Probing the UV-optical backgrounds with GLAST

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TeV Blazars as Probes of the EBL Intensity

(Stecker et al.)

- TeV gamma-rays are attenuated by the EBL
- Allow for the determination of EBL in a wavelength region (5 – 60 μm) dominated by emission from interplanetary dust
- Problem: Intrinsic source spectrum is unknown

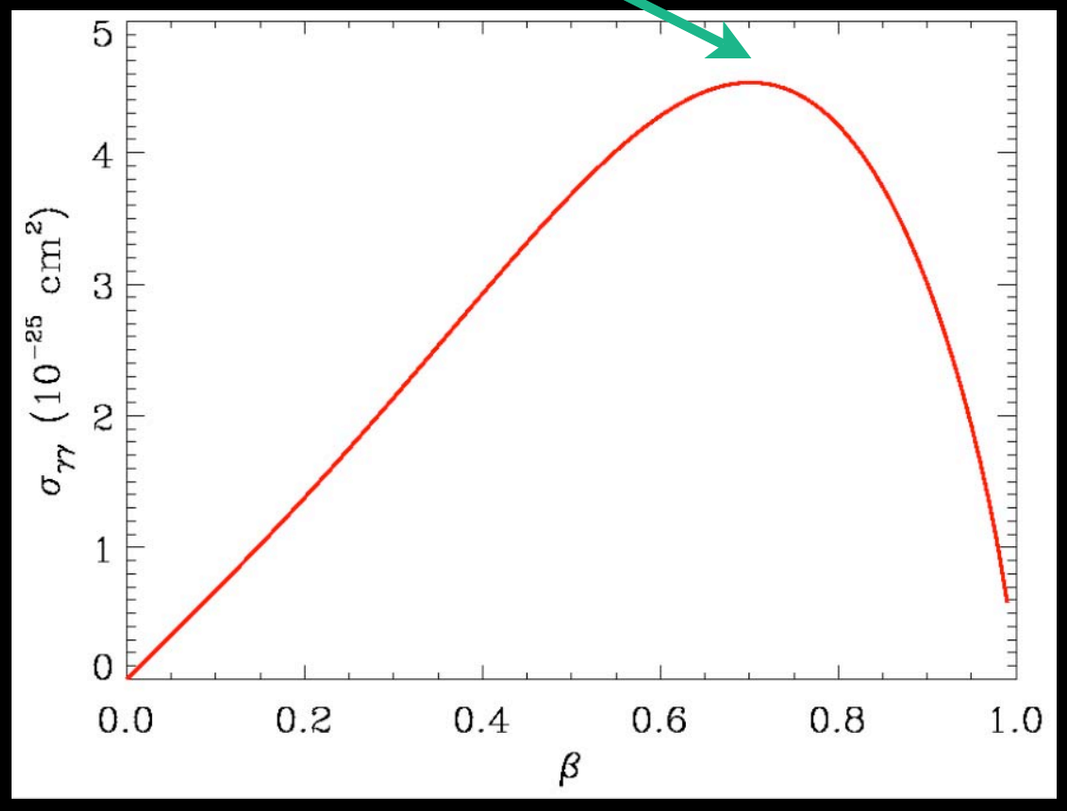
Peak cross section at energies:

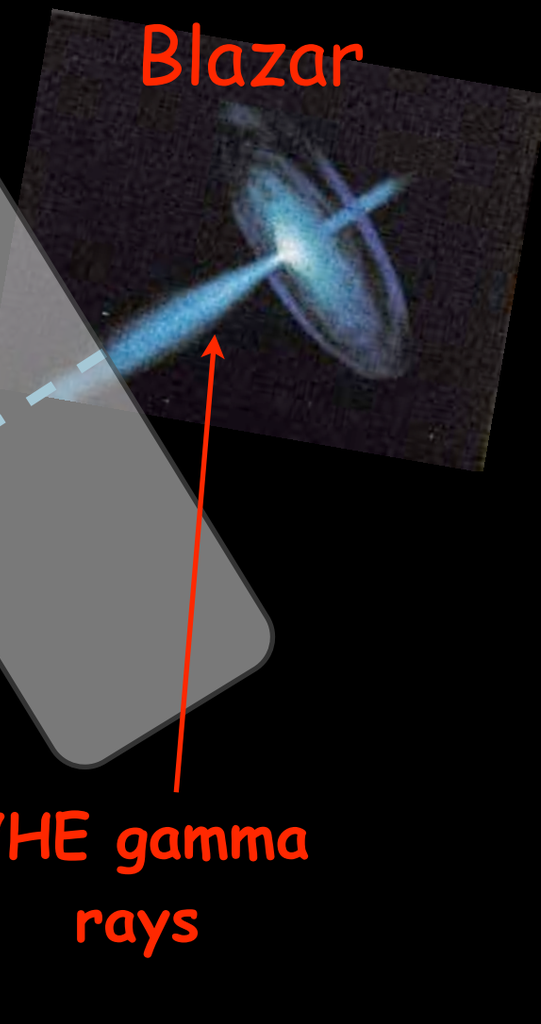
$E_\gamma(\mathrm{TeV})\varepsilon_b(\mathrm{eV}) \approx 1\ \mathrm{MeV}^2$

or

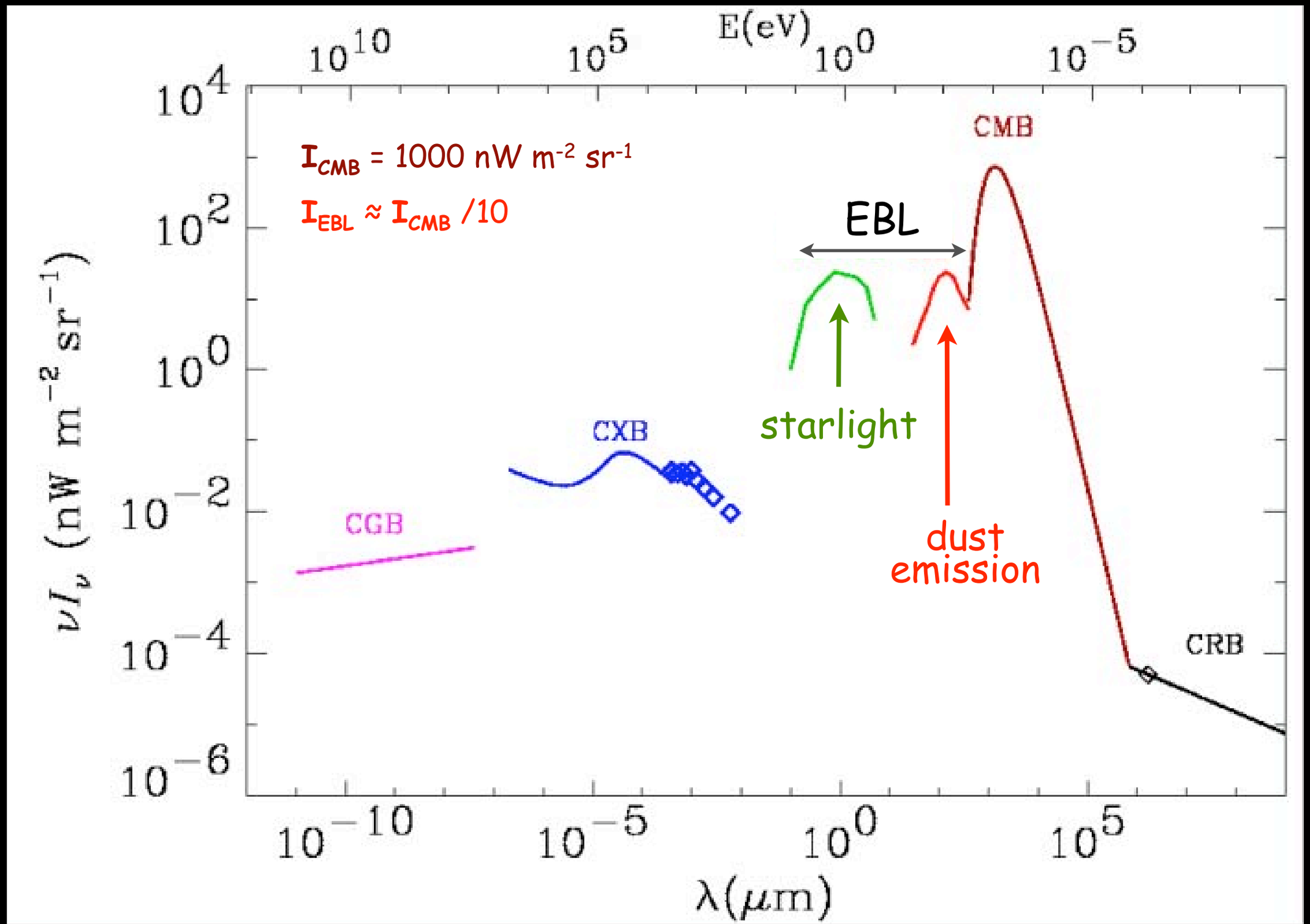
$\lambda_b(\mu\mathrm{m}) \approx 1.24\ E_\gamma(\mathrm{TeV})$

