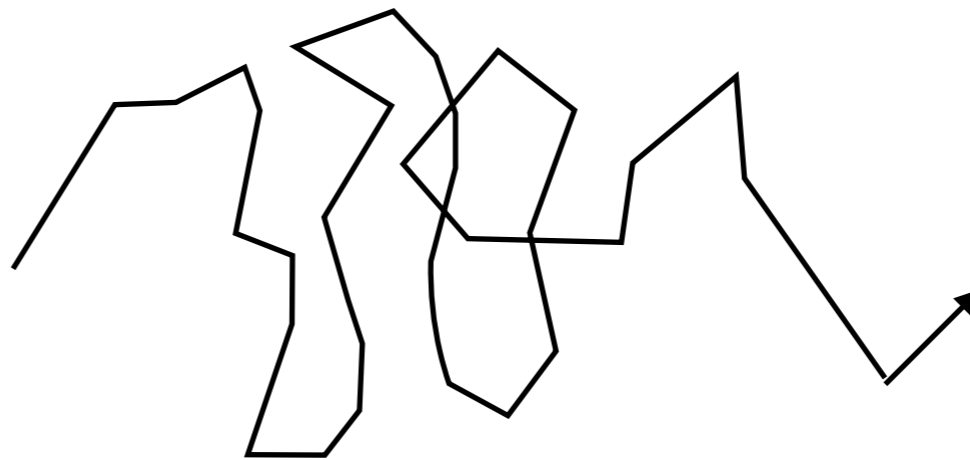
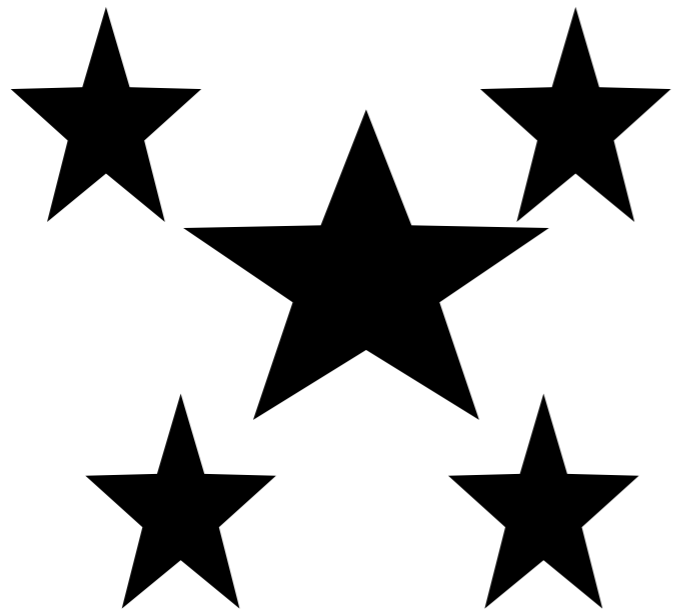


# What is wrong with supernova remnants?

**Pierre Cristofari**

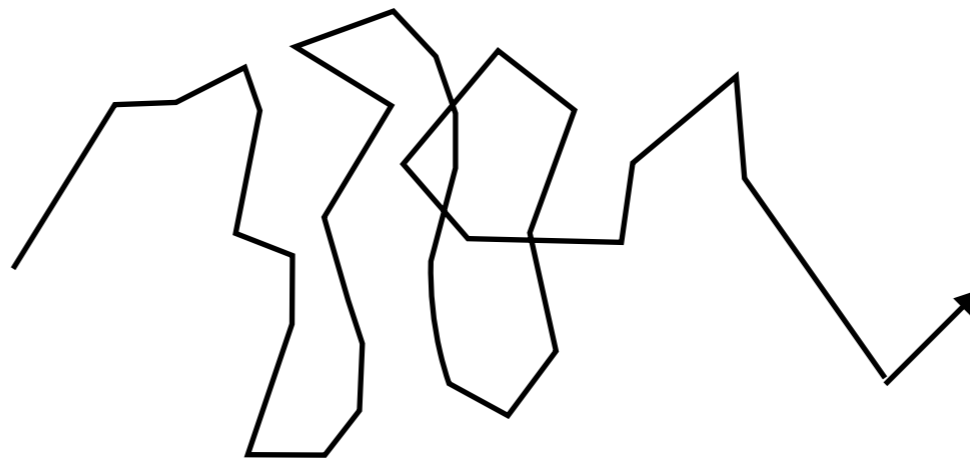


[pierre.cristofari@gssi.it](mailto:pierre.cristofari@gssi.it)





