On the interpretation of the latest AMS-02 cosmic ray electron spectrum

In collaboration with M. Di Mauro & S. Manconi

Based on https://arxiv.org/abs/2010.13825 (sub. PRD)

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Sources of cosmic e- and e+ in the Milky Way

Our goal is to reproduce the spectrum of e- spectrum measured by AMS-02 (PRL, 122 (2019 101101).

Simultaneously, we fit the e+ AMS-02 data (PRL, 122 (2019) 041102)

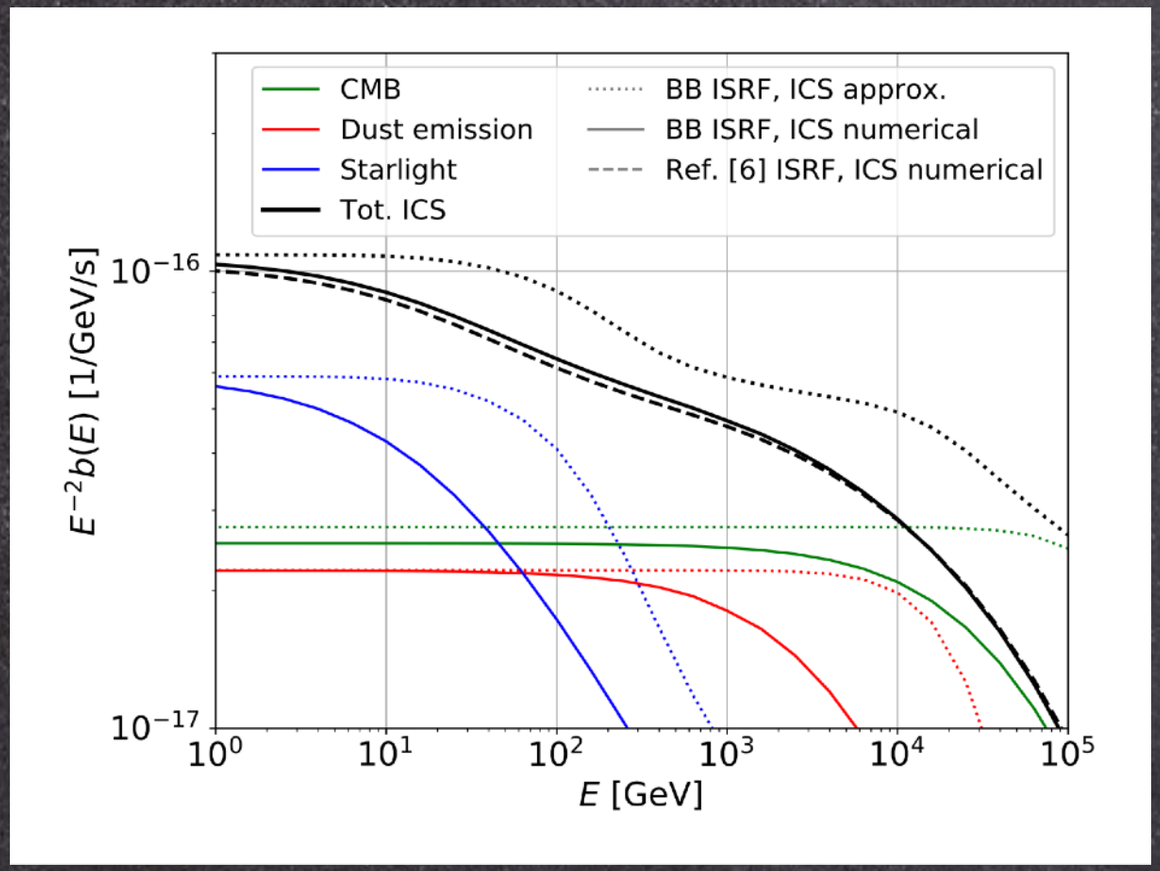
Assess the nature of the hardening in the e- data around 42 GeV.

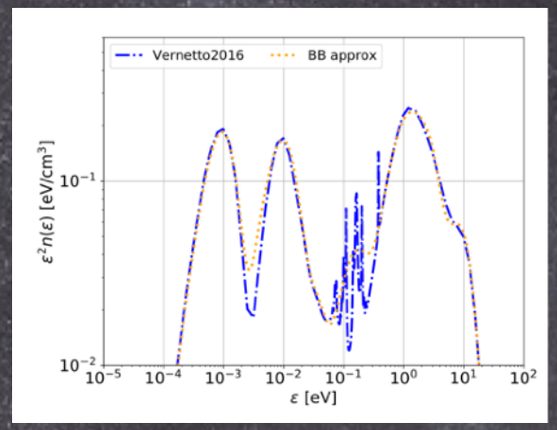
1. Secondary e-, e+
2. Primary e+e- from pulsar
3. Primary e- from SNR

