# Orphan X-ray flares in Blazars

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On behalf of the Fermi-LAT Collaboration

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# Outline of the talk

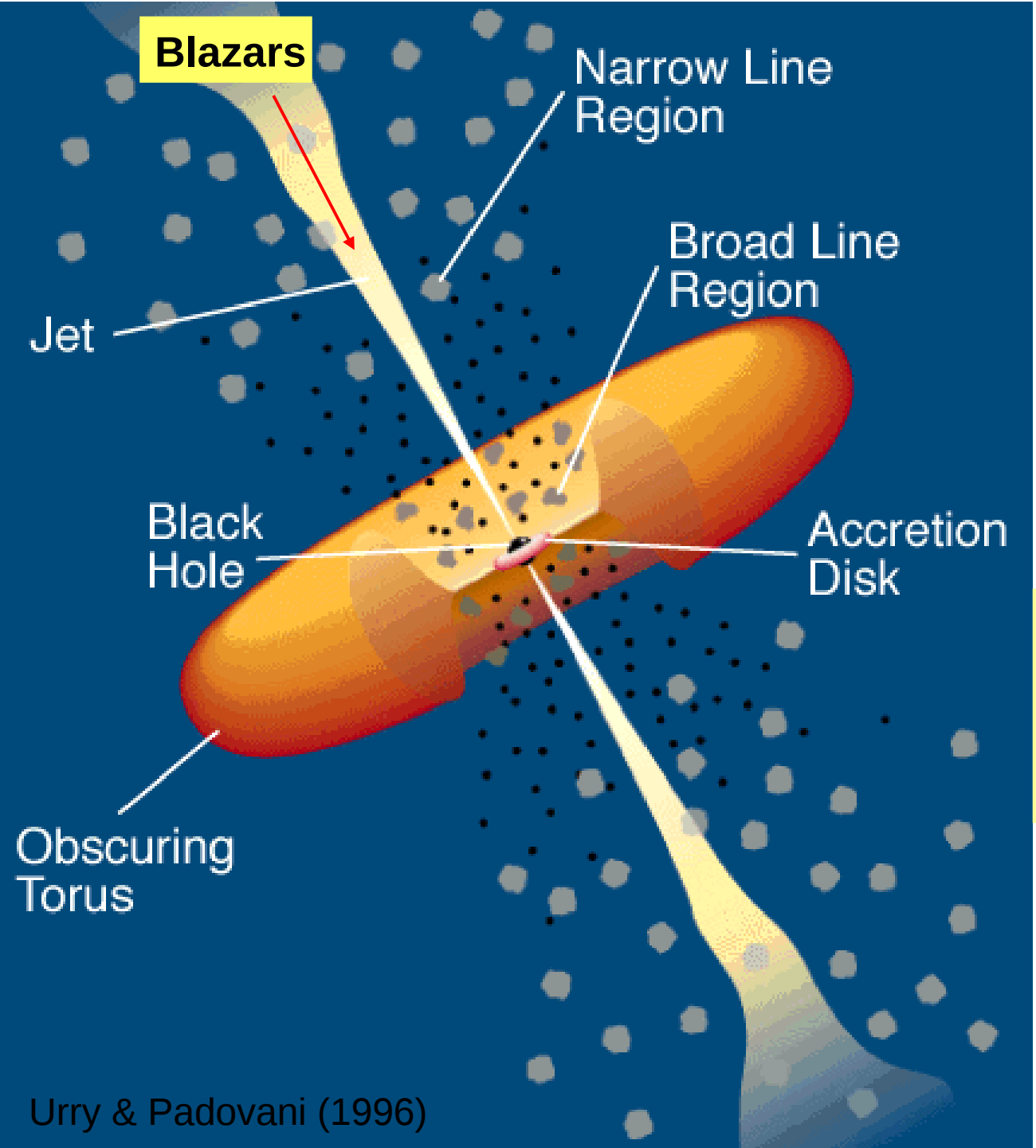
1. Introduction

2. Emission mechanisms