**Sources**



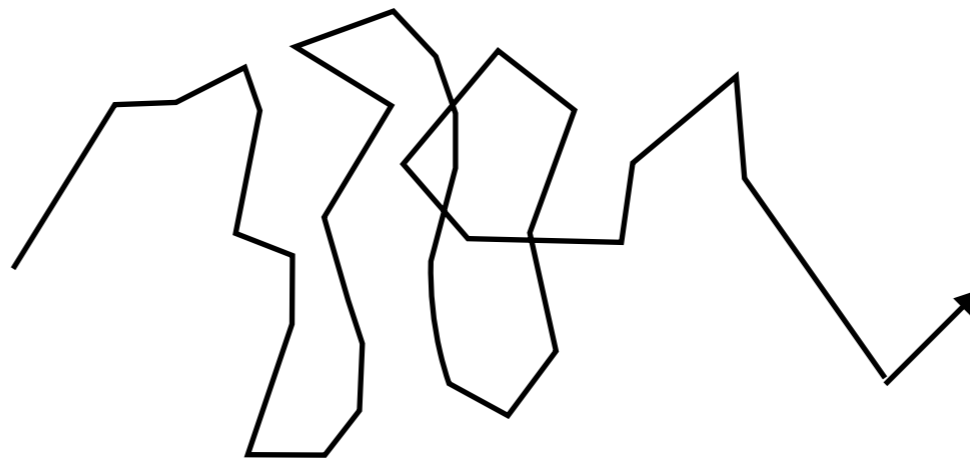
**Transport**



**Measurement**



**Sources**



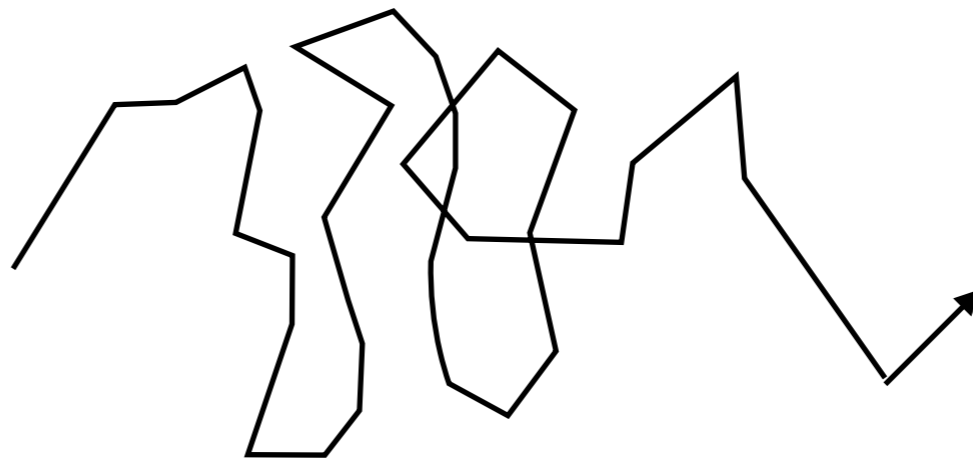
**Transport**



**Measurement**

**Galactic**

**Extra  
Galactic**

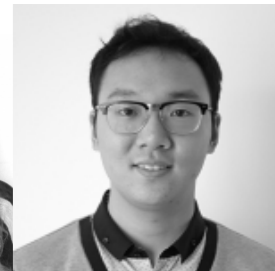


## Sources

## Transport

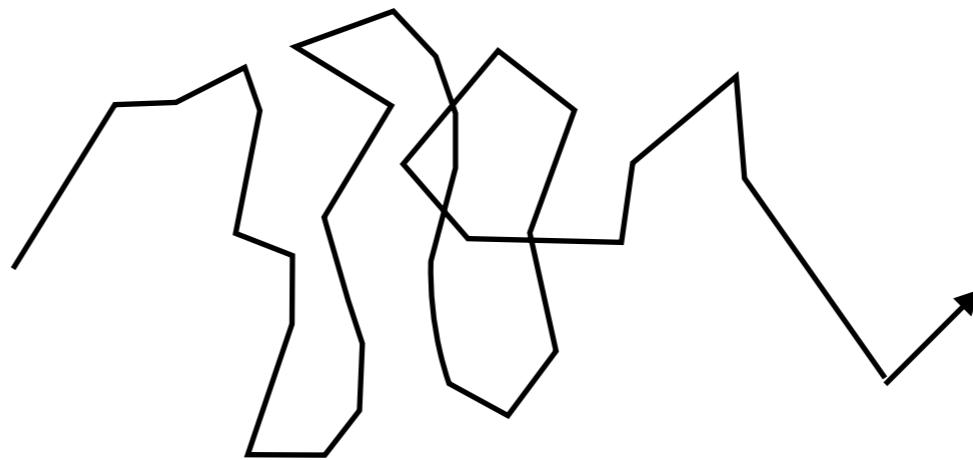
## Measurement

### Galactic



### Extra Galactic





## Sources

## Transport

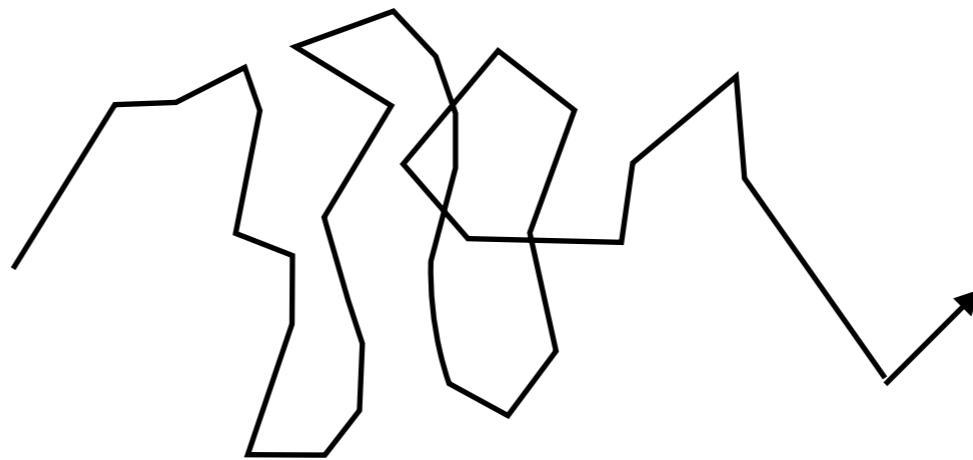
## Measurement

### Galactic



### Extra Galactic



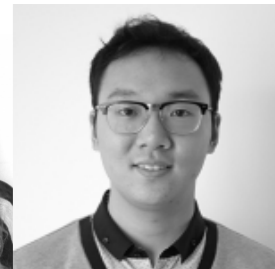


**Sources**

**Transport**

**Measurement**

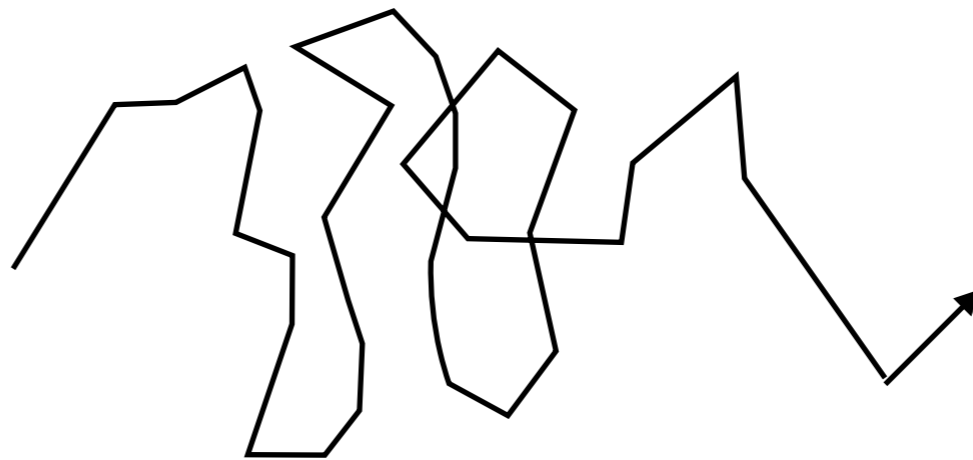
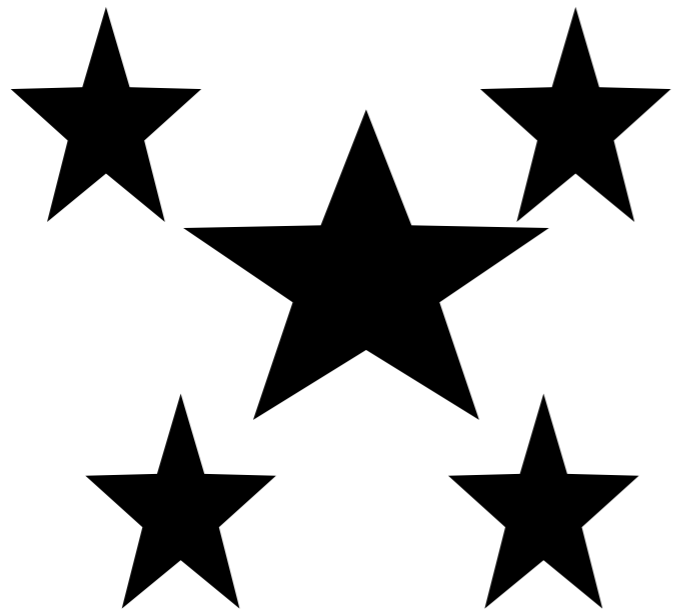
**Galactic**



