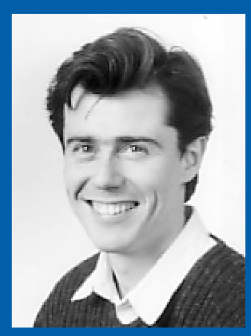
Breaking the Enigma of the X-ray Quasar jets with GLAST



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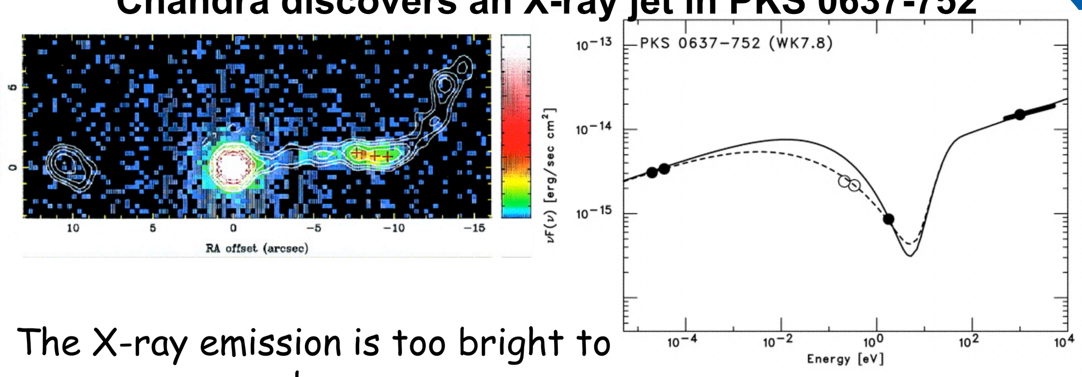
What is the X ray emission mechanism?

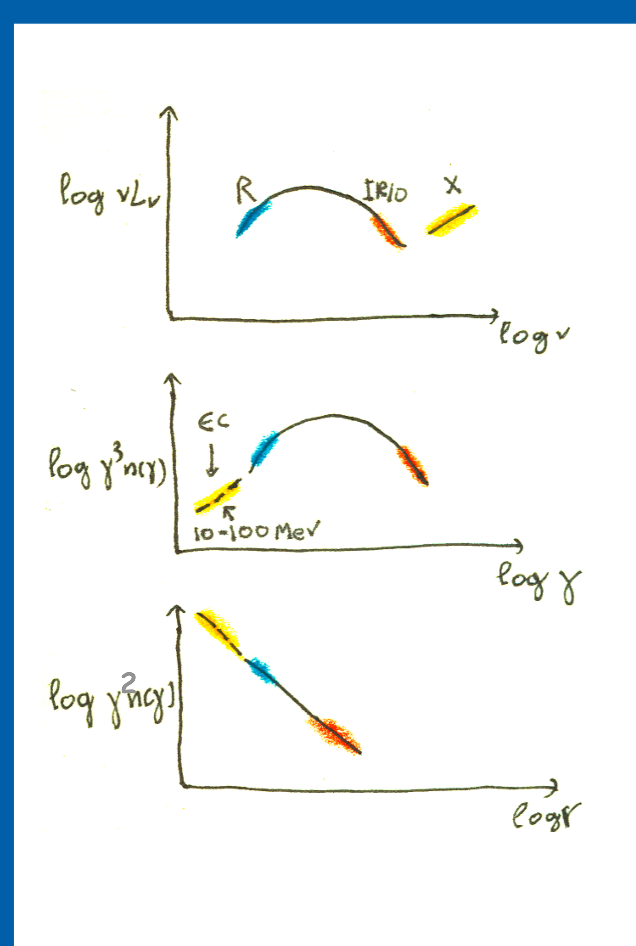
Chandra discovers an X-ray jet in PKS 0637-752



The X-ray emission is too bright to be Synchrotron Self Compton in equipartition. (Schwartz et al. 2000 Chartas et al. 2001) What is then the X-ray emission?

