



# In QED We Trust

Roger Blandford

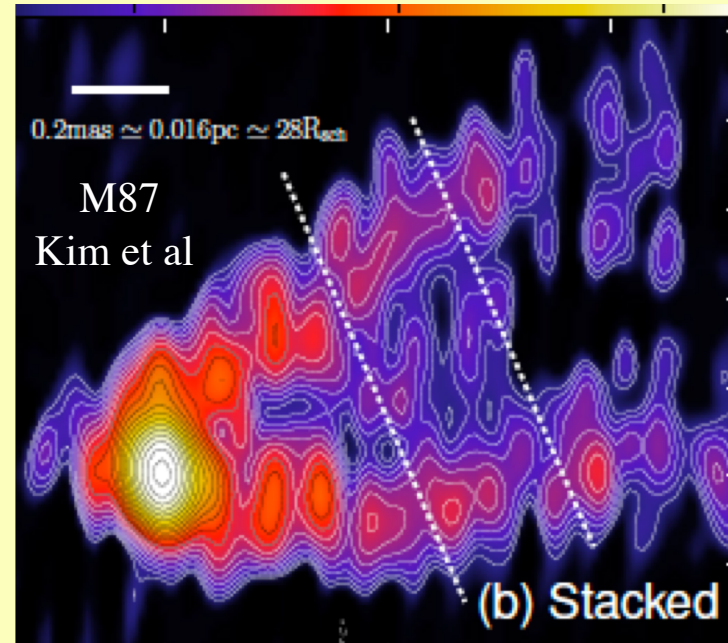
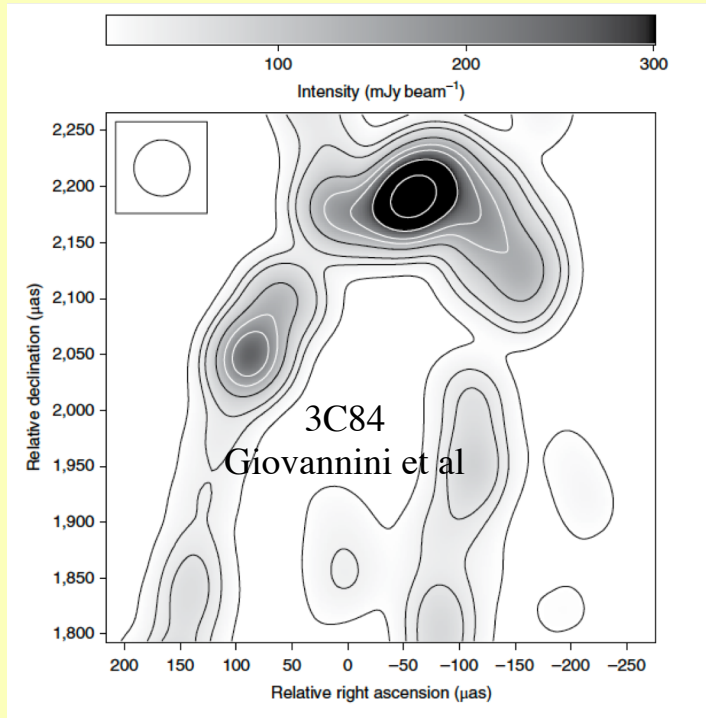
KIPAC