$$\gamma_b + \gamma_{EBL} \longrightarrow e^+ + e^-$$

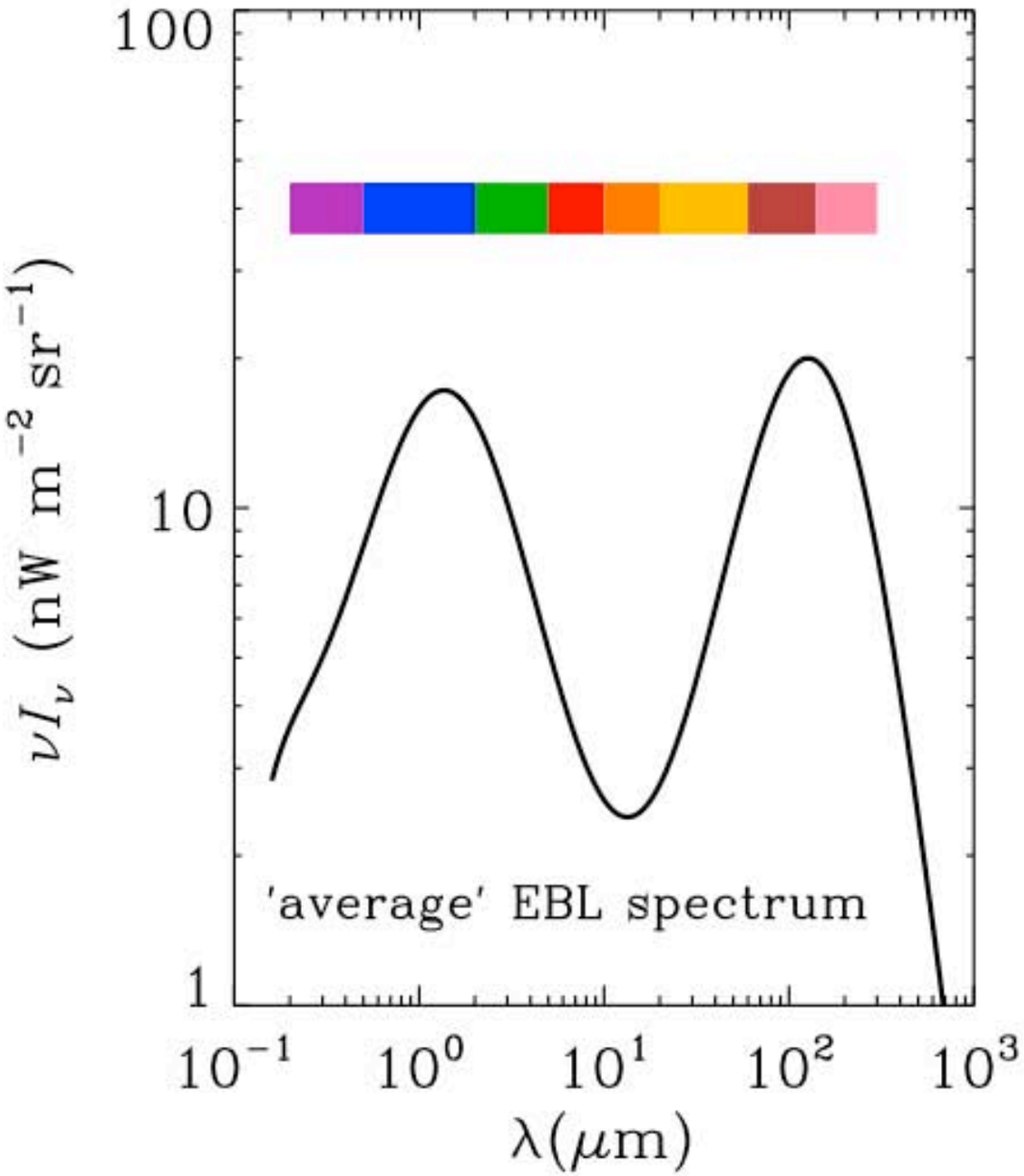


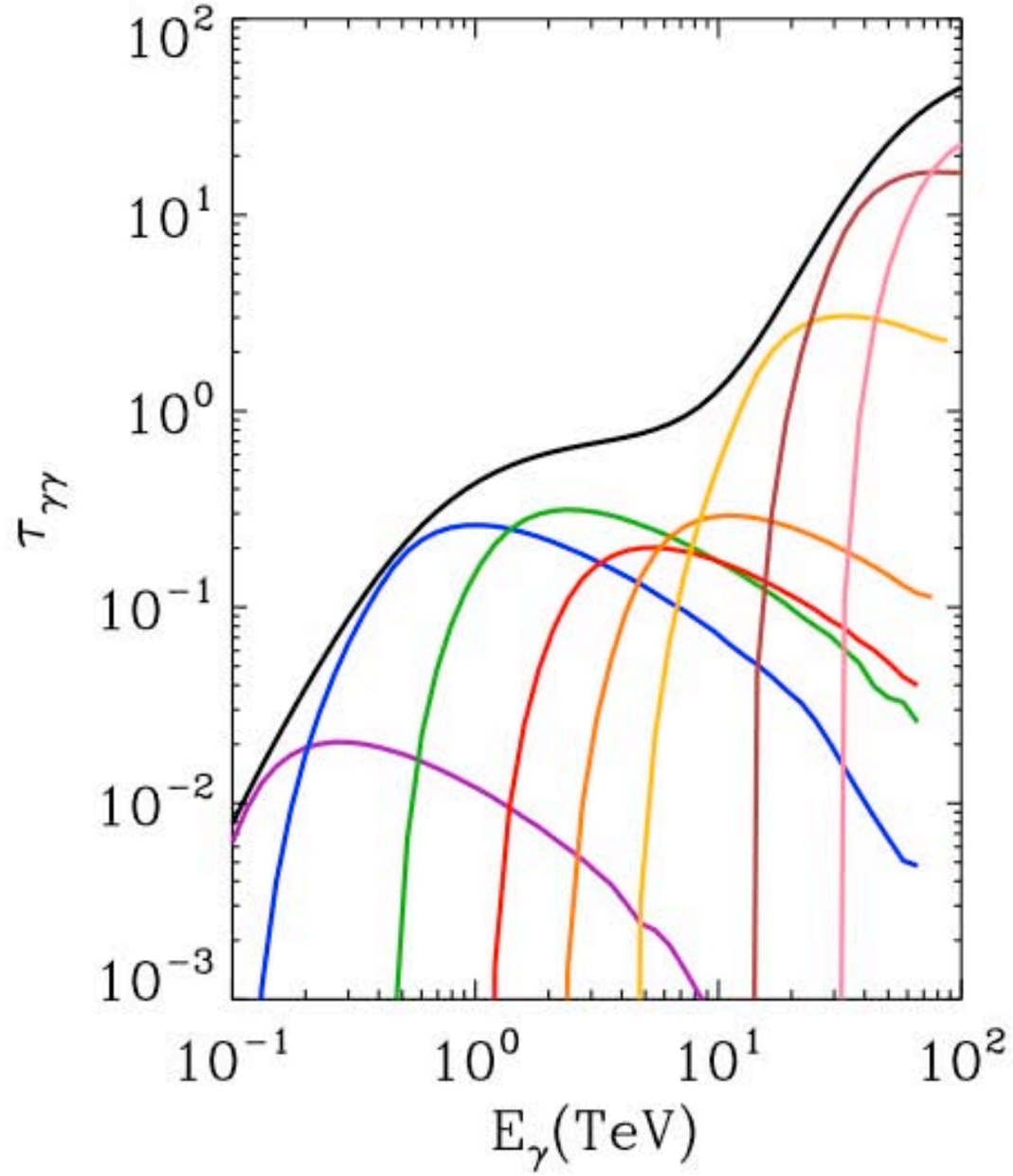


The Extragalactic Background Light (EBL) in Context of Other Backgrounds



Probing the EBL with TeV gamma-rays





The EBL at Near-IR Wavelengths (NIBL)

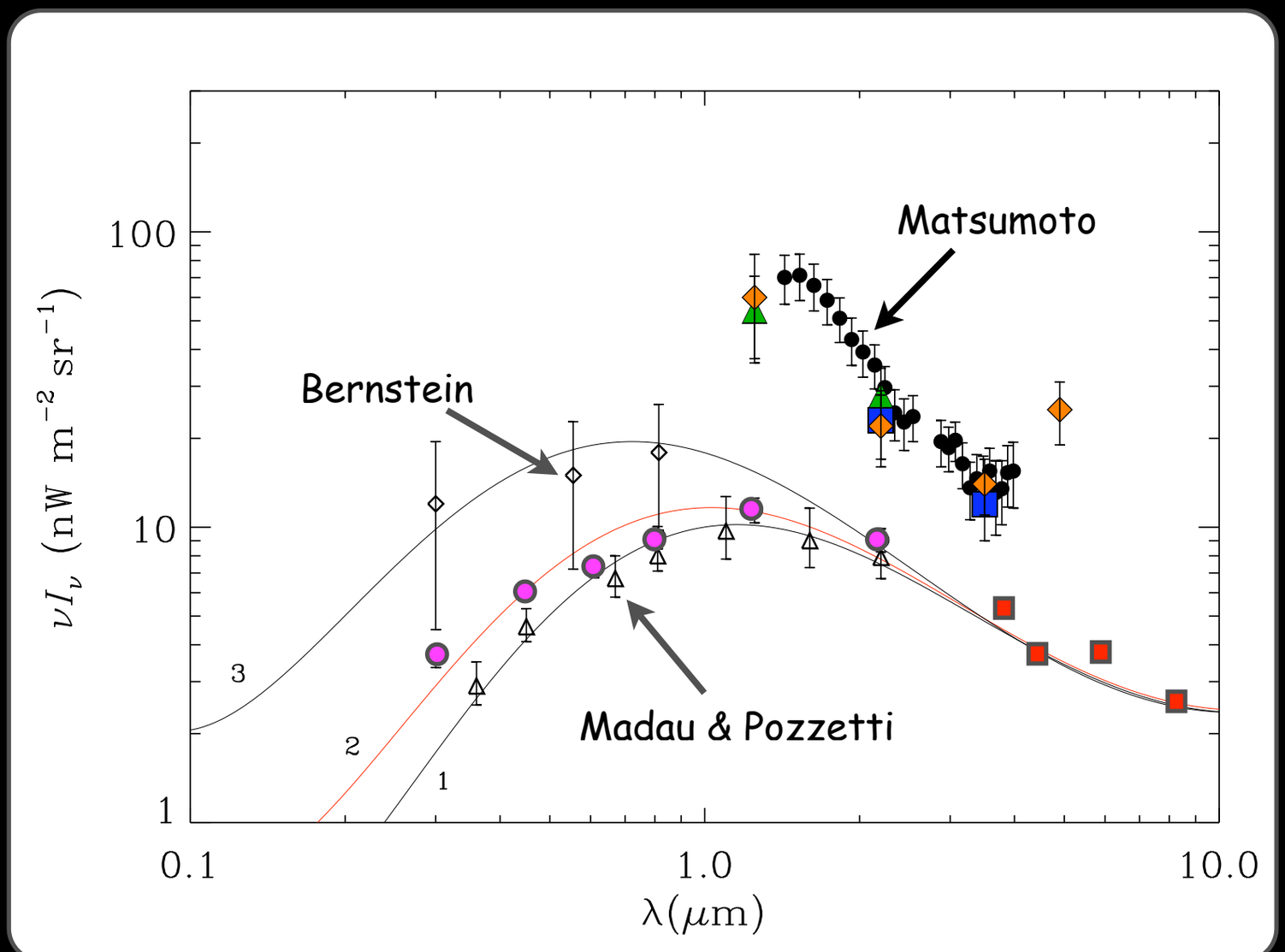
Totani et al. 2001

Arendt & Dwek 2003

Cambresy et al. 2001

Wright 2001

Fazio et al 2004



(1) what is the EBL at UV and optical wavelengths?

(2) is there a signature of Pop III stars in the EBL?

Issues that can be addresses by GLAST

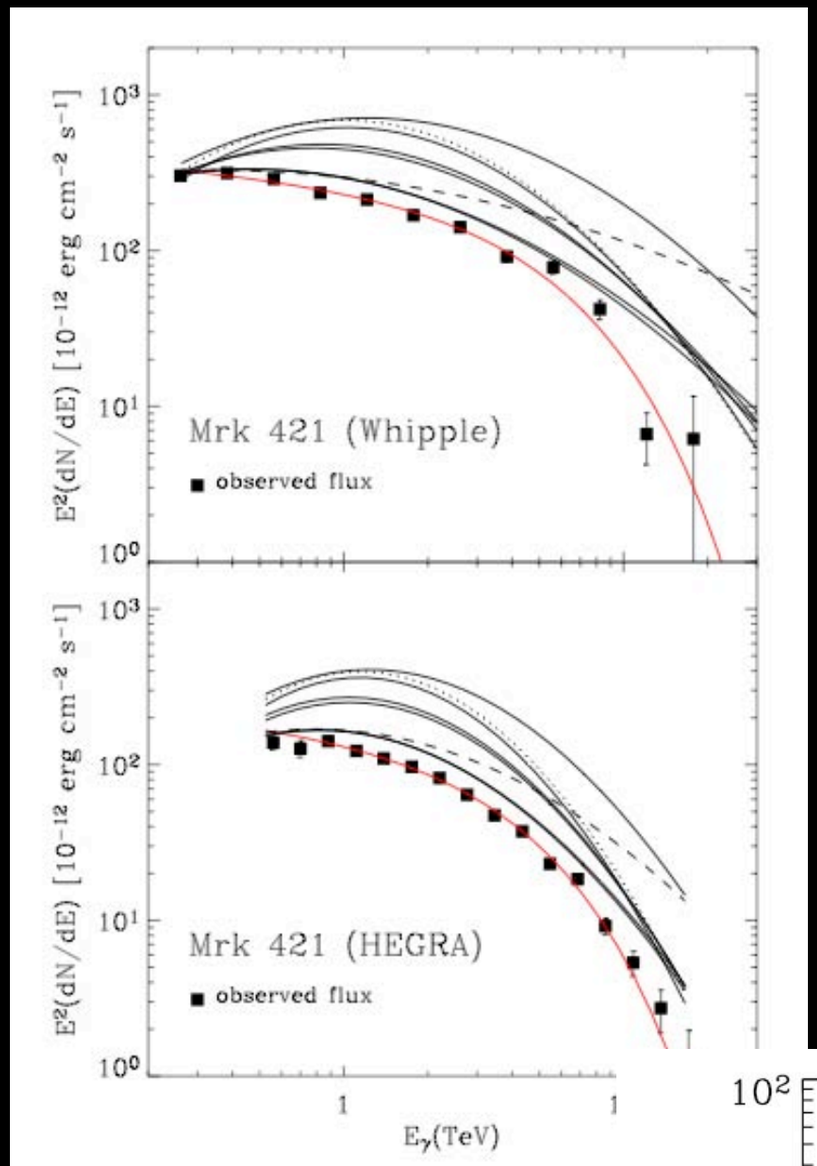
- Simultaneous constraints on the intrinsic blazar spectrum at energies < 100 GeV and the EBL at wavelengths < 0.1 μm
- Search for the signatures of Pop III stars
- Inventory of cosmological HII regions

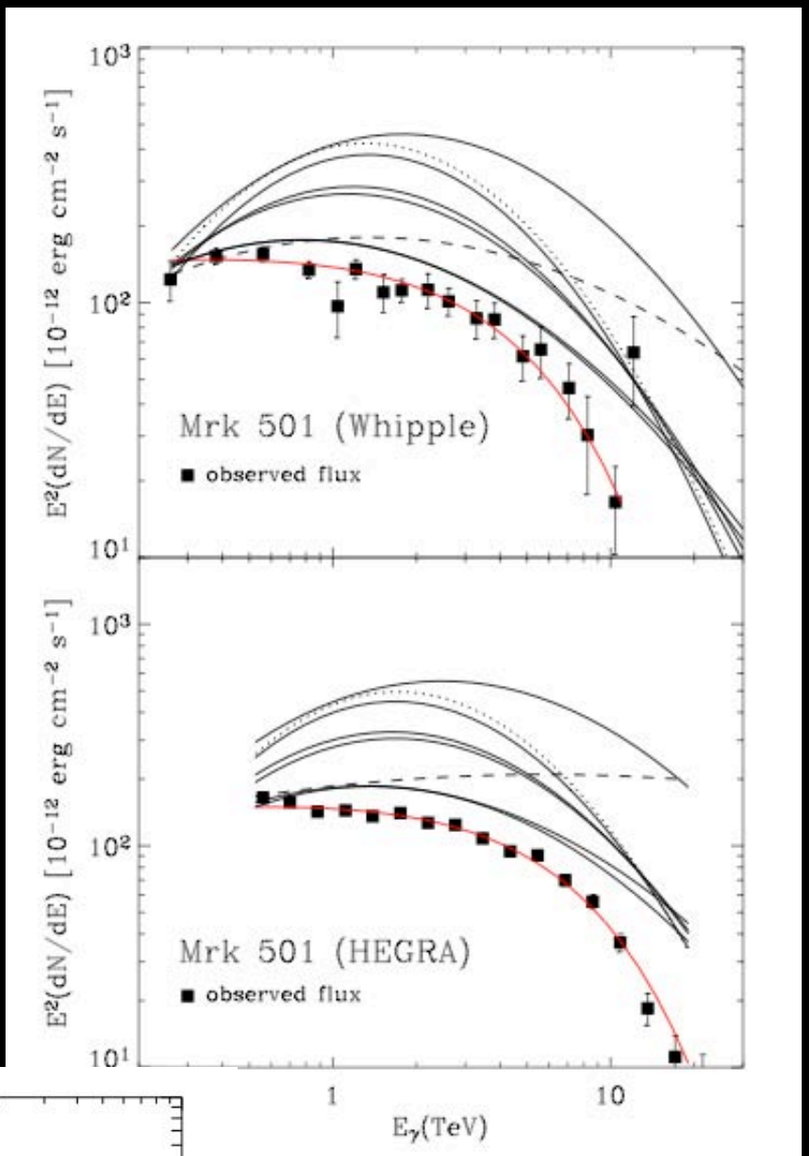
(1)