**Extra Galactic**





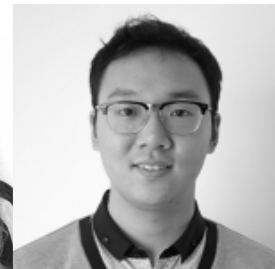


**Sources**

**Transport**

**Measurement**

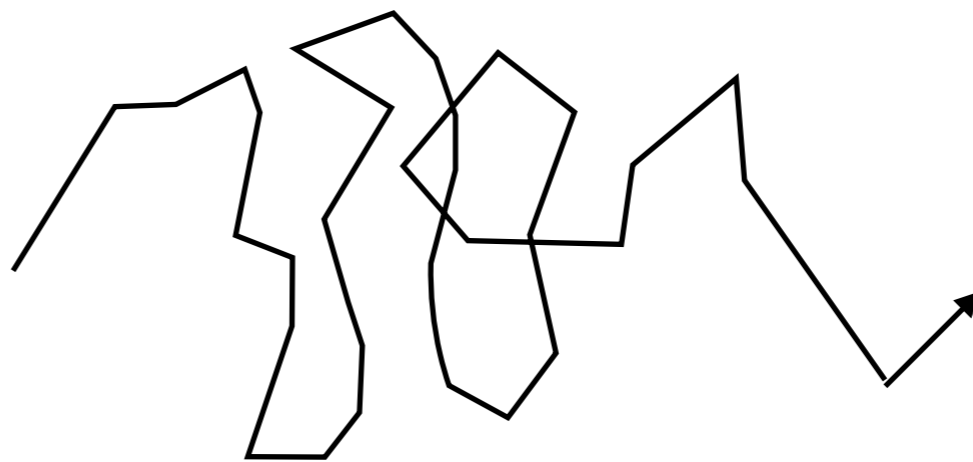
**Galactic**



**Extra Galactic**





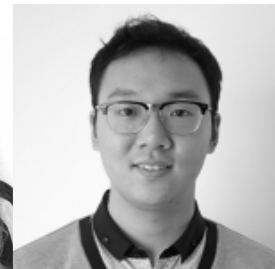


**Supernova remnants**

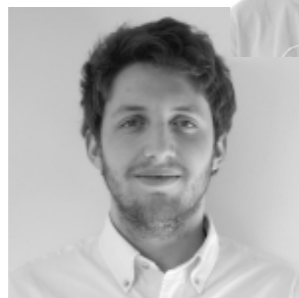
**Transport**

**Measurement**

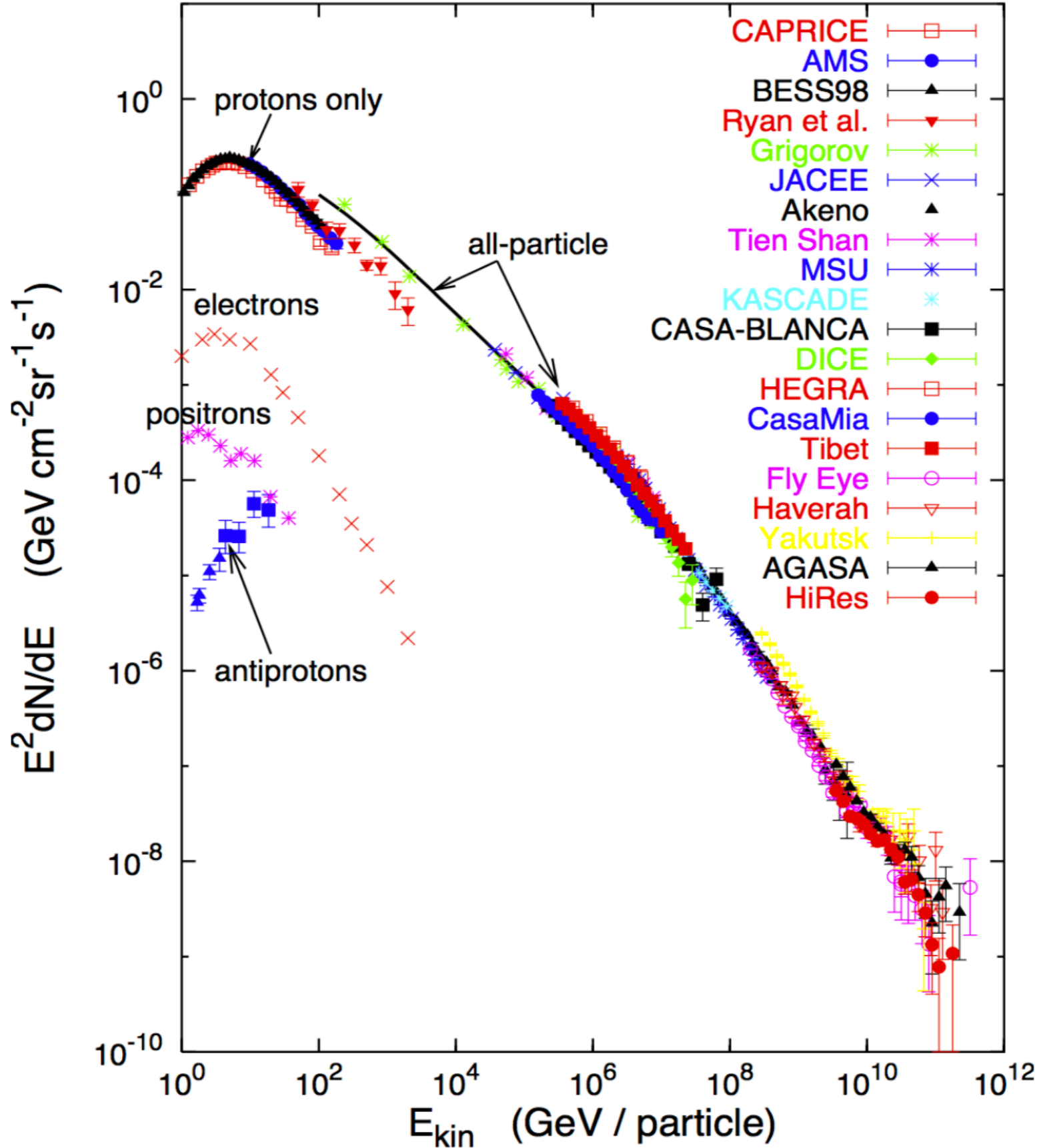