3. What are Orphan X-ray flares

4. X-ray polarization – a tool to probe high-energy emission mechanisms at the base of relativistic jets

5. Summary




# Introduction

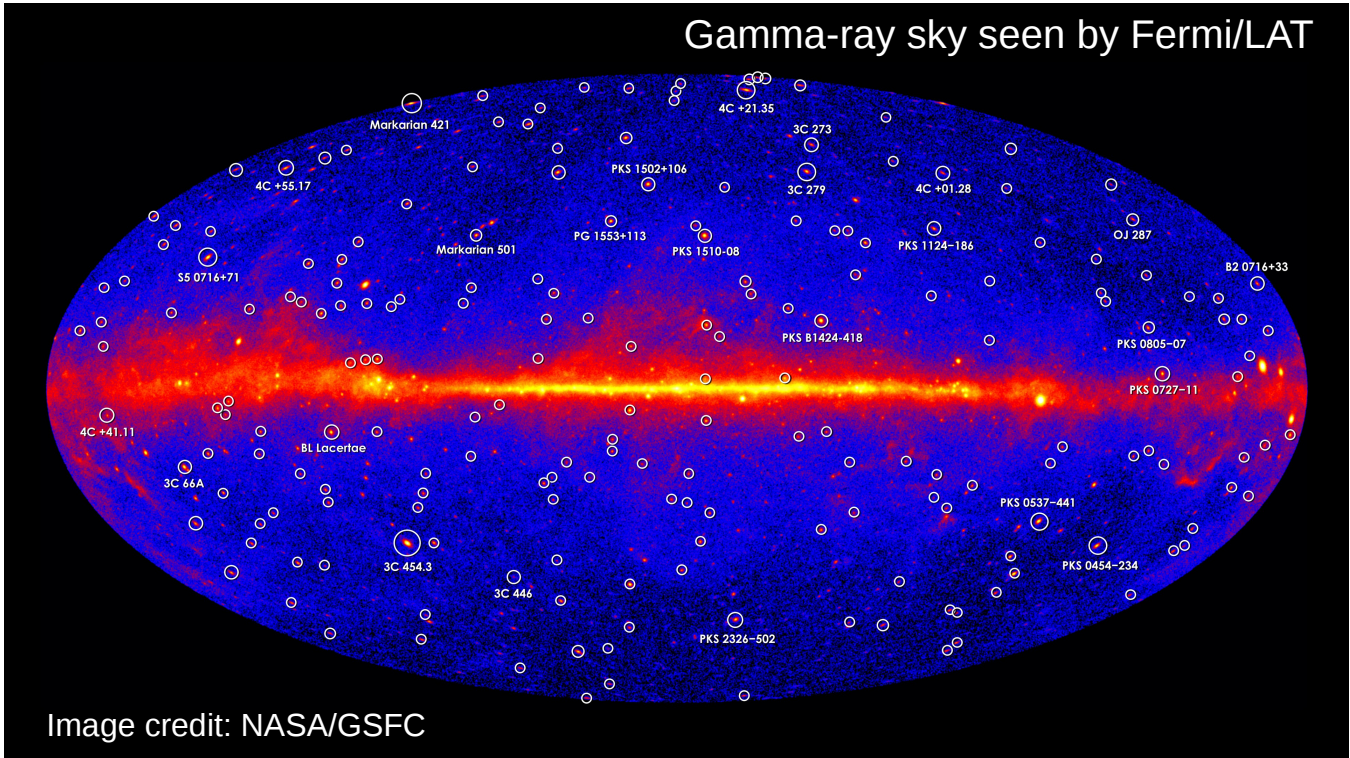
**Relativistic jet outflow with**
**Γ ~few tens**
**Small viewing angles**

