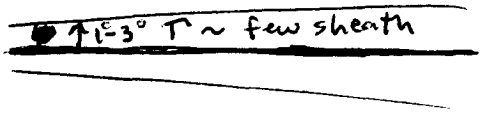
VI. Velocity Gradients Across Jet "Spine-sheath" structure

- Good evidence for this in extended jets of FR I radio galaxies + milliarcsec-scale jet of MKn 501 (Giroletti et al. 2004 ApJ) [Could be caused by Kelvin-Helmholtz instability at boundary]

- Often suggested for compact jets when more free parameters are needed because observational data conflict with model - dangerous! On the other hand, jet launching theorists say it's possible



↑ see spine only when viewing angle $\theta \lesssim \Gamma_{spine}^{-1}$

VII. Jet Energy Density + Luminosity

Studies of FR II radio galaxies give $\langle L_{jet} \rangle \gtrsim 3 \times 10^{44\pm2}$ erg s^{-1}
Lifetimes of jets $\simeq 10^{7\pm1}$ yr

Compact Jets: Can solve for B, K from equations for τ_m + F_m if z, Θ, α, ν_m, + F_m are measured with multi-ν VLBI
Or: take easy way out + assume equipartition

First method gives $B = 10^{-5}\, b_1(\alpha)\, \Theta_{mas}^{4}\, \nu_{m,GHz}^{5}\, F_{m,Jy}^{-2}\, (\delta/1+z)$ G
↑ 2 to 4 for $\alpha = 0.3$ to 1
+ similar expression for K (see Marscher 1983 ApJ)

Equipartition gives $B = b_2(\alpha)\, \delta^{-1} (1+z)^{\frac{5+\alpha}{3+\alpha}} \left[\frac{1+\gamma}{f} D_{Gpc}^{-1}\, \Theta_{mas}^{-3}\, F_{\nu,Jy}\, \nu_{GHz}^{\alpha}\, \gamma_{min}^{-(2\alpha-1)} \right]^{\frac{1}{3+\alpha}}$
where $b_2(\alpha) = 0.3, 1.5, 4.4$ for $\alpha = 0.5, 0.75, 1$ respectively
Here, $\gamma \equiv \frac{u_{protons}}{u_{e^-,e^+}}$, $f \equiv$ volume filling factor of emission,

$\gamma_{min} \equiv$ minimum energy of relativistic electrons
For $\alpha = 0.5$, replace $\gamma_{min}^{-(2\alpha-1)}$ by $\ln(\gamma_{max}/\gamma_{min})$

For the most compact features ($\Theta \sim 0.1$ mas) we can resolve, $B \sim 10^{0\pm1}$ G
$u_{mag} = \frac{B^2}{8\pi} \sim 4 \times 10^{-2\pm2}$ erg cm^{-3}
$L_{mag} \approx \Gamma\, u_{mag} \cdot \pi r^2 c \sim 10^{46\pm1}$ erg s^{-1}

Warning: only measured in a few objects!