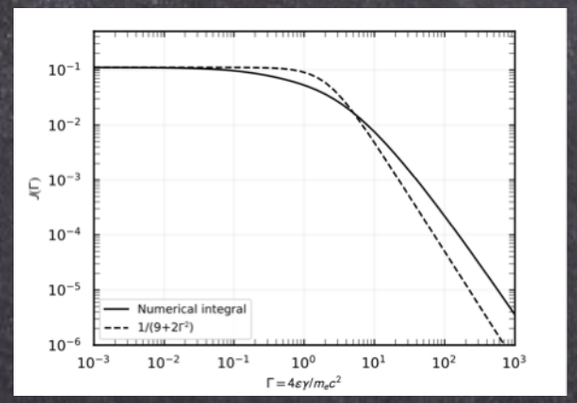
- Smooth (Green 2015) distribution of sources
- Diffusion and energy losses (Synchrotron, Inverse Compton scattering (ICS))
- $Q(E)_{SNR}$: power law with expo cutoff, $Q(E)_{PWN}$: broken power law

Focus on energy losses due to ICS

Energy loss rate on the ISRF by ICS







Changing the ISRF from full (Vernetto & Lipari 2016) to black body approximation is not relevant.

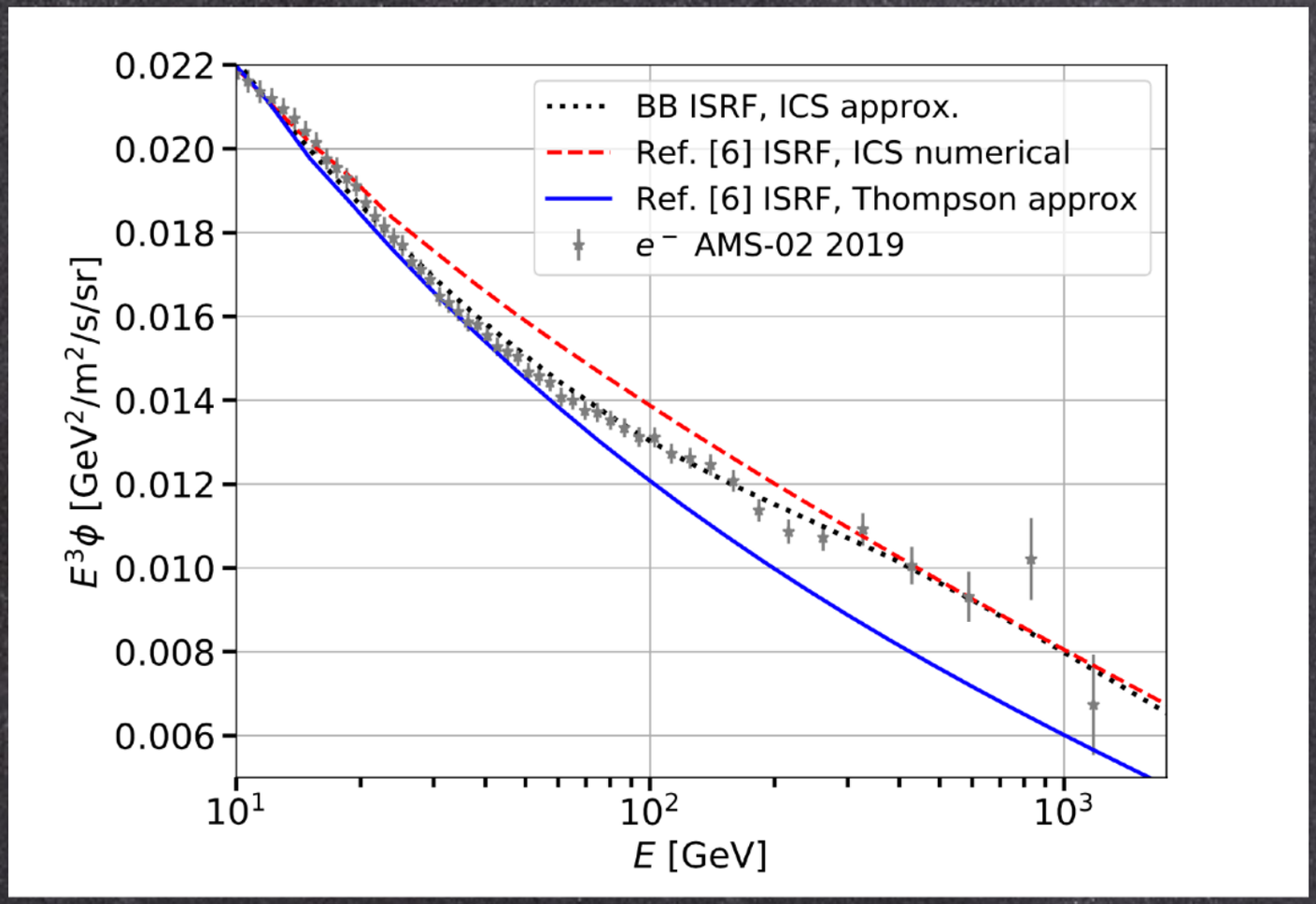
Relevant is changing full ICS computation (numerical) with approximation by (Schlickeiser & Ruppel 2016),

applied in (Evoli, Blasi, Amato, Aloisio PRL2020, but see also PRD2021).