Uchiyama et al. 2005

A. Inverse Compton scattering off the CMB (EC/CMB) (Tavecchio et al. 2000, Celotti et al. 2001)

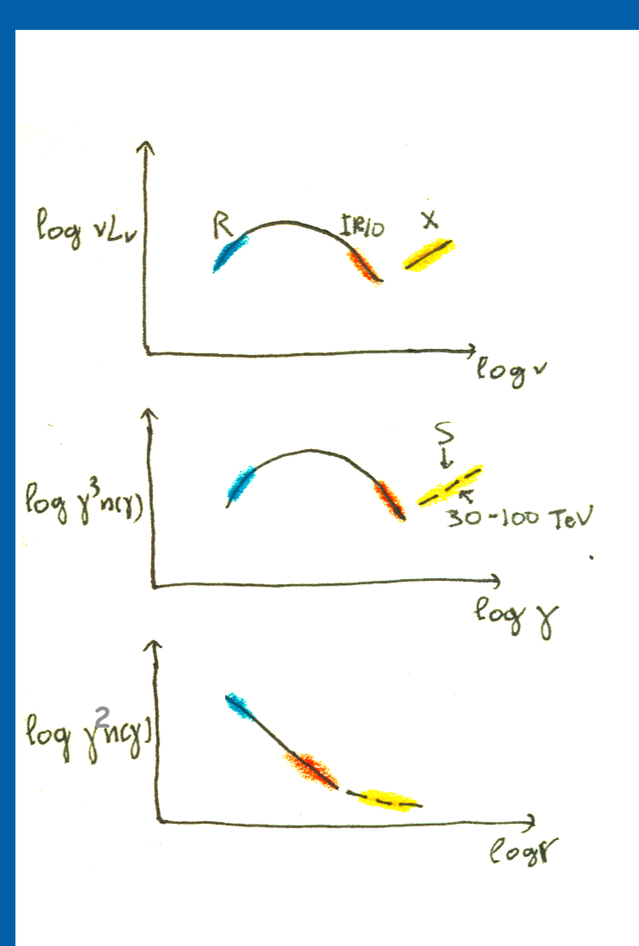


Extends the electron energy distribution (EED) down to 10 -100 MeV energies

Requires relativistic large scale jets (δ~10)

Increased jet power requirements, radiatively inefficient

B. Synchrotron (e.g. Harris et al. 2004, Hardcastle 2006)



Additional EED component at ~1-100 TeV energies

No need for highly relativistic large scale jet

More economical in jet power, radiatively efficient

Two competing models, two γ-ray bands, and a helpful source

- The EED in both models have sub-TeV electrons: Sub-TeV electrons + CMB-> *GeV emission from both models*
- The EED of the synchrotron model has multi-TeV electrons Multi-TeV electrons +CMB-> *TeV emission only from the synchrotron model*

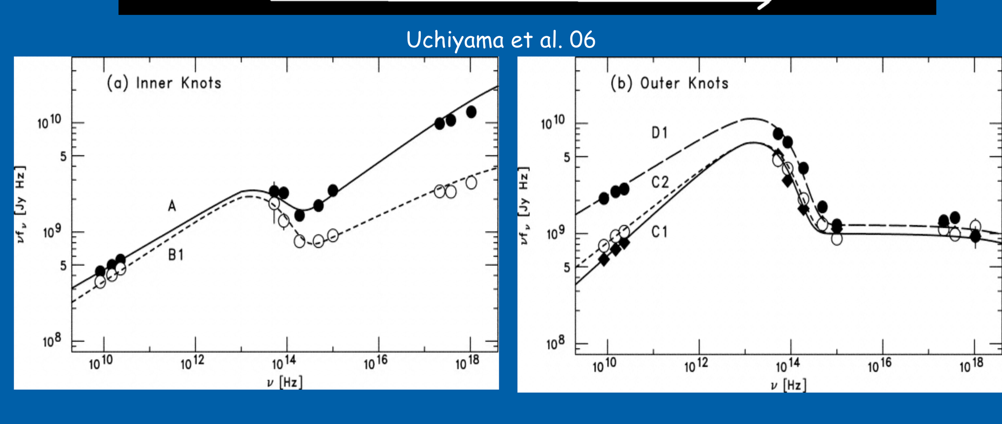
Let's apply these to a bright, nearby source: 3C 273 at z=0.158

Q: Is it close enough for TeV photons to go through the extragalactic background light (EBL)?

A: Yes, it is. The Universe is more transparent than previously thought (Aharonian et al. 2006, HESS detection of z=0.186, z=0.165 blazars).

