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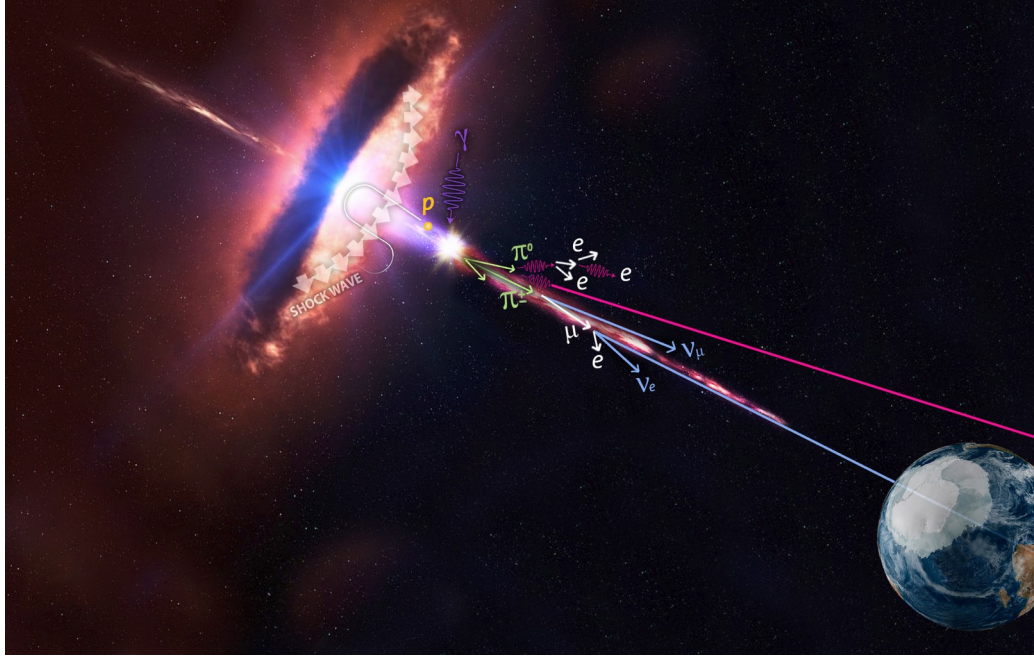
THE ASTROPARTICLE PHYSICS CONFERENCE

Berlin | Germany

37th International Cosmic Ray Conference

12–23 July 2021



Electromagnetic and Neutrino Output from Magnetic Reconnection in Poynting Flux Dominated Jets

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ARIES, India

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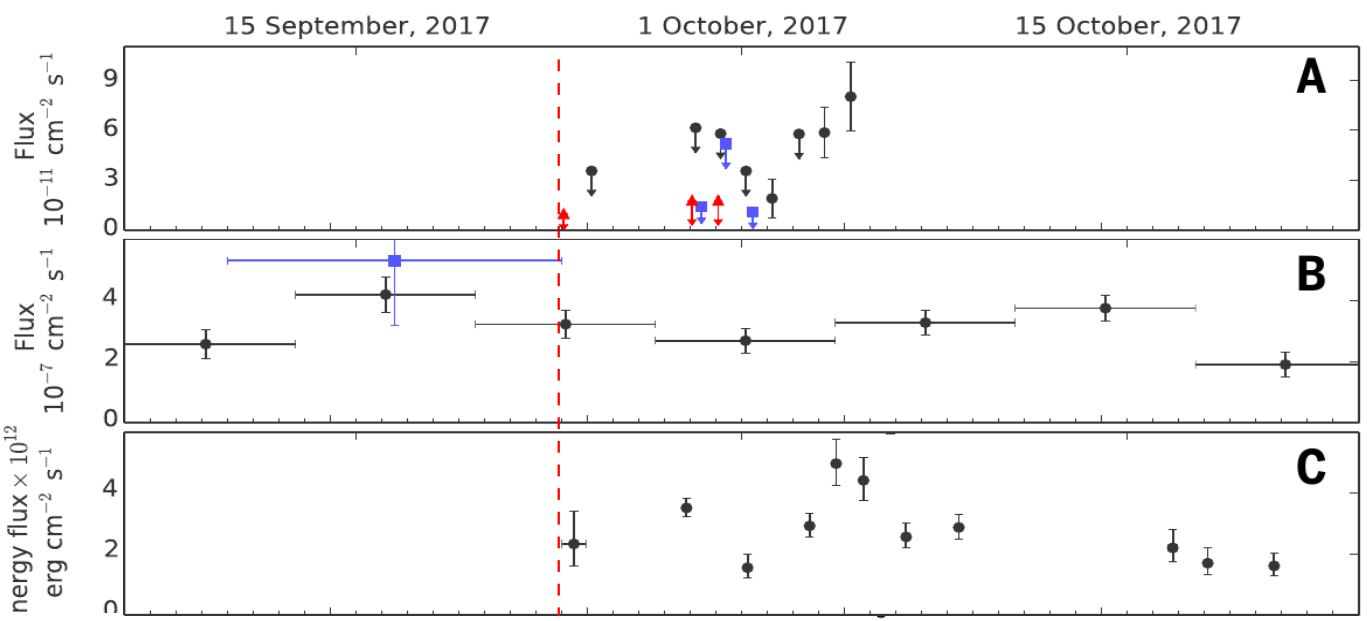
Radboud University, Netherlands

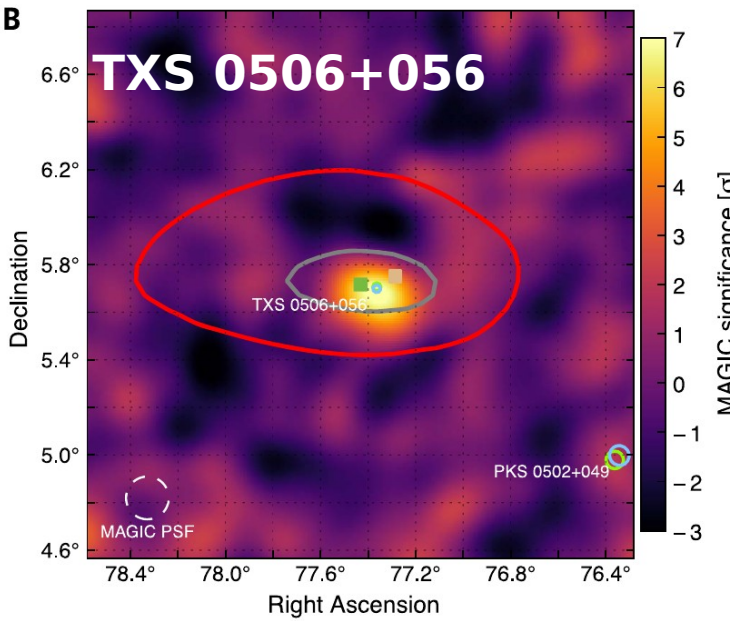
FAPESP

Outline

- Introduction
- The blazar MM emission model
- SED model profiles
- Conclusions

Blazars are candidate MM sources.





