POLARIZATION ROTATIONS FROM KINK INSTABILITIES

Krzysztof Nalewajko
Nicolaus Copernicus Astronomical Center
Warsaw, Poland

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NATIONAL SCIENCE CENTRE
POLAND

QUESTIONS ON THE NATURE OF POLARIZATION ROTATIONS

- are polarization rotations coherent or stochastic?
- what is polarization degree doing during the rotations?
- how does relativistic aberration affect the rotations?
- could kink instability explain the largest rotations?
- is there a connection with gamma-ray flares and radio activity?

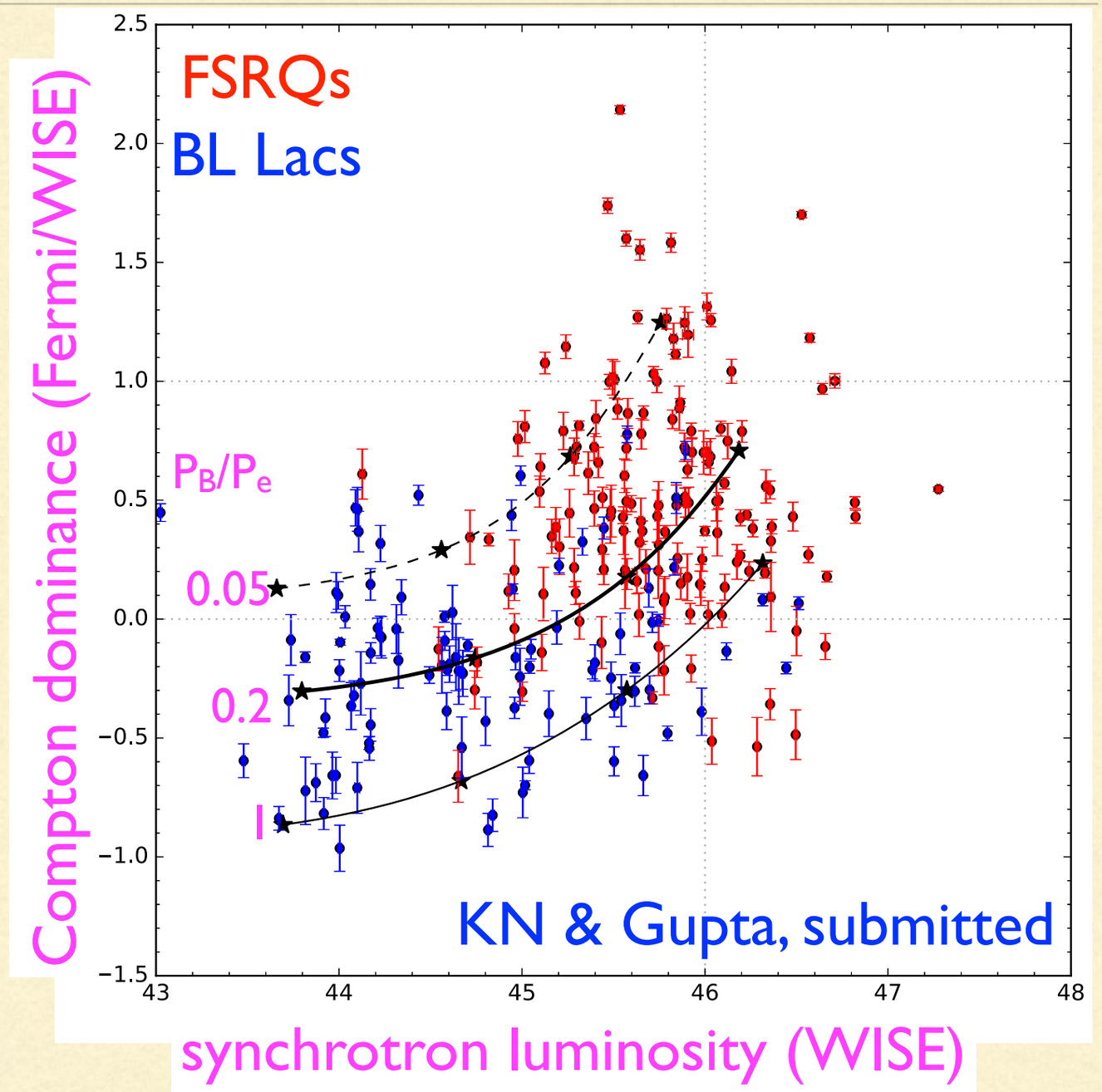
MATTER-DOMINATED BLAZAR JETS?

- Compton dominance
  $q = L_{IC}/L_{syn}$
  probes jet magnetization

- preference for matter-dominated jets, even not including protons (cf. Tavecchio & Ghisellini 2016)

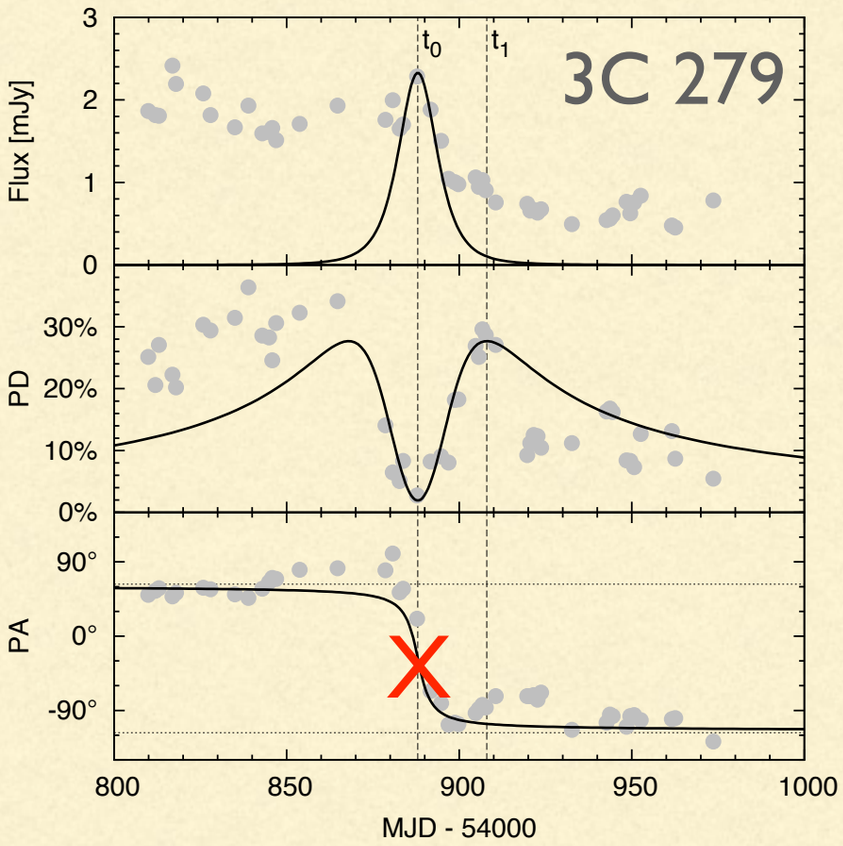
- caveat: radiative efficiency of electrons ~50%

- magnetically dominated with total radiative efficiency 95%? (Potter 2016)



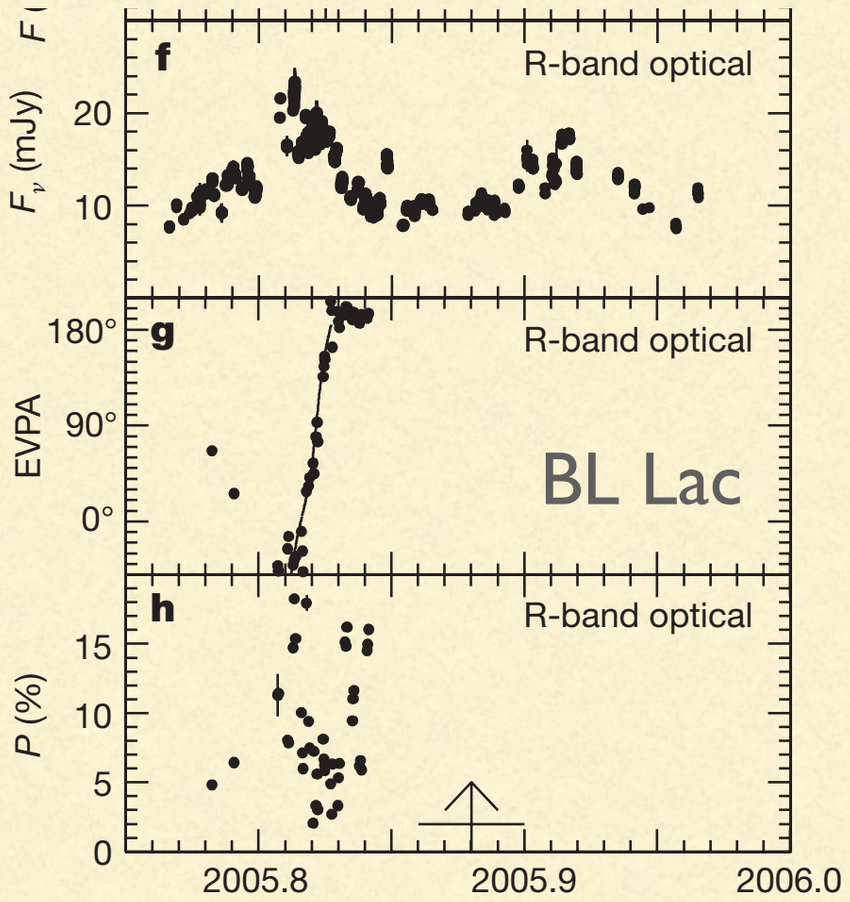
HISTORIC OBSERVATIONS OF POLARIZATION ROTATIONS

polarization swing of 180 deg with simultaneous optical flare and polarization minimum?