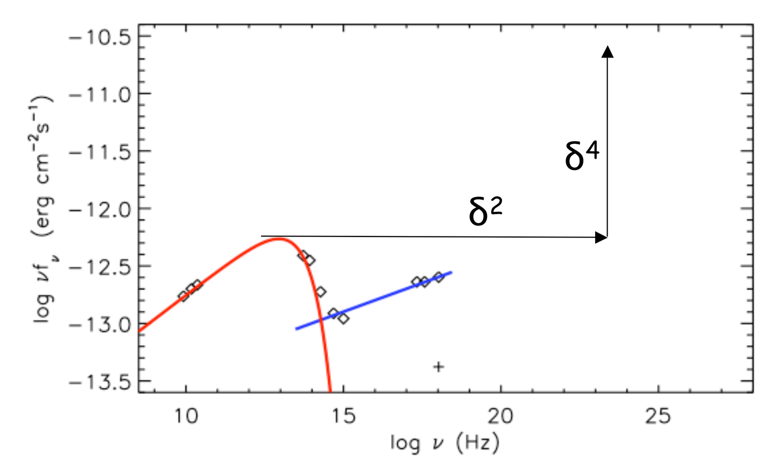
← Blazar core 12" to the left

Uchiyama et al. 06



The γ Ray Verdict GLAST & TeV scopes

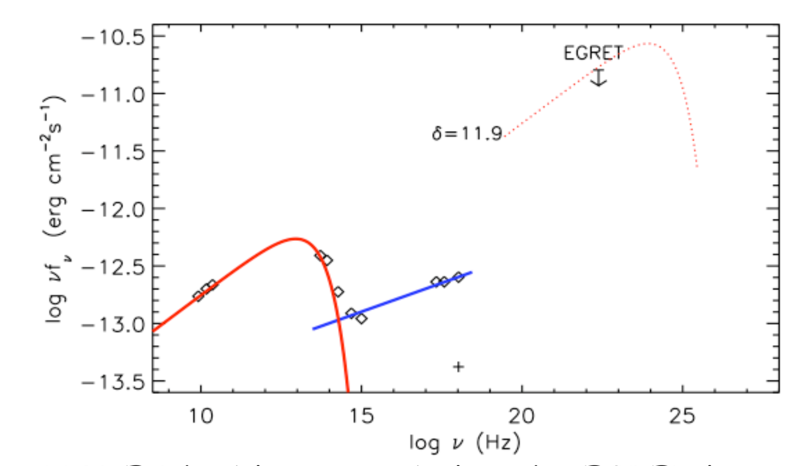
1



Add up all the flux of the jet.
Red line: synchrotron emission
Blue line: optical - X-ray emission of ? Nature

Regrdless of the nature of the blue line emission, the electrons producing the red line will upscatter the CMB, producing a similar GeV component shifted in frequency and power by $\nu_{CMB}\delta^2$ and $L_{syn}\delta^4$, where δ is the jet Doppler factor.

2

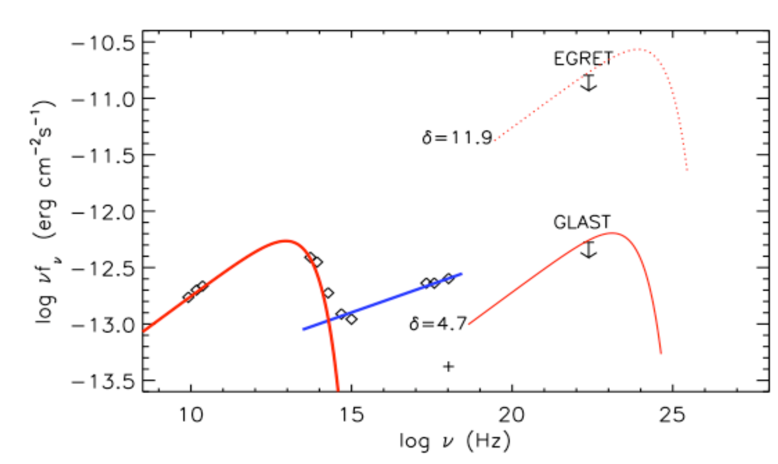


NOTE: The blazar was below the EGRET limit about half the time the source was observed. This sets an upper limit to the jet emission.

