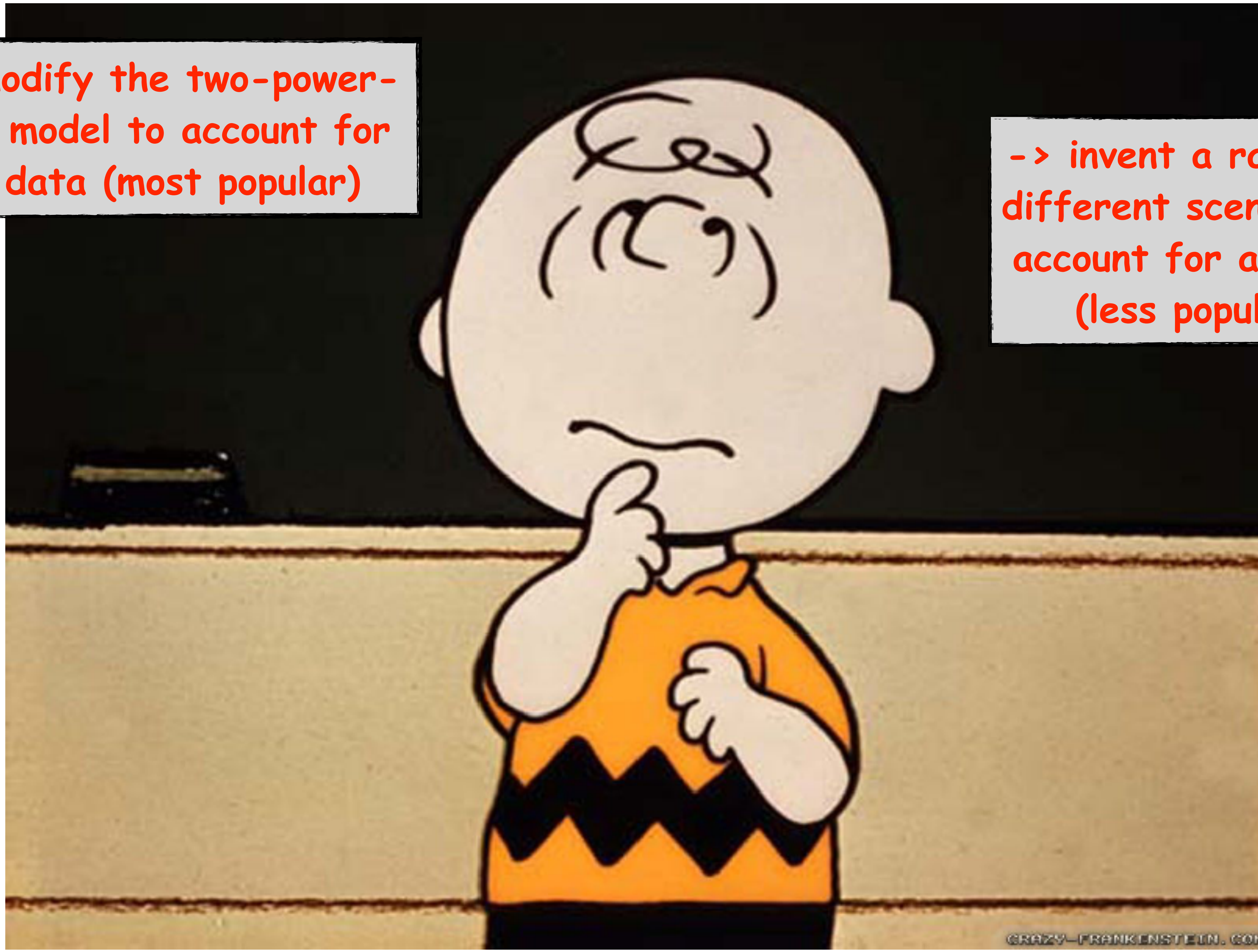


Hadronic or leptonic?

Powerful CR accelerator in the Galactic centre?

So? Two possibilities…

-> modify the two-power-laws model to account for all data (most popular)



-> invent a radically different scenario to account for all data (less popular)

Advertisements...

For a review of the problems of the SNR paradigm

Gabici et al. 2019, IJMPD, 28, 1930022-339 (arXiv:1903.11584)

PhD thesis on Cosmic Rays

COSMIC RAY ACCELERATION IN STAR FORMING REGIONS
(ED STEPUP)