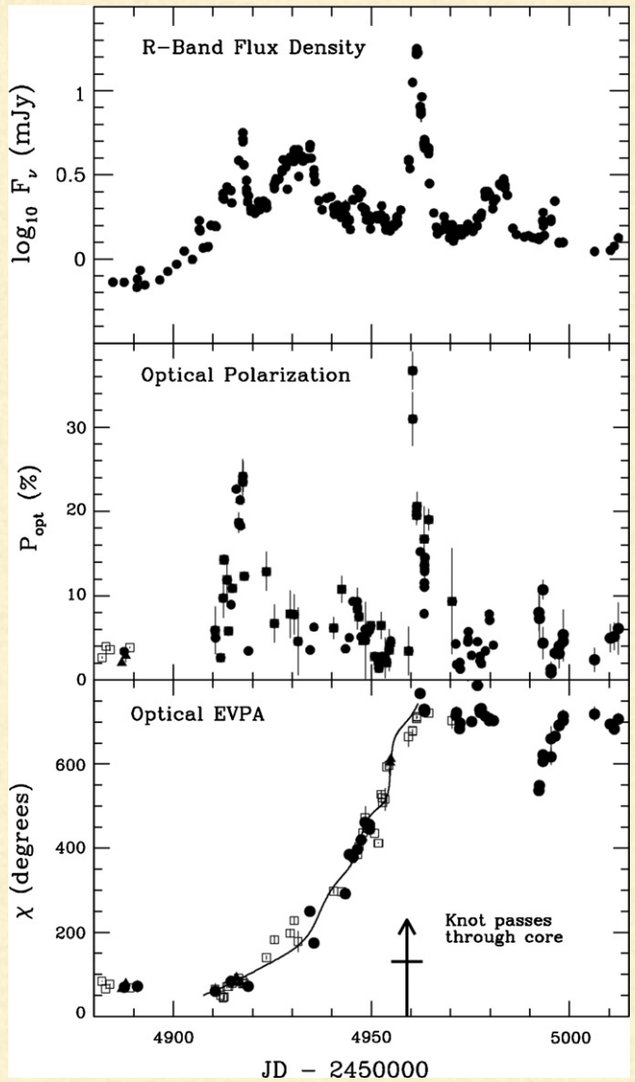
Fermi+MWL (2009), KN (2010)

high polarization degree bracketing polarization swing?



Marscher et al. (2008)

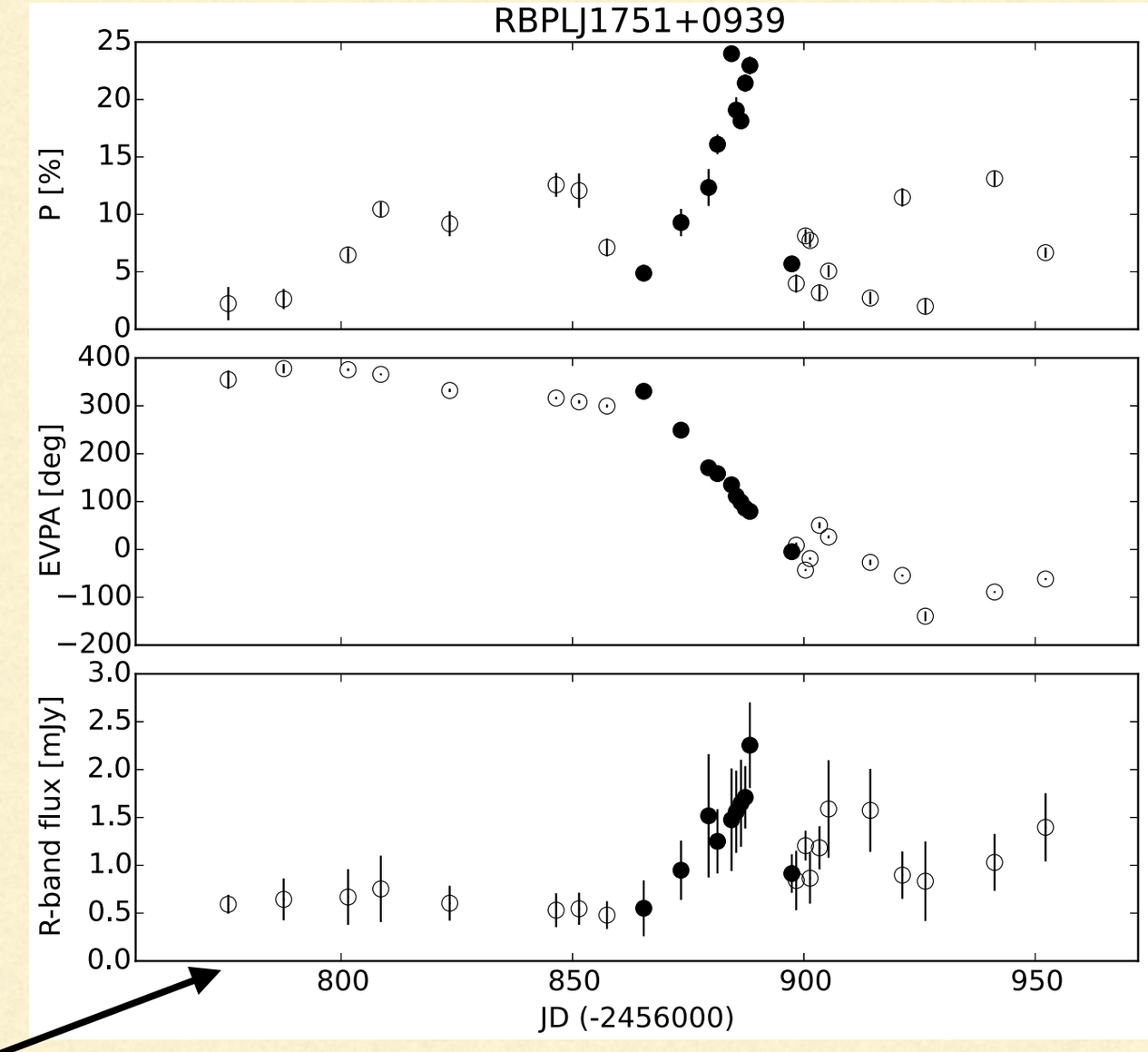
PKS 1510-089



Marscher et al. (2010)

COHERENT PATTERNS OF POLARIZATION DEGREE?

