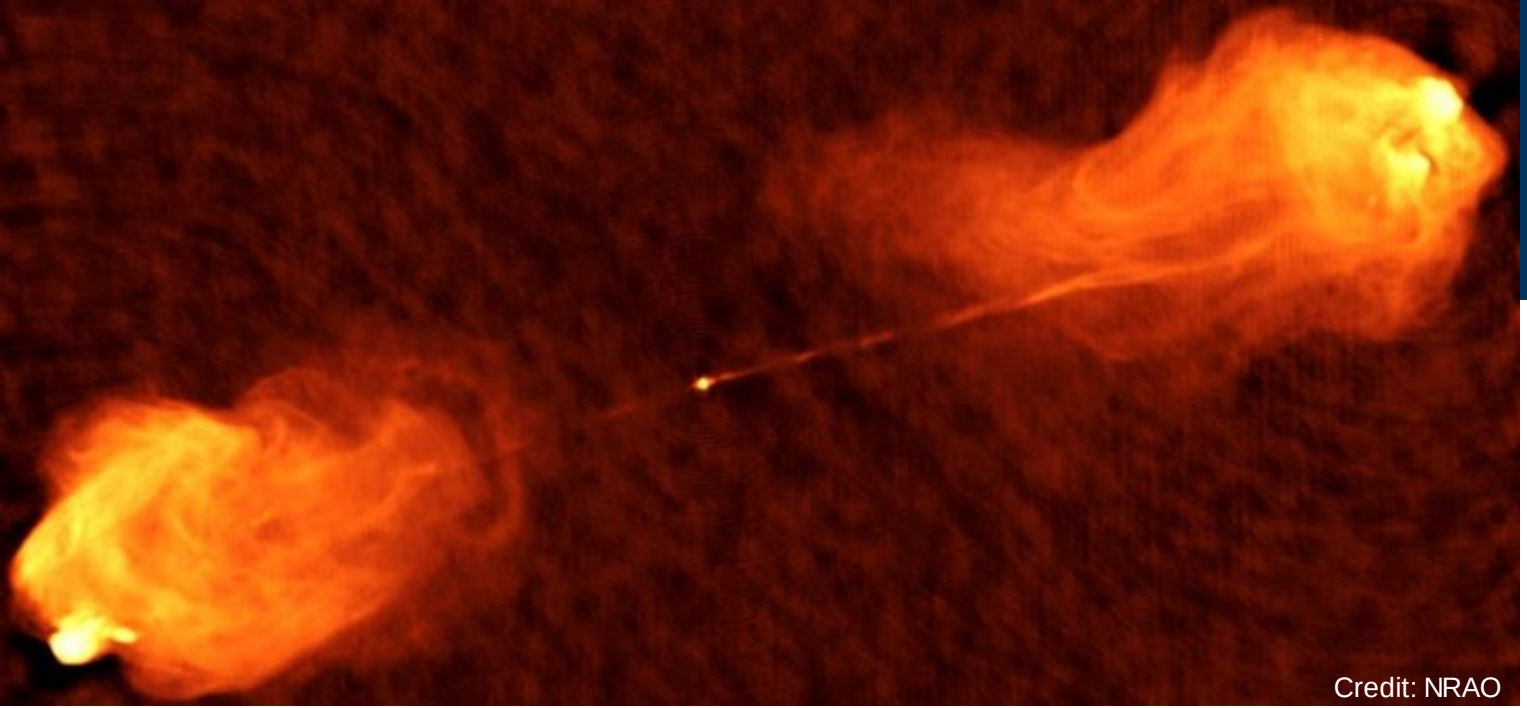


RUHR-UNIVERSITÄT BOCHUM

COSMIC-RAY TRANSPORT IN BLAZARS

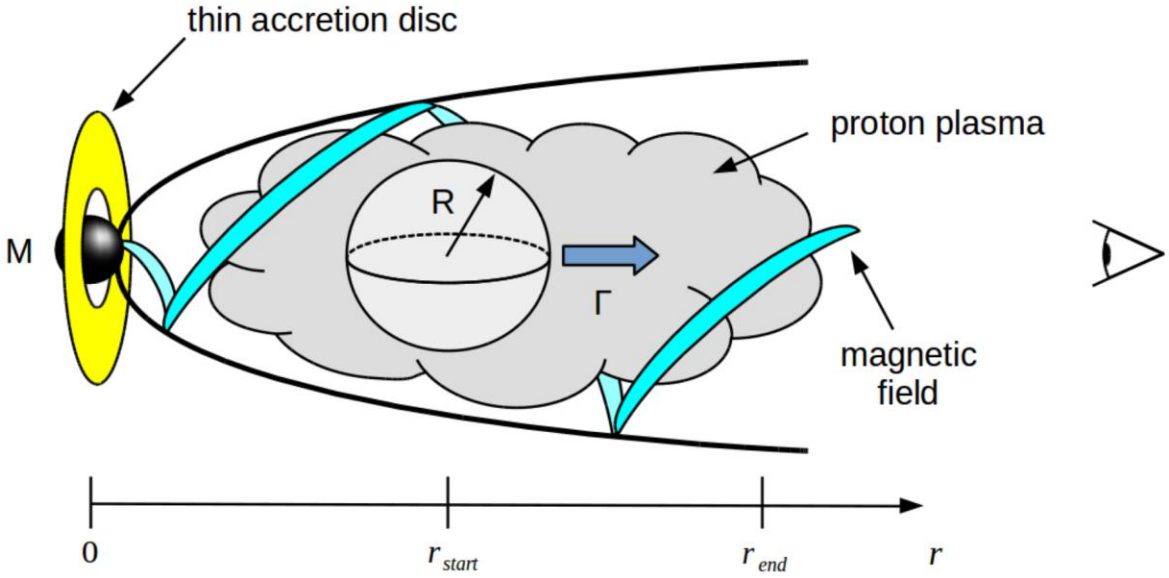
DIFFUSIVE OR BALLISTIC PROPAGATION?

Contribution 102288

RUHR UNIVERSITÄT BOCHUM

AGN plasmoid model

- Relativistic and compact plasmoids moving along the jet
  - Radii 10^12-10^14 m
  - Turbulence with B = 1 G
  - High densities
- Production of secondaries in plasmoid
- Is transport diffusive or ballistic in plasmoid?



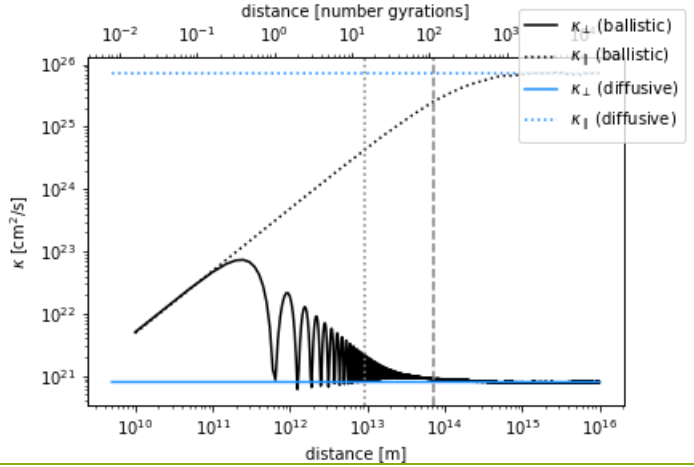
Credit: Hörbe et al. 2020

Diffusive propagation

- Diffusive transport
  - **Single particle view**: random walk of particles with 50% prob. to change direction
  - **Statistical view**: transport equation $\frac{\partial f}{\partial t} = \sum_i \kappa_i \frac{\partial^2 f}{\partial x_i^2}$
- A paradox:
  - Each step is made at finite speed
  - Diffusion occurs with infinite speed → non-vanishing probability of particles at positions that could not be reached with finite speed
- Its resolution: no contraditction for large times → diffusive propagation not valid at early times