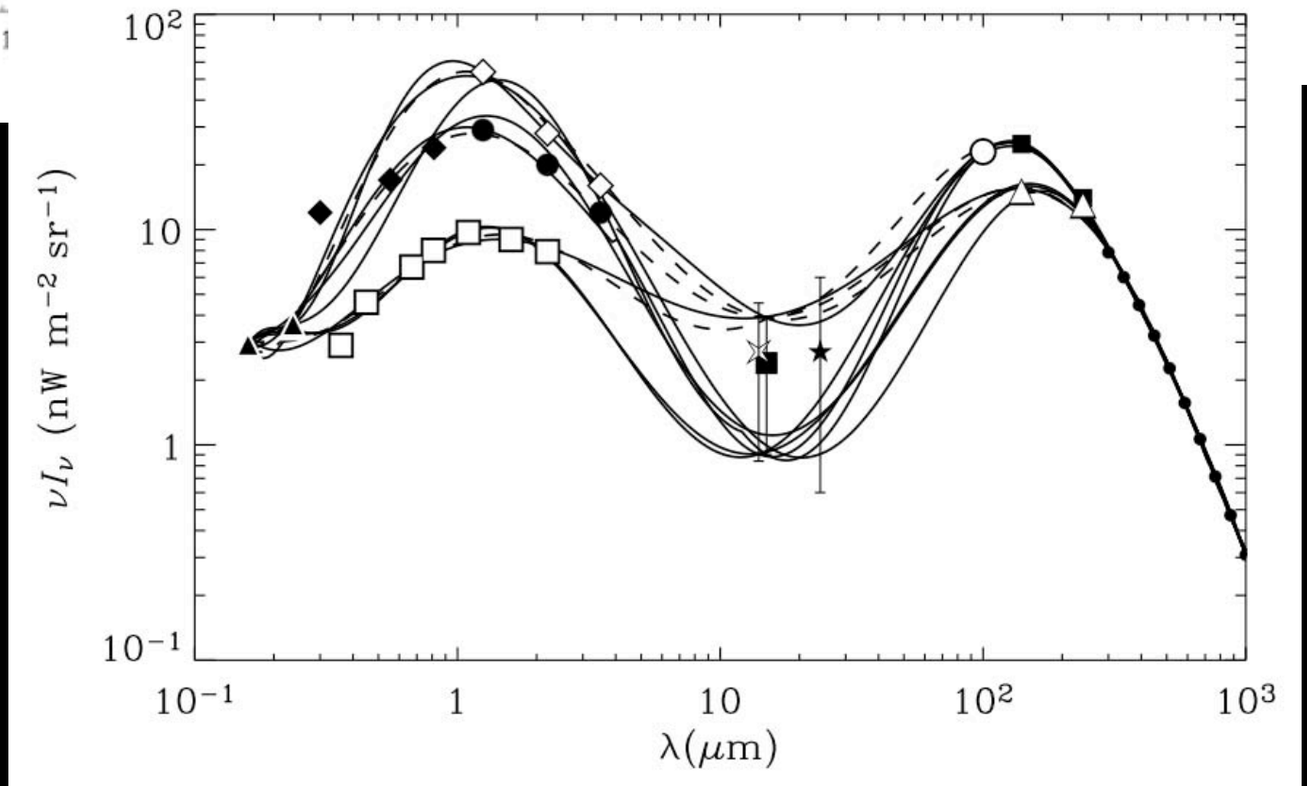
Simultaneous Constraints on the intrinsic blazar spectra and the EBL

Viable Intrinsic Blazar and EBL Spectra

Constraints on gamma-ray production mechanisms





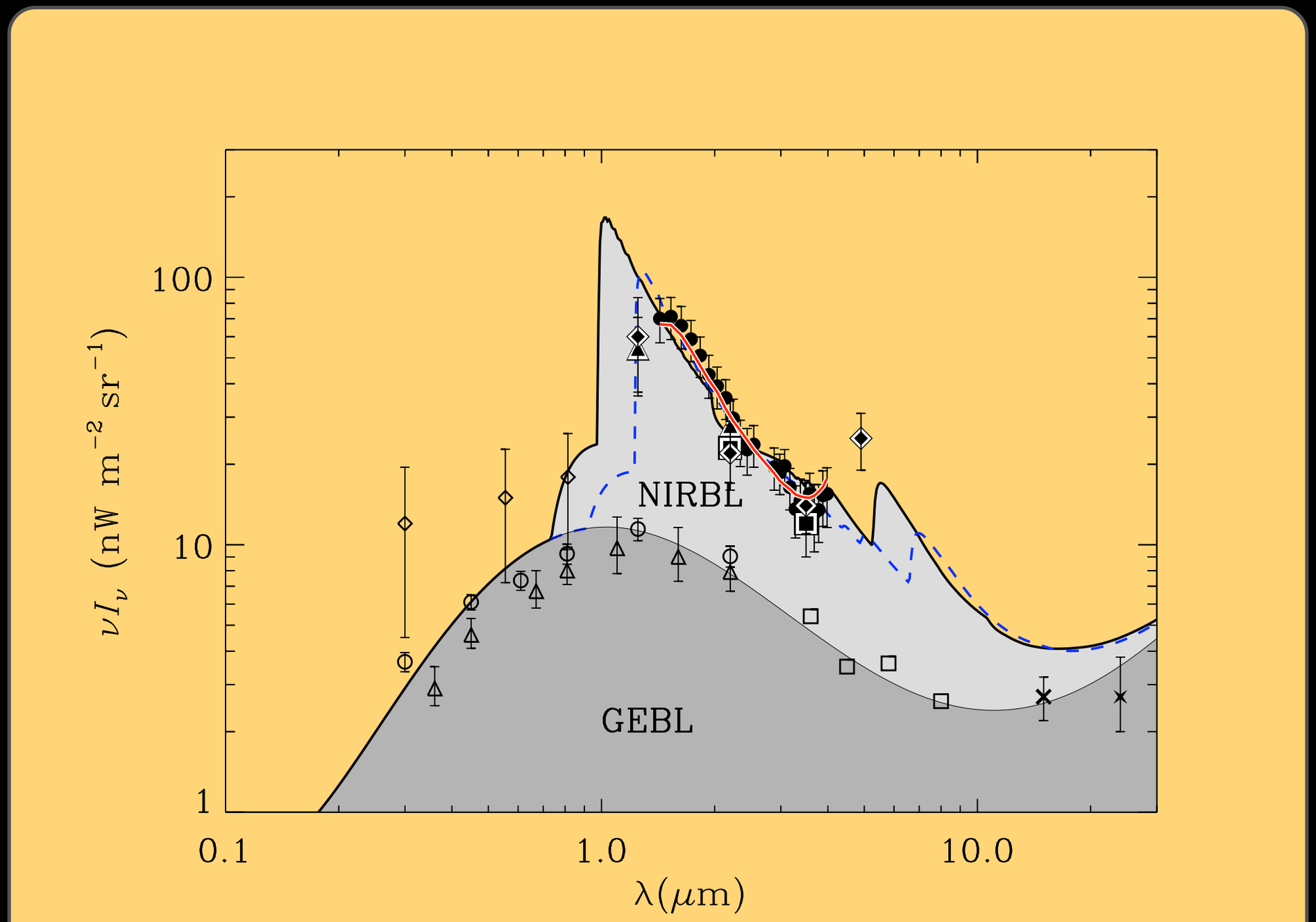


(Dwek, Arendt, & Krennrich 2005)

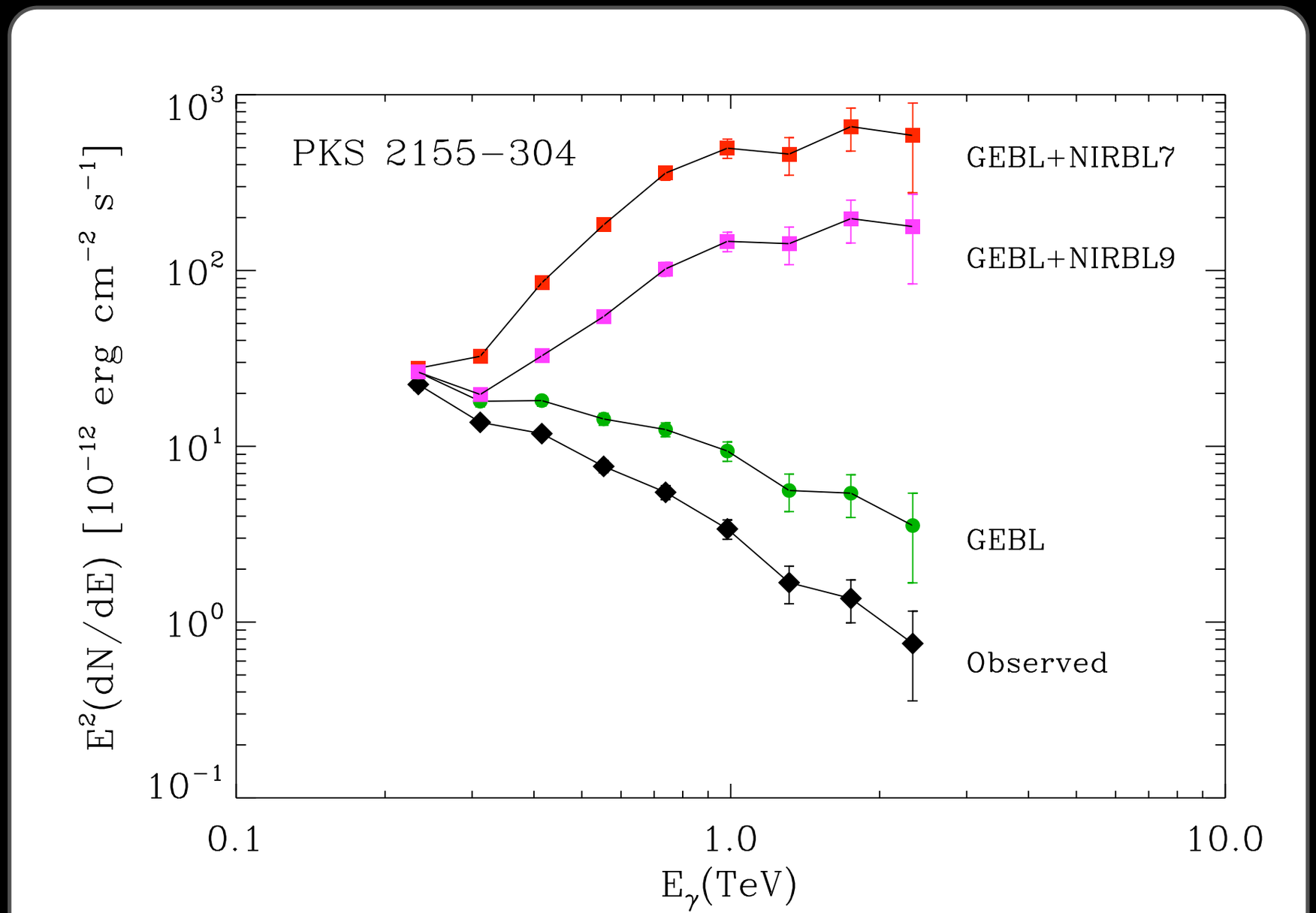
Best fit Pop III models

$z_{min} = 7$ $z_{max} = 15$ (NIRBL7)

$z_{min} = 9$ $z_{max} = 30$ (NIRBL9)

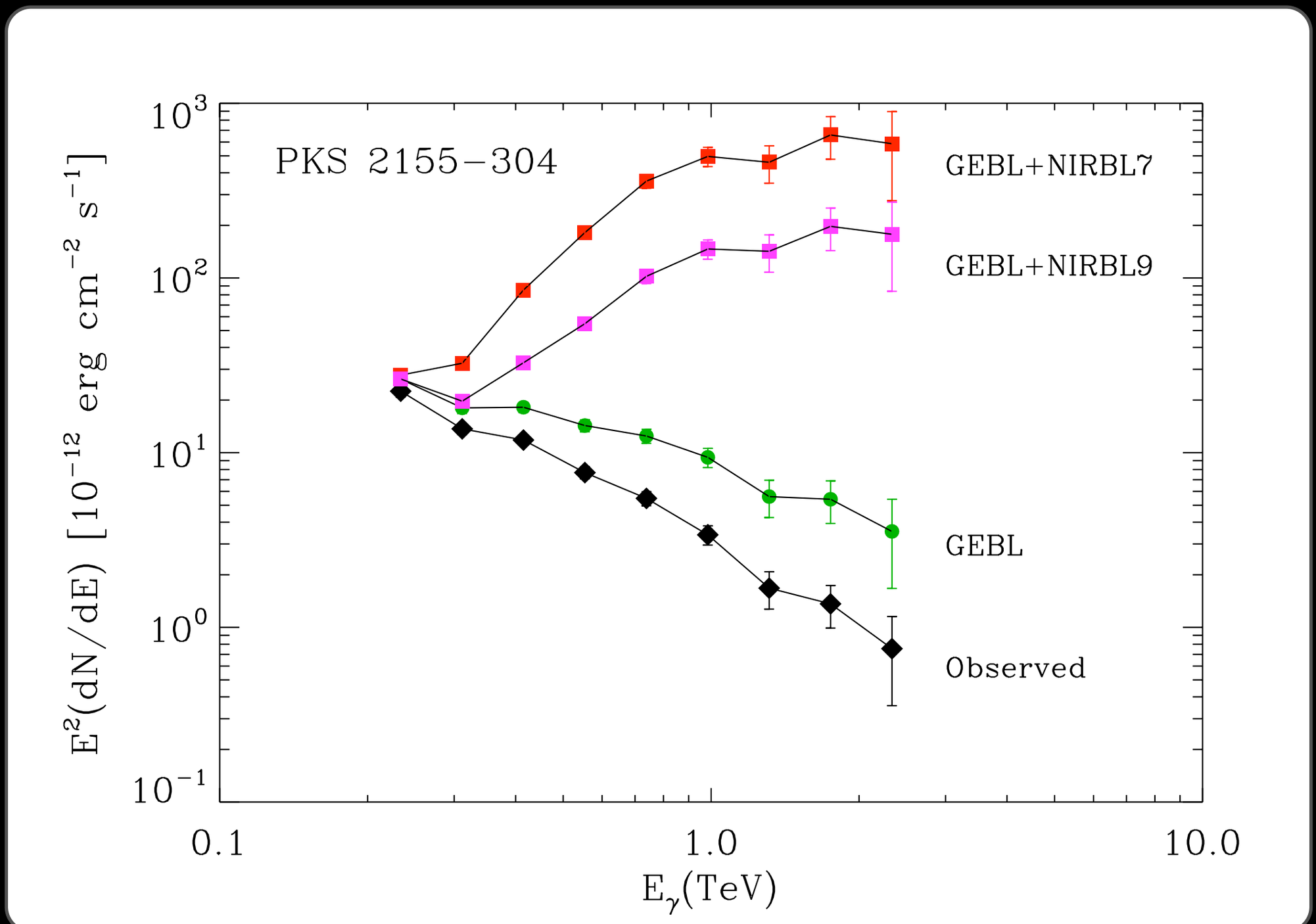


TeV Observations of PKS 2155-304 (z=0.117)