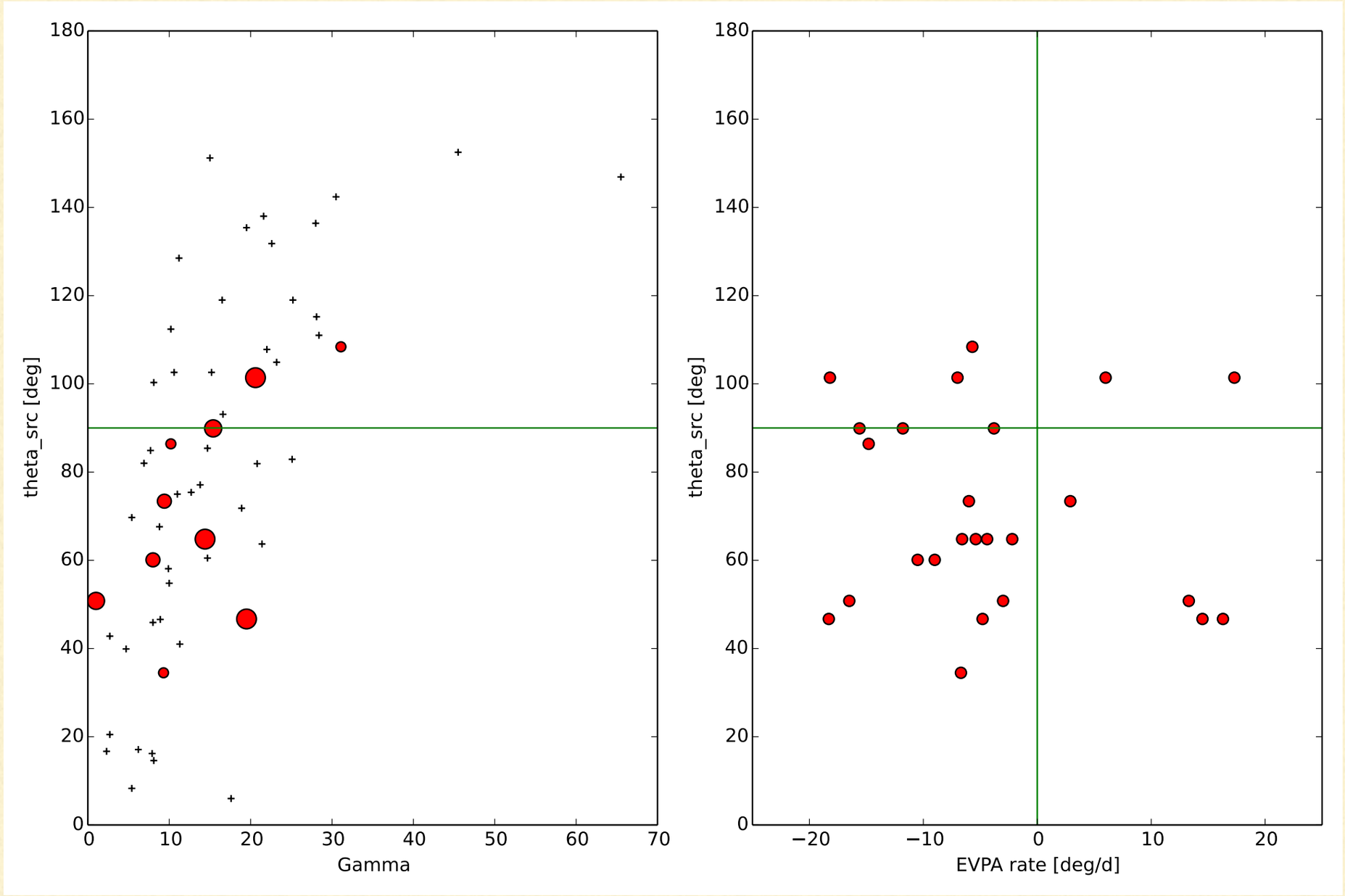
- there appears to be no universal behavior of polarization degree
- most polarization rotations could be stochastic (supported by matter domination)
- hard to explain large smooth rotations by stochastic process (Kiehlmann et al. 2016)
- there are also interesting cases



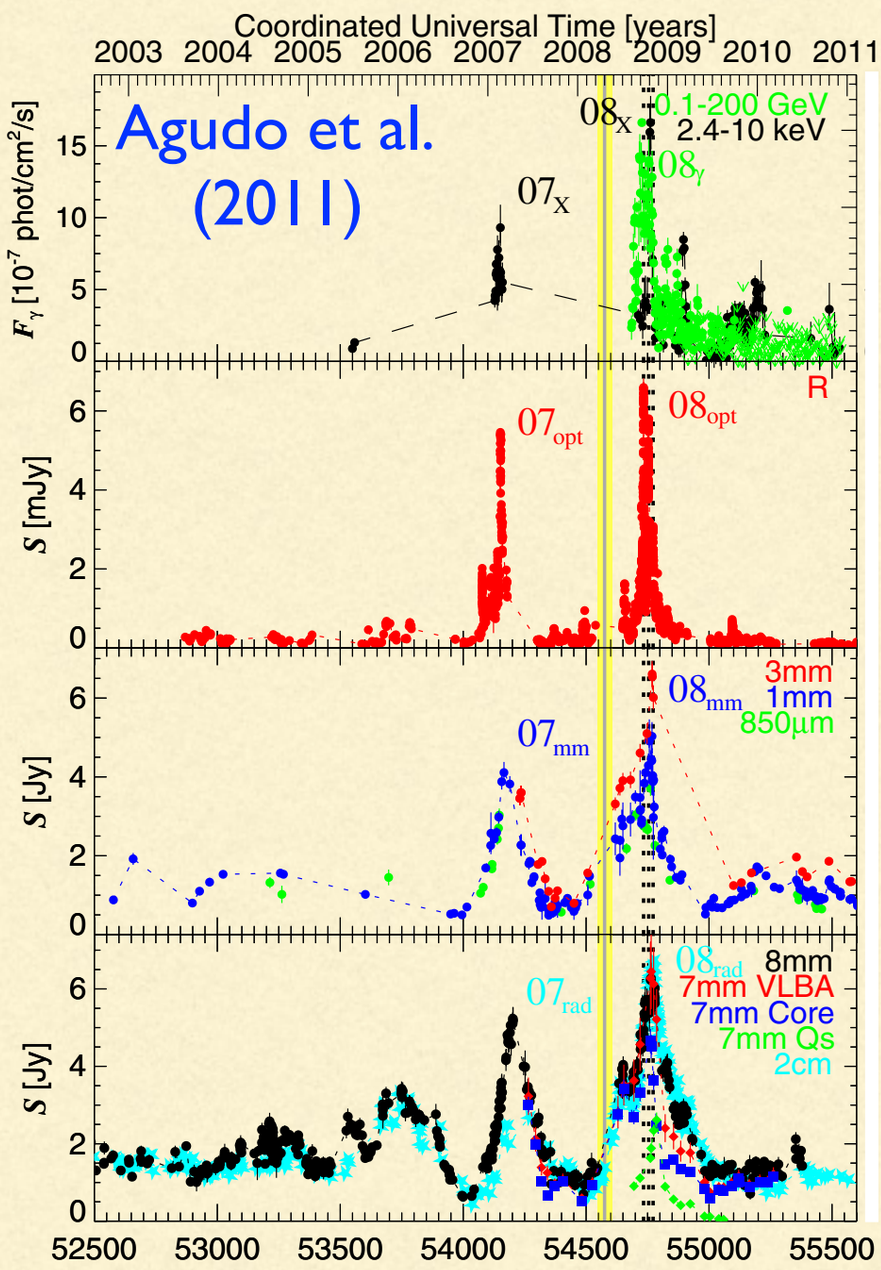
Blinov et al. (2016a)

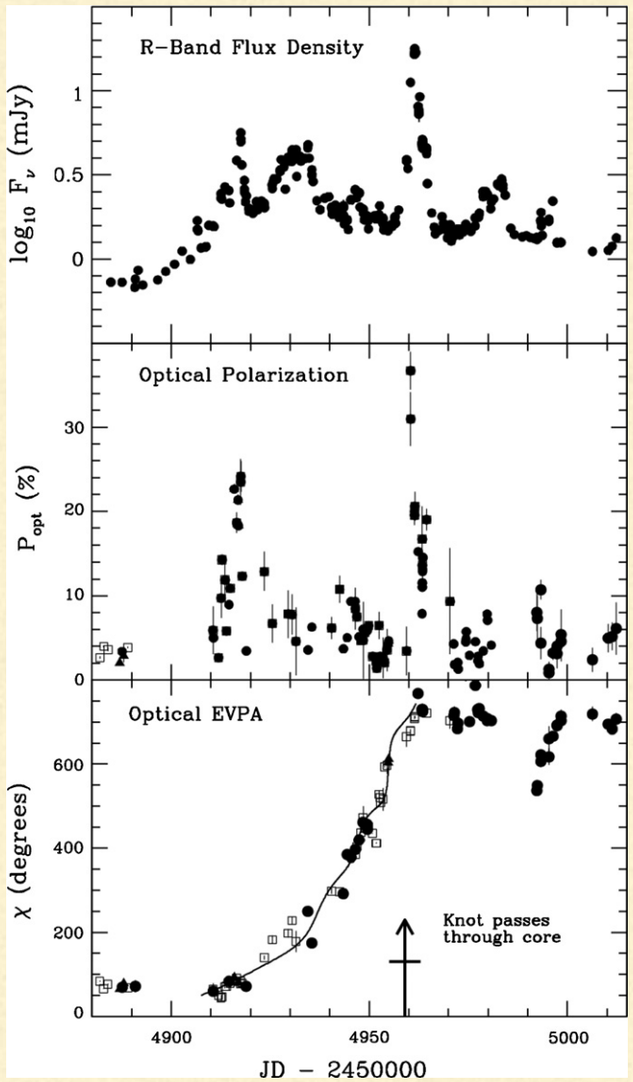
EFFECT OF RELATIVISTIC ABERRATION ON POLARIZATION ROTATIONS?