IMPORTANT: We do not know how low the blazar drops, but it must be substantially below the EGRET limit, since it was undetectable half of the time.

COOL: Existing good old EGRET limits require δ<11.9

3

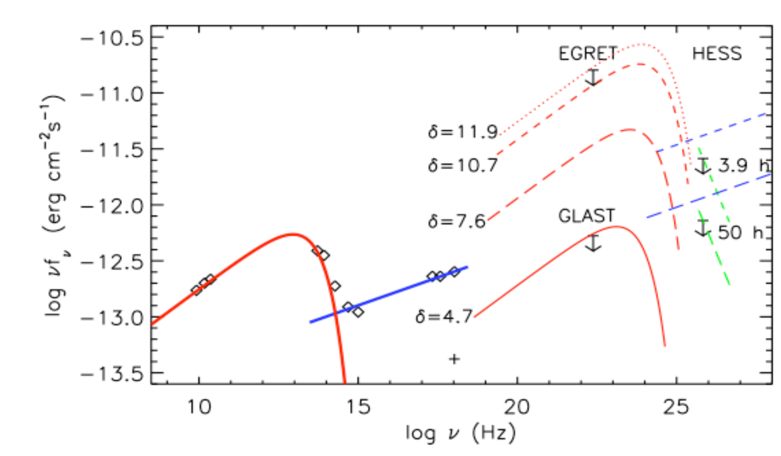


In the EC/CMB hypothesis, values of δ<~10 require extremely high jet power (L_{jet}>~10^{47-49} erg/s, Uchiyama et al. 2006). This is unlikely.

GLAST will see the jet+blazar as a point source and will give us a deeper upper limit on the jet flux, therefore a smaller upper limit on δ, further disfavoring EC/CMB.

If GLAST does not detect the source, then δ<4.7. This would eliminate the EC/CMB model.

4

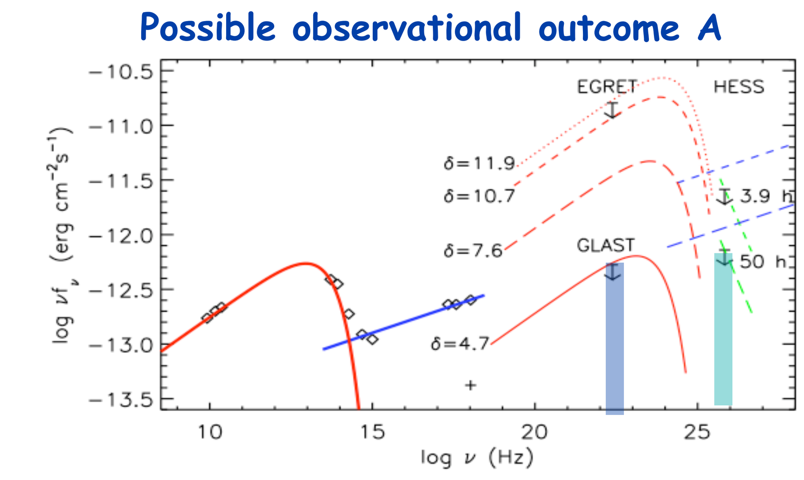


If the blue line emission is synchrotron, then the electrons producing it will also produce TeV emission.

HESS shallow limit (Aharonian 2005): In the synchrotron hypothesis, δ<10.7 (blue/green broken line before/after absorption from the EBL).

50 hours HESS observations can push δ<7.6 in the synchrotron hypothesis.