**Galactic**



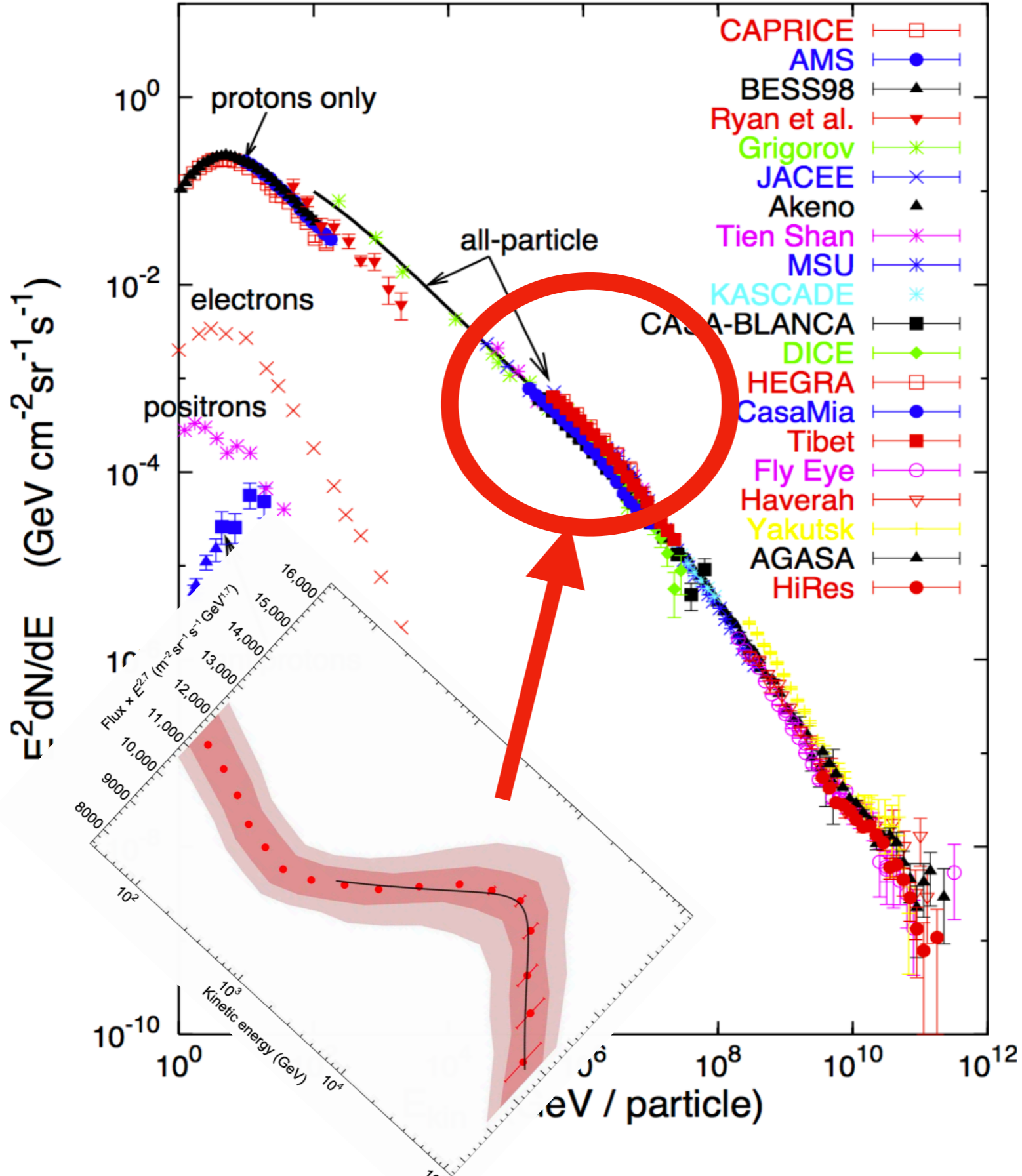
**Extra Galactic**



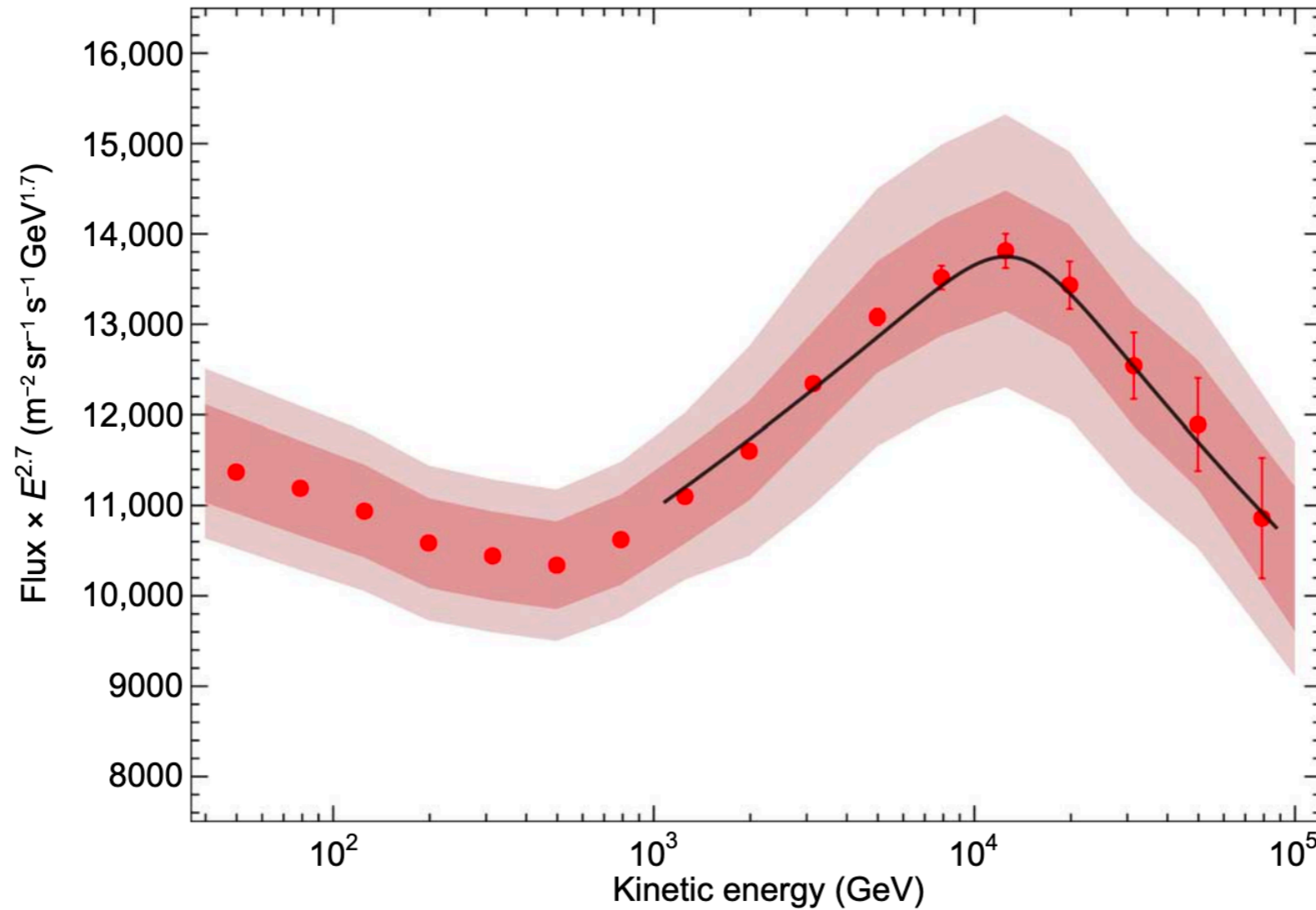
# Local cosmic ray spectrum



# Local cosmic ray spectrum



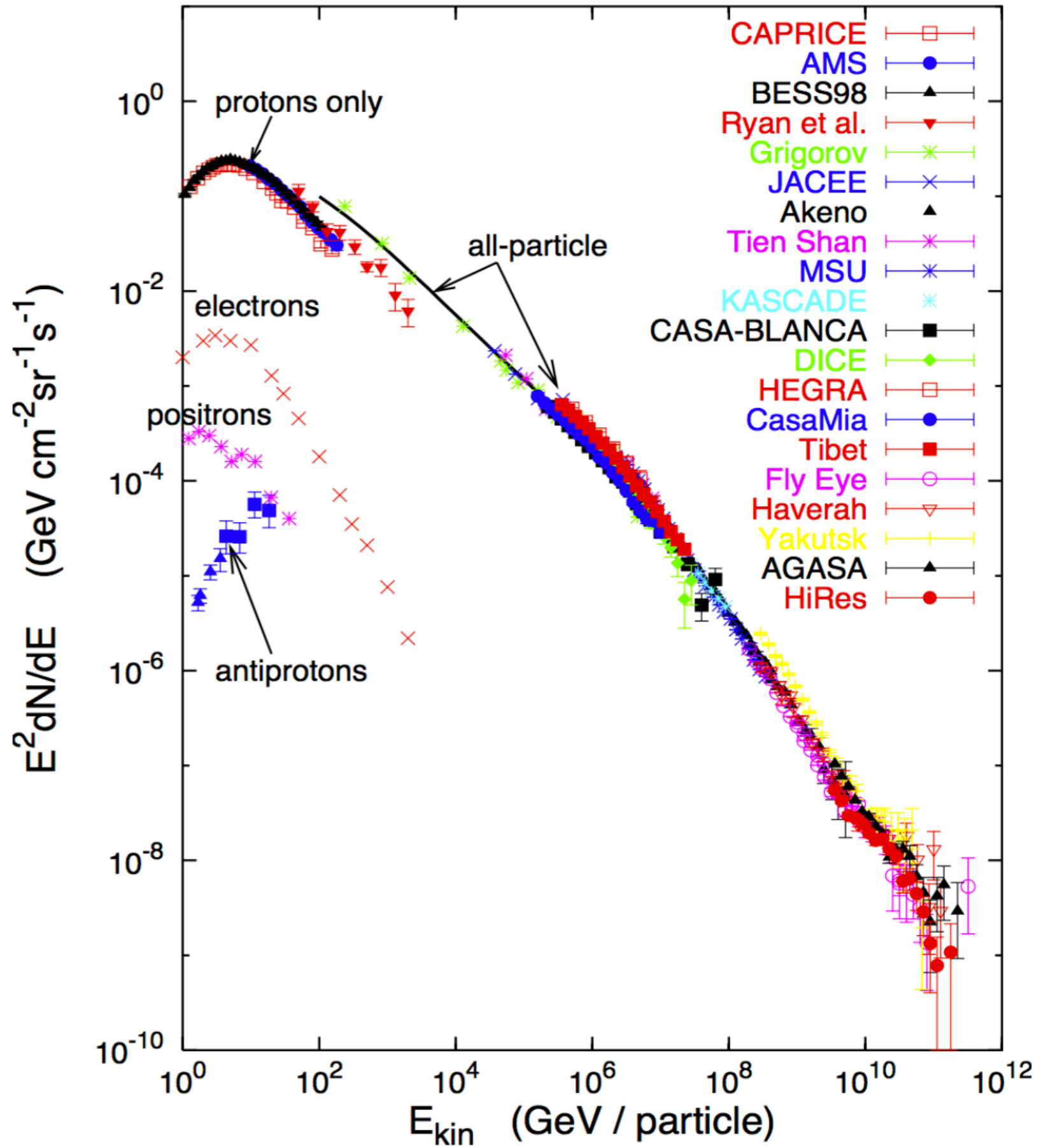
# DAMPE Proton spectrum



**Where does this  
come from ?**

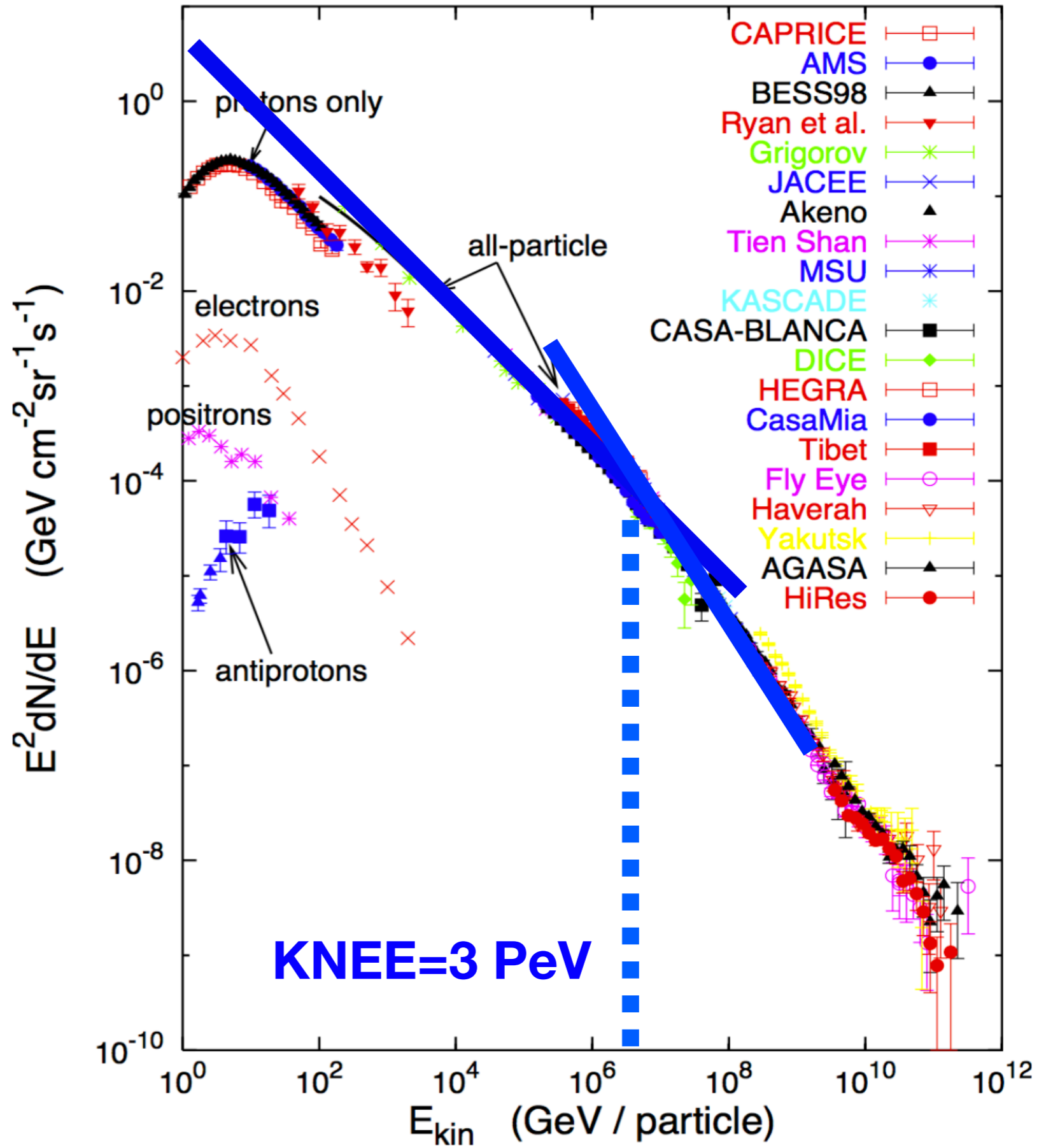
**Dark Matter?  
Local source?  
Special source?**