- Robopol found certain blazars to be rotators (Blinov et al. 2016b)
- intrinsic viewing angle (Savolainen et al. 2010)

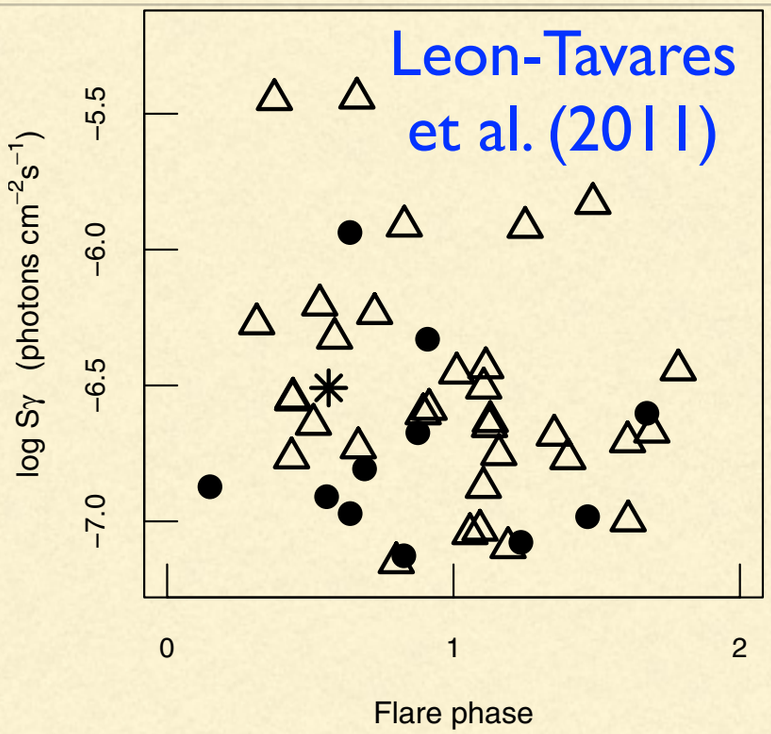


BLAZAR FLARE CONNECTIONS



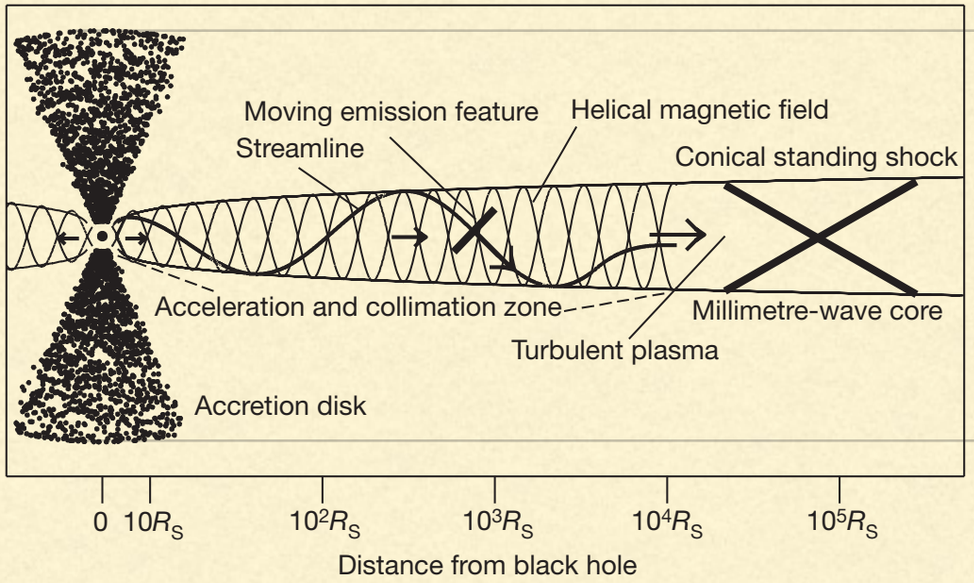


Marscher et al. (2010)

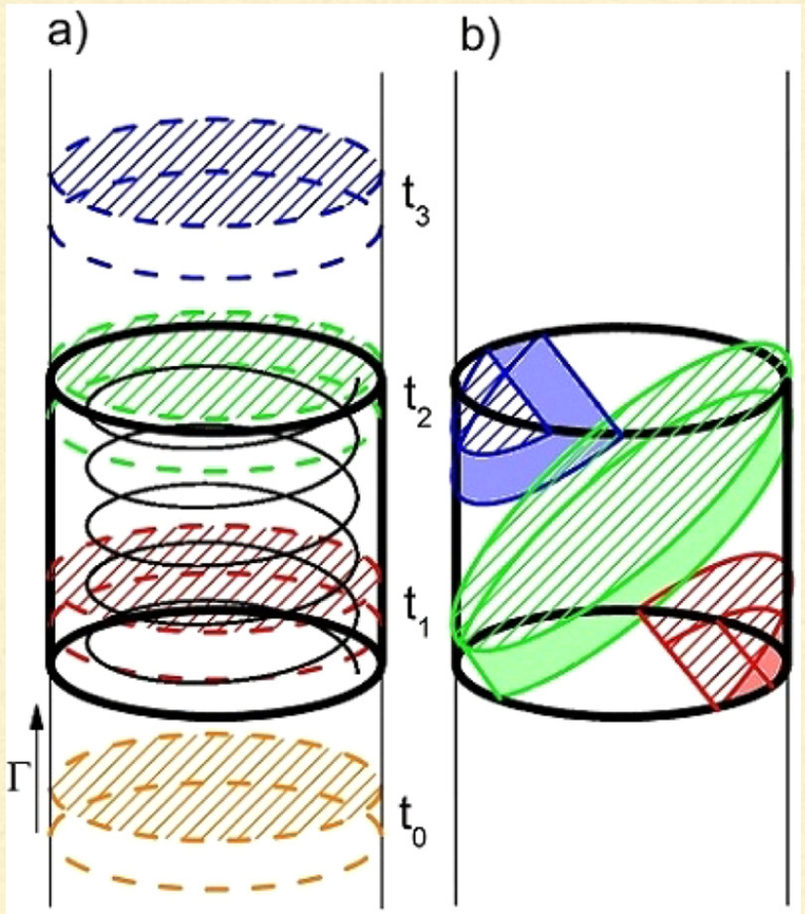


radio/mm emission: jet calorimeter?
optical/gamma flares: non-linear dissipation? criticality? trigger?