There is no evidence for the absorption signature of Pop III stars in the TeV spectrum of PKS 2155-304 (z=0.117)

H.E.S.S. (Aharonian et al. 2005)



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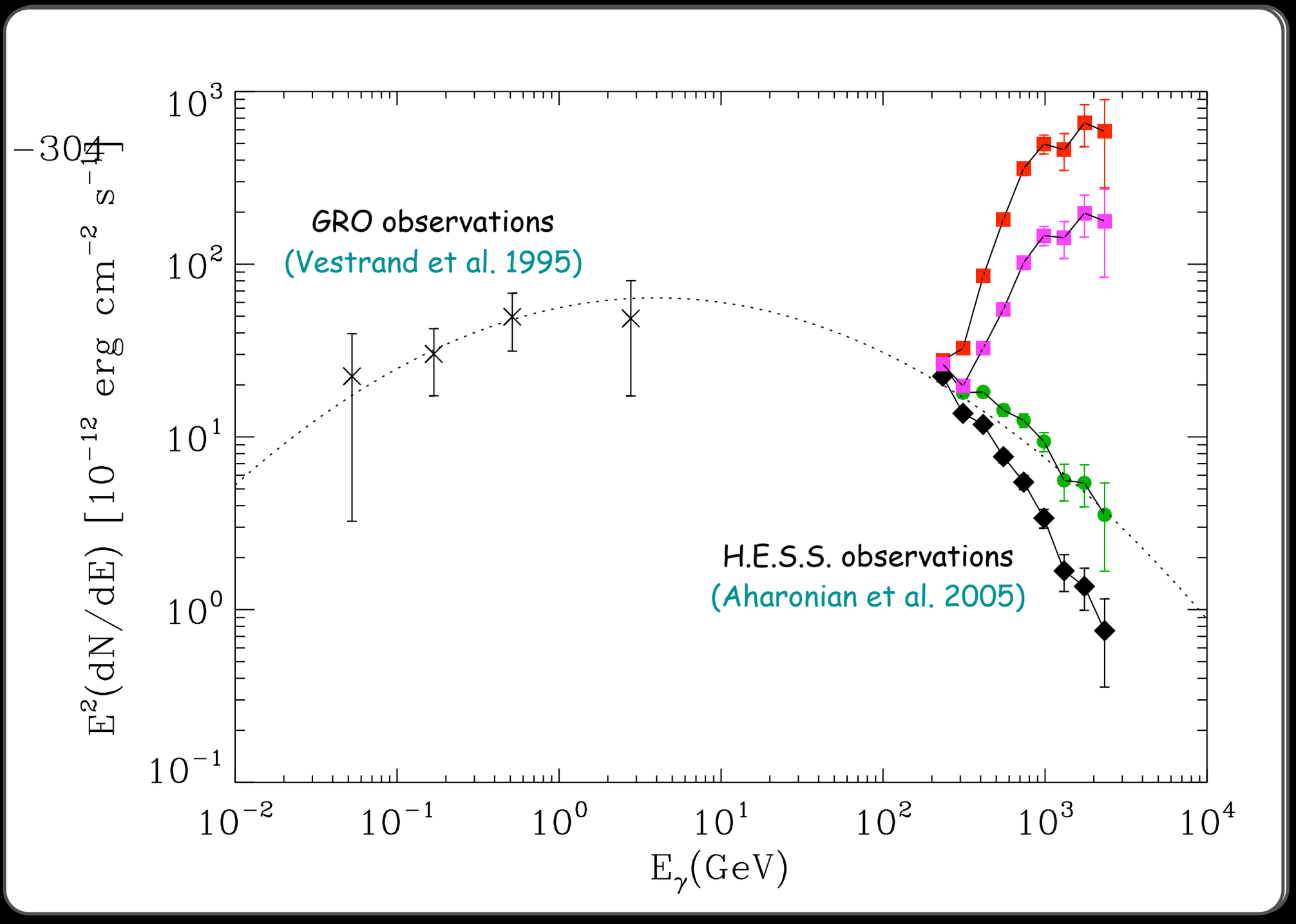
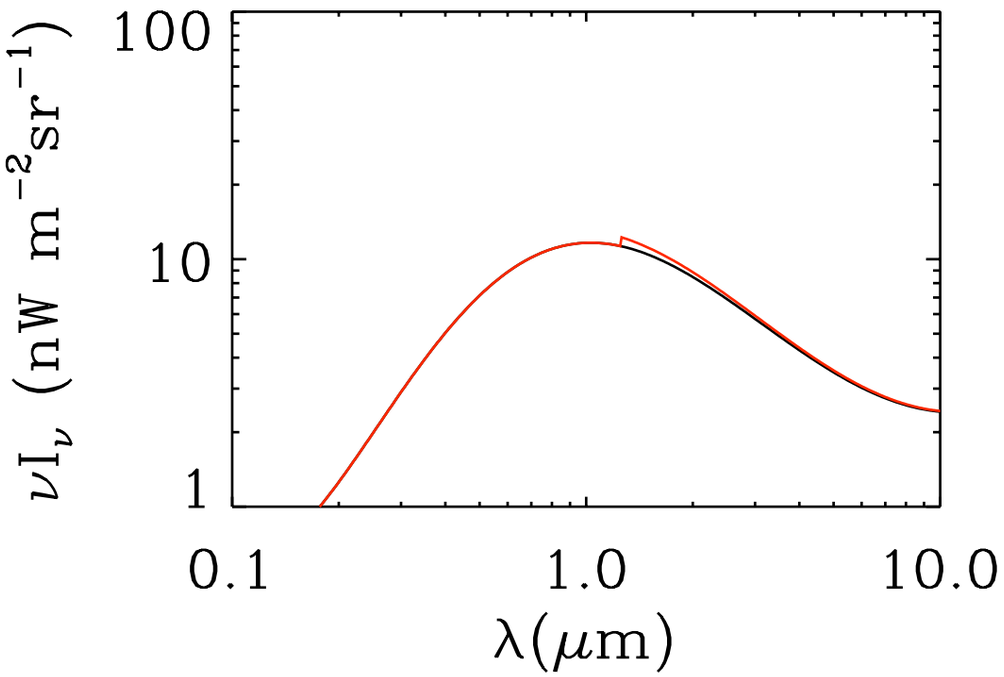


(2)