# Why do we care?

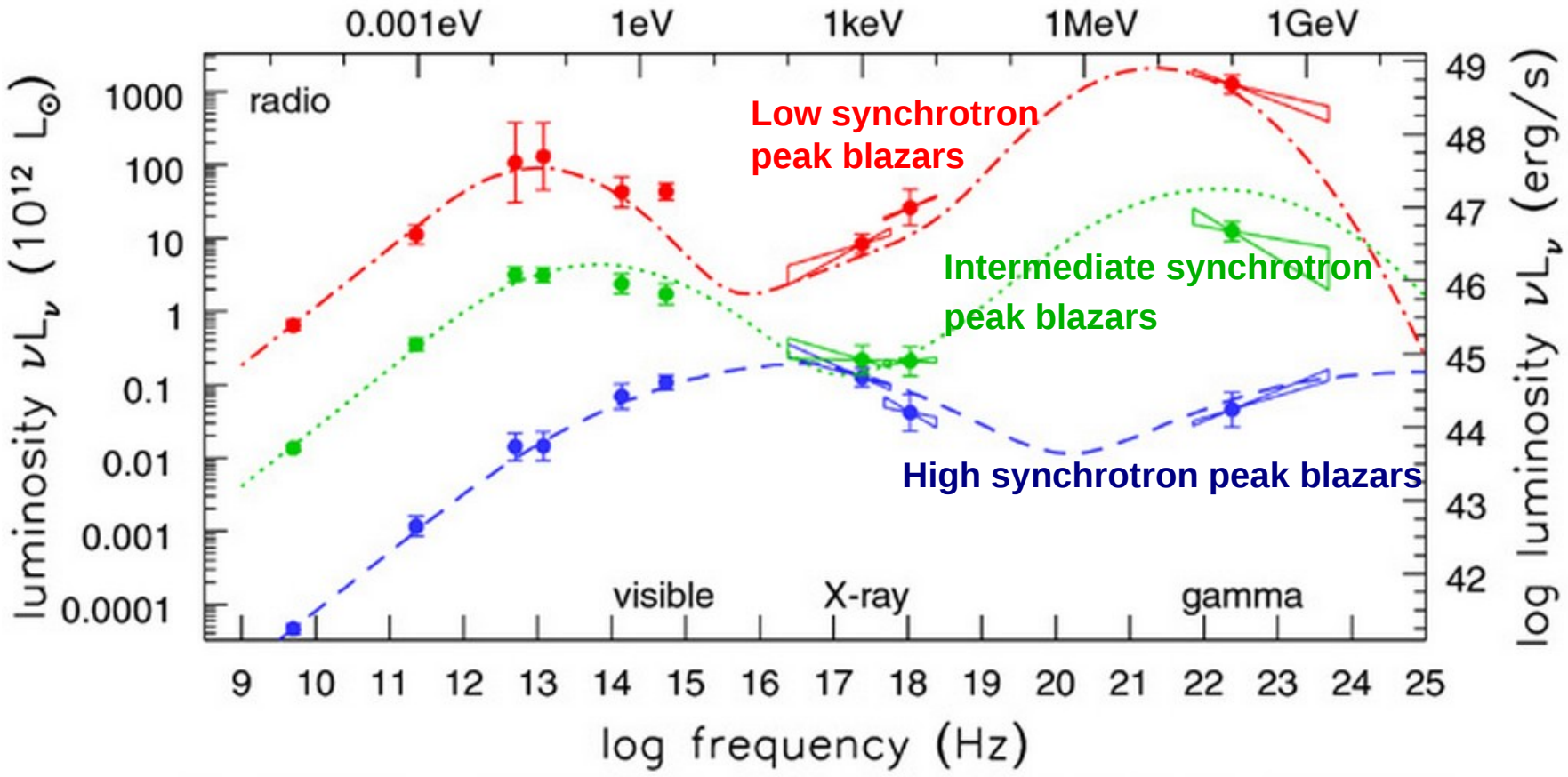

High energy (GeV) gamma-rays have been reported for more than thousand blazars.
High-energy radiation is believed to be related to relativistic particles accelerated in jets.