Stanford

with

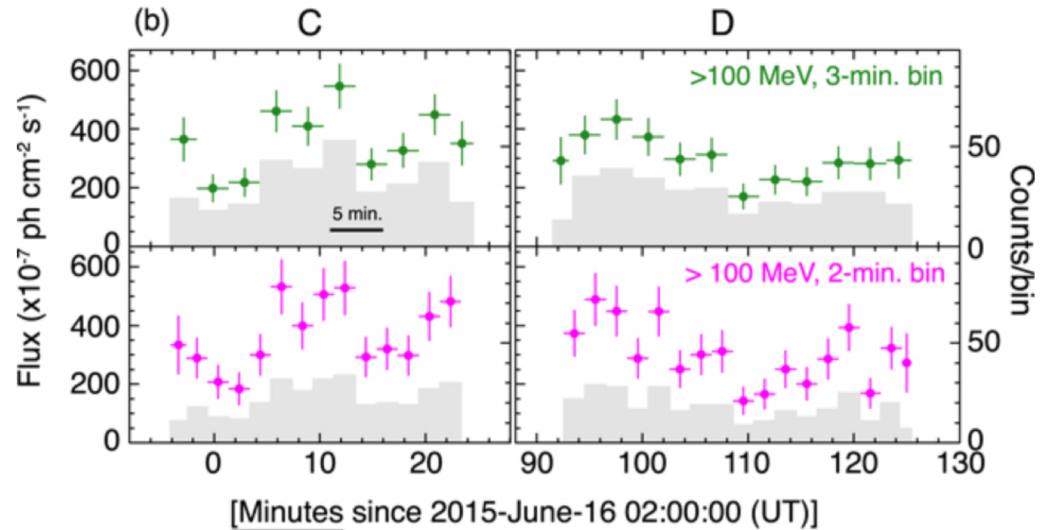
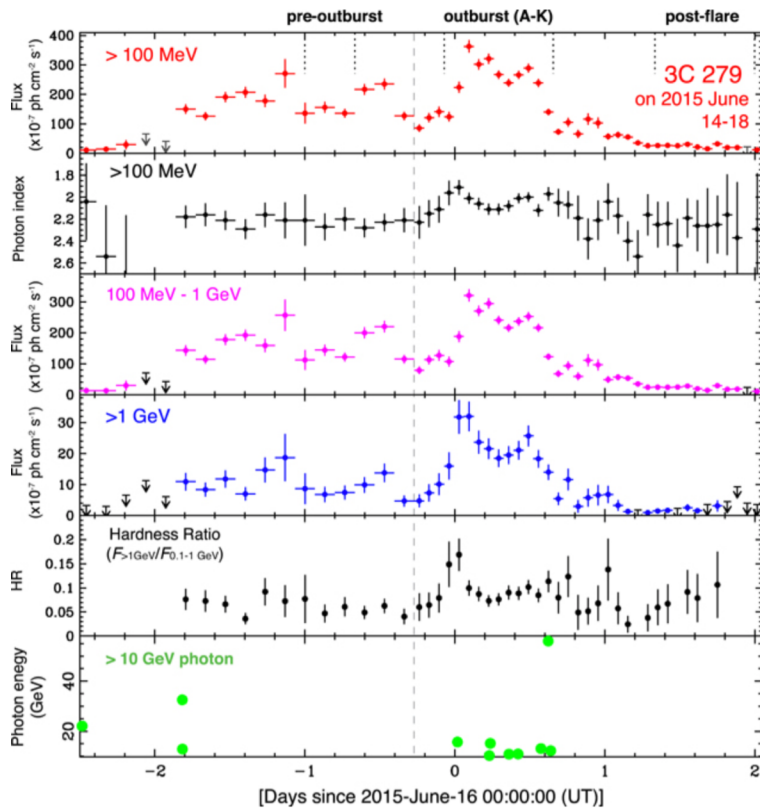
Richard Anantua, Mitch Begelman, Ke Fang,  
Noemie Globus, Amir Levinson, Greg  
Madejski, Dave Meier, Manuel Meyer,  
Tony Readhead, Jeff Scargle, Paul Simeon,  
Dan Wilkins, Yajie Yuan

# Jets formed near spinning black holes



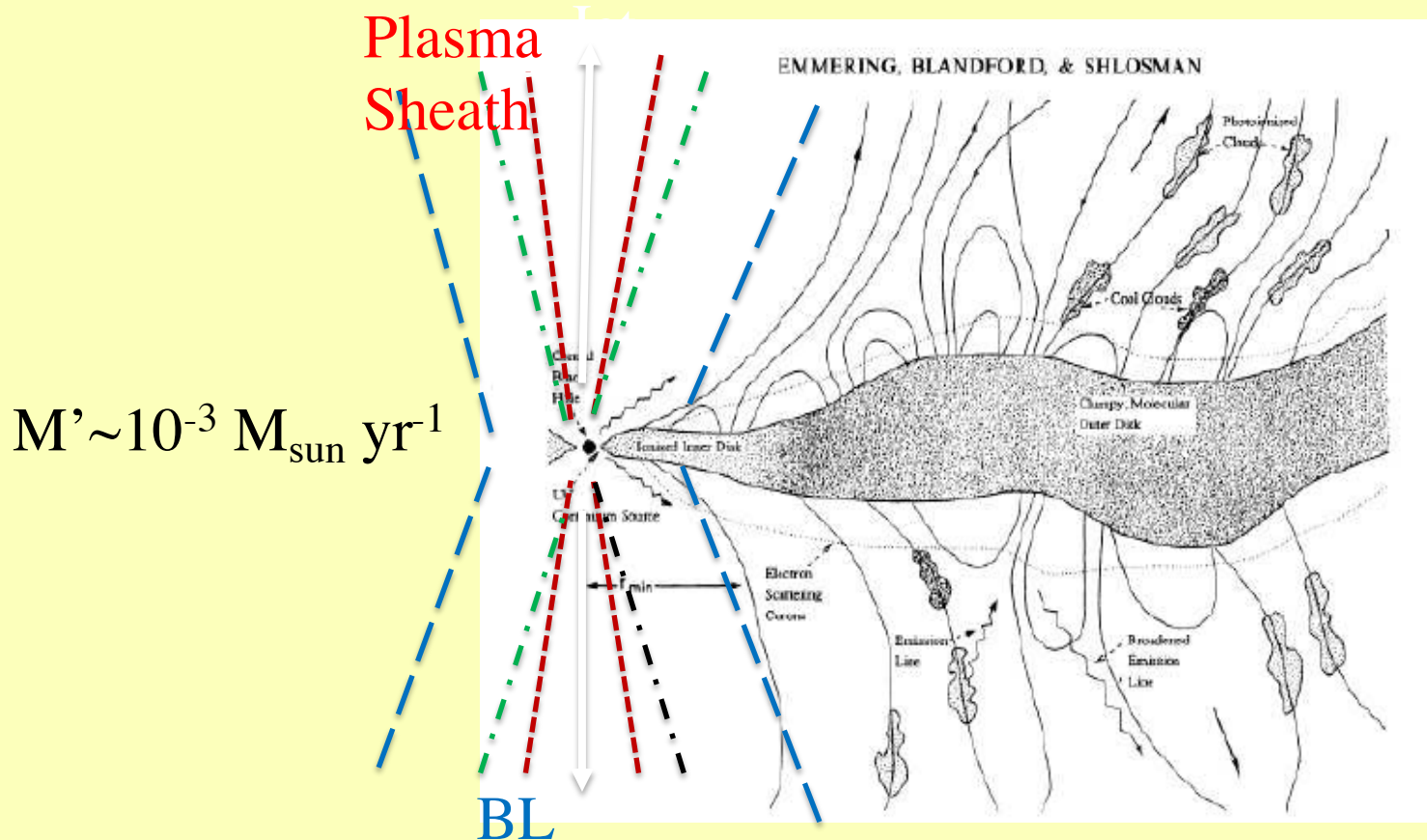
- Event Horizon Telescope?