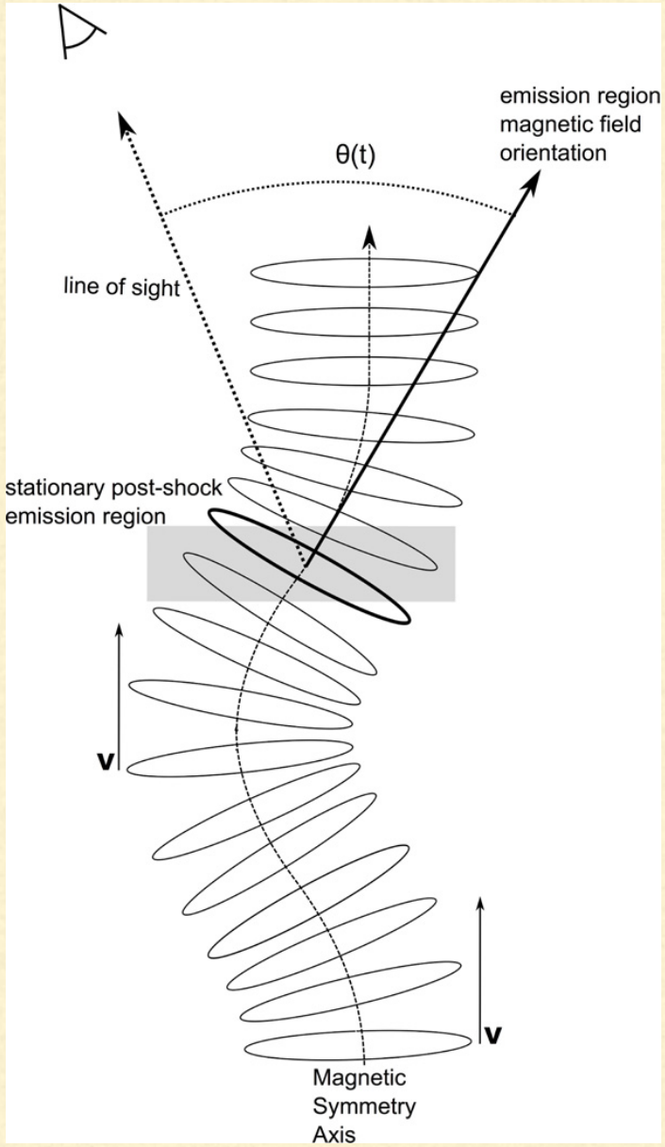
PROPOSED MODELS



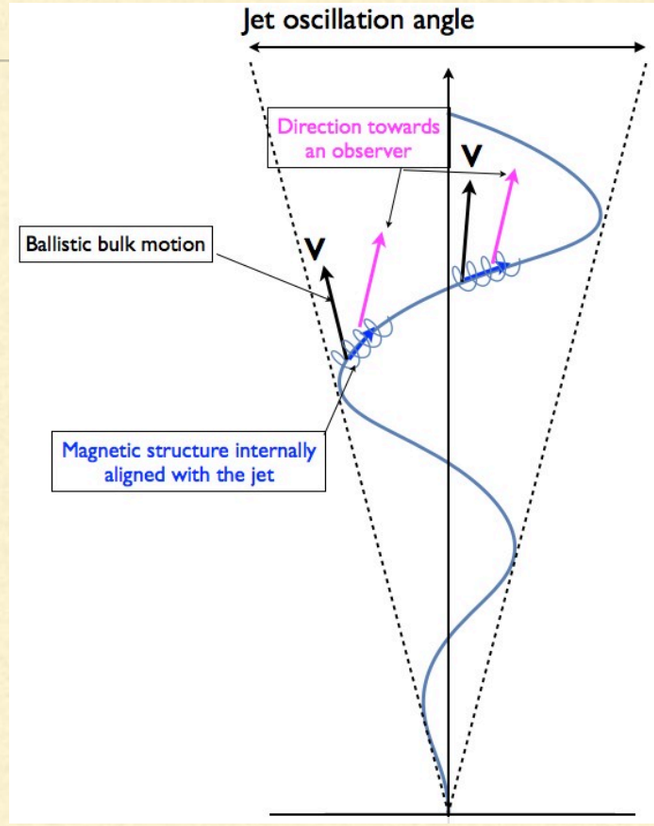
Marscher et al. (2008)

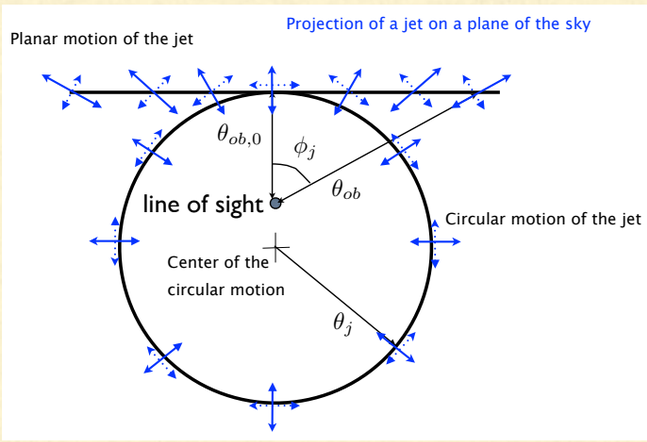


Zhang et al. (2015)



Perlman et al. (2011)

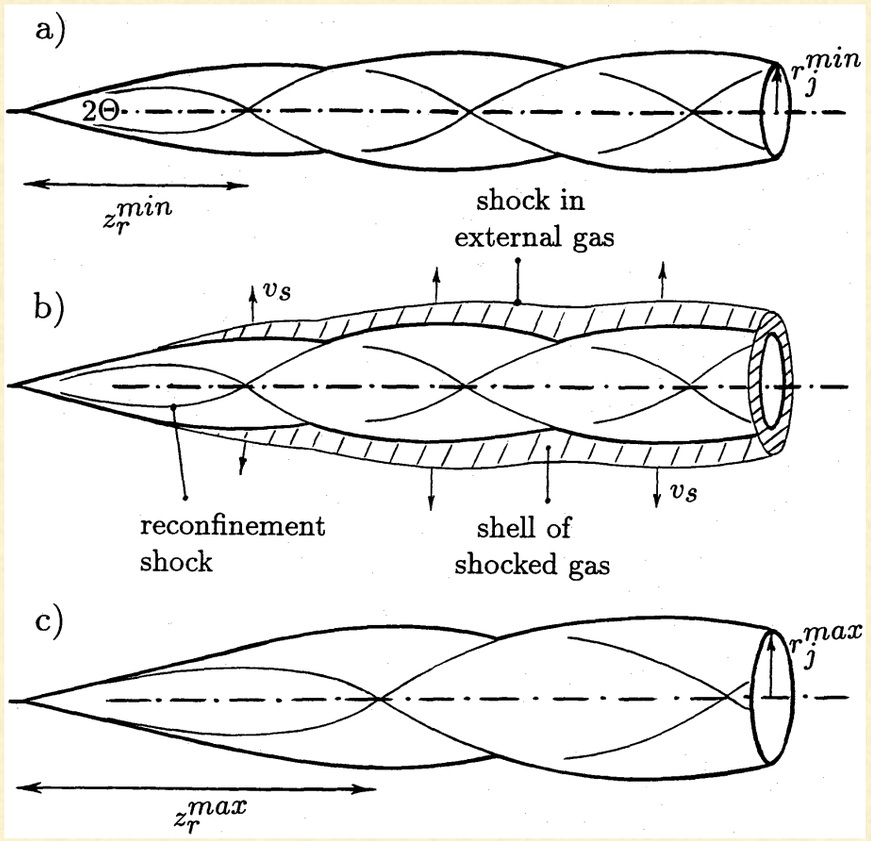




Lyutikov & Kravchenko (2017)

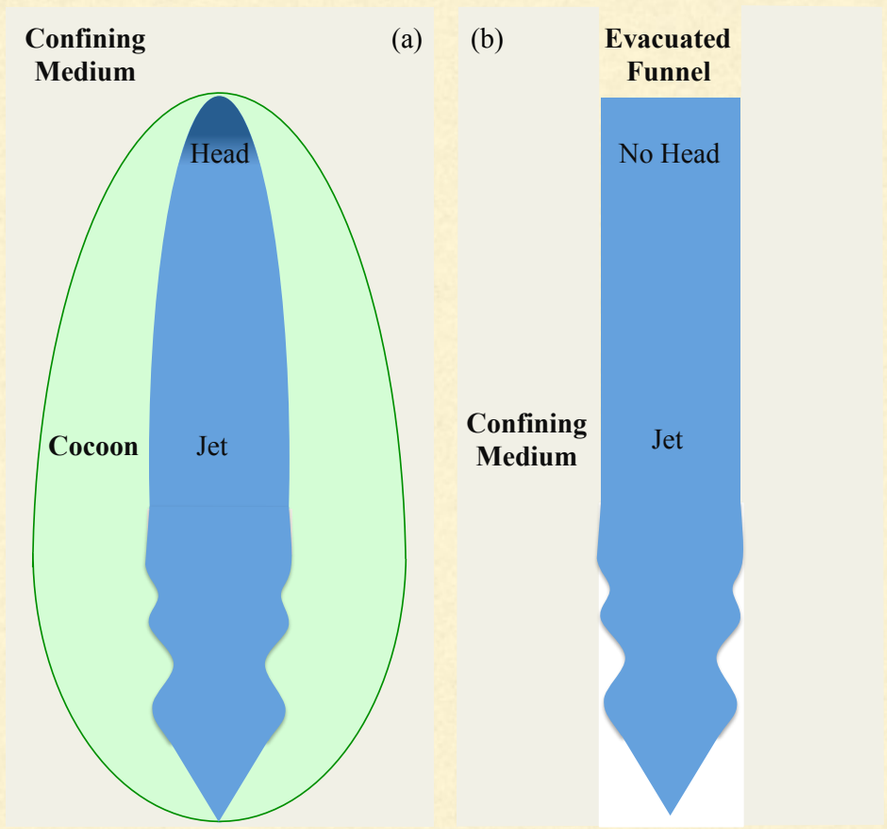
KINK INSTABILITIES TRIGGERED BY VARIATIONS IN JET POWER?