Detecting (constraining) Pop III stars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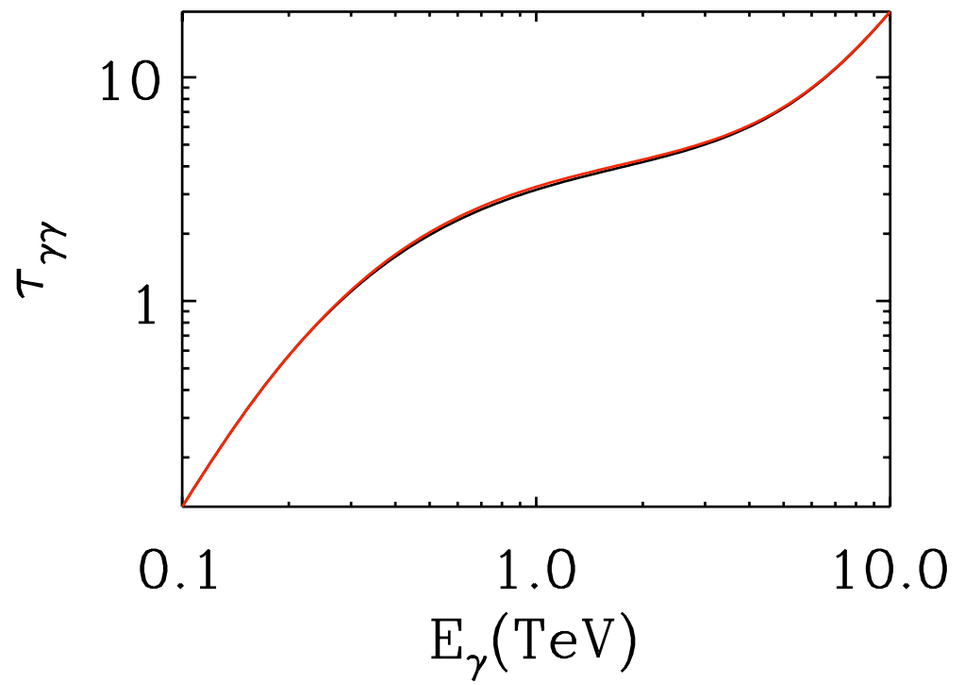
νI_ν (nW m^{-2}sr^{-1})
$\lambda(\mu m)$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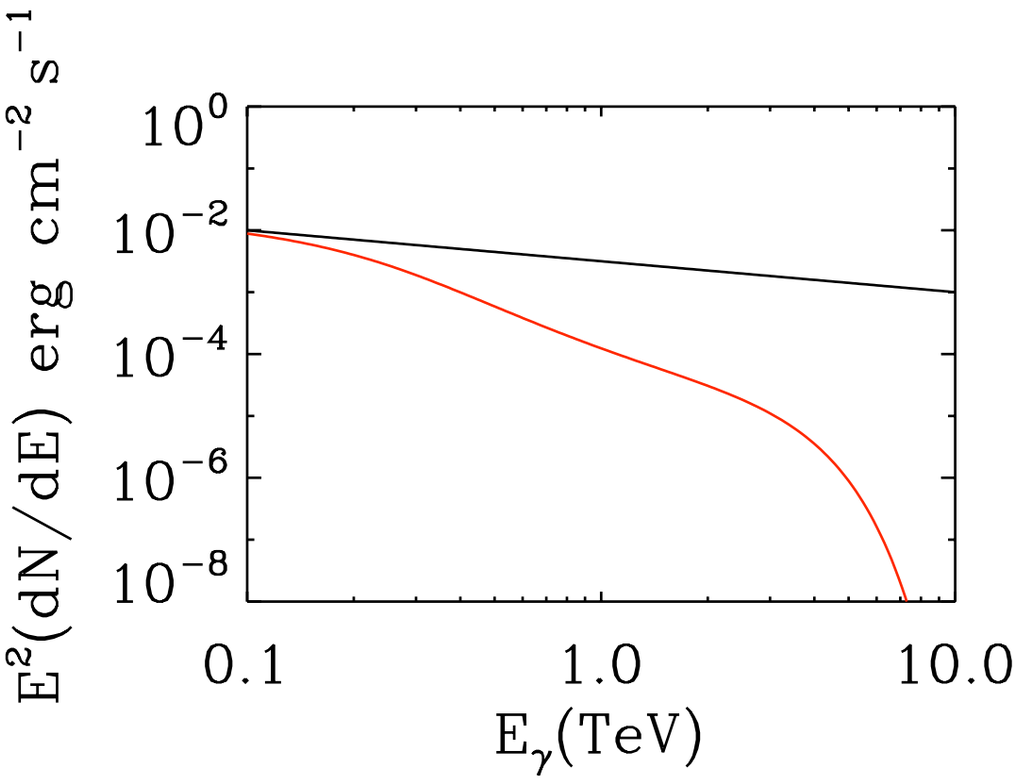
$\tau_{\gamma\gamma}$
E_γ(TeV)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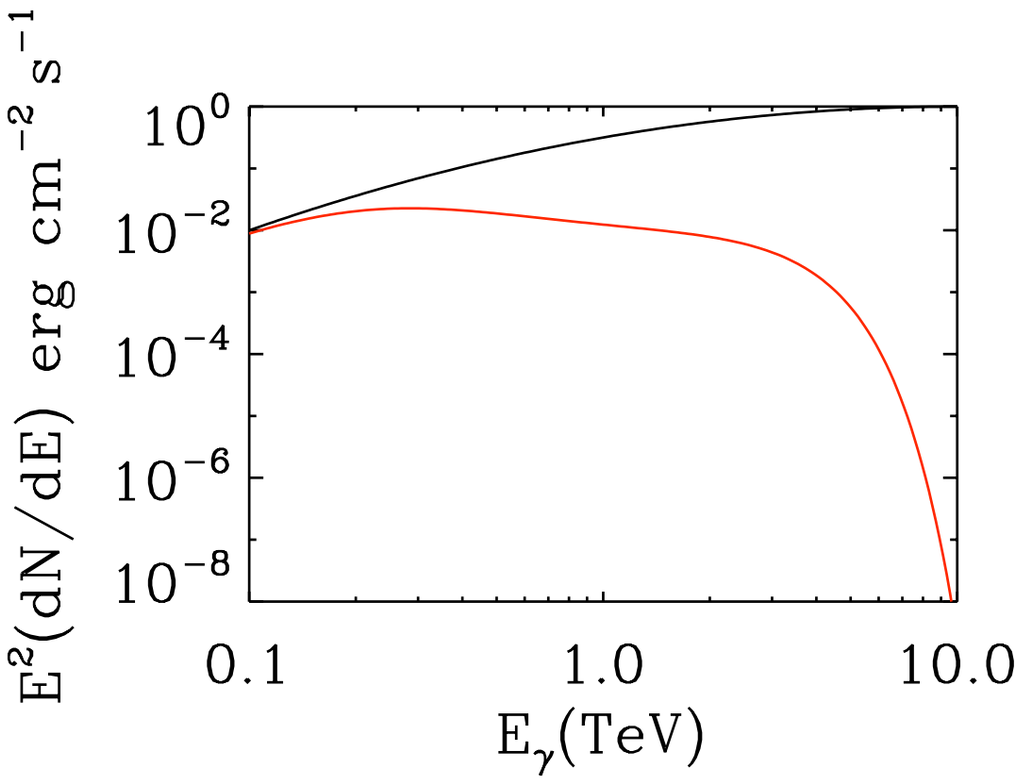
$E^2(dN/dE)$ erg cm^{-2} s^{-1}
E_γ(TeV)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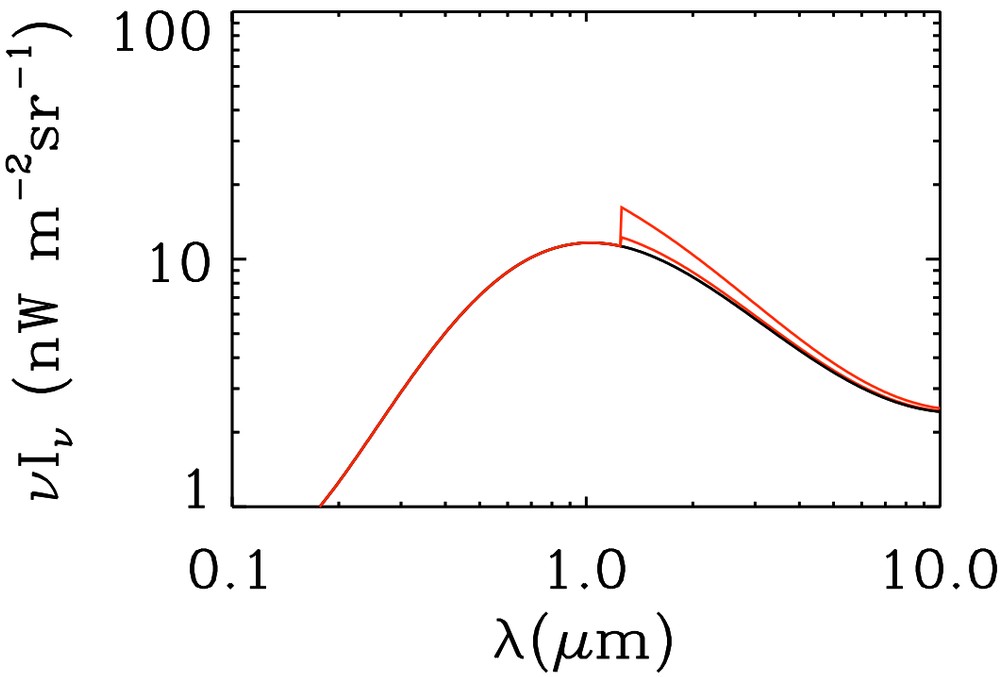
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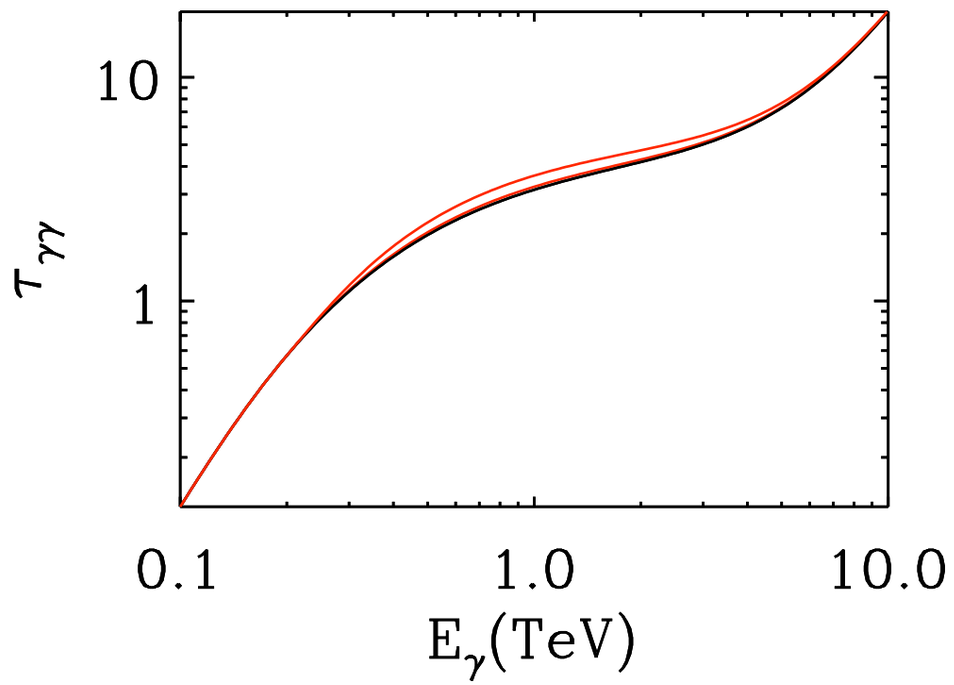
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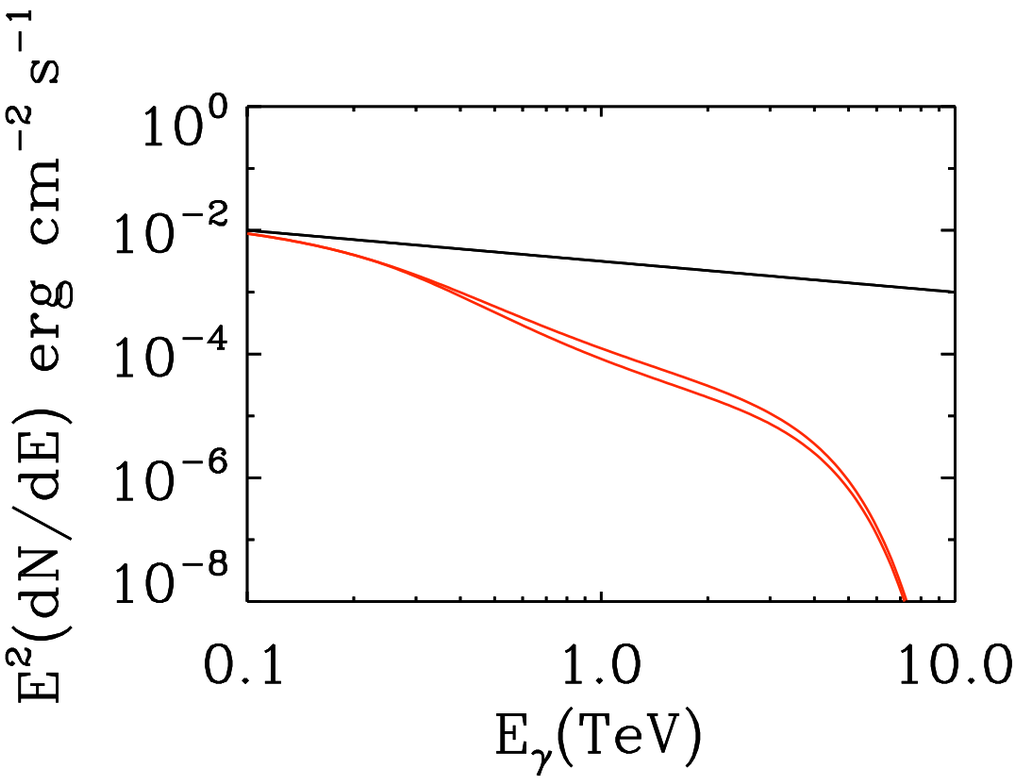
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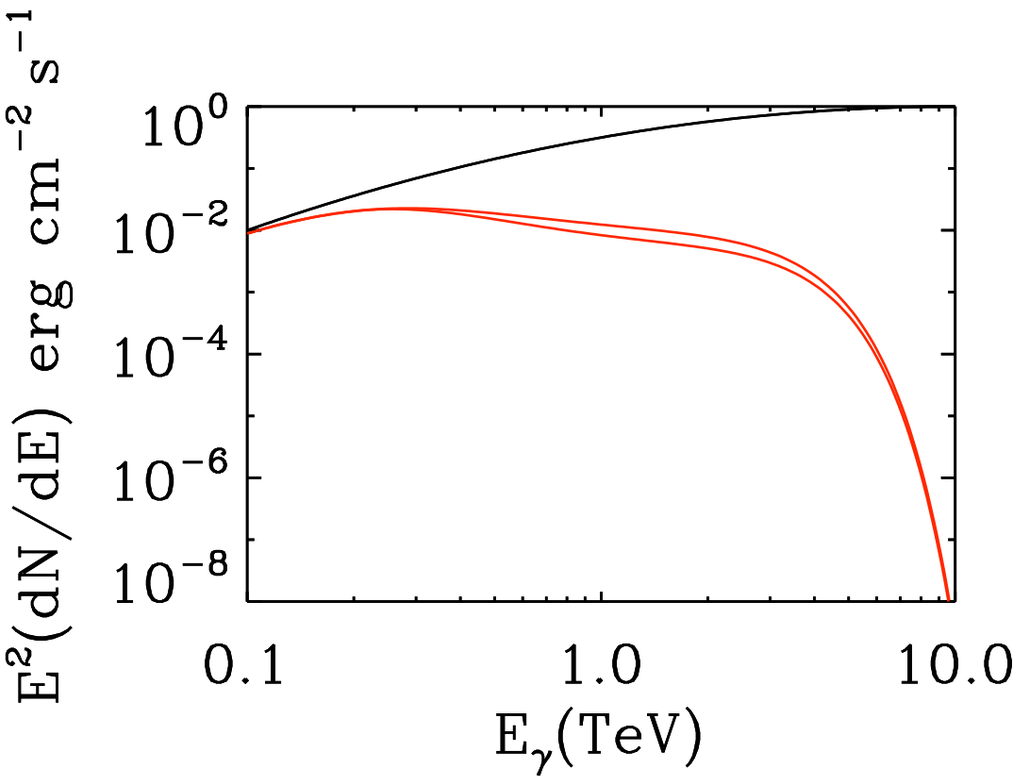
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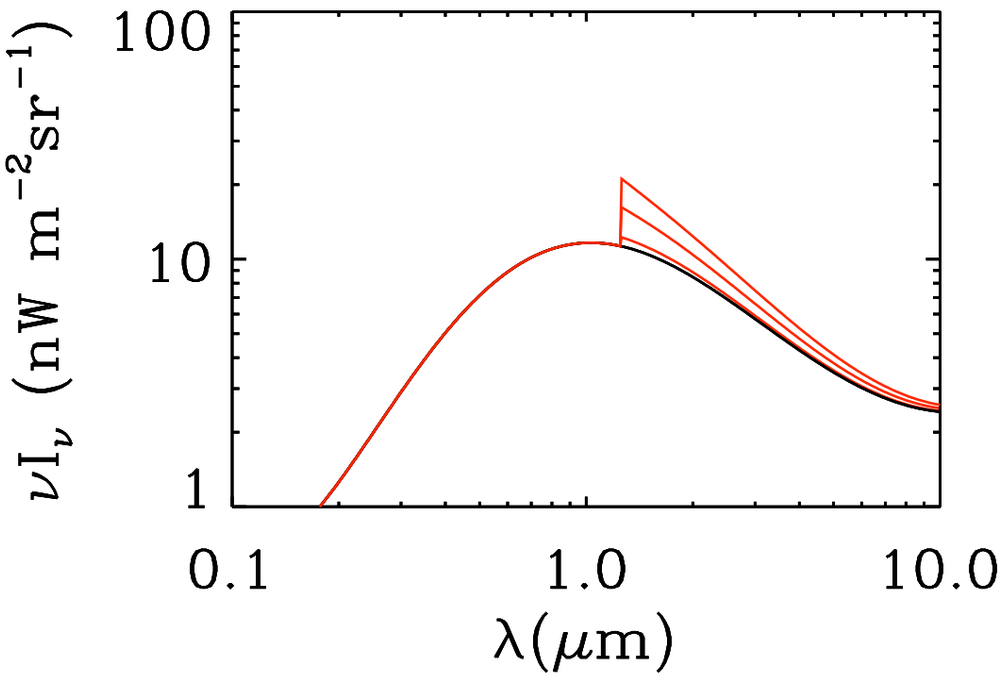
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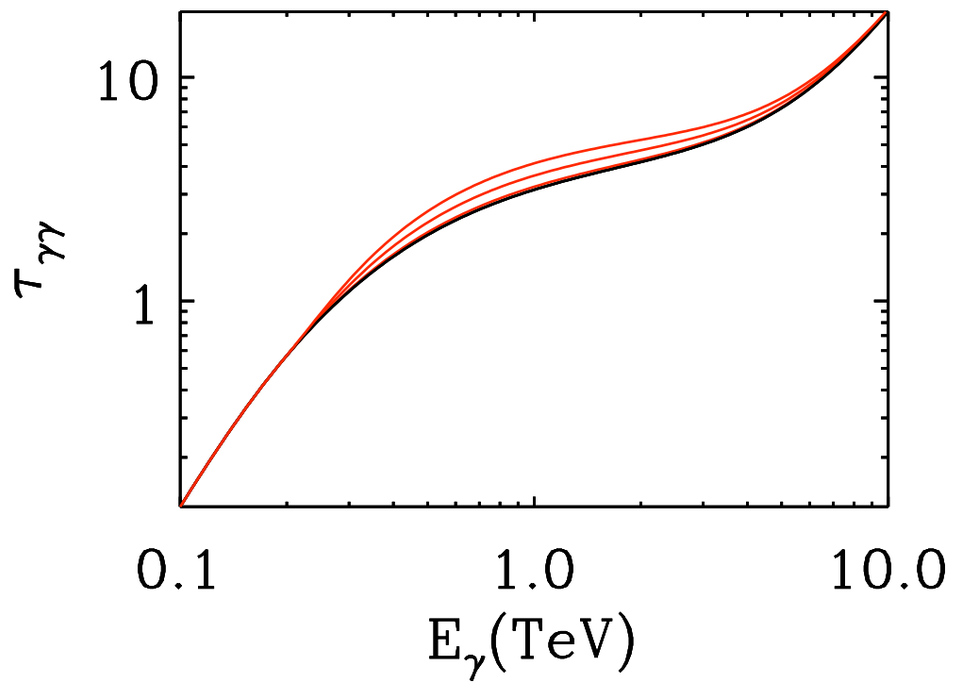
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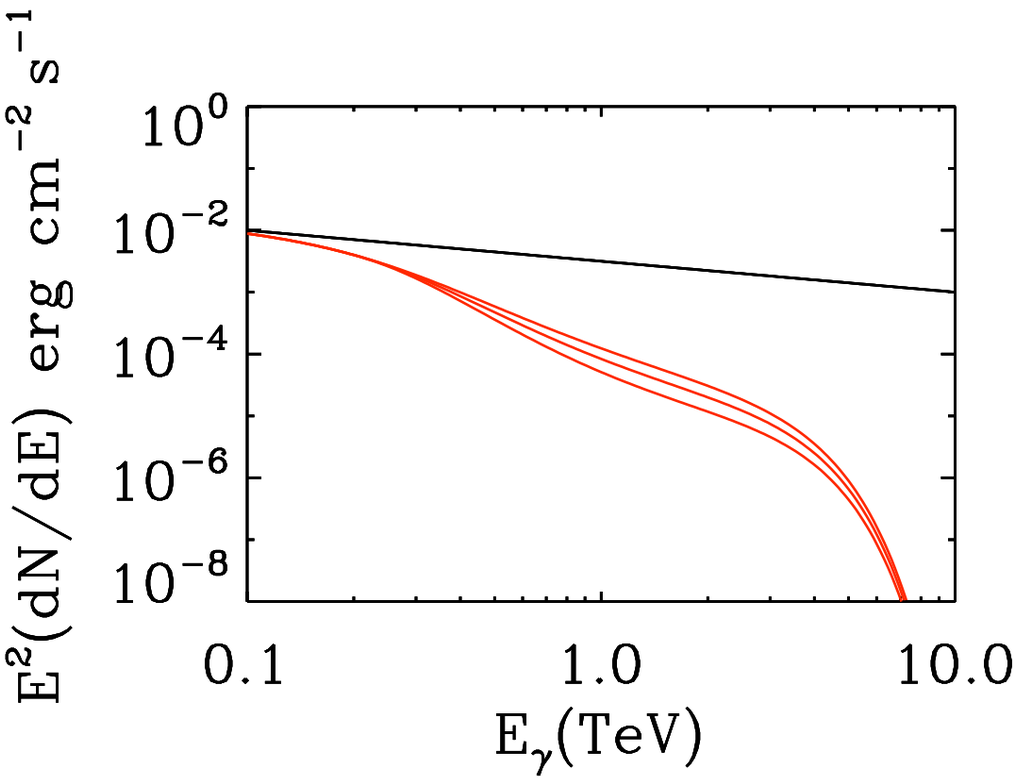
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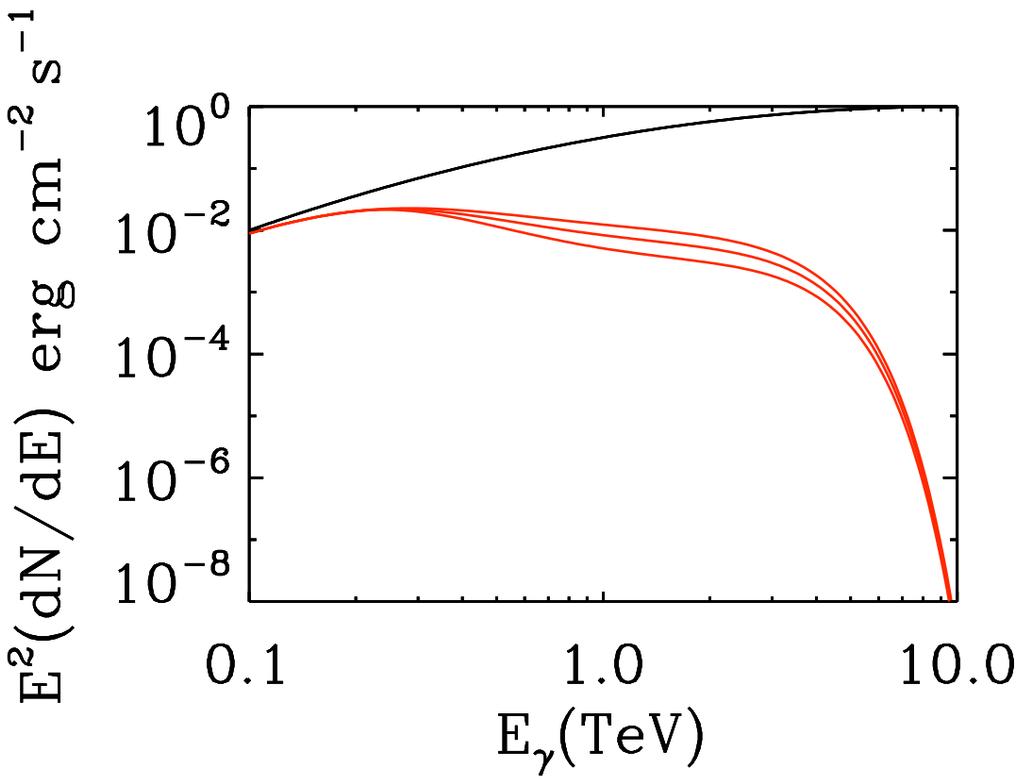