**Blazars are considered as the prime candidates for the emission of Ultra High Energy Cosmic Rays (UHECRs).**

**Origin and location of high-energy emission ?**

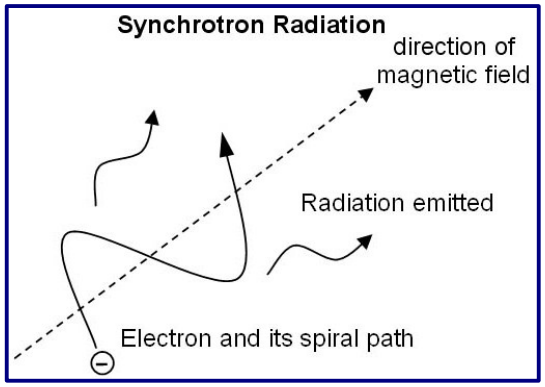


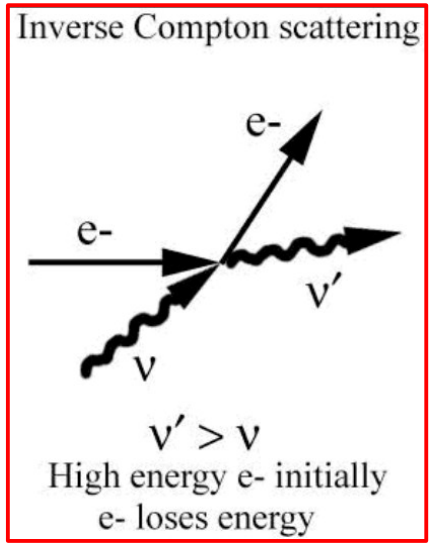
# Blazar classification

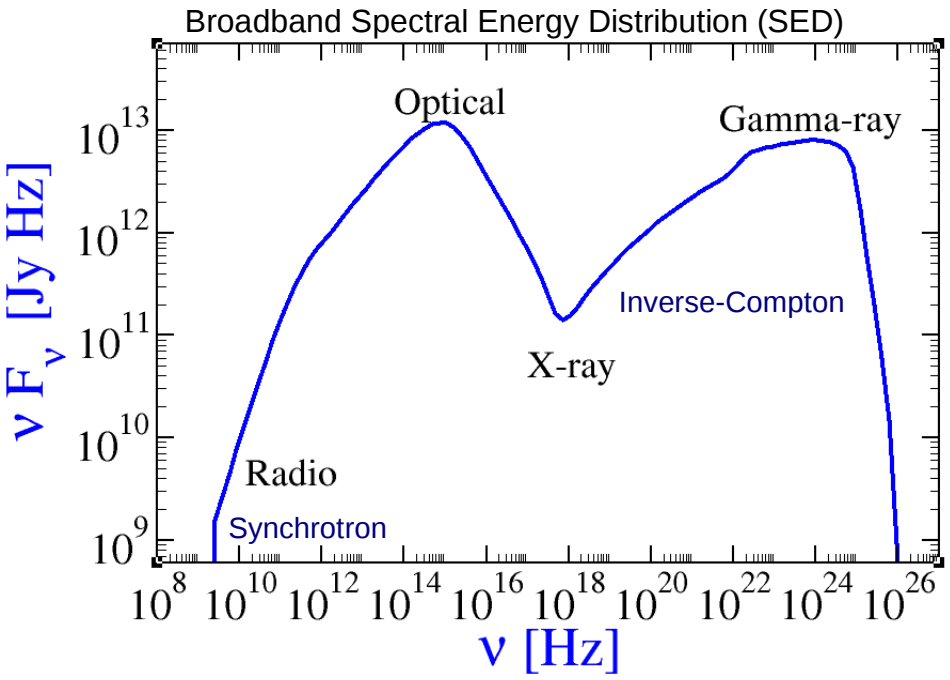