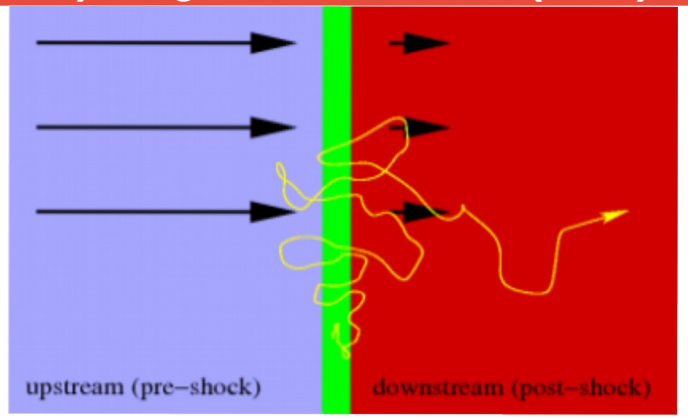
Aartsen et al. (2018), Science.

- Where is the particle acceleration region(s)?
- What is the mechanism(s) that accelerates the parent hadrons?

1st order Fermi acceleration, possible mechanisms:

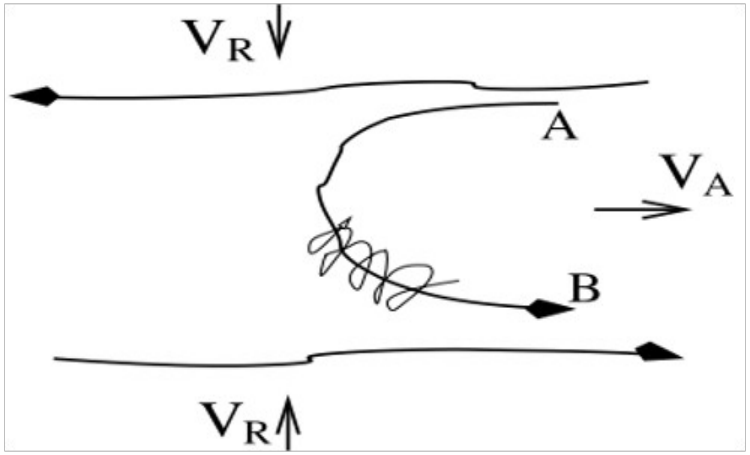
Shock

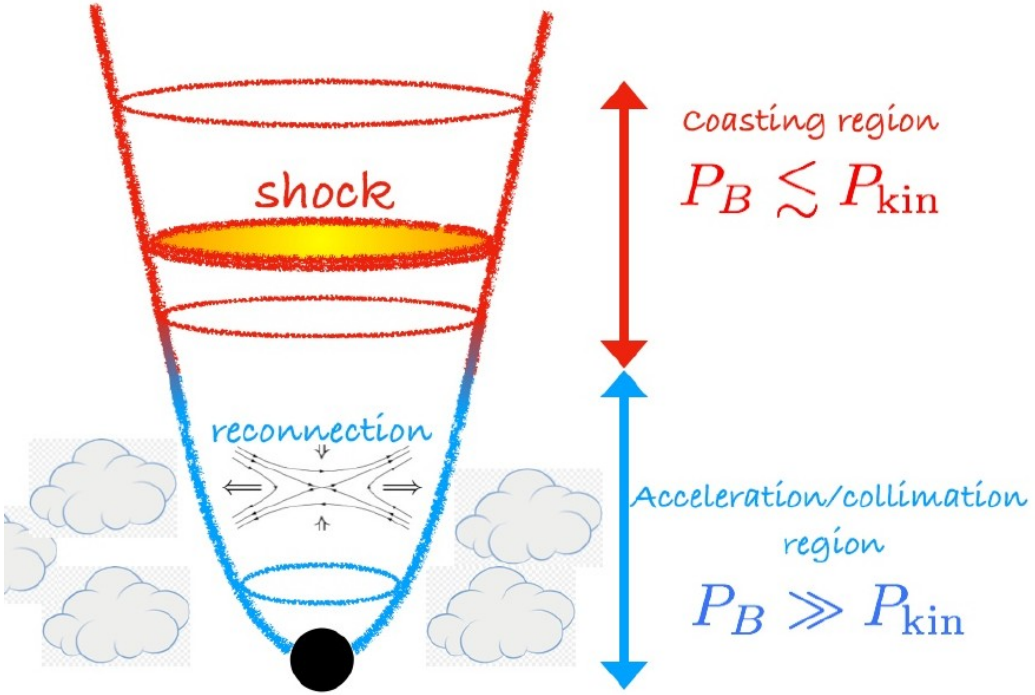
Bell (1978); Begelman & Eichler (1997)



Magnetic Reconnection

de Gouveia Dal Pino & Lazarian (2005); Kowal et al. (2012)





Credit: F. Tavecchio (2021), Galaxies

<— ● ***Kinetically dominated***

<— ● ***Magnetically dominated***

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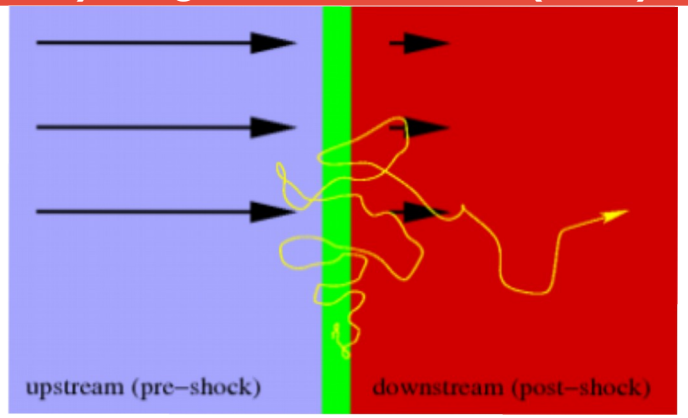

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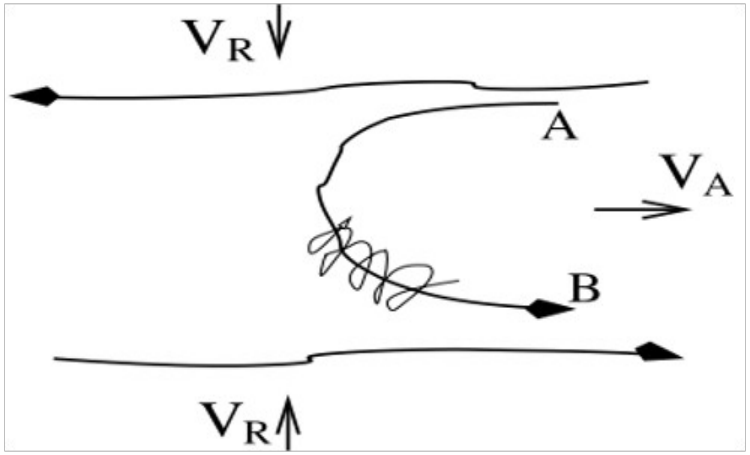
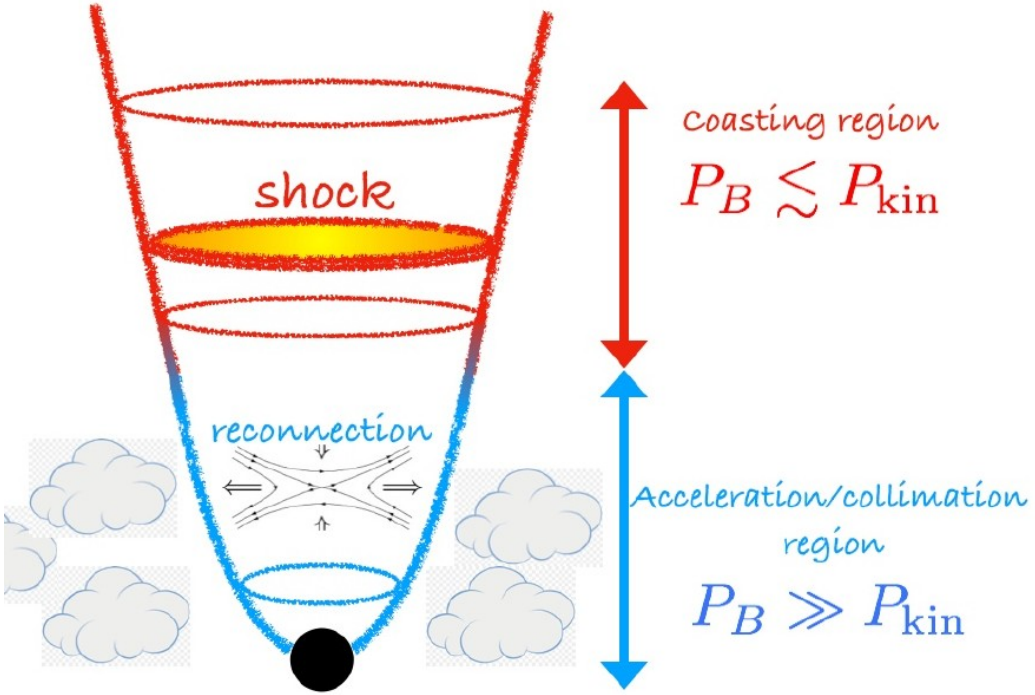