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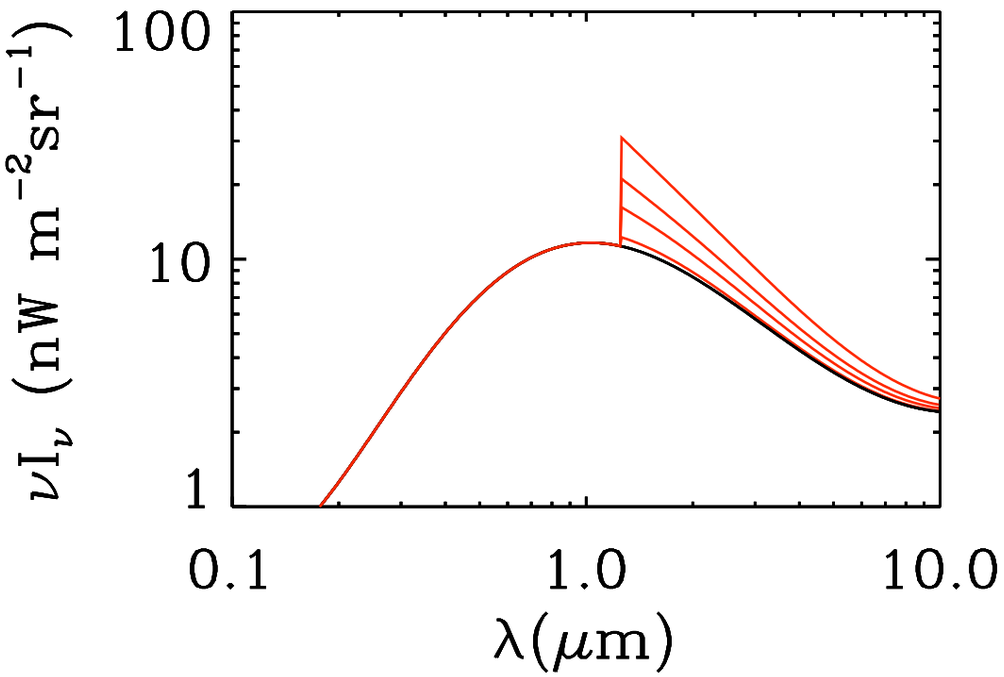
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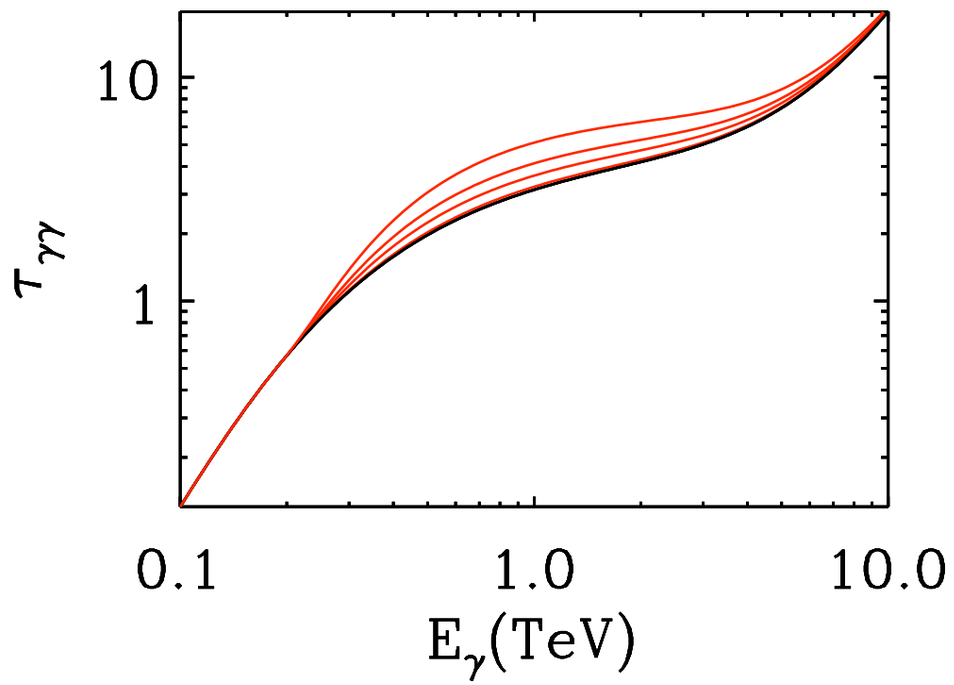
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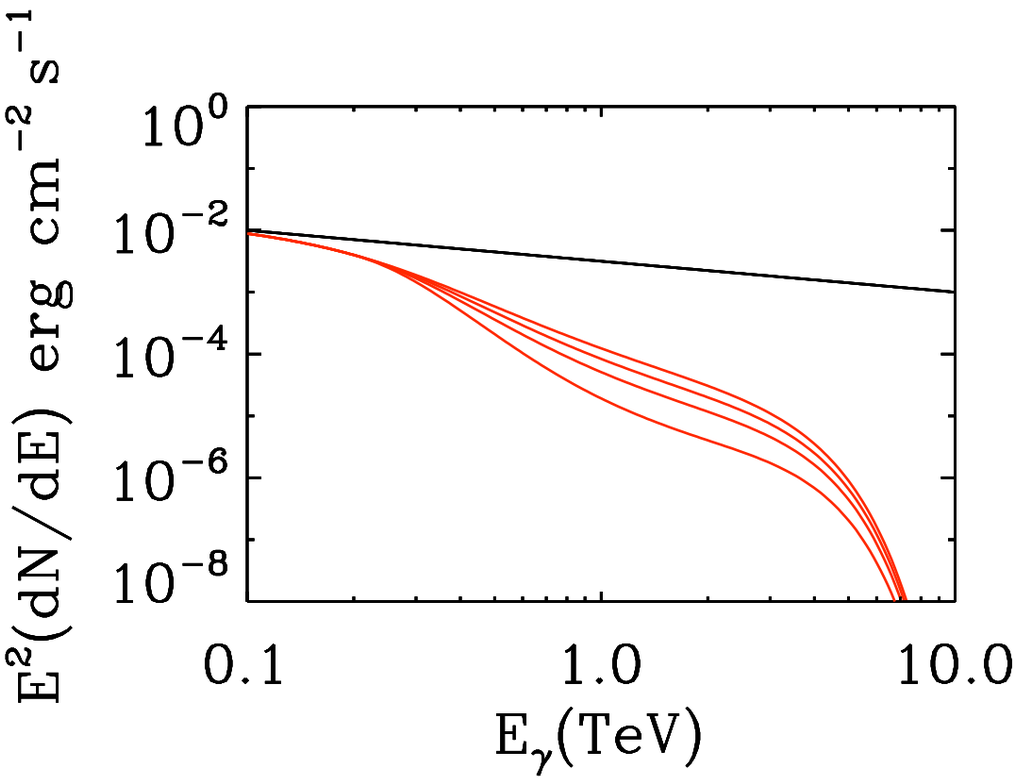
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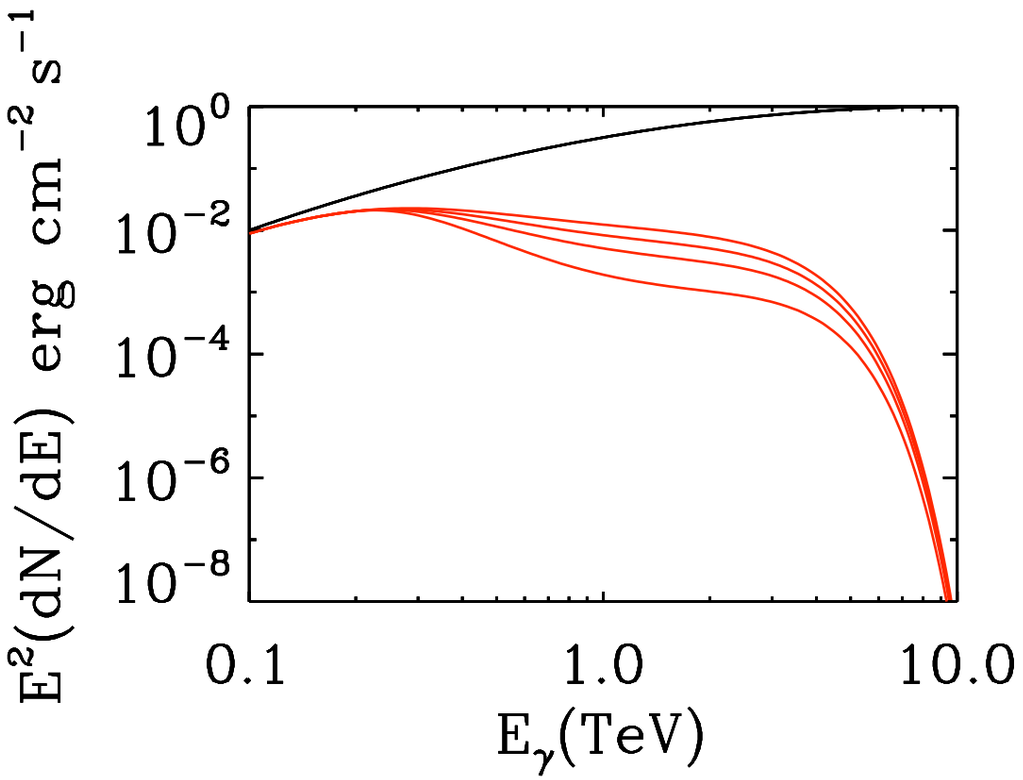
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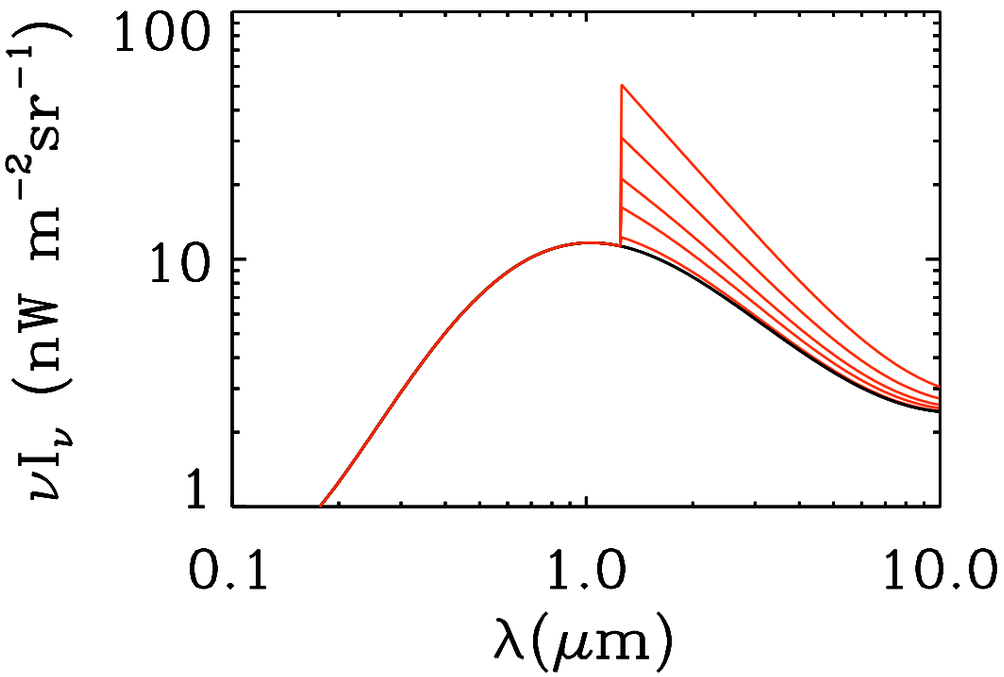
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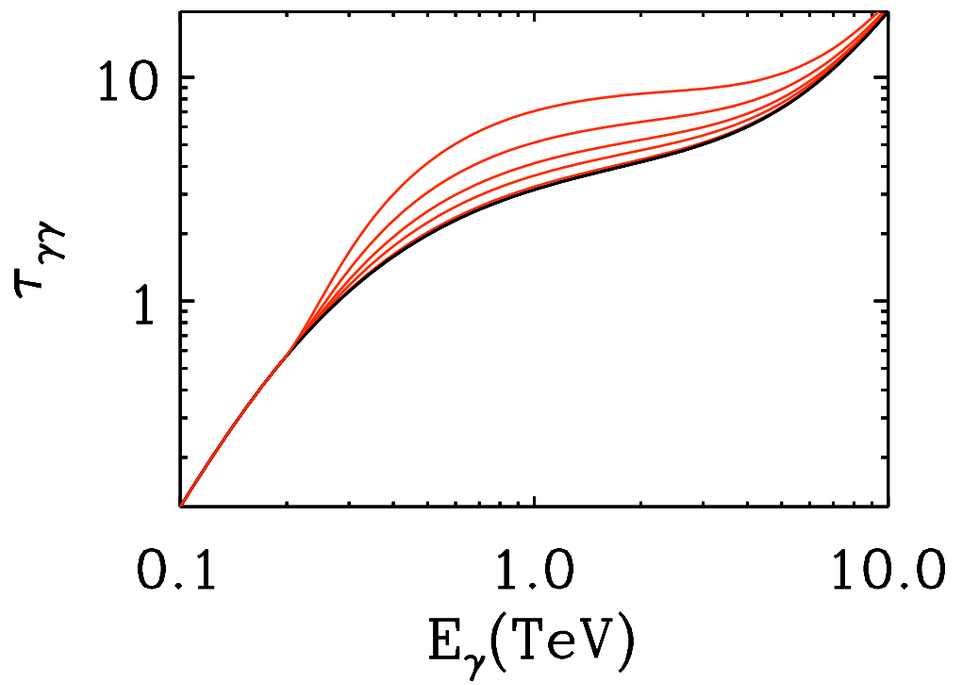
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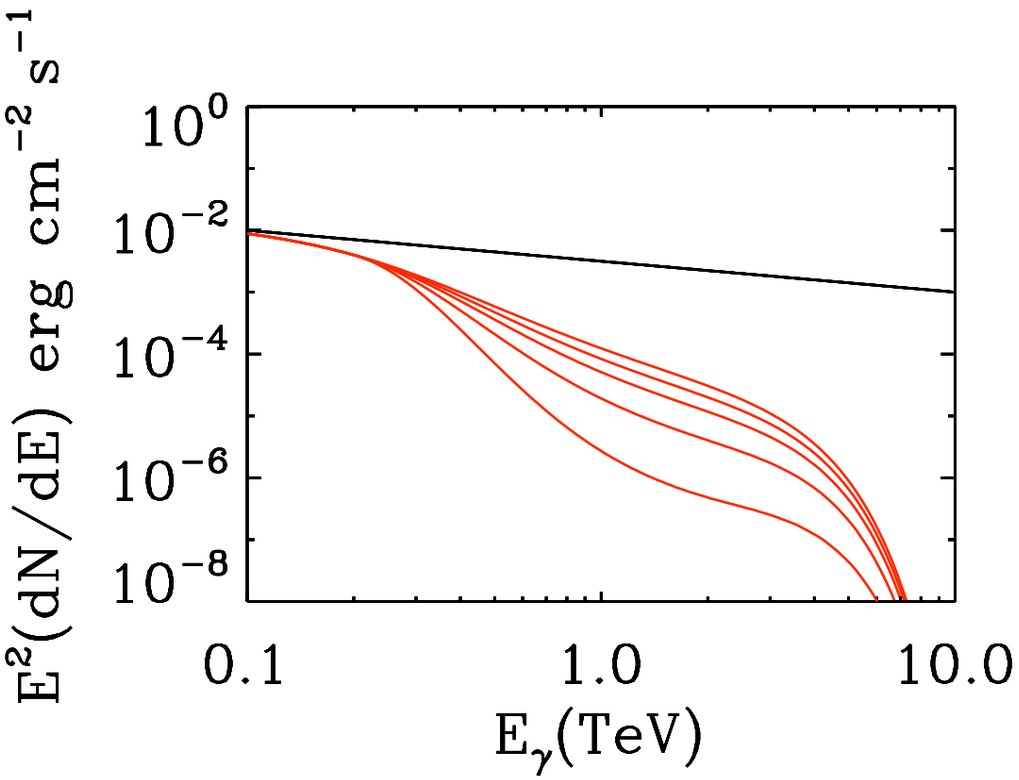
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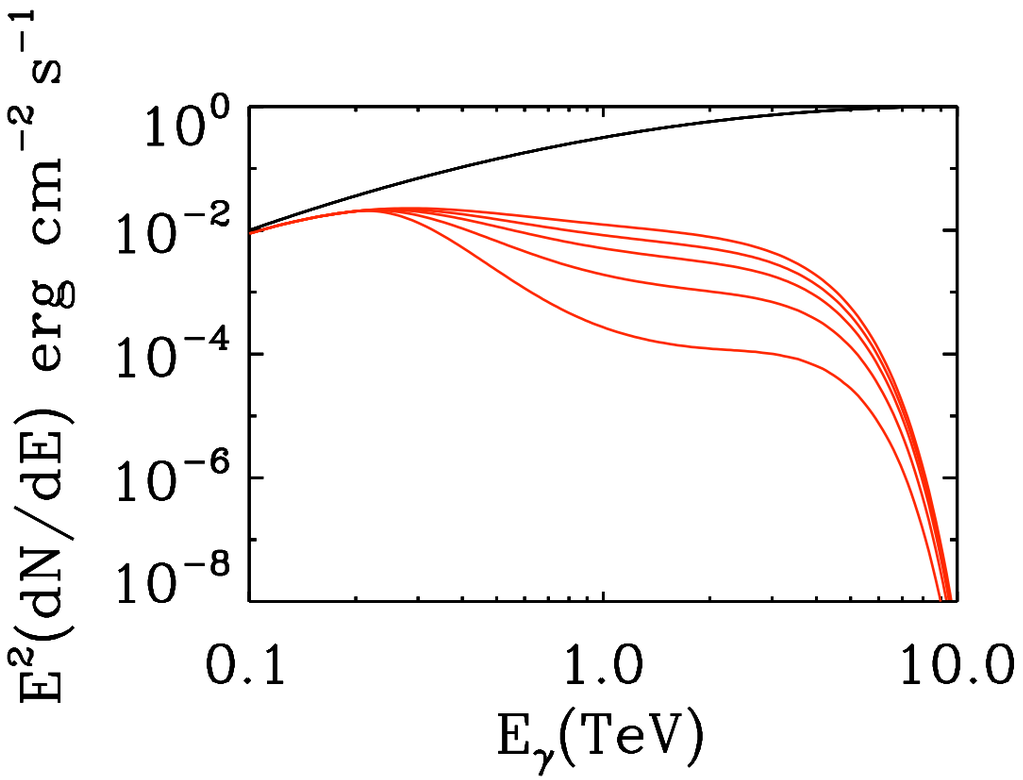
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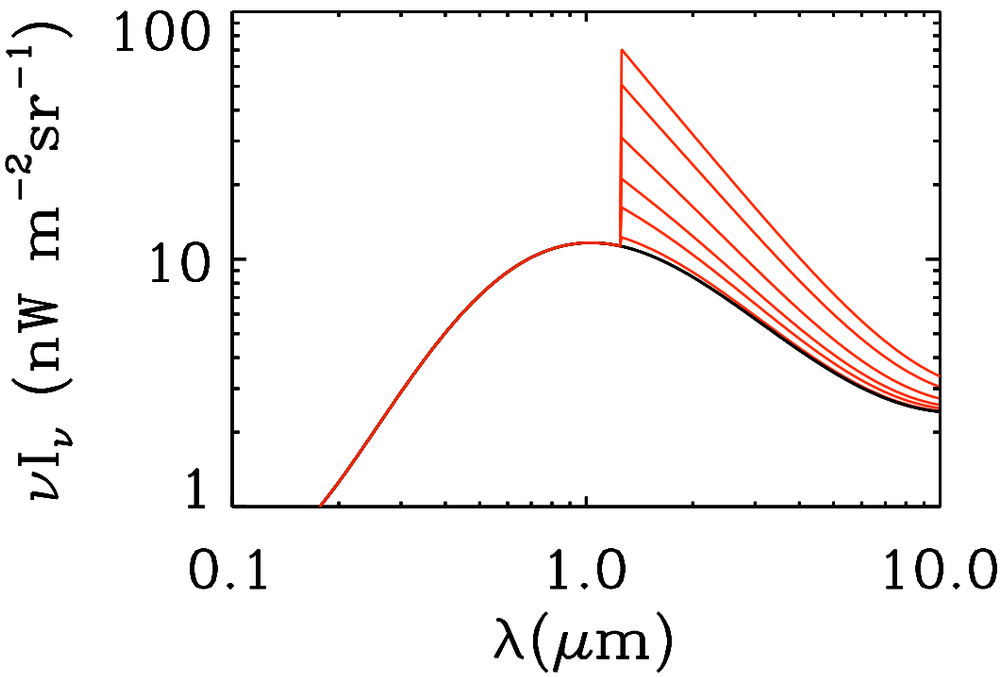
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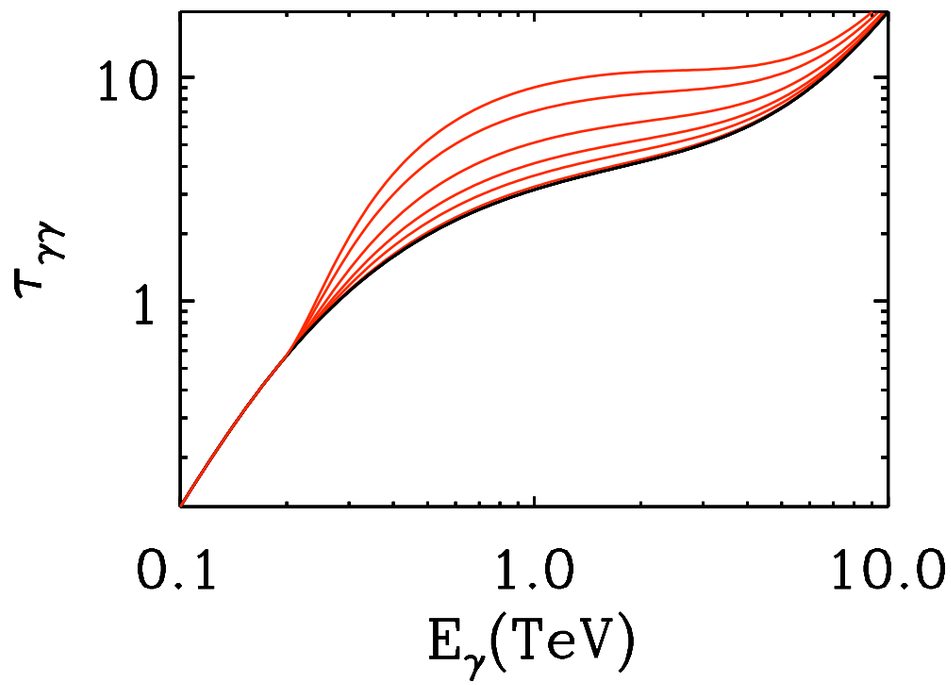
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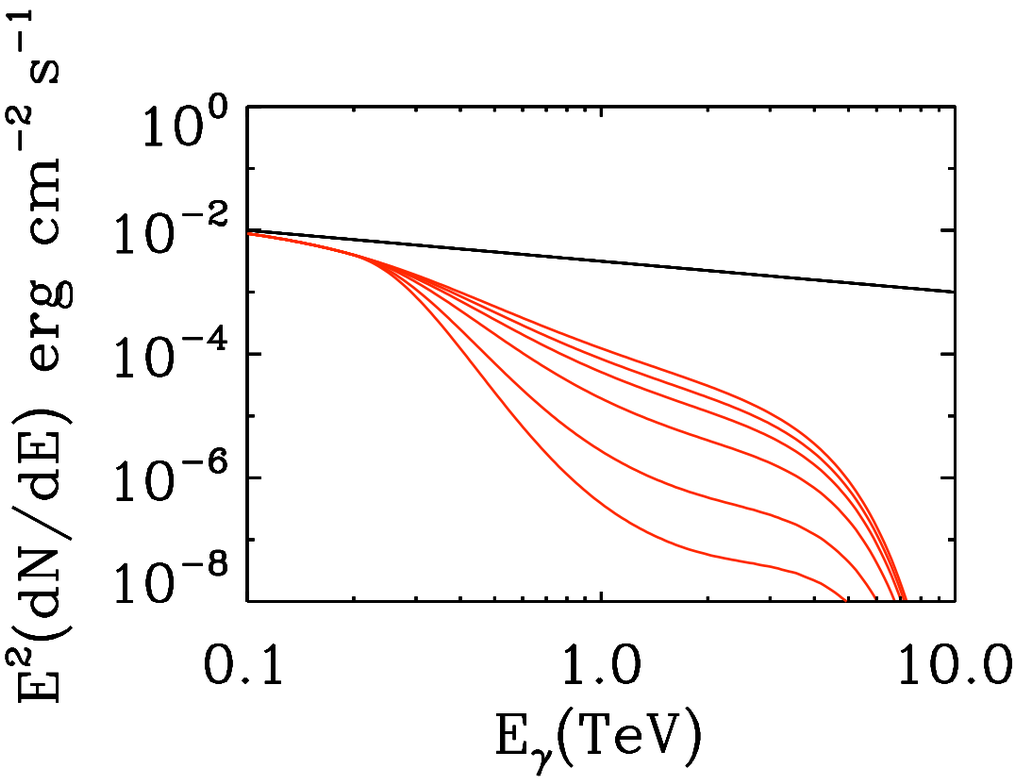
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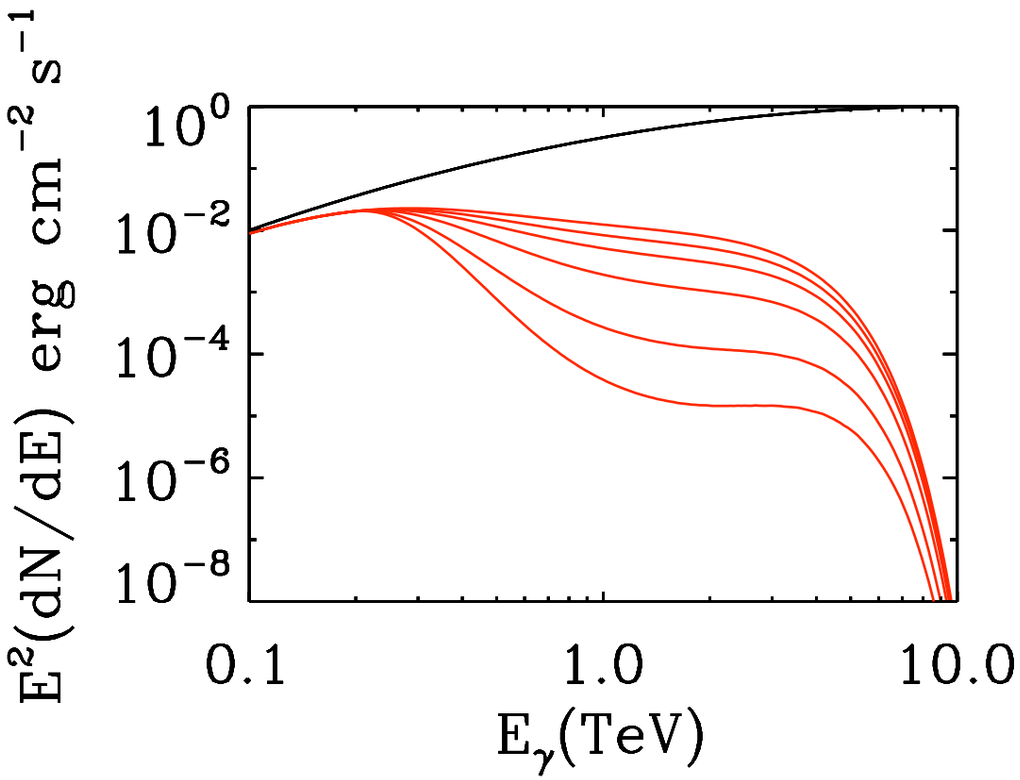
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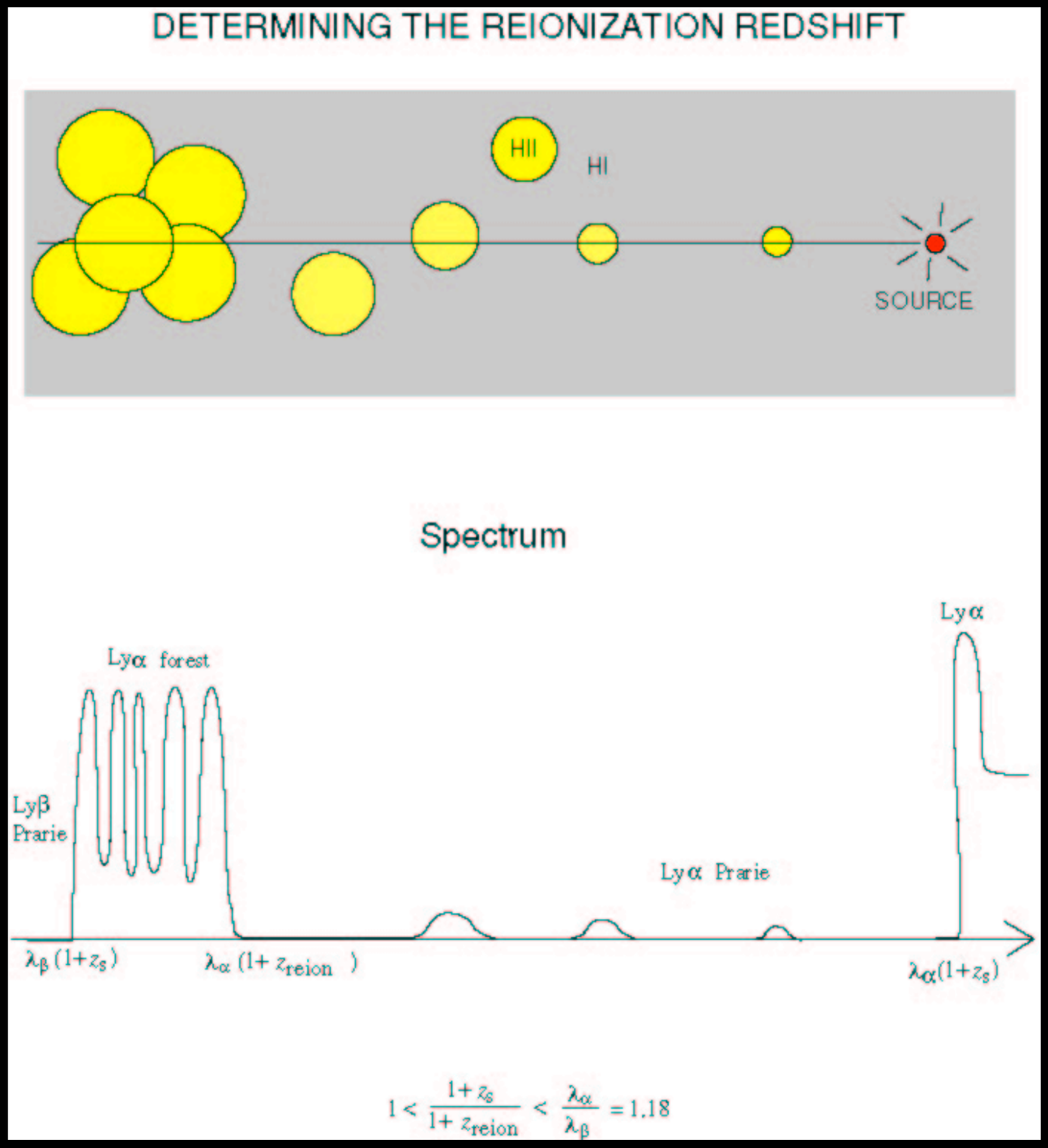
$E^2(dN/dE)$ erg cm^{-2} s^{-1}
E_γ(TeV)