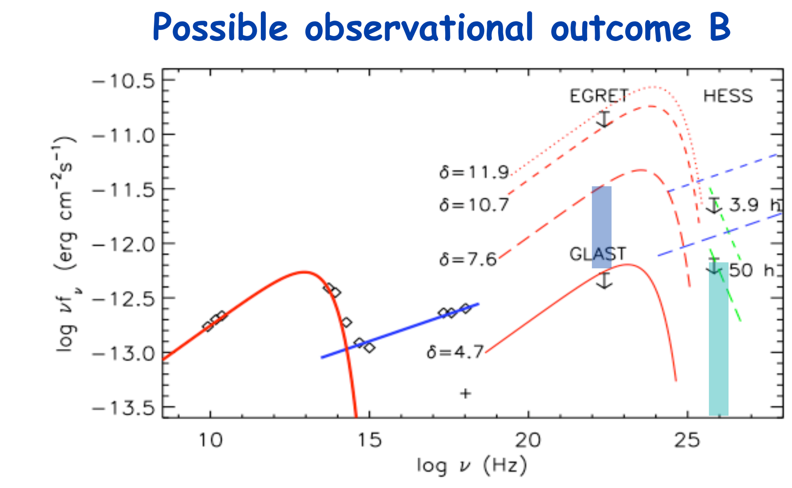
Possible observational outcome A



Neither GeV nor TeV emission is detected: δ<4.7
No constraints on the synchrotron model.

EC/CMB requires too much power. Strongly disfavored.

Possible observational outcome B

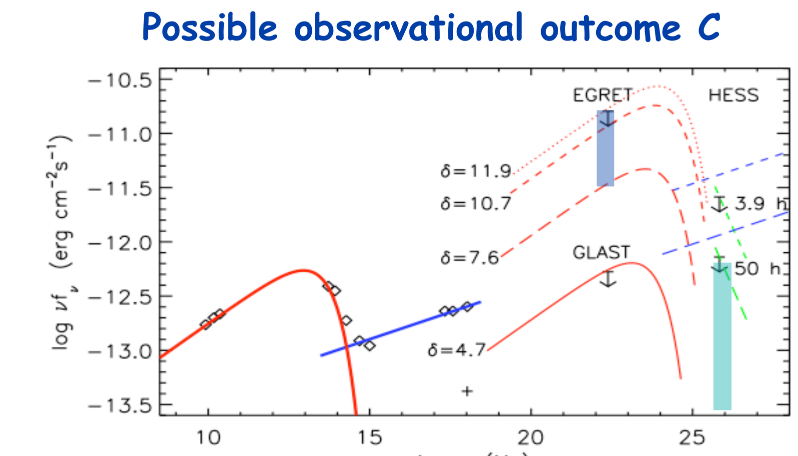


GeV emission is detected at a low level: 4.7<δ<7.6
TeV emission still is too weak to be detected .

No constraints on the synchrotron model.

EC/CMB requires too much power. Disfavored.

Possible observational outcome C

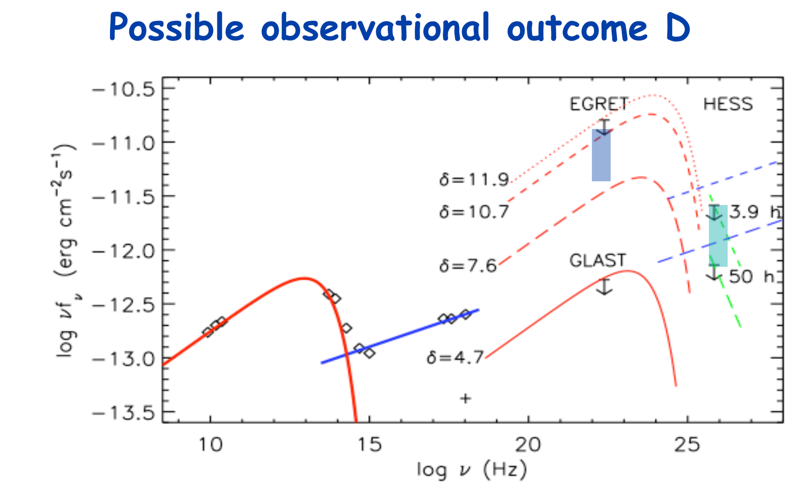


Jet* GeV emission is detected at a high level: 7.6<δ<11.9.

If we do not detect the corresponding TeV emission at a level between the 3.9 and 50 hour limits, the synchrotron model is OUT.

*hard, steady

Possible observational outcome D



Jet GeV emission is detected at a high level: 7.6<δ<11.9.

If we do detect the corresponding TeV emission at a level between the 3.9 and 50 hour limits, the synchrotron model is IN.

Conclusions.

1. EGRET and HESS already constrain the jet Doppler factor and emission
2. GLAST and further TeV observations can confirm of refute the EC/CMB and synchrotron models.

More in our paper: ApJ 653, L5