Emission Models : Leptonic vs. Hadronic

# Blazar Broadband Emission : Leptonic Models



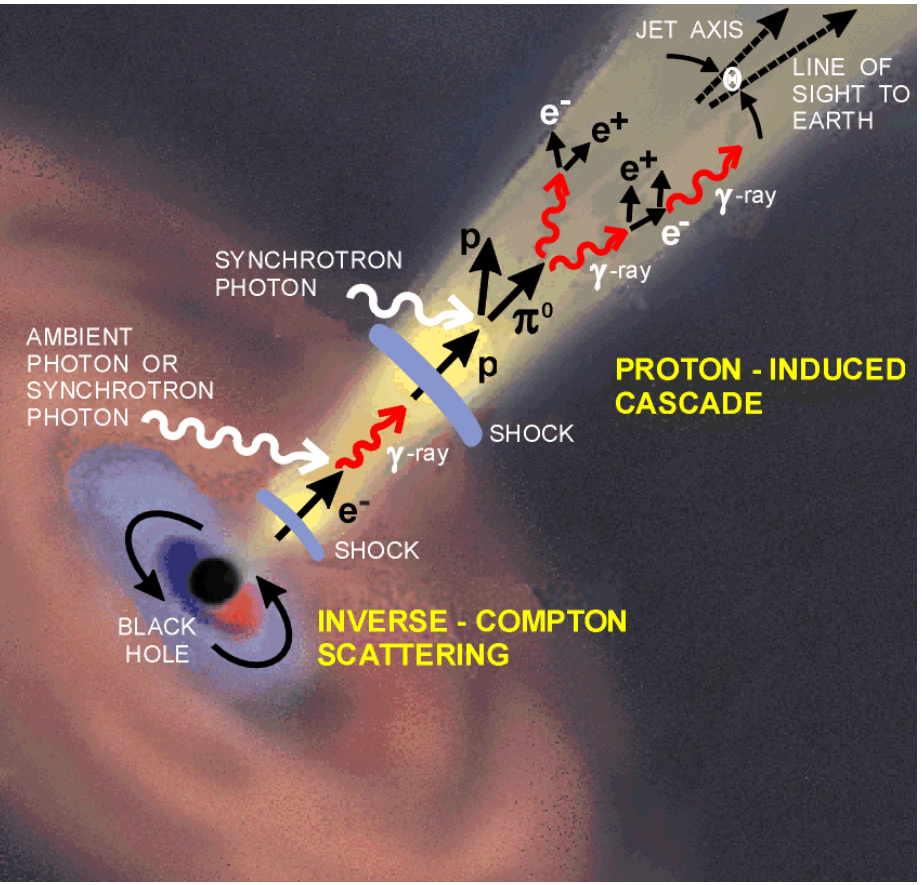



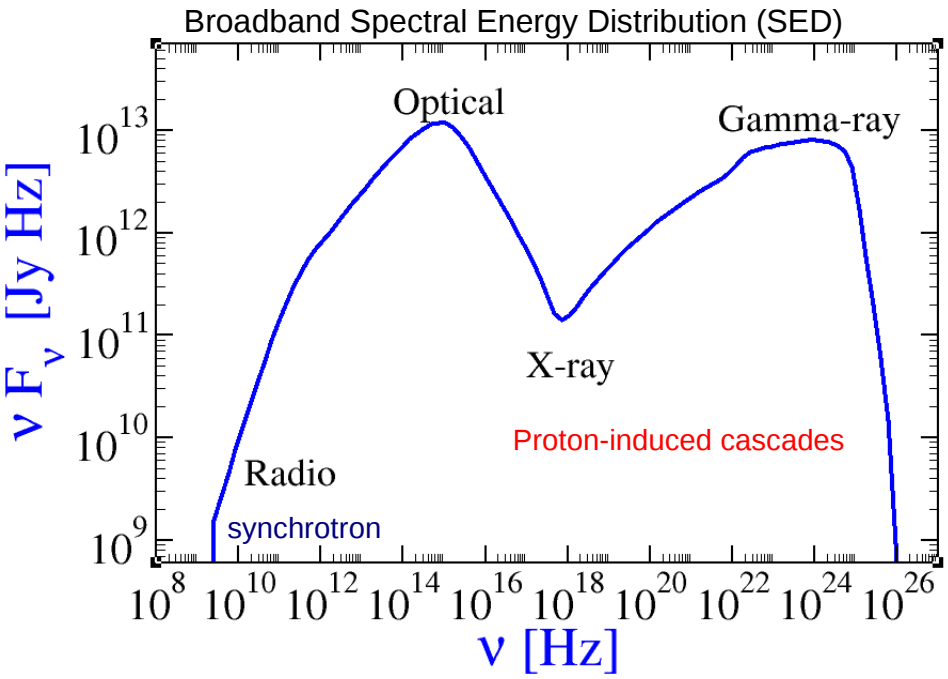

Seed photons

Synchrotron Self-Compton : synchrotron photons from the jet

External Compton : thermal photons from accretion disk, broad-line region, and/or molecular torus