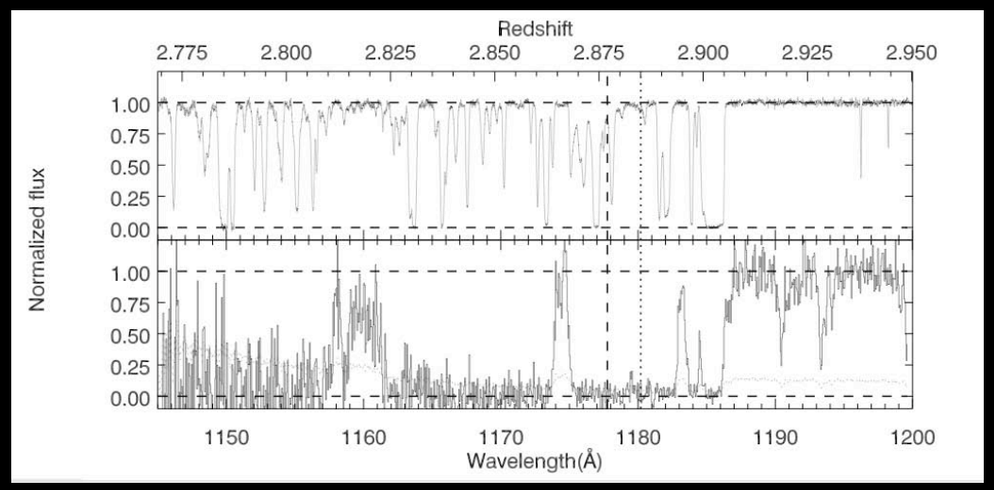
(3)

