Secondary particle yields from photomeson production in BLR radiation fields of blazars

A. Reimer *(University of Innsbruck)*, **A.M. Brown** *(University of Durham)*

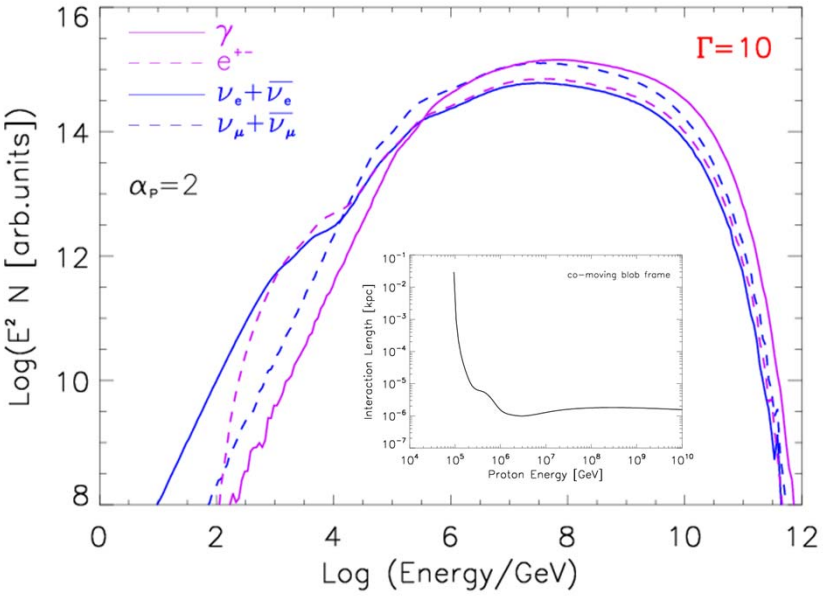
- *Consider:* **Hadronic p-γ interactions** with **external target photons** in the **co-moving blazar jet frame**

  -> anisotropic target radiation field

- *Method:* **Modified SOPHIA2.0 code**
- *Application:*

  Photomeson production within BLR line target radiation field

➡ ***Electromagnetic / ν-power ~ 1***



For comparison to previous approximations see poster.

universität innsbruck

Method

Durham University

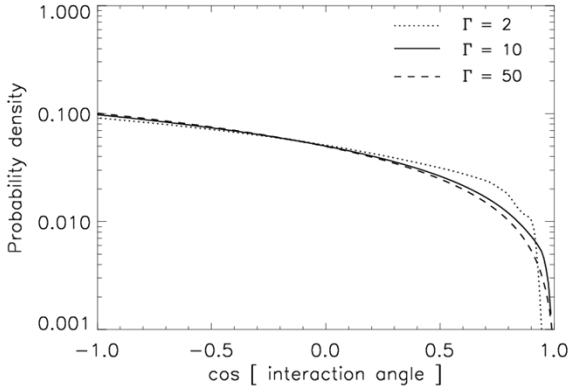
- *Consider:*

Secondary particle production from **hadronic p-γ interactions** off **external target photons** with **isotropically distributed CR protons** in the **co-moving blazar jet frame**

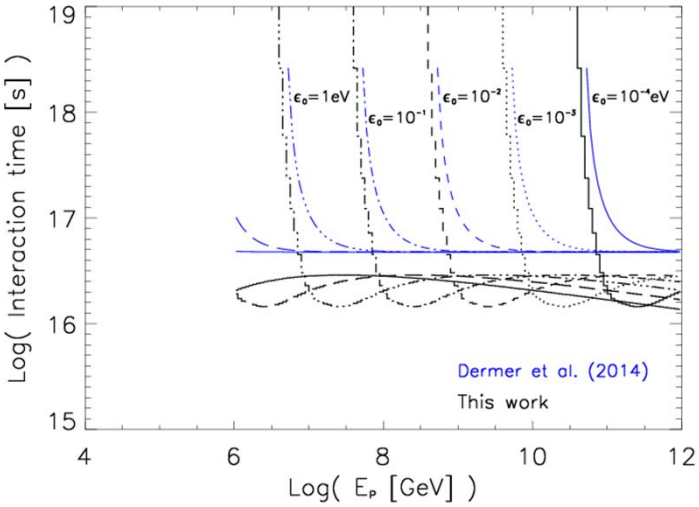
-> externally isotropic target photon distribution appears anisotropic (beamed) in co-moving frame

- *Use:* **Gyro-phase averaged interaction rate**

- *We modified :* **SOPHIA2.0**[1] **Monte Carlo code to take into consideration the corresponding non-isotropic interaction angle distribution**
(see right figure for an example)



- **Comparing to** Dermer et al (2014)[2] yields **~2-3 times higher interaction rates in our work** for mono-energetic (energy ε_0) target photon fields

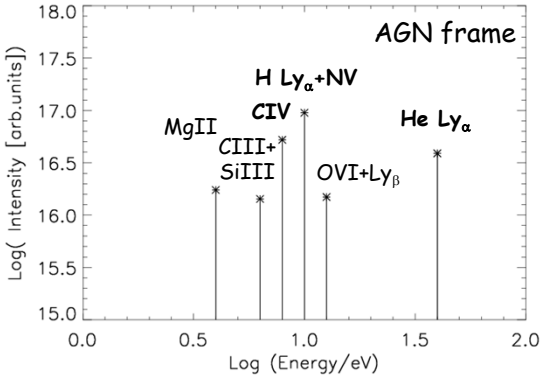


Results

- *We consider:*

Emission region within BLR line target radiation field
[see DMI2014(2)] **& isotropically** (co-moving jet frame)
distributed proton spectrum