jets of increased power try to adjust to environment



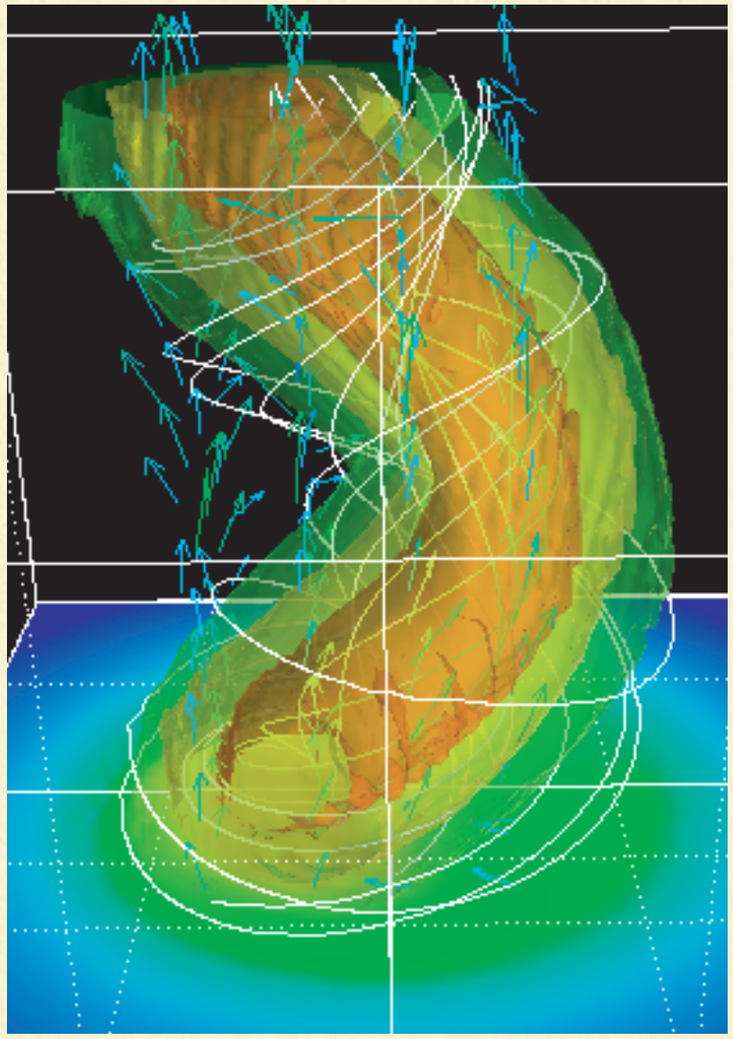
Komissarov (1994)

stability of jets to current modes depends on environment



Bromberg & Tchekhovskoy (2015)

kink is the main current mode

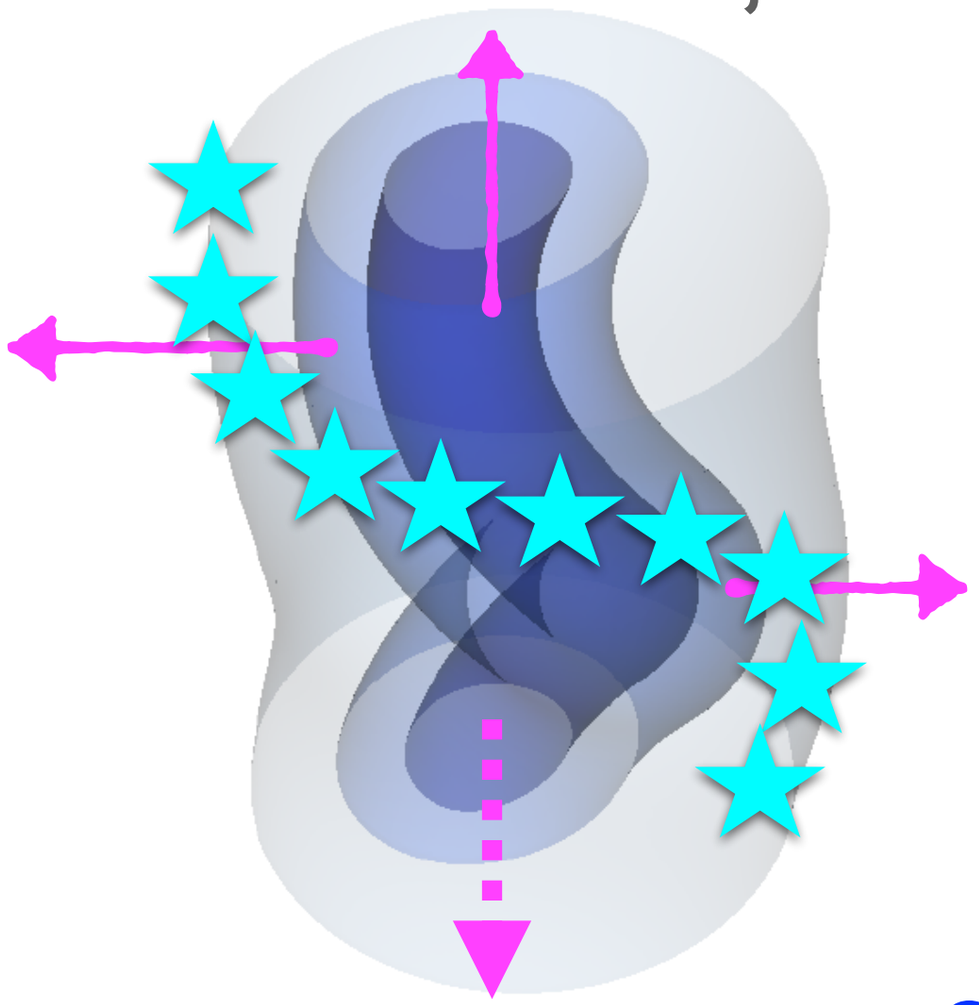


Mizuno et al. (2011)

TOY MODEL OF KINK INSTABILITY

jet co-moving frame

helical perturbation driving radial motions that lead to inner jet colliding with outer jet regions