Probing intergalactic UV bubbles

Probing the intergalactic medium (IGM) with the Gunn-Peterson Effect



When do UV bubbles become opaque to ≈ 100 GeV photons ?

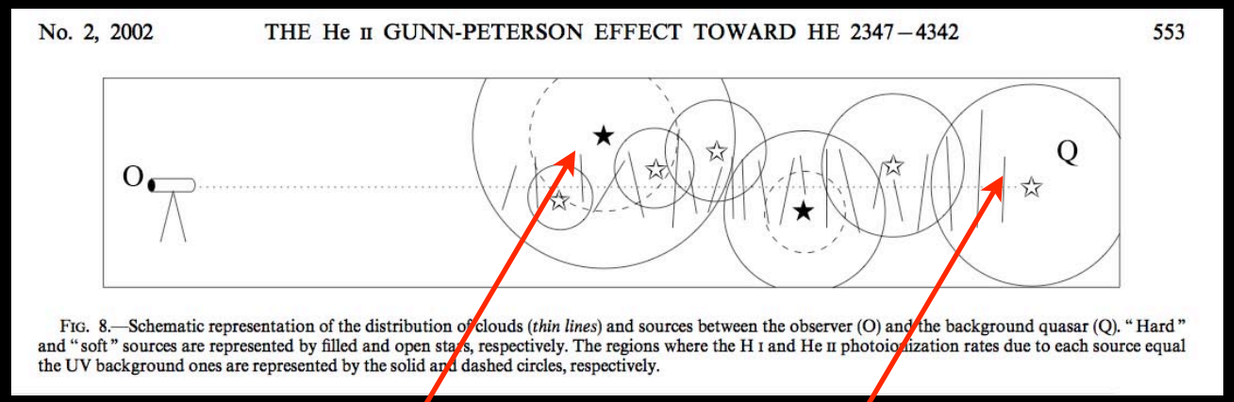


$$\tau_{\gamma\gamma} = n_\gamma \, \sigma_{\gamma\gamma} \, \Delta L$$

$$\Delta z \approx 0.02 \;\; at \;\; z \approx 3$$

$$\Delta L \approx 200 \; Mpc \; \approx 6 \times 10^{26} \; cm$$

$$\sigma_{\gamma\gamma} \approx 4 \times 10^{-25} \; cm^2$$



Fossil or "fresh" HII regions
(UV bubbles)

$$\tau_{\gamma\gamma} \approx 1 \longrightarrow$$

$$n_\gamma \approx 10^{-3} - 10^{-2} \;\; ph \; cm^{-3}$$

Galactic HII regions

$$n_\gamma \approx 1 \;\; ph \; cm^{-3}$$