# 3C 279

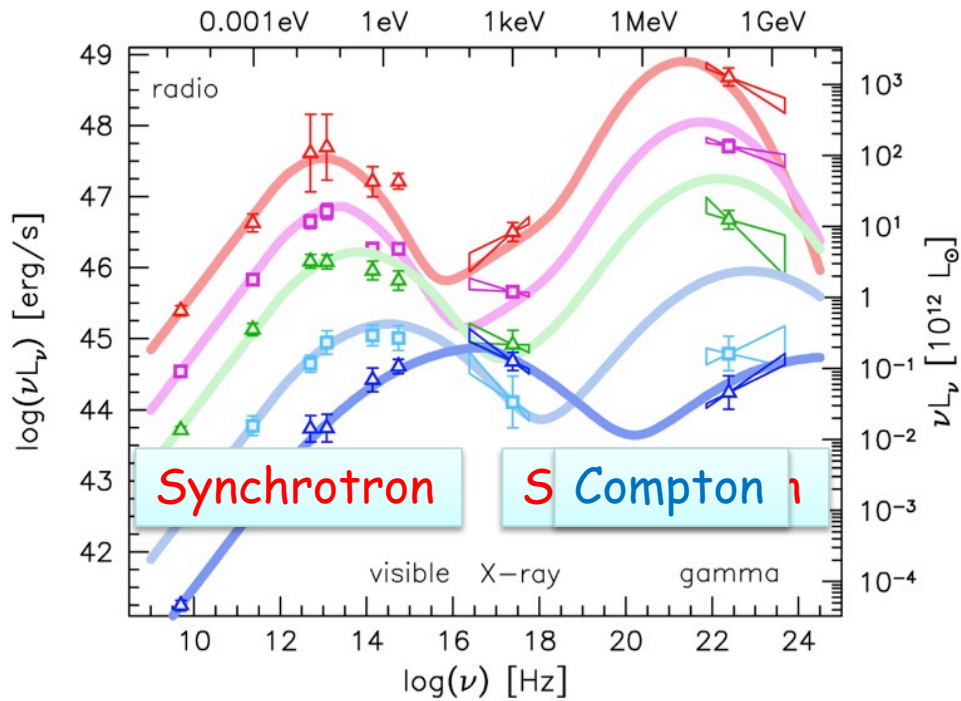


- Quasar jet  $\gamma$ -rays can vary in minutes  $\Rightarrow$  inner jet?
- $\gamma$ -rays from inner jet absorbed by UV;  $\sigma_{\gamma\gamma} \sim 0.2\sigma_T$

# Emission Lines Formed by Magnetic Wind



- Shielding  $>13.6\text{eV}$  with plasma sheath avoids pair production
- Emission line clouds are magnetically-confined disk outflow
- Variable  $E_{\gamma} < 30 \text{ GeV}$
- Compare with Gravity observations of 3C 273 etc