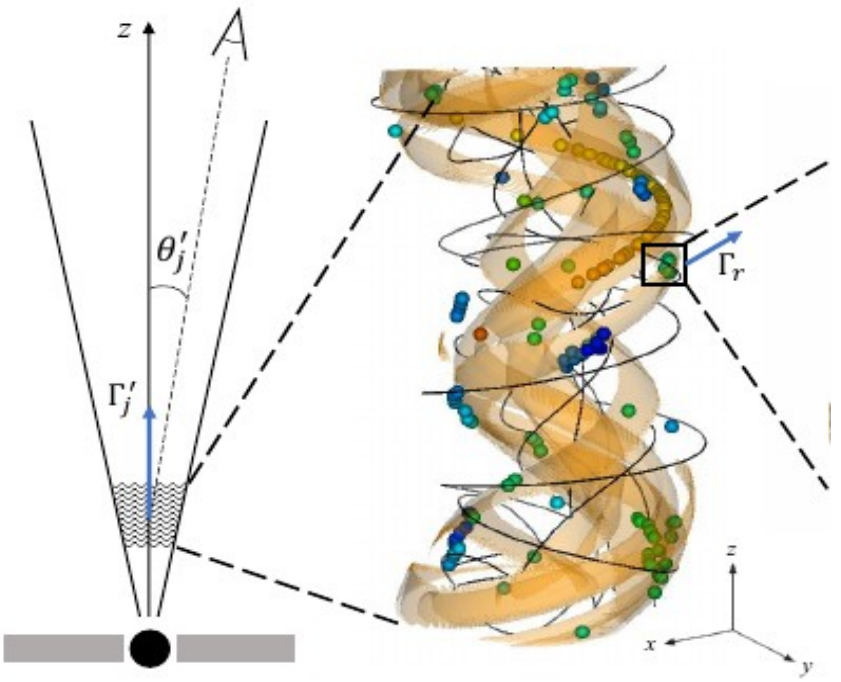
Credit: F. Tavecchio (2021), Galaxies

- ***Kinetically dominated***

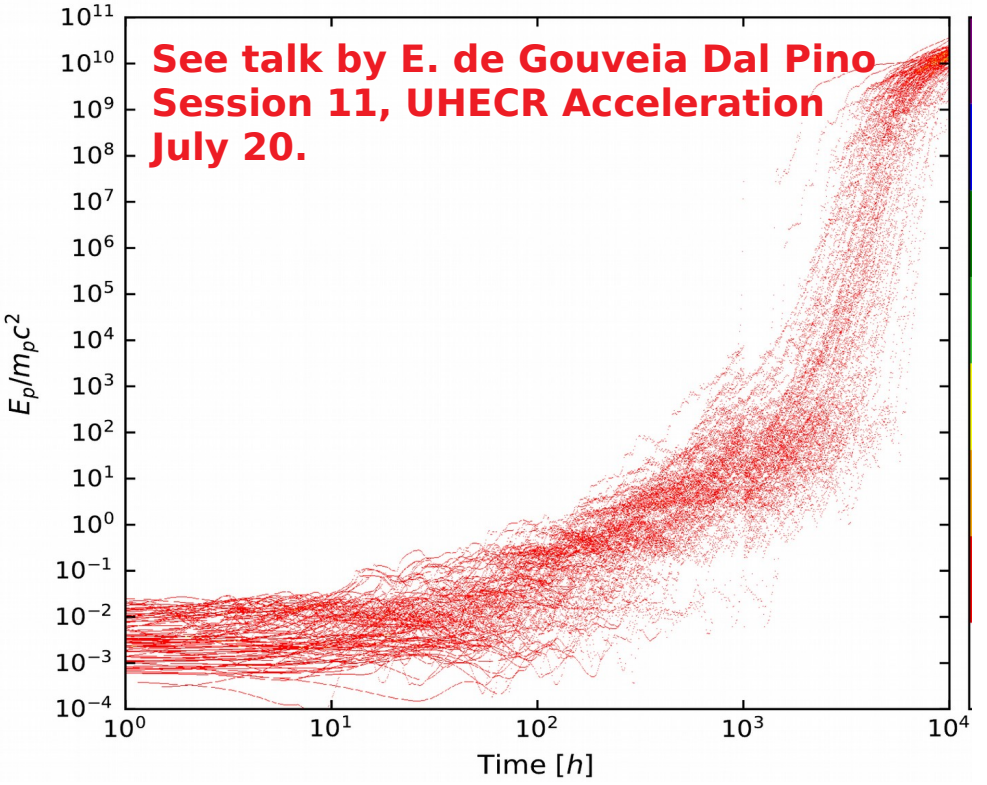
- ***Magnetically dominated***

Motivation: particle acceleration by reconnection. Test particle simulations.

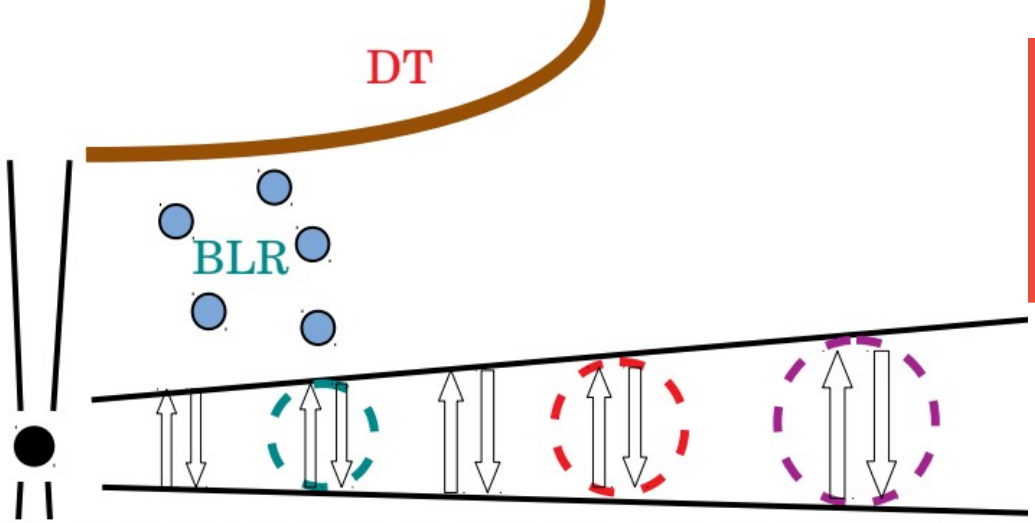
Kadowaki et al. (2021)