# Supernova remnants

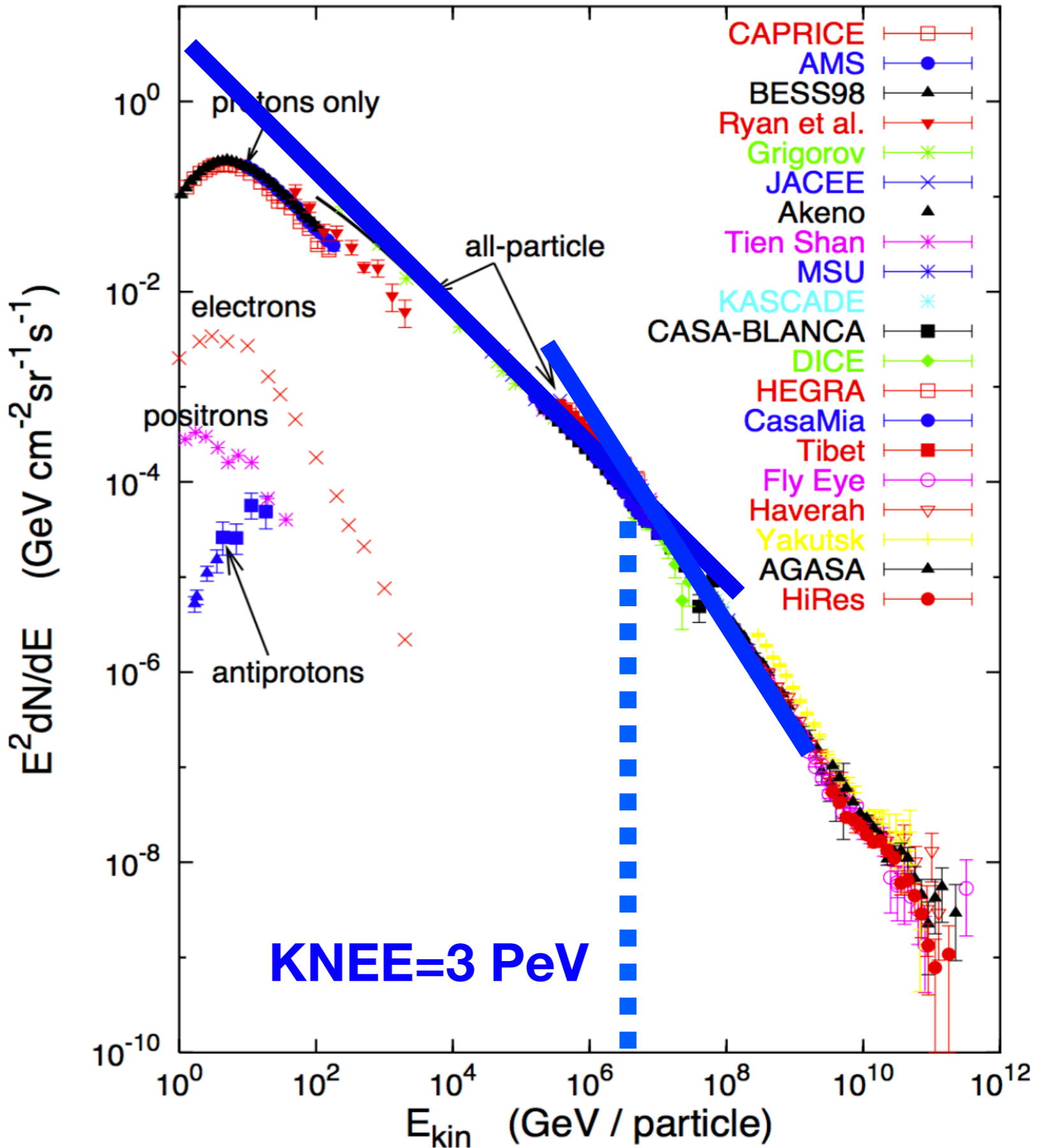
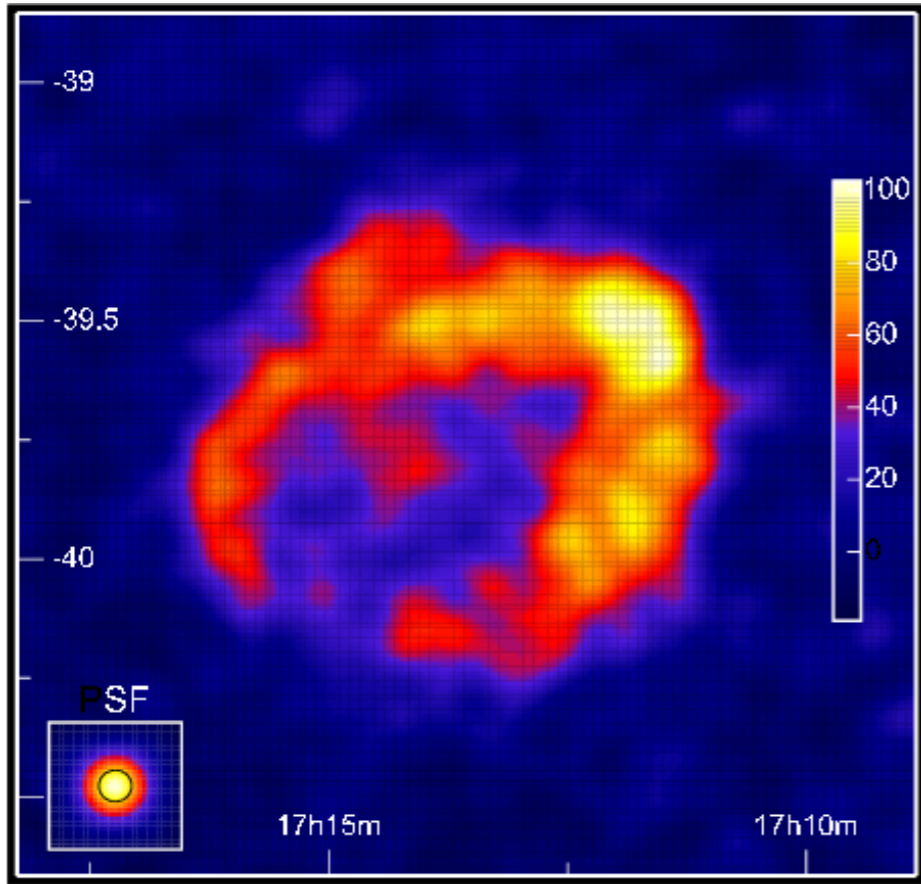