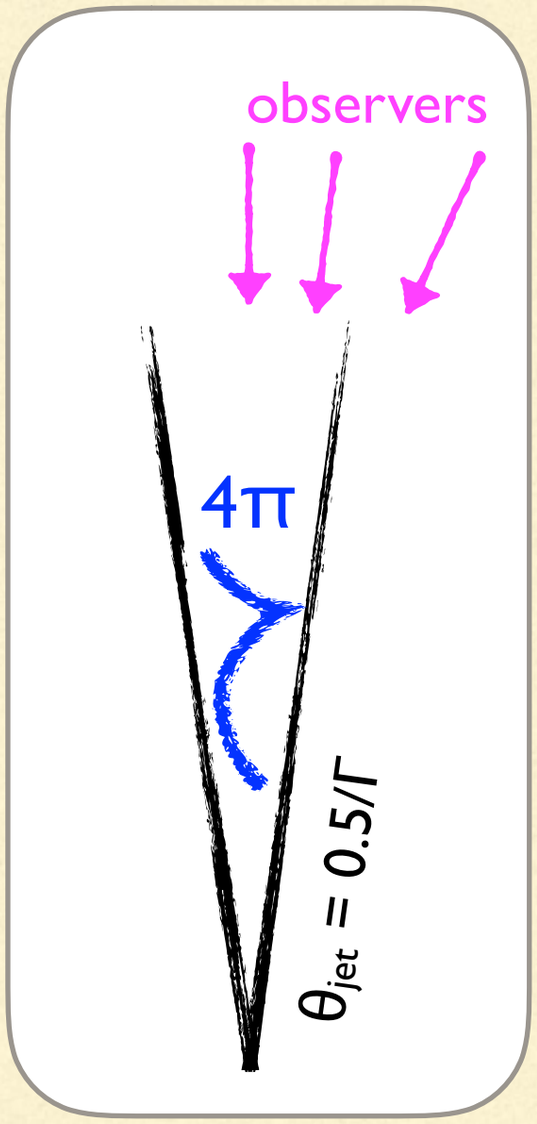


helical dissipation pattern where perturbation passes through jet boundary

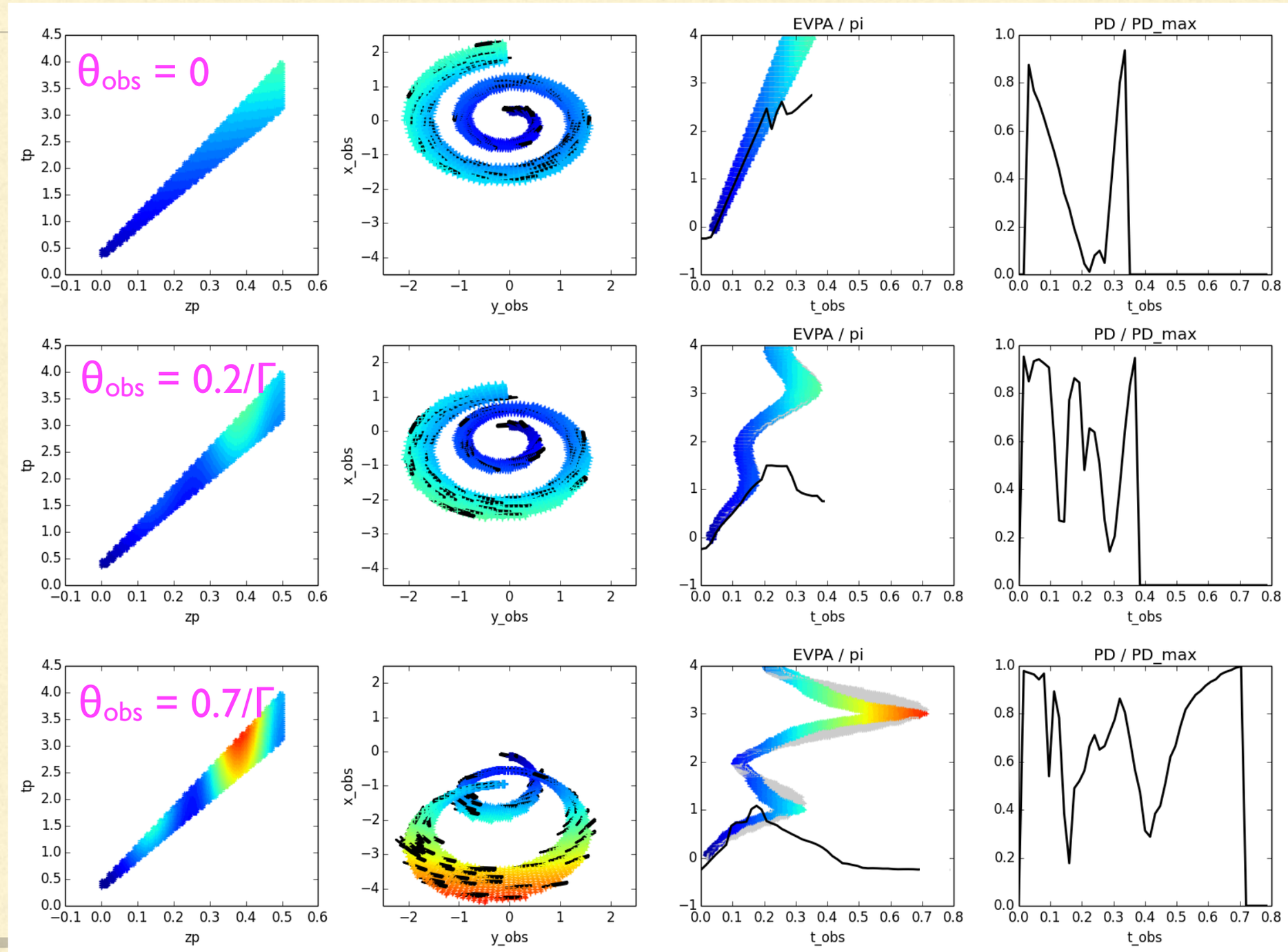
O'Neill et al. (2012)