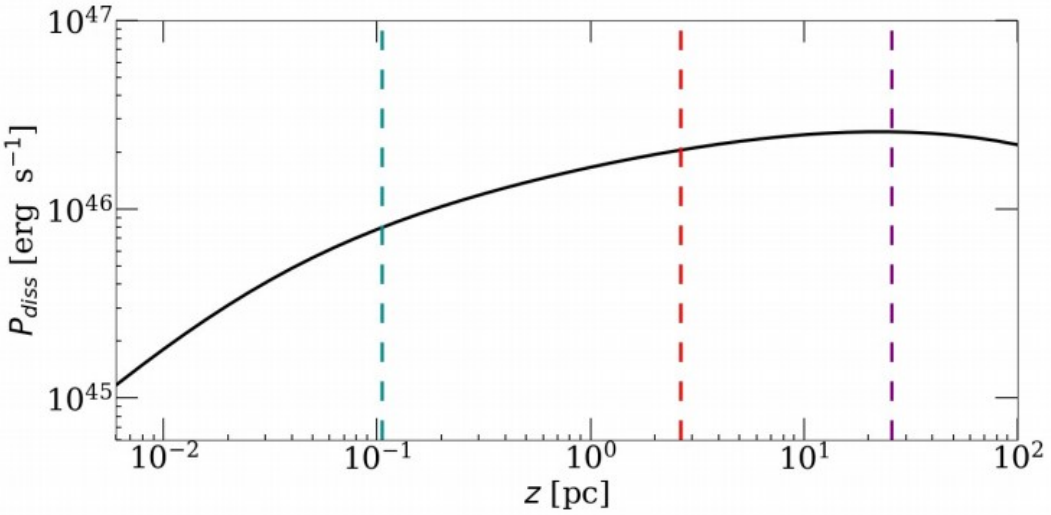


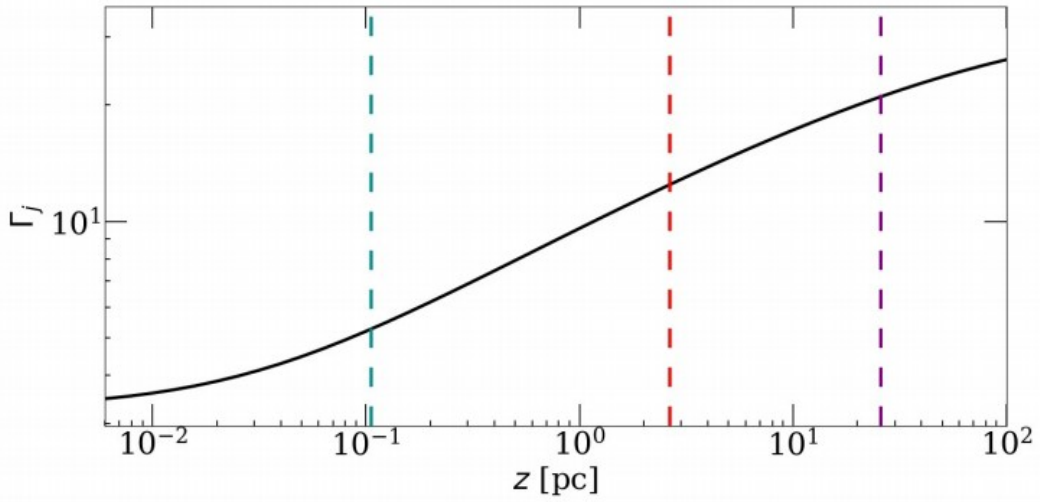
Medina-Torrejon et al. et al. (2021)



- What is the electromagnetic and neutrino output?
- What is the impact of the internal and external target radiation fields?



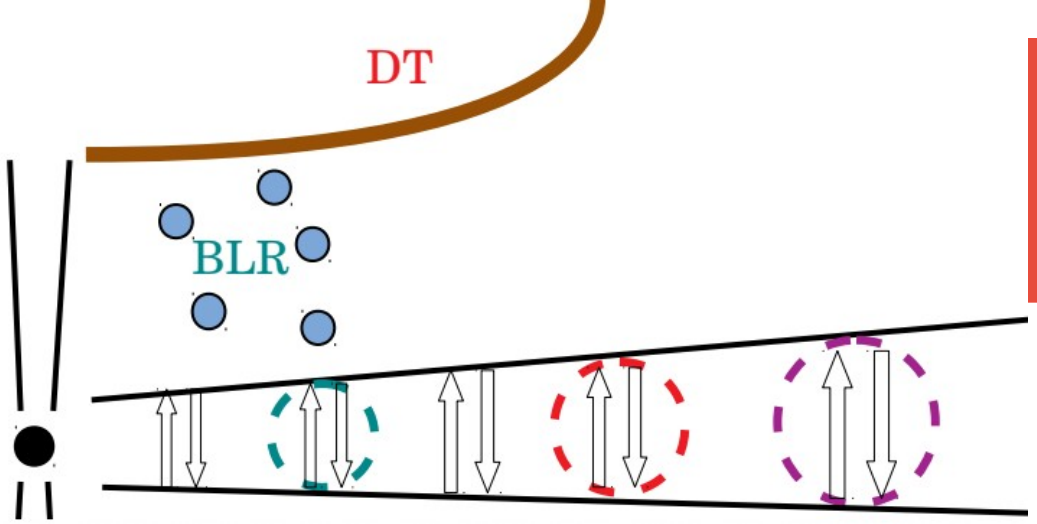




Analytic model for magnetic reconnection in the jet:

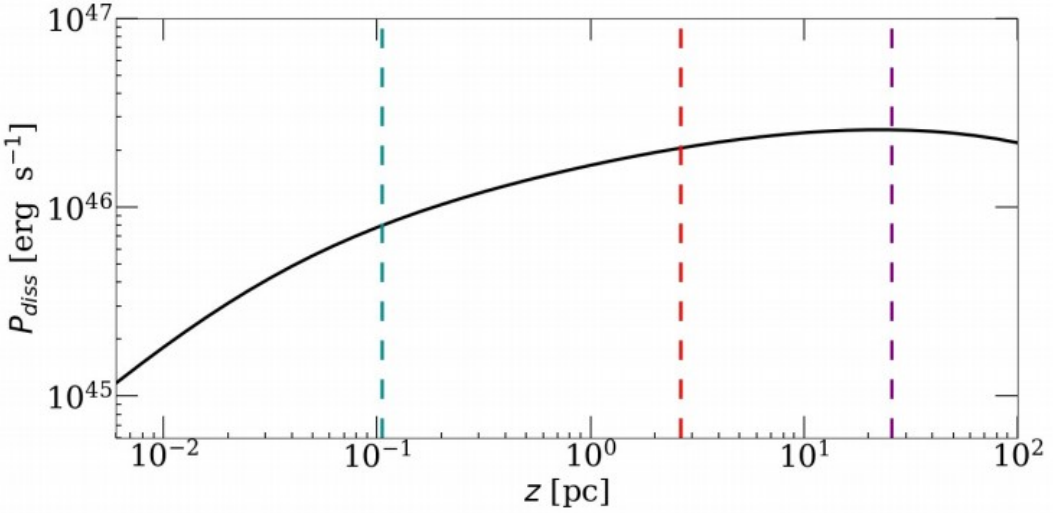
Reconnection striped jet model

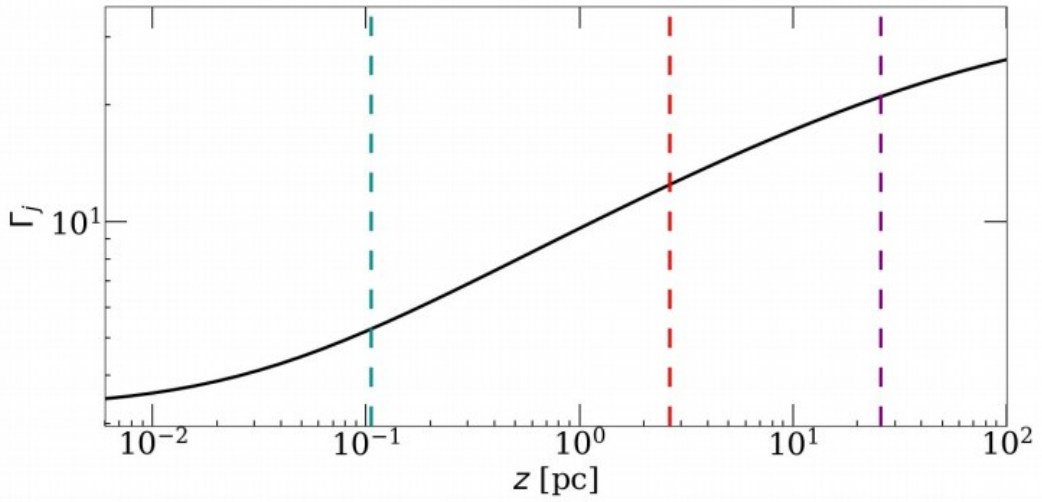
Giannios & Uzdensky (2019)
Zhang & Giannios (2021)

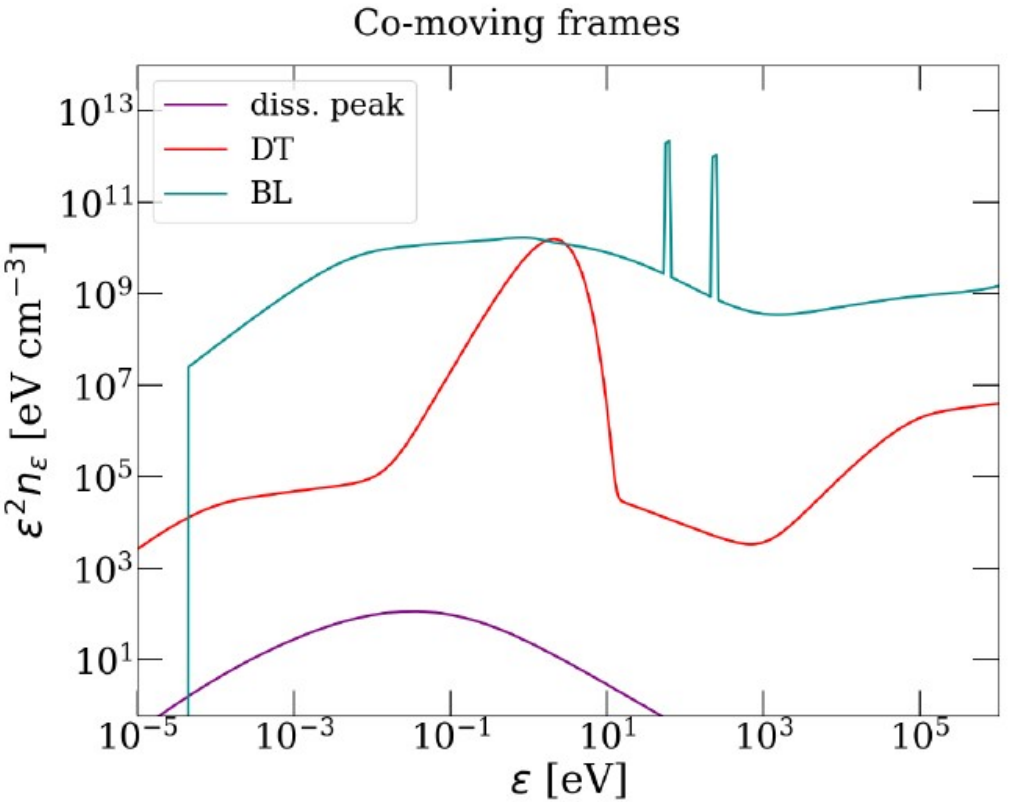


Target n_{ph} =

- **SSC + DT + BLR (zone 1)**
- **SSC + DT (zone 2)**
- **SSC (zone 3)**







Reconnection striped jet model

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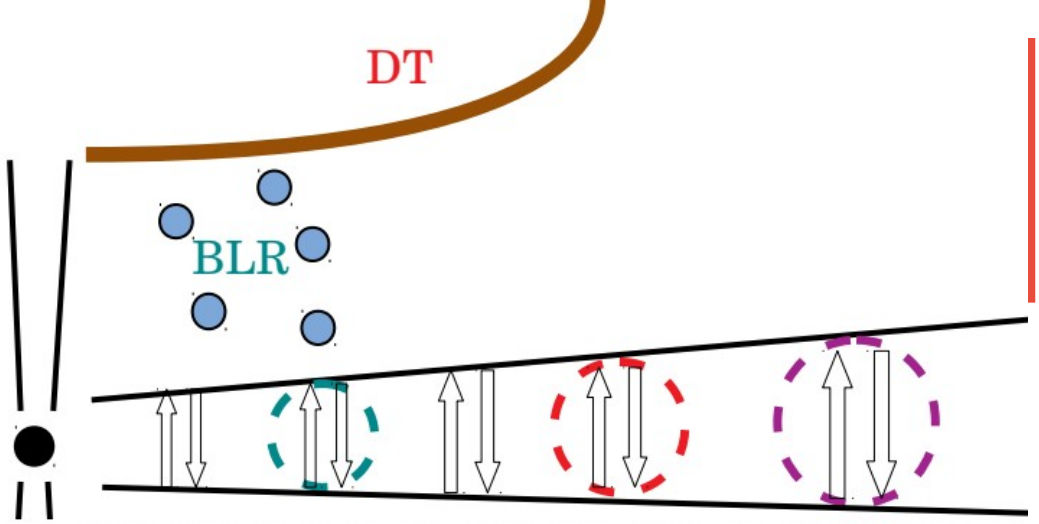
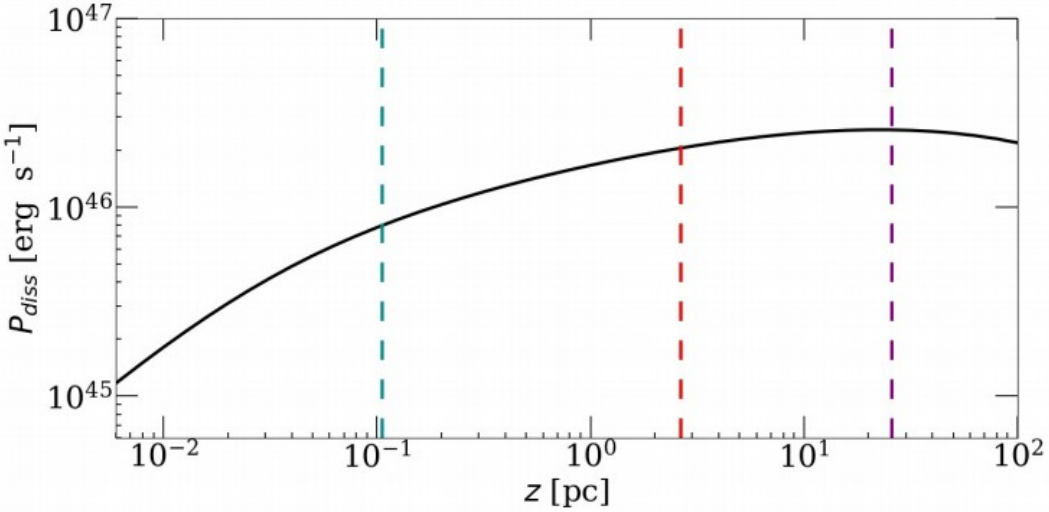
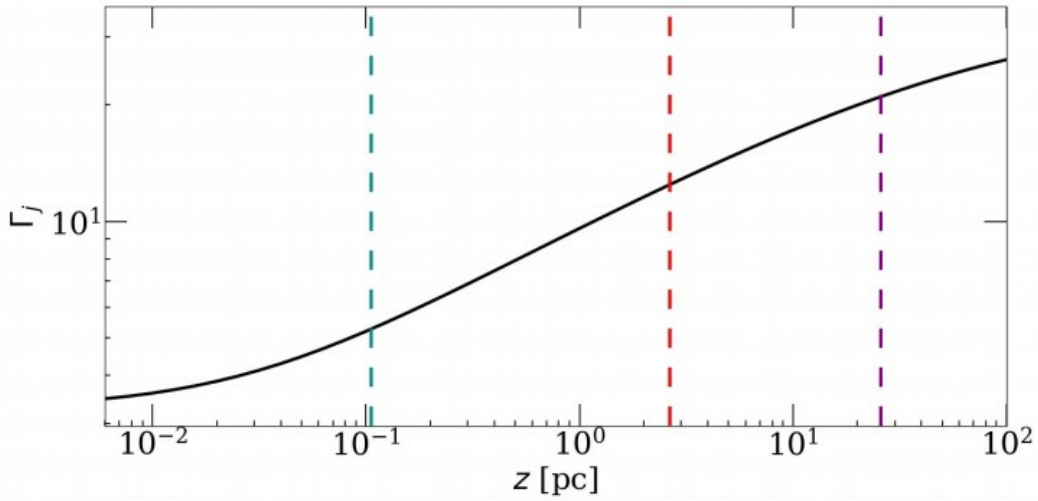