# Supernova remnants



# Supernova remnants



**‘DAMPE’ bump, was not expected from SNRs.**

**Can it be a signature of something?  
(Special SNRs, reacceleration, etc.)**



# DAMPE bump with SNRs?

1. Very simple analytical description of SNRs

**Trapped**

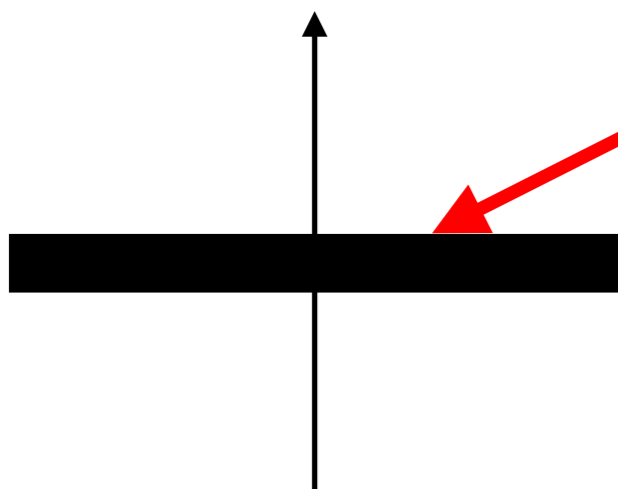
$$N_{\text{acc}}(p)dp = \int_{t_0}^{T_{\text{SN}}} dt \frac{4\pi}{\sigma} r_{\text{sh}}^2(t) u_{\text{sh}}(t) f_0(p', t) dp'$$

**Escaping**

$$N_{\text{esc}}(p) = \int_{t_0}^{T_{\text{SN}}} dt \frac{4\pi}{\sigma} r_{\text{sh}}^2(t) u_{\text{sh}}(t) f_0(p, t) \delta(p, p_{\text{max}}(t))$$

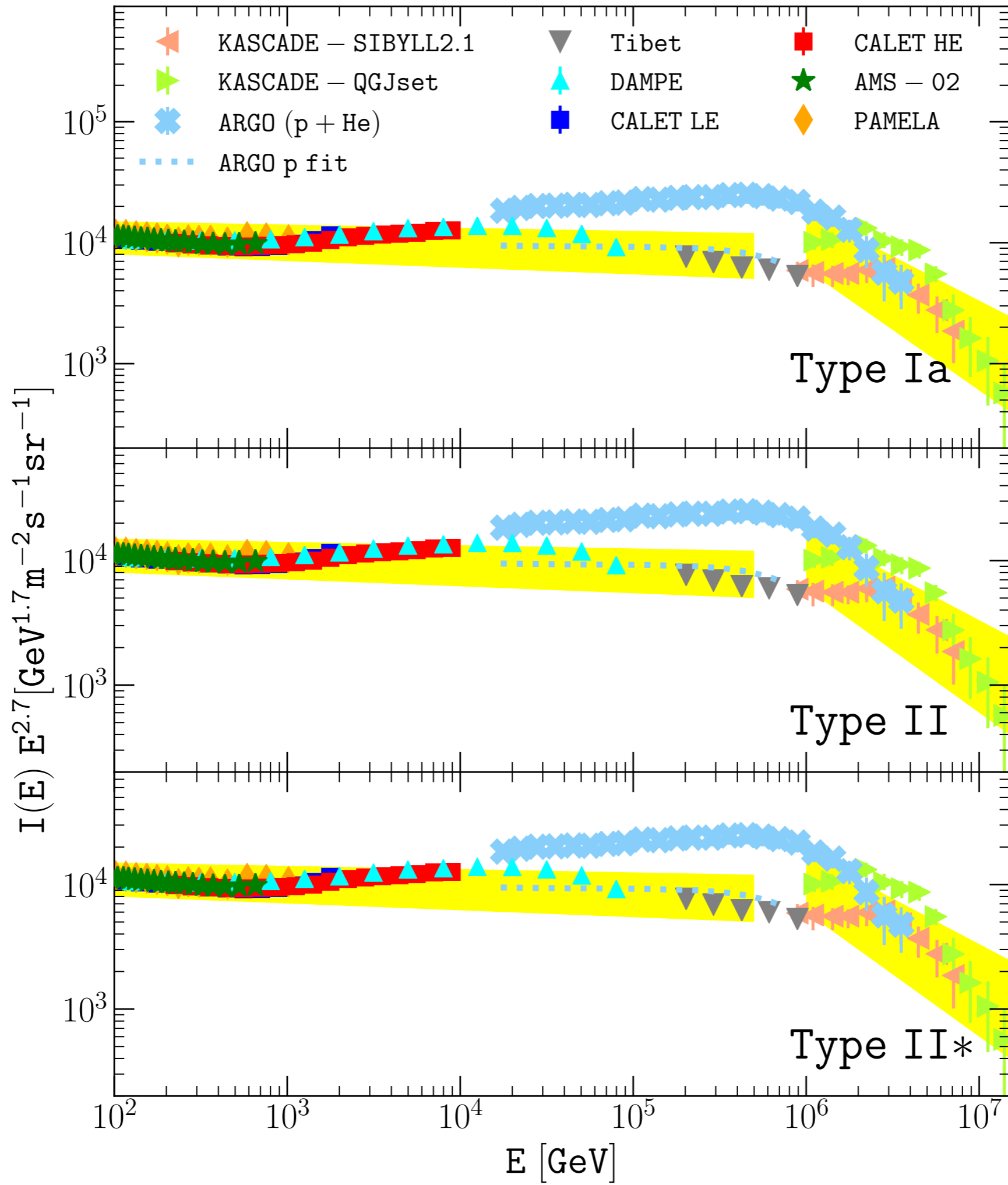
2. Very simple Galactic transport

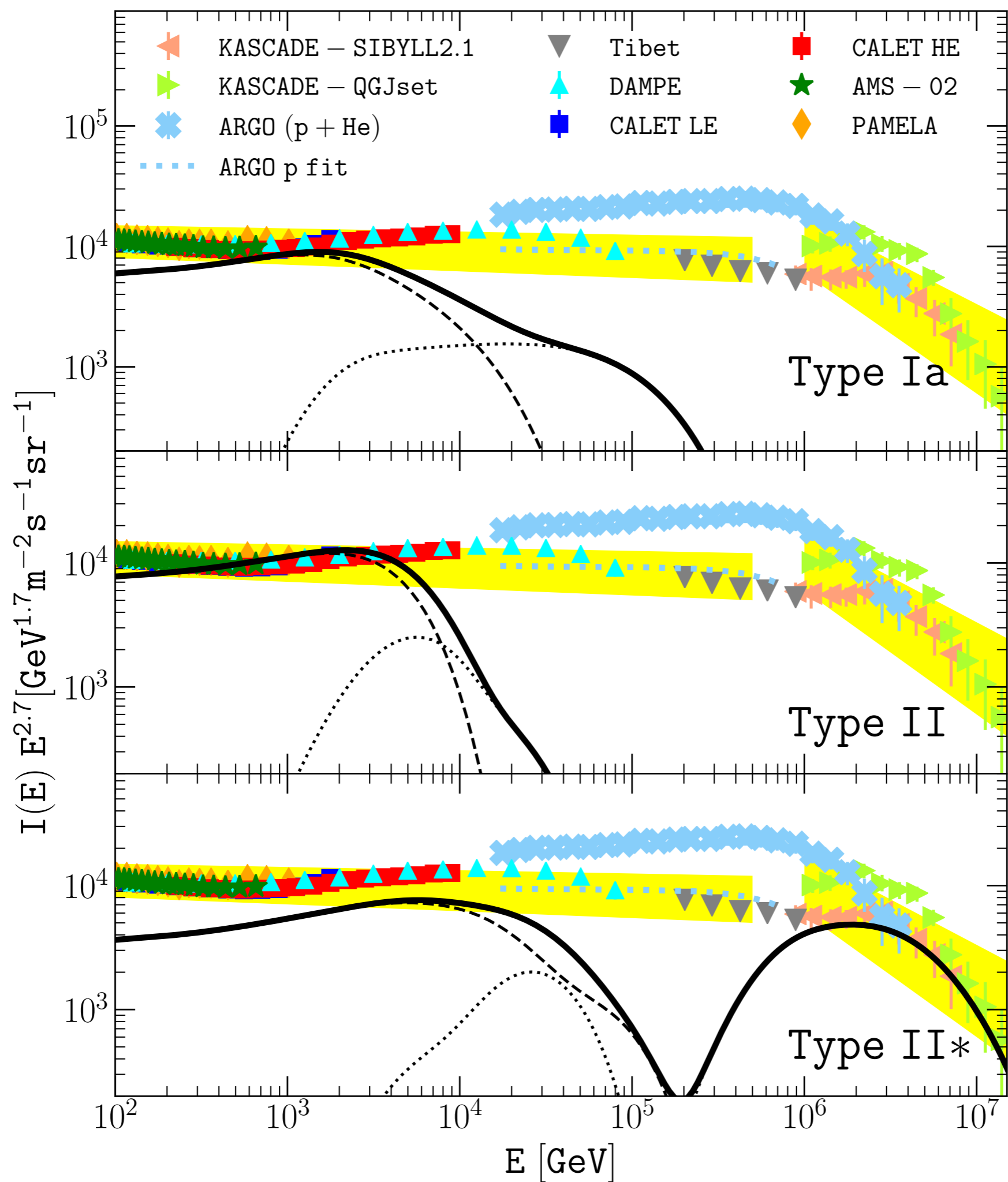
$$-\frac{\partial}{\partial z} \left[ D(p) \frac{\partial f}{\partial z} \right] + u \frac{\partial f}{\partial z} - \frac{du}{dz} \frac{p}{3} \frac{\partial f}{\partial p} + \frac{1}{p^2} \frac{\partial}{\partial p} \left[ p^2 \left( \frac{dp}{dt} \right)_{\text{ion}} f \right] = q(p, z)$$