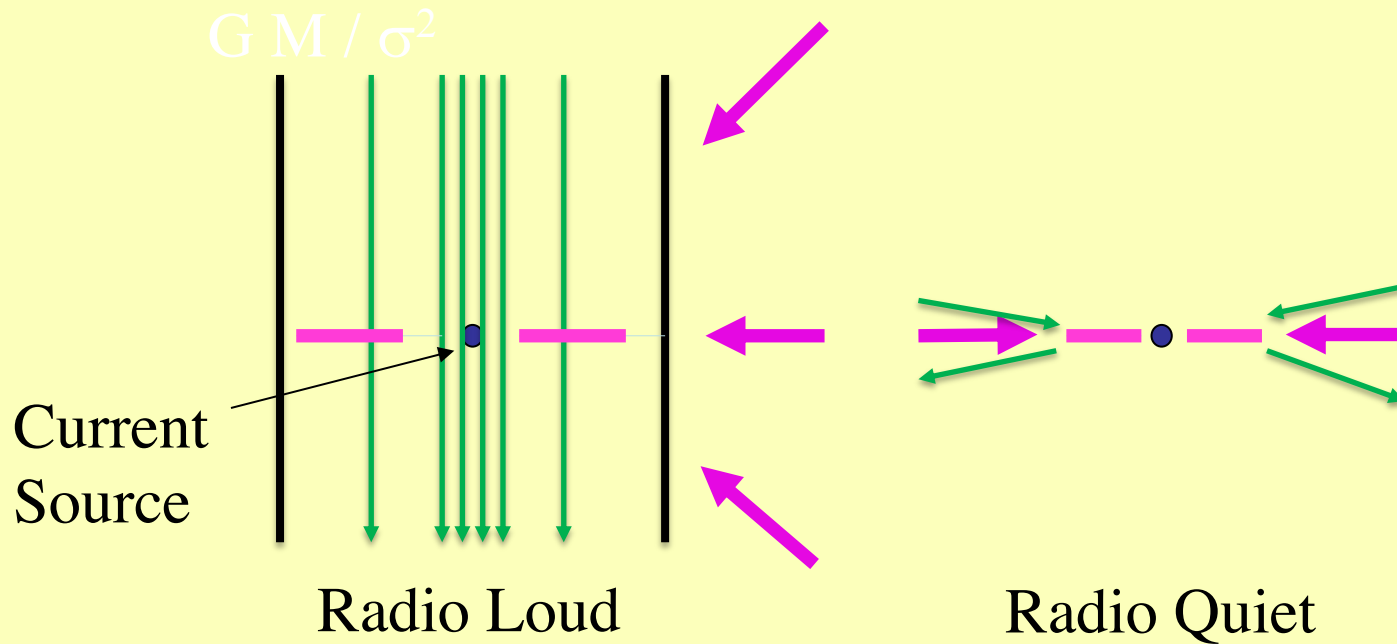
- One zone model must be wrong
- Compton model incompatible with strongly magnetized jets
- Direct electron acceleration  $E_{\text{synchrotron}} < 70\text{MeV}$
- However, protons can be accelerated to PeV-EeV energy
- Create TeV-PeV pairs, efficiently;  $\sigma_{\text{BH}} \sim \alpha \sigma_{\text{T}}$
- Below pion production threshold

# Summary

- Imaging jet launch region
- Strong magnetic field
- Rapid  $\gamma$ -ray variability of quasars suggest emission from inner jet and UV shielding by plasma sheath
- Large magnetic field suggests proton acceleration Bethe-Heitler pair production and synchrotron  $\gamma$ -rays

# Extra Slides

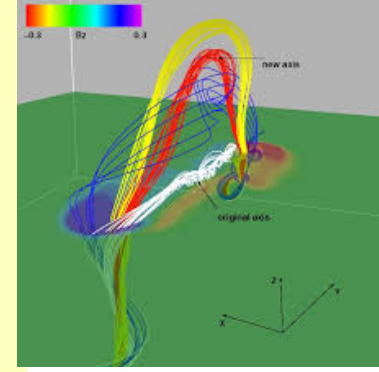
# Radio Loudness



- Spinning hole necessary but insufficient for powerful radio jet
- High latitude accretion traps flux; disk accretion does not
- Current source concentrates field at hole -  $B \sim 1/r$ ;  $L_{\text{jet}} \sim M' \sigma c$
- Strong jets stay supersonic; weak jets become bubbles, plumes



# Magnetoluminescence



- Magnetic jets unstable
  - Tangled magnetic “ropes”?
- Magnetically reconnect knot
  - Change topology
    - Tait, Alexander, Jones...:  $t+t^3-t^4$
  - Slow  $< c/\log$
- Untangle magnetic rope
  - Same topology
  - Fast  $\sim c$
  - Charge starvation  $\rightarrow$  Electric friction  $E \cdot B$
  - Proton acceleration,  $\gamma$ -ray emission