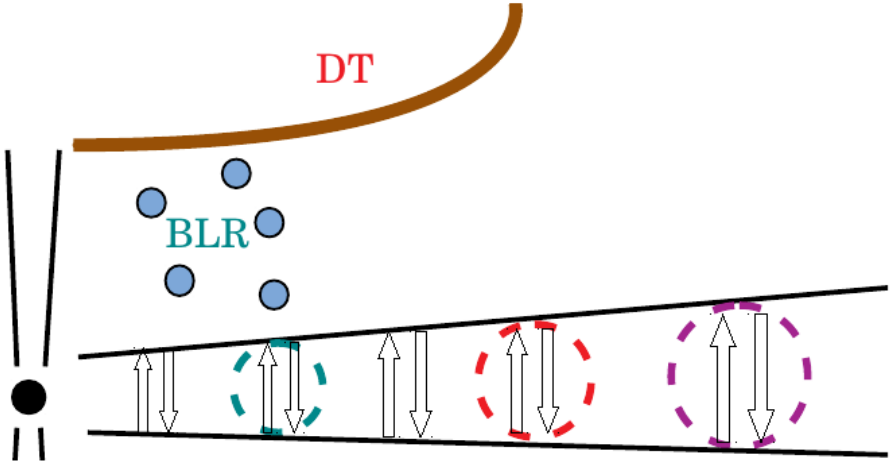
$$\eta_{p,e} P_{diss} = (\Gamma_j \theta_j z)^2 \pi c \tilde{U}_{p,e}$$

$$\frac{\tilde{B}^2}{4\pi} = \frac{4\epsilon^2}{\Gamma_\infty^6 (l_{min}\theta_j \zeta)^2 \pi c} \frac{1-\chi(\zeta)}{\chi^2(\zeta)} L_j,$$

$$P_{diss} = \left[\frac{1-\chi(\zeta)}{\chi}\right]^k \zeta L_j,$$

$$\Gamma_j = \Gamma_\infty \chi(\zeta),$$

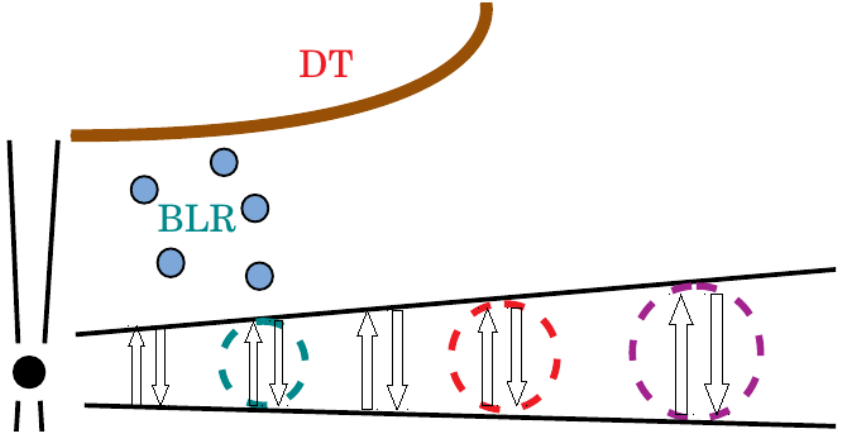
$$\frac{d\chi}{d\zeta} = \frac{(1-\chi(\zeta))^k}{\chi^2(\zeta)},$$



We build a lepto-hadronic emission model accounting for:

electrons →
- Synchrotron
- SSC
- External Compton

protons →
- Neutrinos
- π^0 cascade
- π+/- cascade
- B-H cascade
- Proton synchrotron



We build a lepto-hadronic emission model

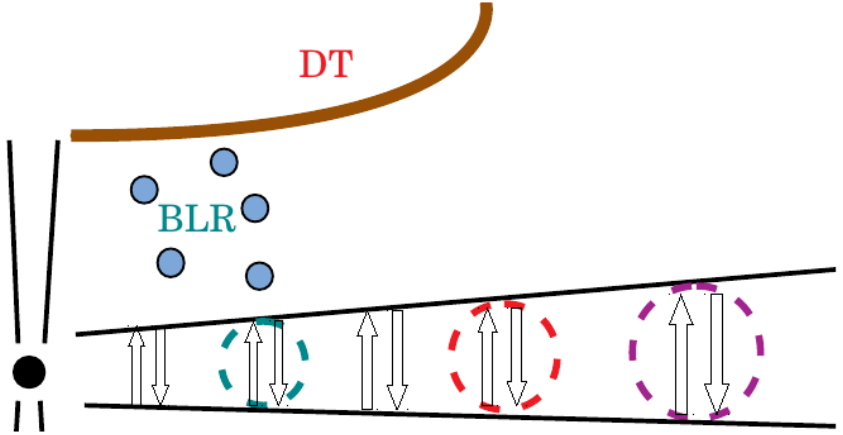
diss. peak
DT-zone
BL-zone
DT emission
BL emission
ν_s diss. peak
ν_s DT
ν_s BL
Total EM
Total ν_s