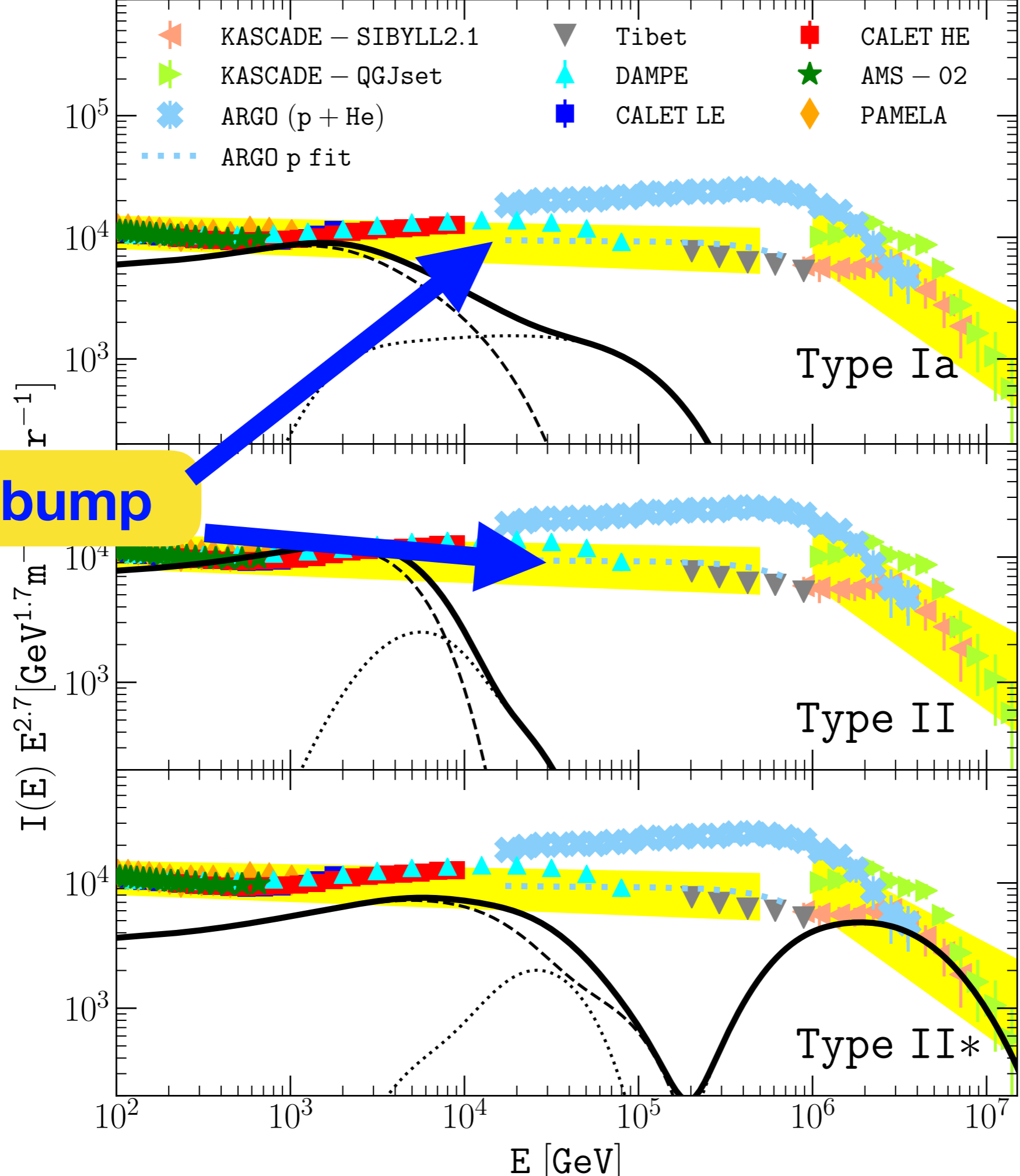
**SNRs injecting particles**

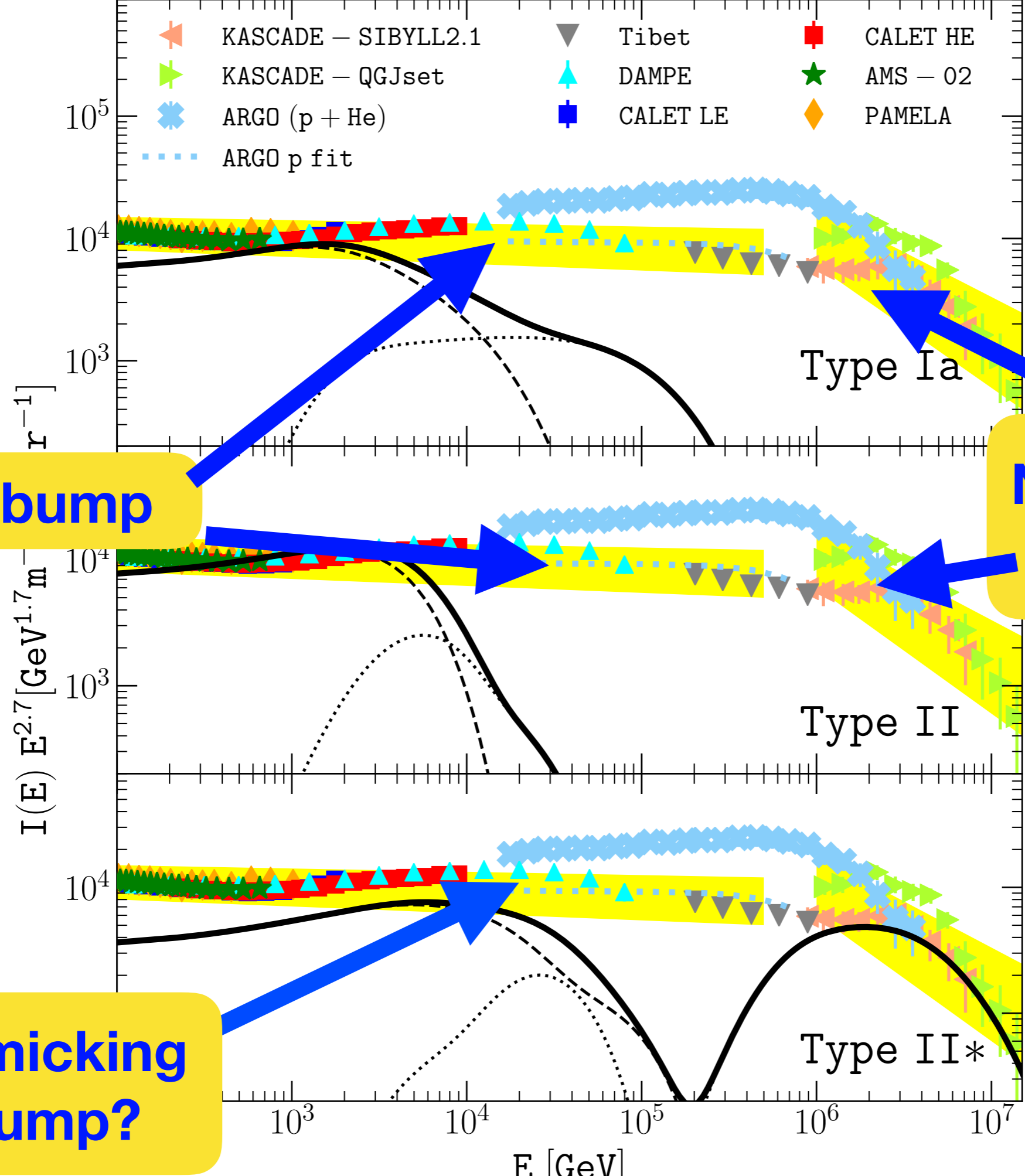
**Galactic disk**  
 $z = 0$

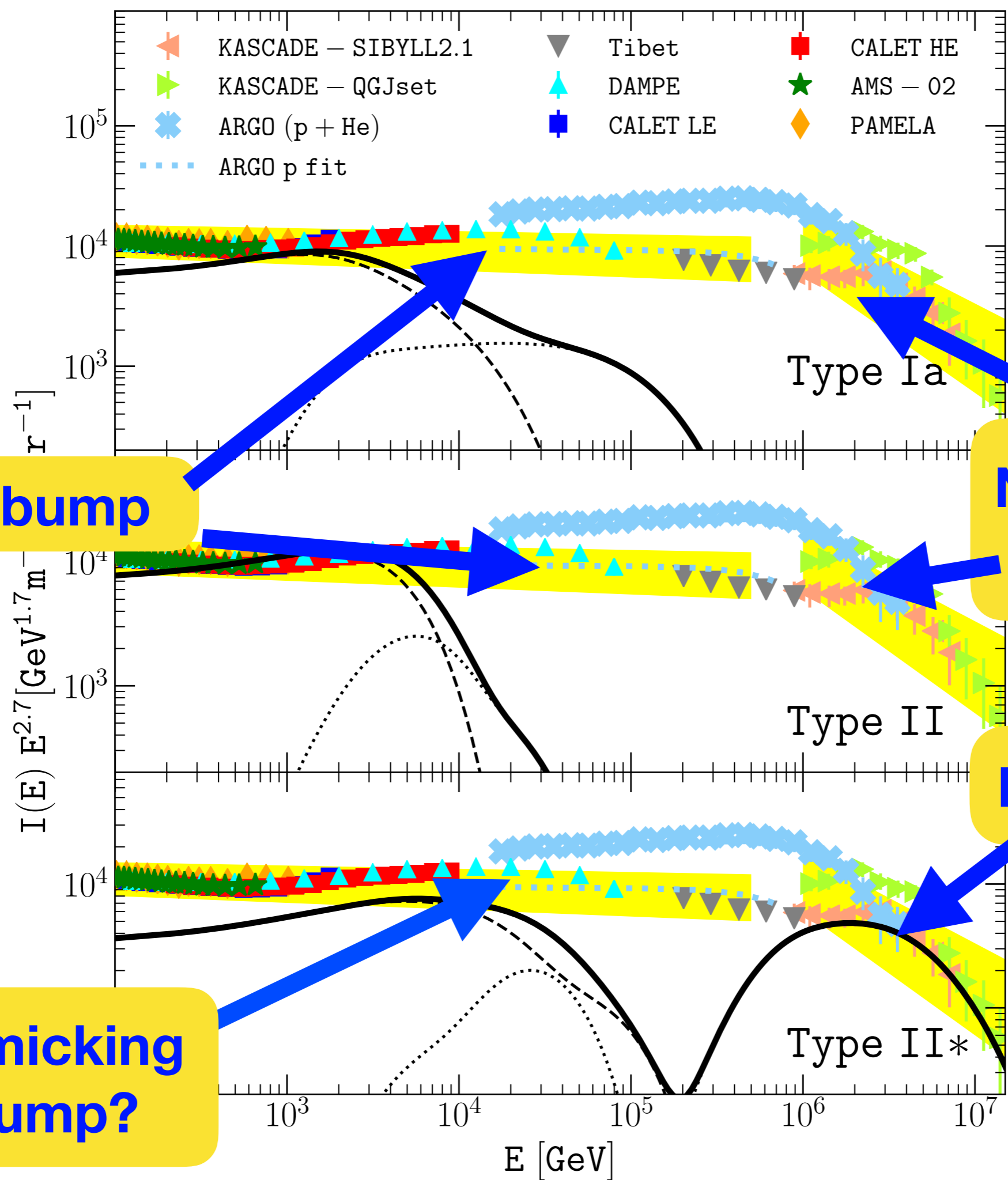


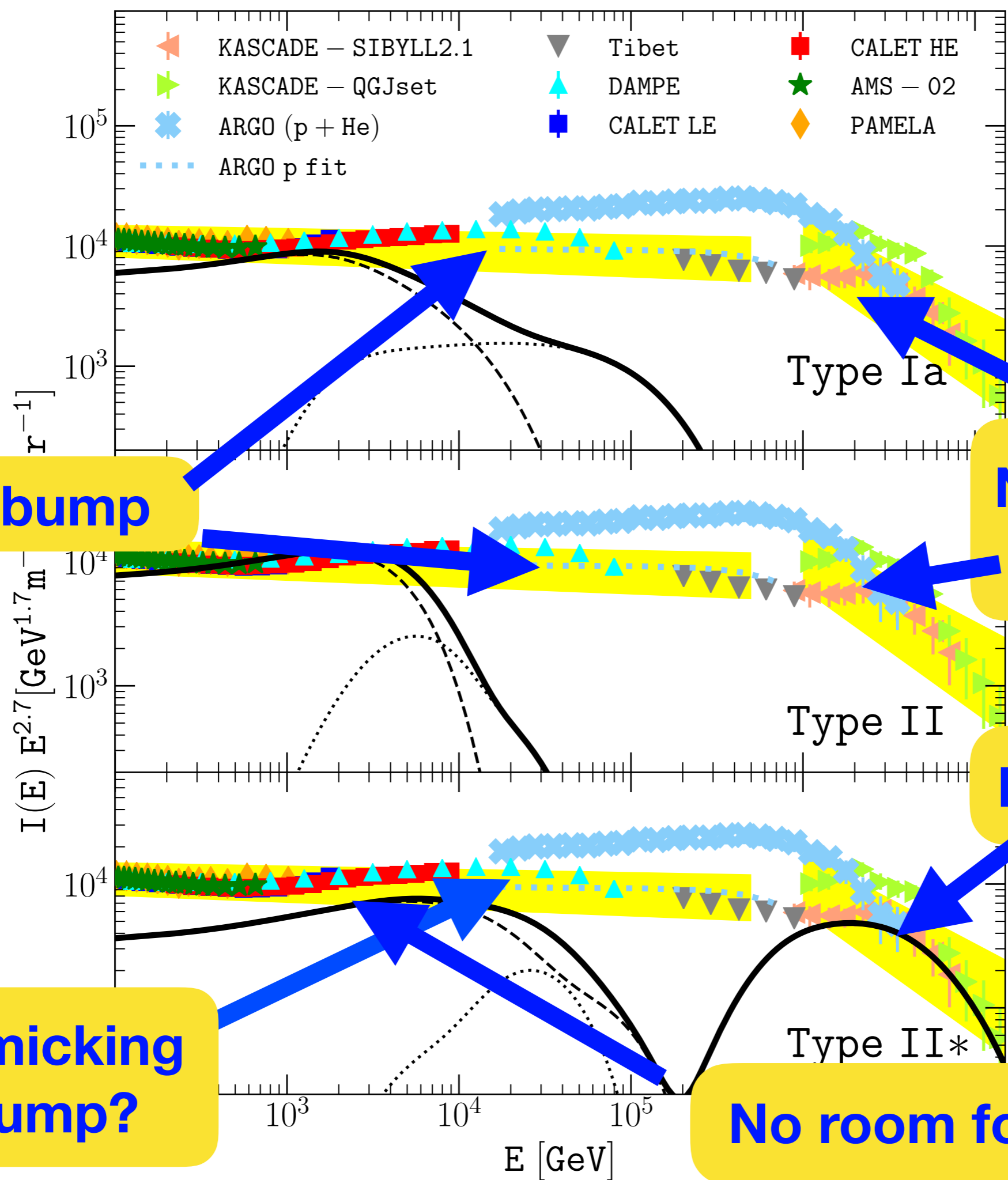


**No bump**









**No bump**

**Not reaching PeV**

**Reaching PeV**

**Mimicking bump?**

**No room for other SNRs**



**Simple bump -> Strong  
implications in the CR world**

- 1. Maximum energy? New mechanism?**
- 2. Knee, really?**
- 3. Reacceleration?**
- 4. Other sources? (Massive stars?)**
- 5.**

**Let's talk about it..**