# Blazar Broadband Emission : Hadronic Models



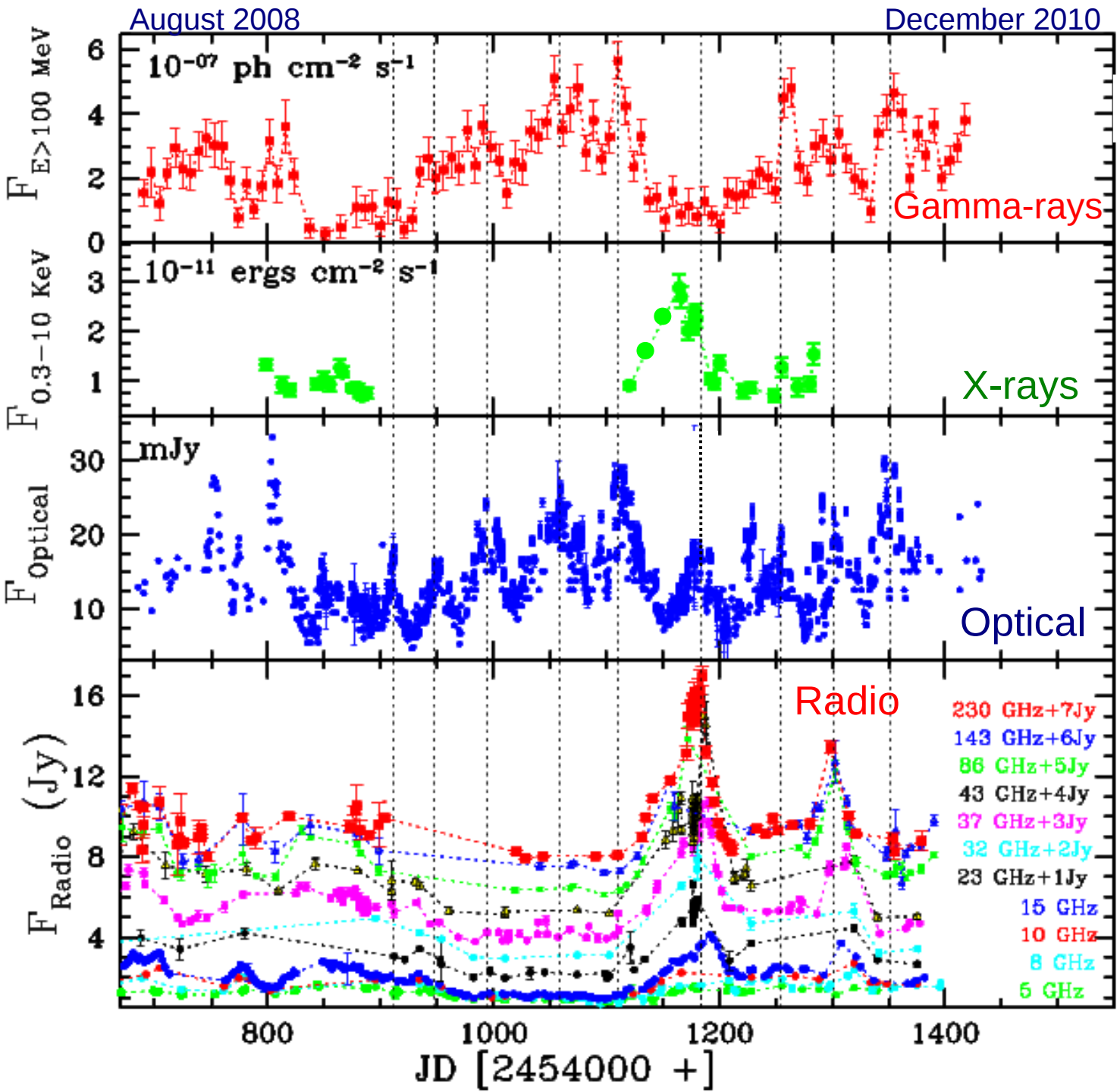




Significant fraction of jet power converted into acceleration of protons in strongly magnetized (B ~ several tens of Gauss) environments reaching the threshold for pγ-pion production ($E_p \geq 10^{19}$ eV).