M_{BH}= 3.0e+09 $M_\odot$

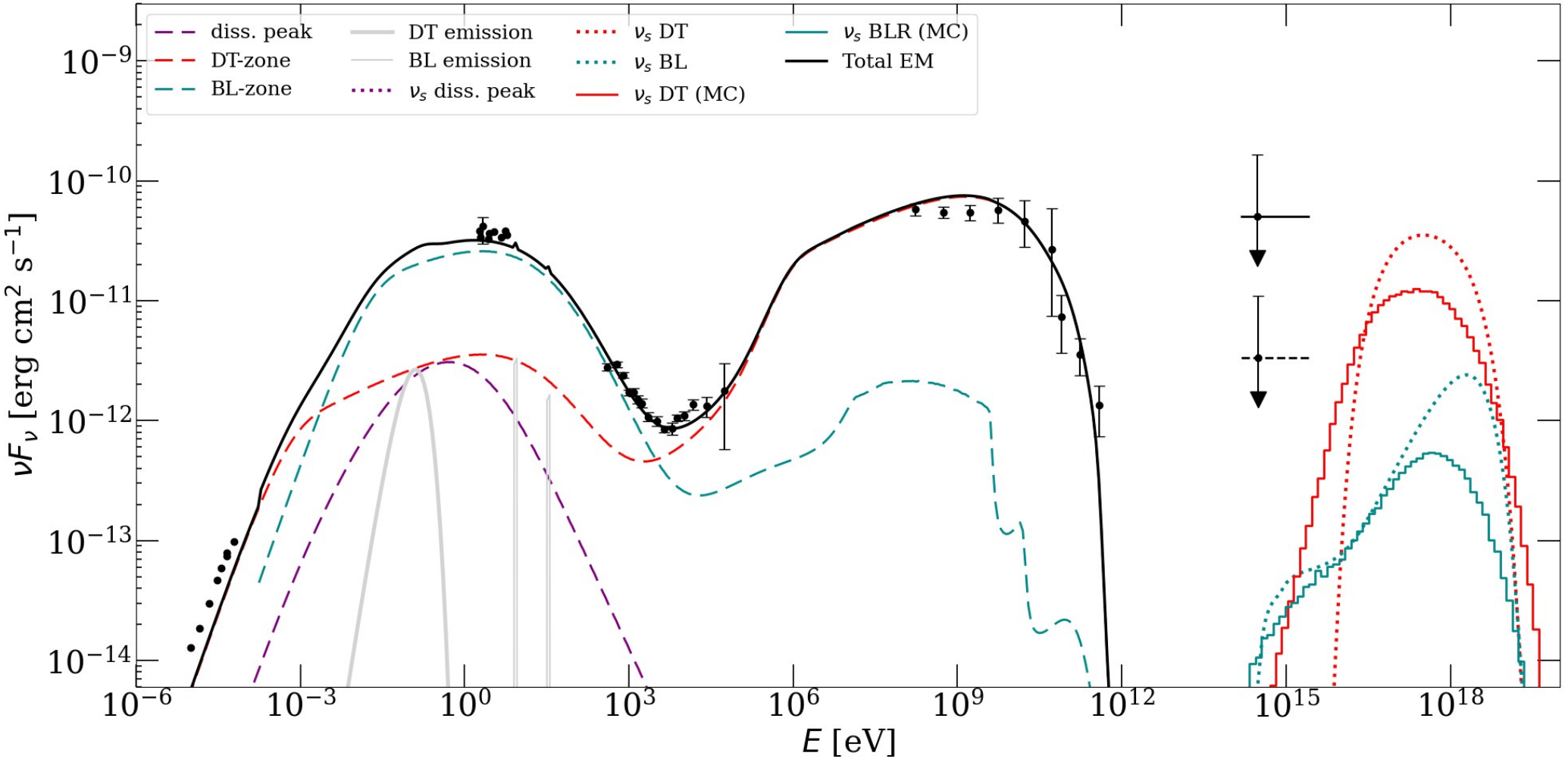
$\dot{m}$= 0.028

EL_E [erg s^{-1}]

E [eV]



Application to the 2017 neutrino event from the blazar TXS 0506+056



Monte Carlo simulatio of CR propagation for neutrino production:

- `CRPropa3` **code**
  Alves Batista et al. (2016)

- We set a magnetic field with **turbulent spectrum of index -11/3,** compatible with RMHD simulations. —>

- The MFPs for photo-hadronic collisions are calculated based on the analytic target, photon fields

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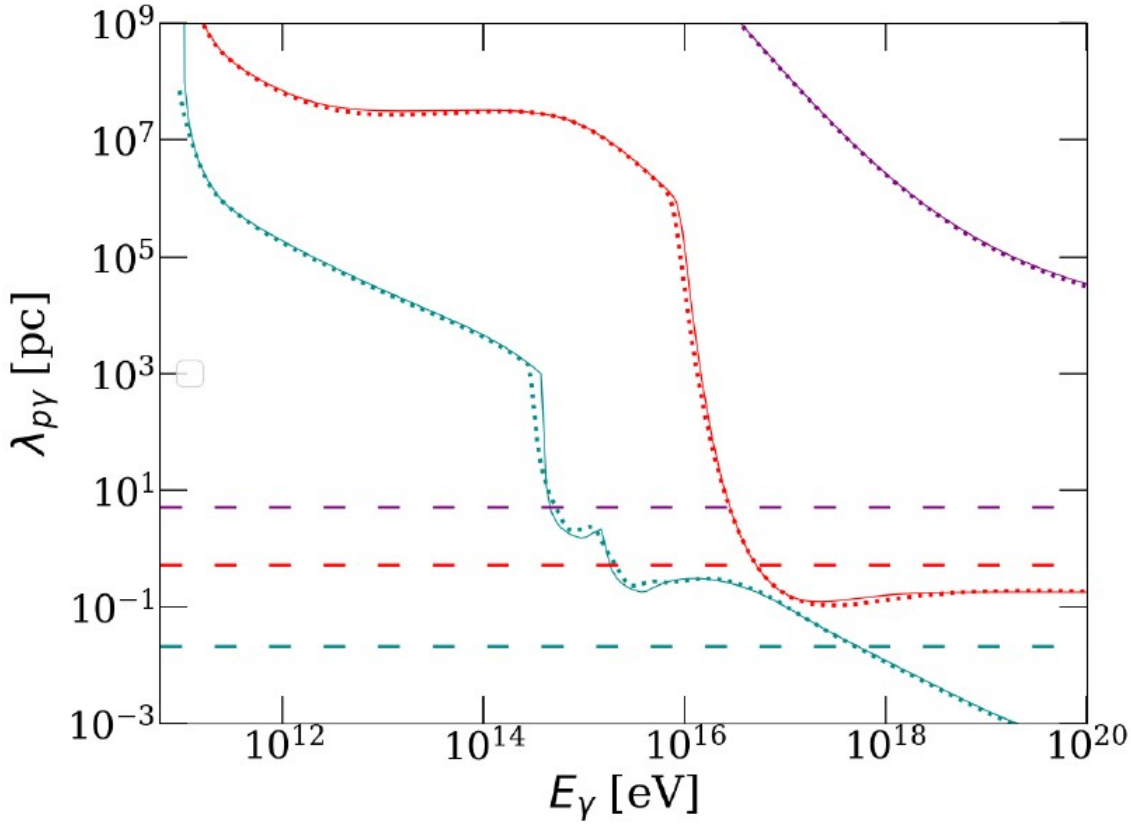