ICS approximation is poor for AMS-02 energies (Fang, Bi, Lin arXiv:2007.15601).

It induces visible change of slope (starlight - CMB)

Effect of energy losses on the e- flux



Different treatments for ICS losses implemented in e- flux computation

[6] : Vernetto & Lipari PRD 2016

- ICS approximated cross section -> e- flux following ASM-02 data
- Thomson approximation too soft
- Full numerical ICS -> no evident slope change

Other options to explain AMS-02 data?

Positrons, and the break in the e- spectrum

e+ and e- AMS-02 spectra FITTED with a multi-component model

$\gamma_{1,PWN}=1.88$, $\gamma_{1,PWN}=2.31$, $\eta_{PWN}=0.91\%$, $\gamma_{SNR}=2.67$, $W_{SNR}=1.4\ 10^{49}$ erg, $q_{sec}=1.32$

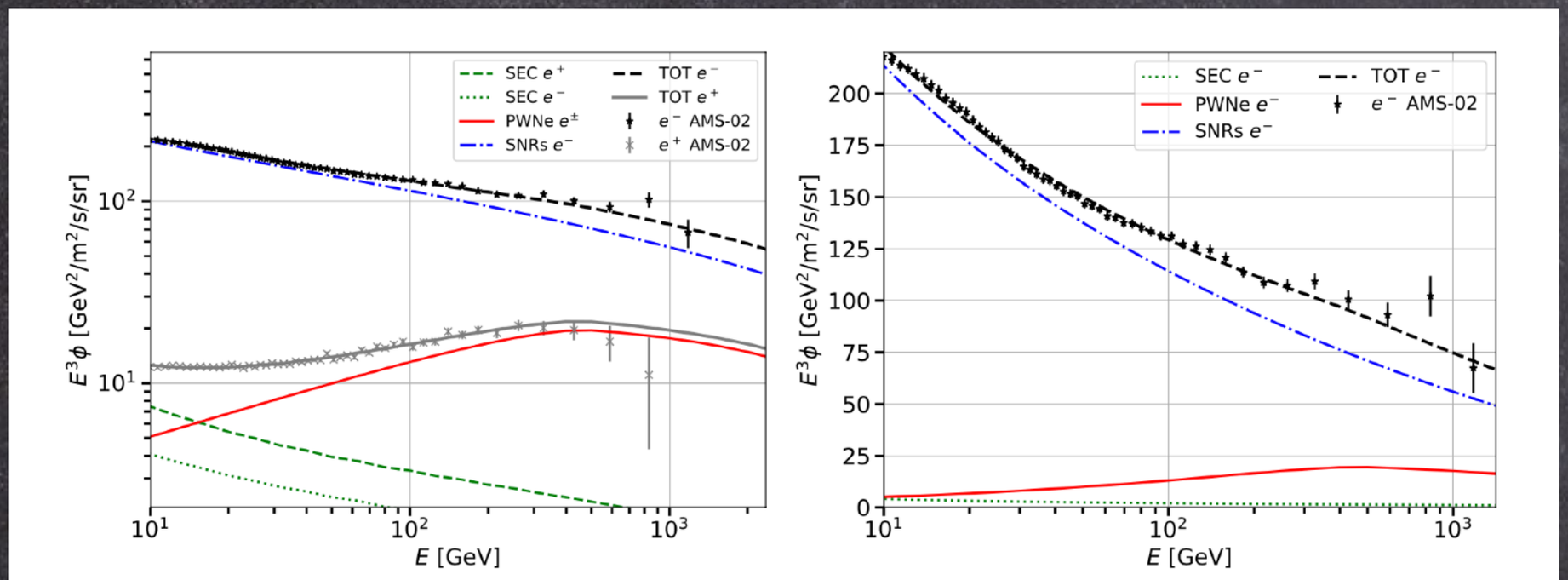
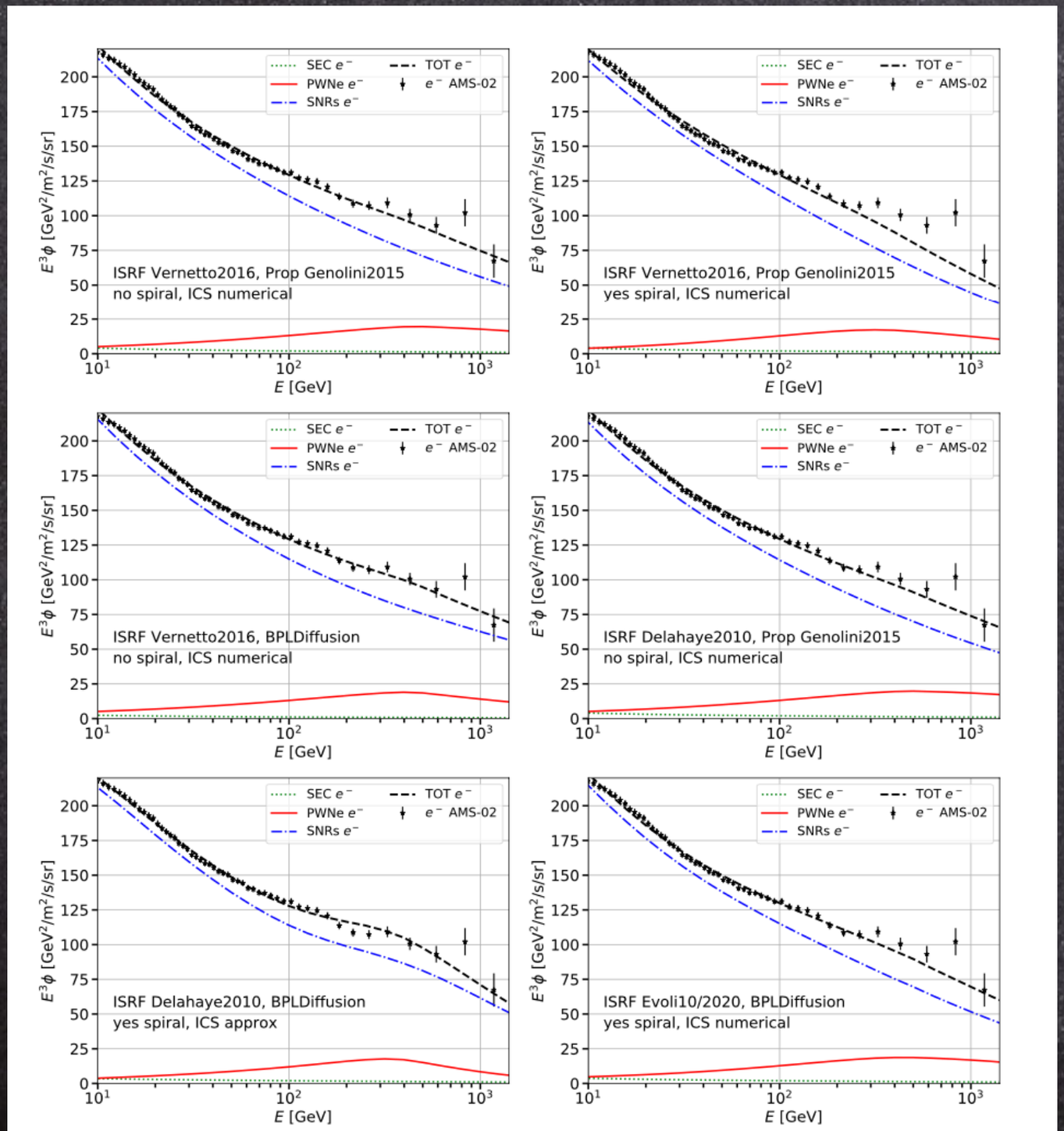


FIG. 4. Left Panel: Result for the combined fit to e^- and e^+ AMS-02 data (black and grey data points). We show the secondary production of e^+ (dashed green line) and e^- (dotted green line), $e^\pm$ from PWNe (solid red line), e^- from SNRs (dot-dashed blue line). Right Panel: same as the left panel but zooming in the e^- sector.

Full (numerically) energy losses kept into account

The break at 42 GeV is well explained by the interplay between SNR and PWN contribution

Different inputs: impact on e- flux



Changes in the ISRF and/or propagation parameters irrelevant

ICS poor approximation shapes SNR e- flux

Significance for PWN contribution is 4-8σ

Conclusions

- We have demonstrated that approximated ICS cross section gives a bad description in AMS-02 energy range

- Within this approximation, we recover AMS-02 slope change at 42 GeV

- Full numerical ICS does not predict e- slope change

- AMS-02 e- and e+ data are naturally fitted with dominant SNR e- and e± from PWNe

- The break measured by AMS-02 in the e- flux at ~ 40 GeV is very likely due to the interplay between SNR and PWN emission