**We expect to see correlation between broadband flares**

**Do we observe such a correlation?**

**Not always**

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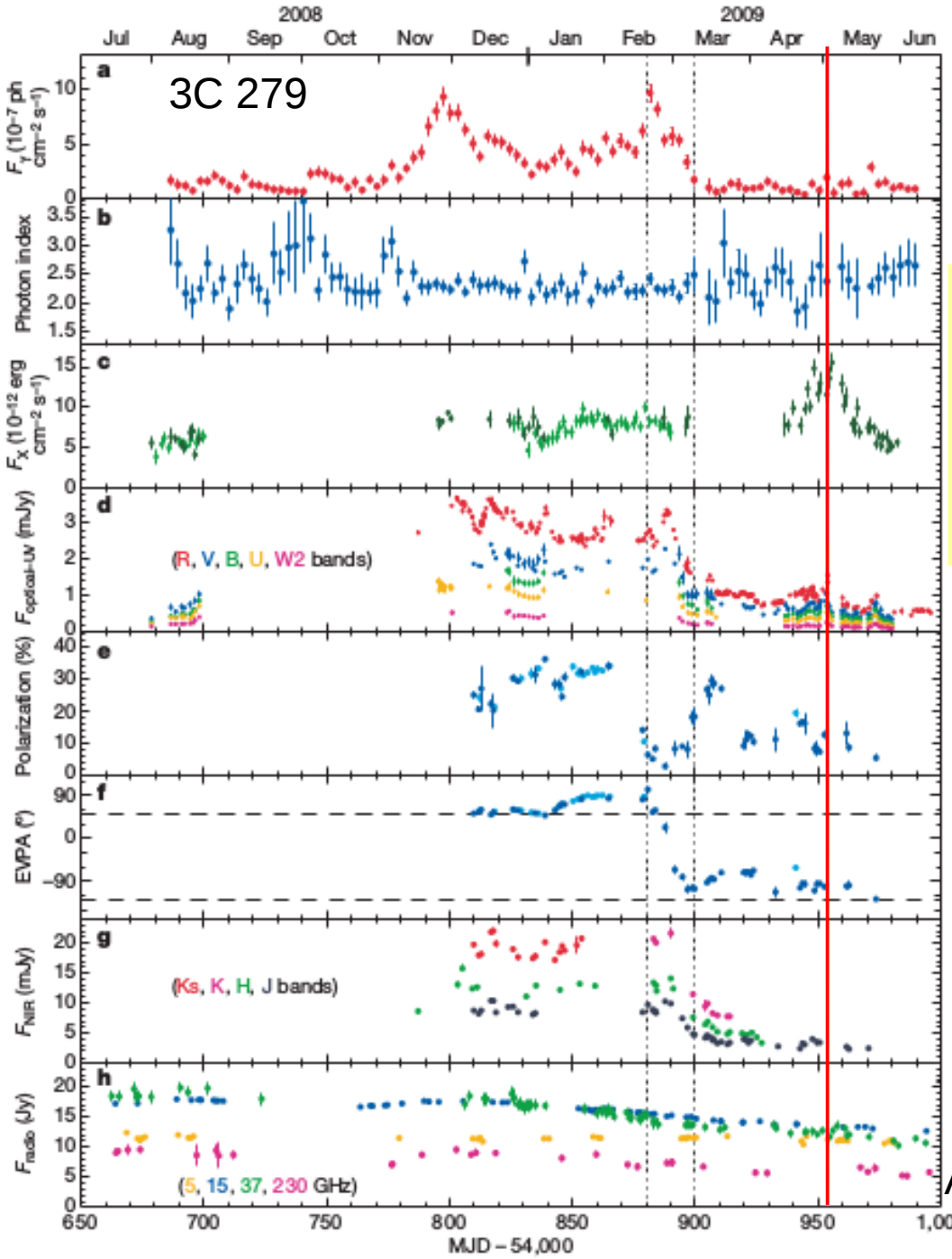
Rani et al. 2013, A&A