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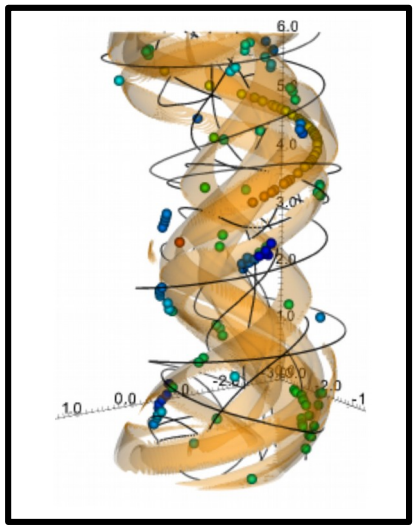

Kadowaki et al. (2021)
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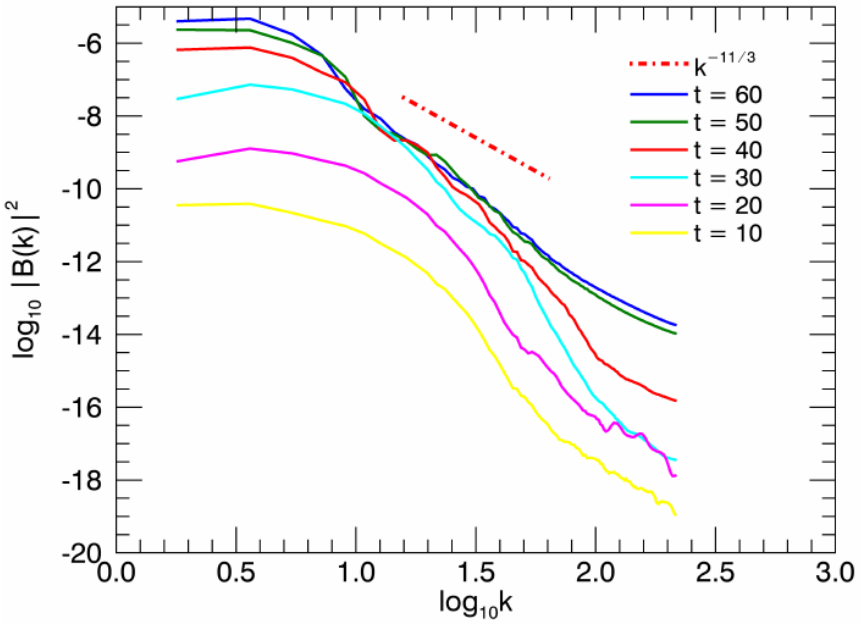
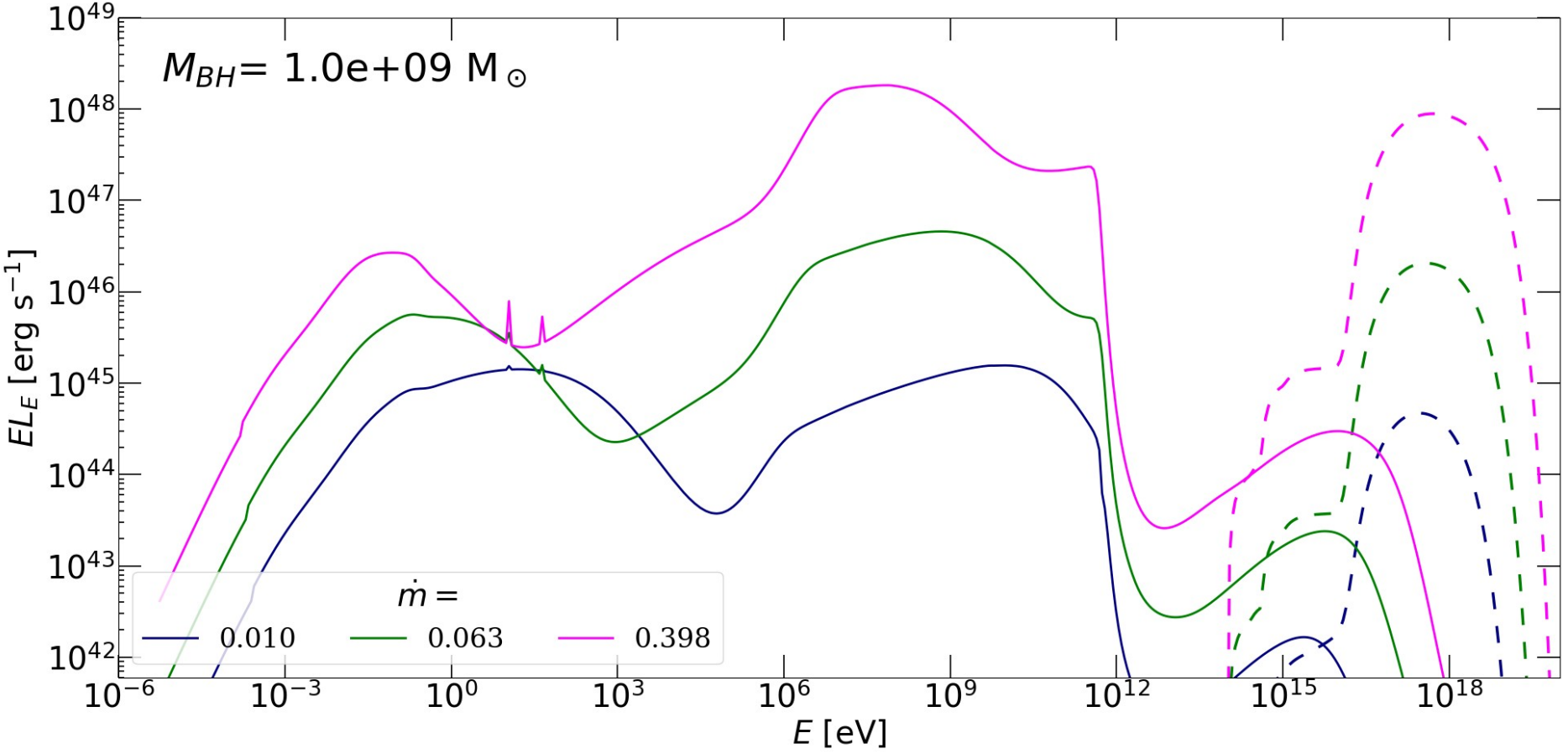


See talk by E. de Gouveia Dal Pino Session 11, UHECR Acceleration July 20.

- The MFPs for photo-hadronic collisions are calculated based on the analytic target, photon fields

Application of the MM emission model for BL Lacs and FSRQs



$$\dot{M}_j/\dot{M}_a \propto \dot{m}^{-1/2} \qquad E_b \propto \dot{m}^{-1} \qquad \Gamma_\infty \propto \dot{m}^{1/4}$$

Summary

➔We developed a **leptonic-hadronic** blazar emission model based on particle acceleration by **magnetic reconnection** and the **analytic reconnection striped jet model**.

➔The emission is powered by **magnetic reconnection** in the jet, in the transition from **magnetically to kinetically dominated** flow, which is compatible with test particle CR acceleration (see the talk by E. de Gouveia Dal Pino, session 11 UHECR Acceleration, July 20).

➔We find **good agreement** of the model discussed here in interpreting the 2017 neutrino event from the blazar **TXS 0506+056** as shown by a **preliminary SED fit** in this talk.