MODEL OF LARGE ROTATIONS
TOROIDAL MAGNETIC FIELDS

PRELIMINARY

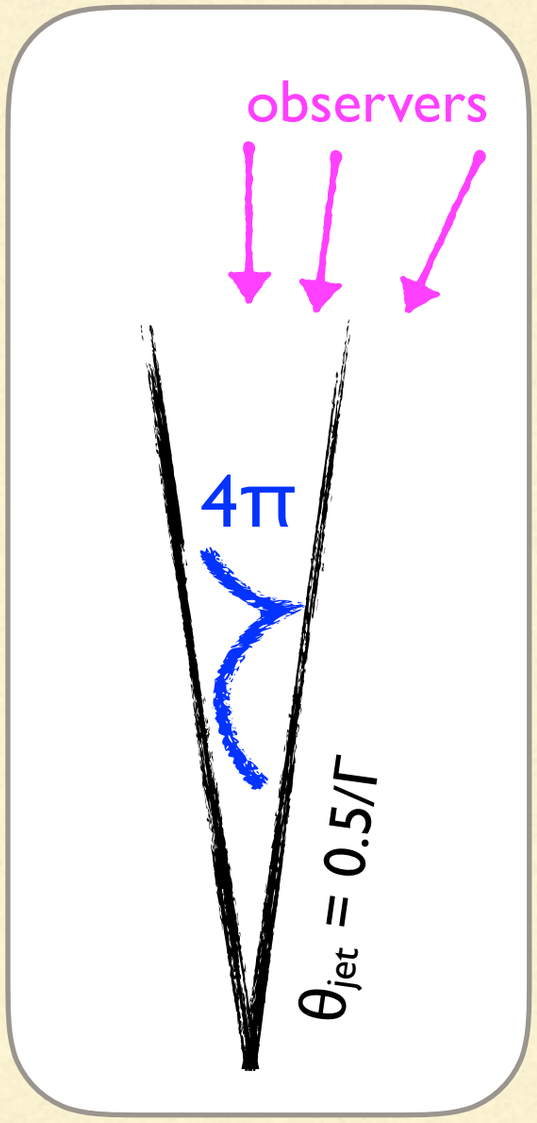


color = t_{obs}



MODEL OF LARGE ROTATIONS
POLOIDAL MAGNETIC FIELDS

PRELIMINARY



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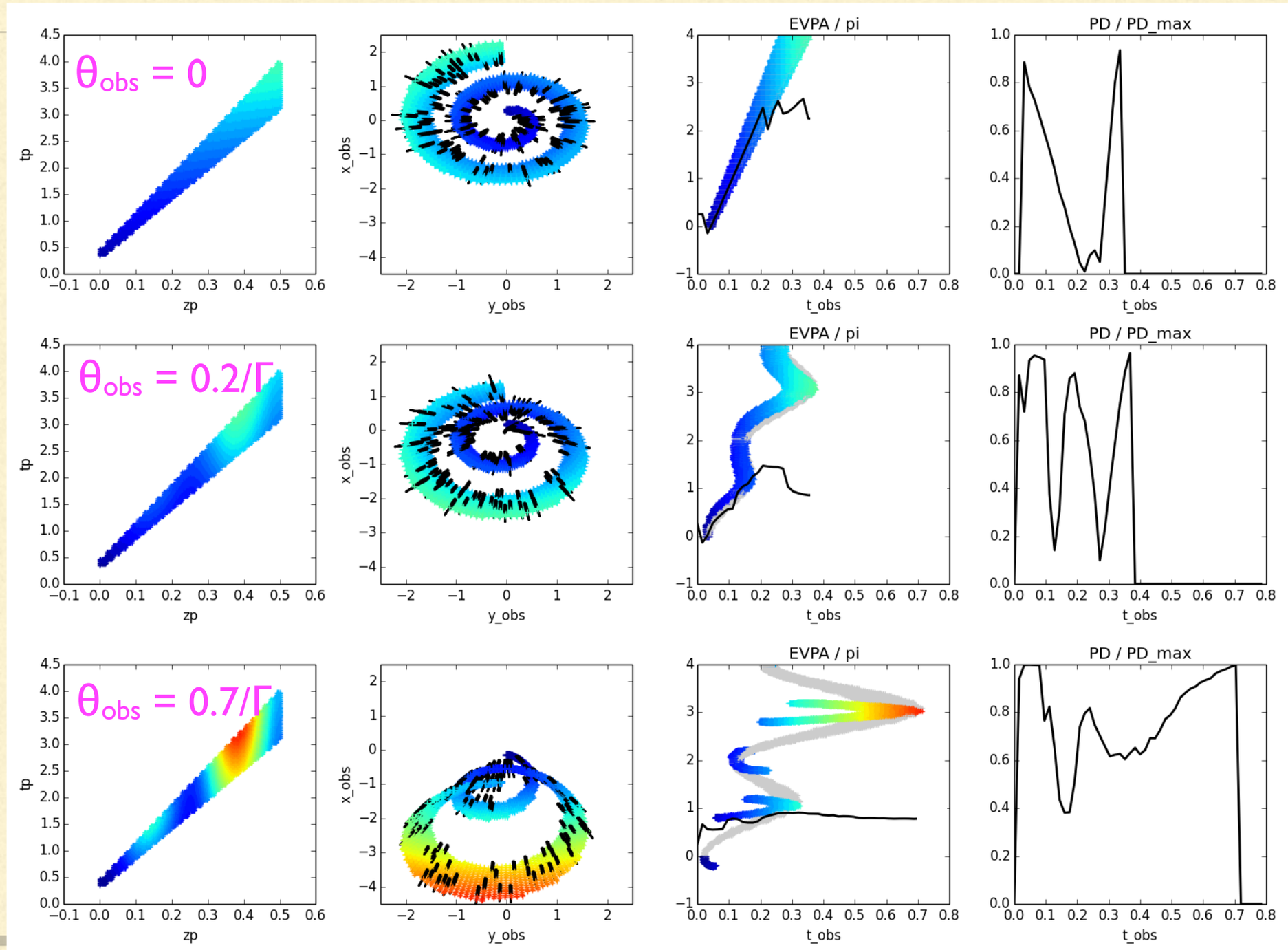
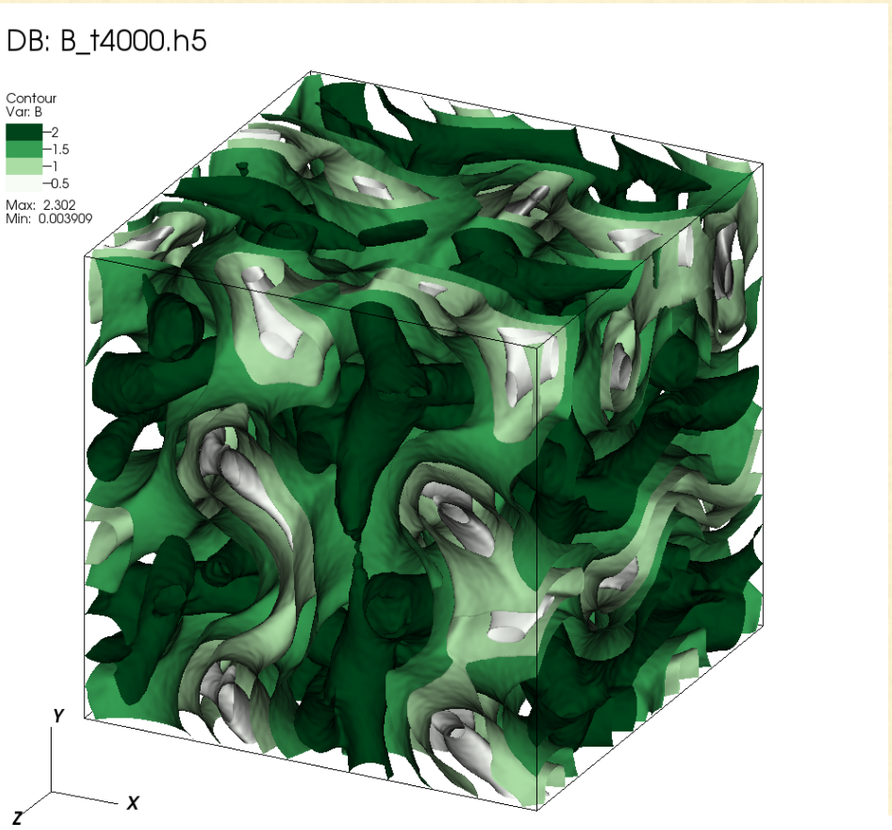
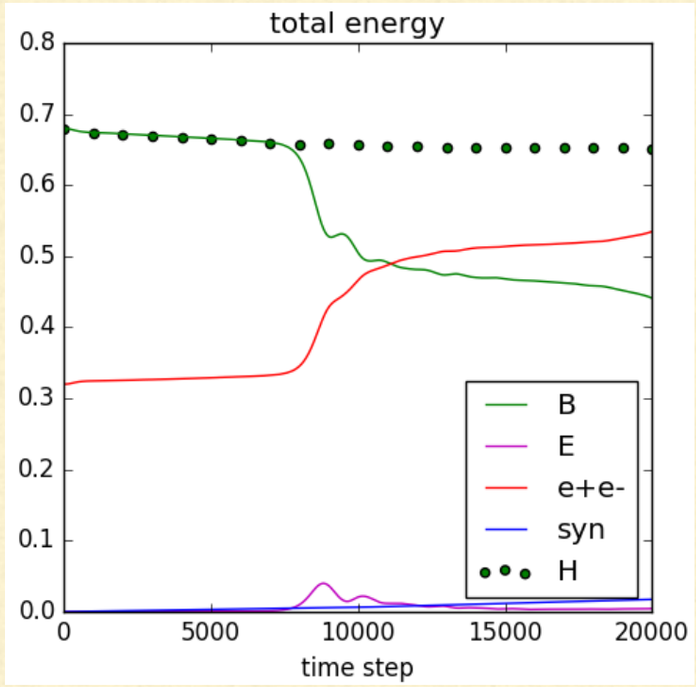
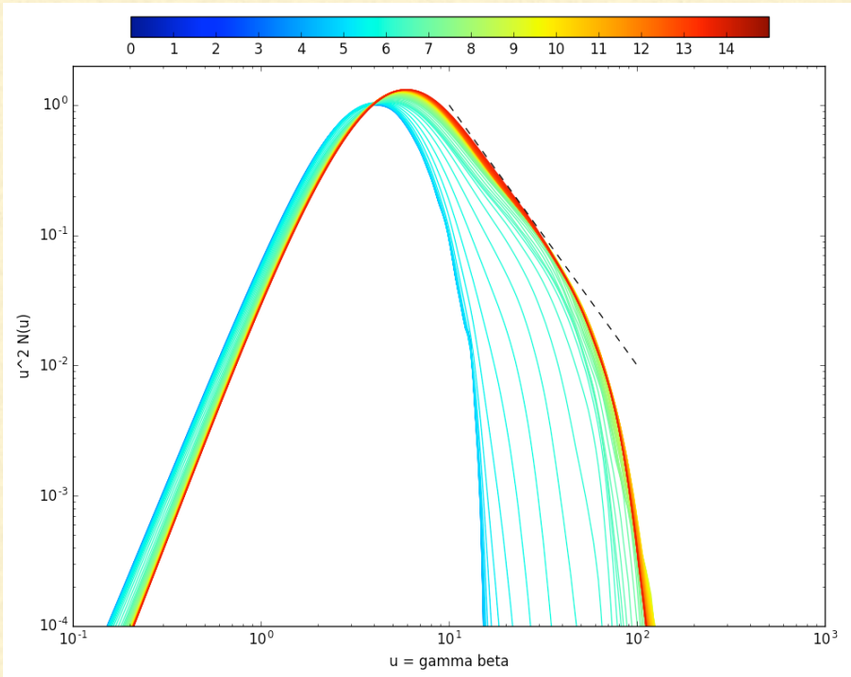


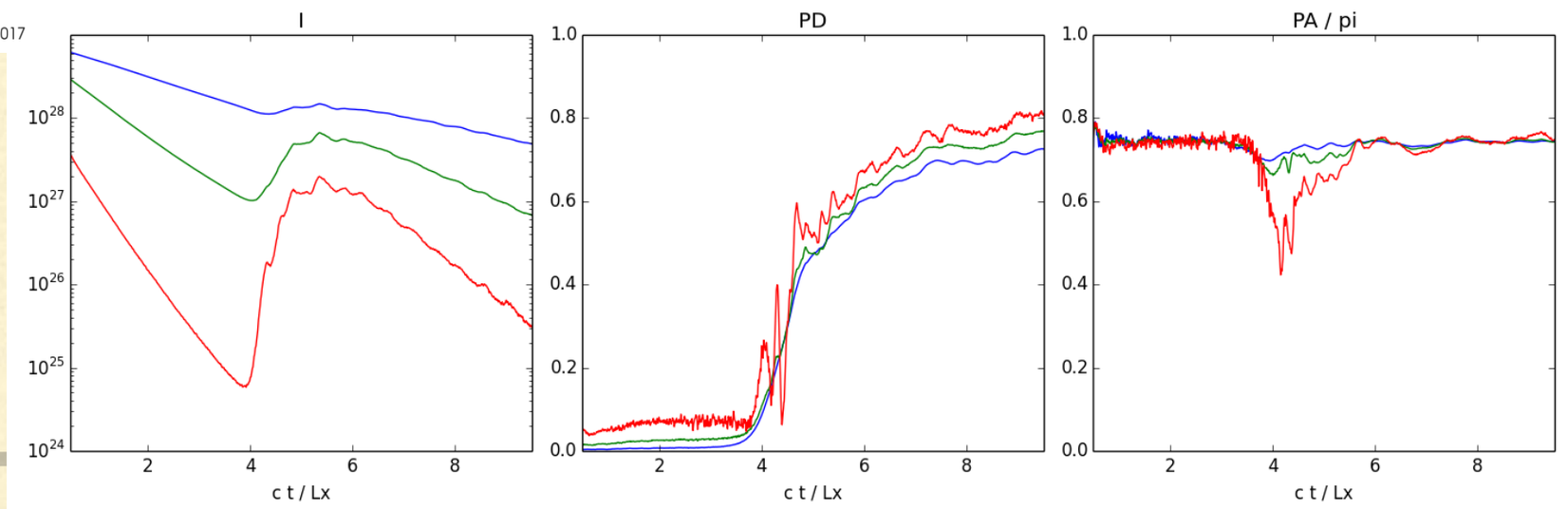
SIMULATED SYNCHROTRON POLARIZATION FROM *ABC* RECONNECTION WITH 3D PIC







PRELIMINARY



CLUES ON THE NATURE OF POLARIZATION ROTATIONS

- are polarization rotations coherent or stochastic?
  blazar emitting regions are likely matter dominated
  which supports stochastic models

- what is polarization degree doing during the rotations?
  hard to identify any consistent pattern
  coherent polarization degree essential for coherent nature of rotation

- can relativistic aberration explain rotators vs. non-rotators?
  observational evidence suggests rotations at large co-moving viewing angles

- could kink instability explain the largest rotations?
  very difficult to reproduce smooth polarization rotations
  highly variable depolarization due to light-travel effects

- is there a connection with gamma-ray flares and radio activity?
  increasing jet power (radio/mm outburst) could trigger kink instability and non-linear dissipation (optical/gamma flare + polarization rotation)

Thank you!