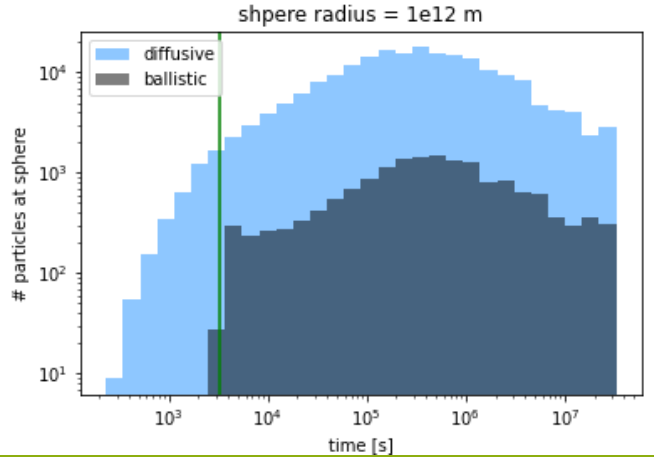
Propagation regimes in time

- Initial ballistic propagation turns into diffusion
  - diffusive models cannot describe both
  - Telegraph equation is better suited (see proceeding)



- Diffusive approach overestimates particles that leave plasmoid

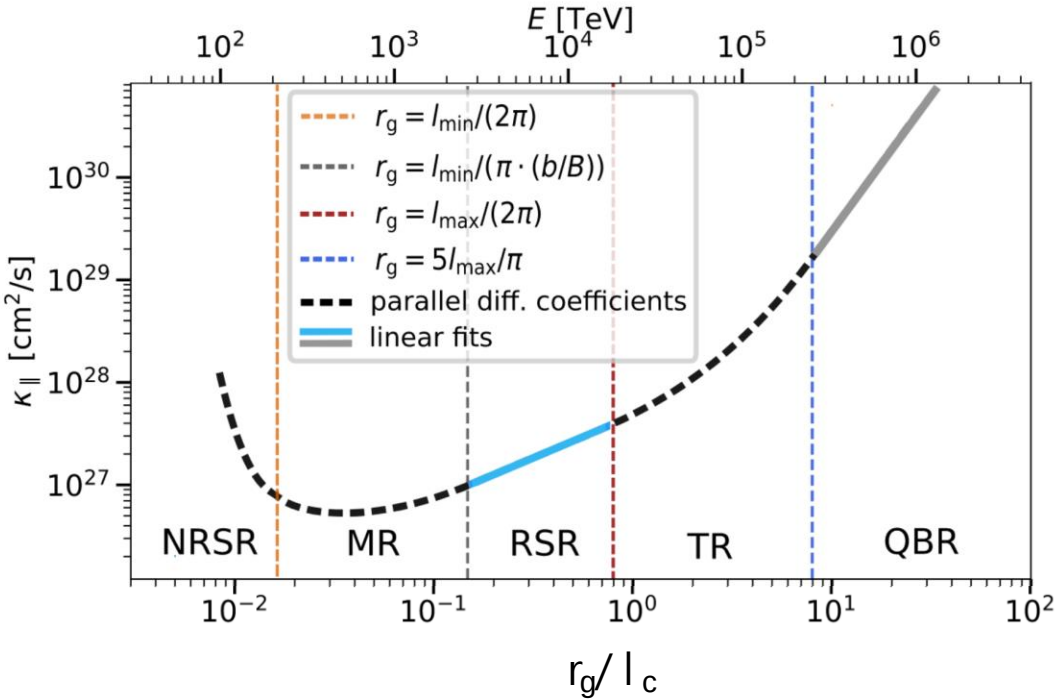
  → diffusive models underestimate production of secondaries in plasmoid



Transport regimes in energy

- Resonant-scattering regime (RSR)
  - Extends over many orders in nature
  - Energy scaling of diffusion coefficient: $\kappa \propto E^{1/3-1}$
- Quasi-ballistic regime (QBR)
  - Extends over many orders in nature ($r_g \gg l_c$)
  - Diffusion coefficients increase fast: $\kappa \propto E^2$
- Mean-free path scales linearly with κ

  ➡ Much time needed to reach diffusive limit in QBR



Credit: Reichherzer et al. 2020

Overview plot

Hillas-like overview plot

1. There are different propagation regimes in time
    1. ballistic
    2. diffusive
2. Different energy regimes of particle transport
    1. RSR → diffusive
    2. QBR → ballistic