$N_p \sim E^{-\alpha p} \exp(-E_p/E_{p,max})$, $E_{p,max}=10^{10}$GeV



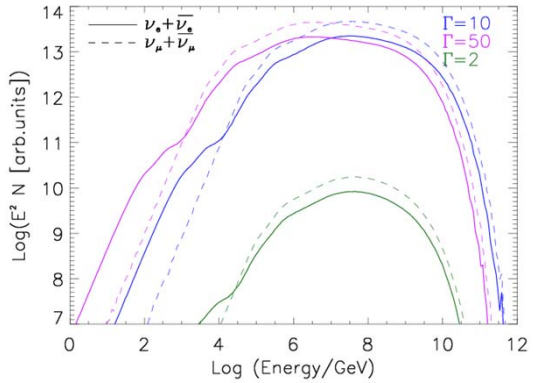
- **Examples of secondary particle spectra:**

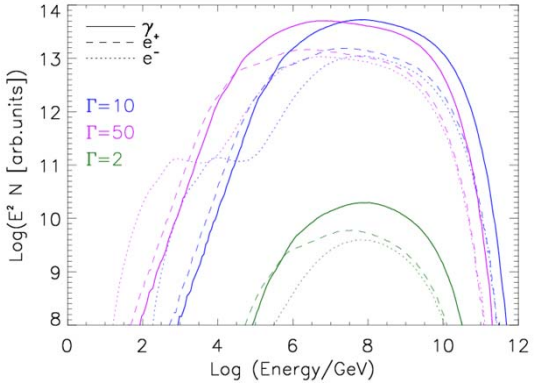
(AGN frame; all neutrons decayed;

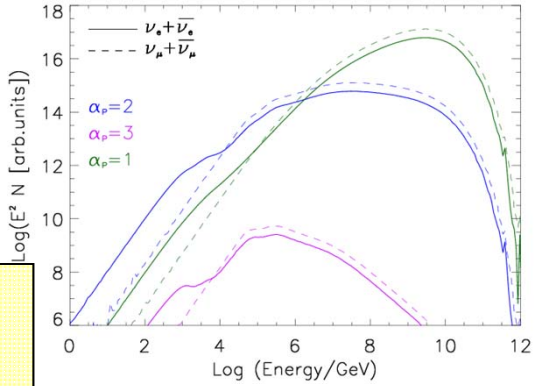
viewing angle θ**=5°**)

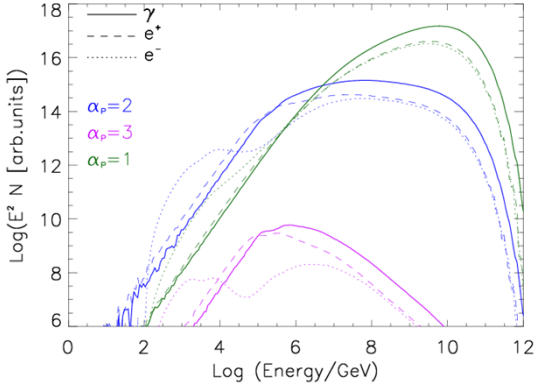
α_p = 2

bulk Lorentz factor Γ = 10









We found:

(γ+e⁺+e⁻-power)/ ν -power ~ 1

Comparison to previous approximations

Example of

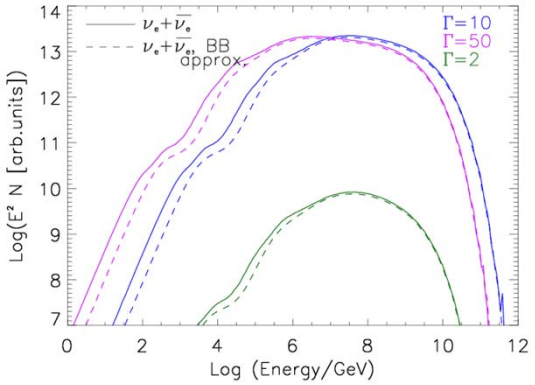
Previous approximation of co-moving (') target photon field:

Isotropically distributed blackbody photon field with peak intensity at

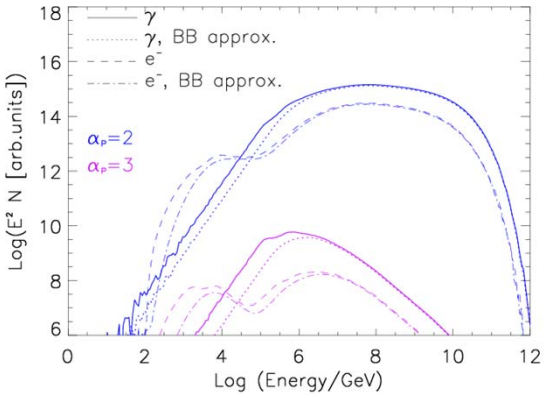
$$\nu'_{peak} \approx 1.5\Gamma\, \nu_{Ly\alpha}$$

[Tavecchio & Ghisellini 2008; Böttcher, Reimer & Marscher 2009; Reimer 2009]

Blackbody approximation underestimates secondary particle yields @ low-energy part of spectrum.



α_p = 2, θ=5°



Γ = 10, θ=5°

- ***Outlook:*** Photomeson production in the co-moving jet frame of externally anisotropic target radiation fields.

References:

(1) A. Mücke, R. Engel, J.P. Rachen, R.J. Protheroe, T. Stanev 2000, CPC, 124, 290
(2) C.D. Dermer, K. Murase, Y. Inoue, 2014, JHEA, 3, 29 (DMI14)
(3) F. Tavecchio & G. Ghisellini, 2008, MNRAS, 386, 945
(4) M. Böttcher, A. Reimer & A. Marscher, 2009, ApJ,703, 1168
(5) A. Reimer, 2009, ,Int.J.Mod.Phys.D, 18, 1511