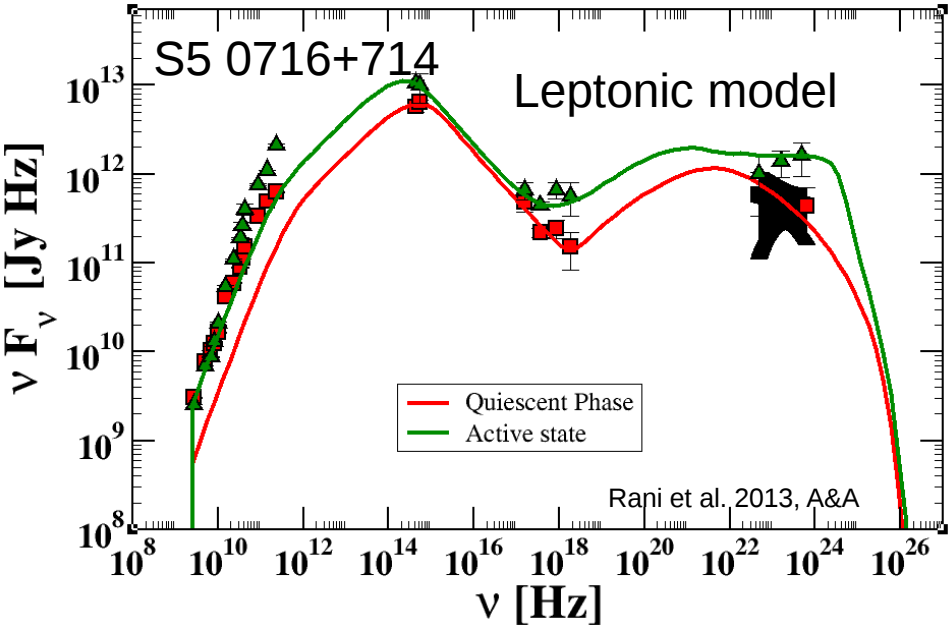



**Orphan X-ray flares :**

**No correlation with broadband flares**

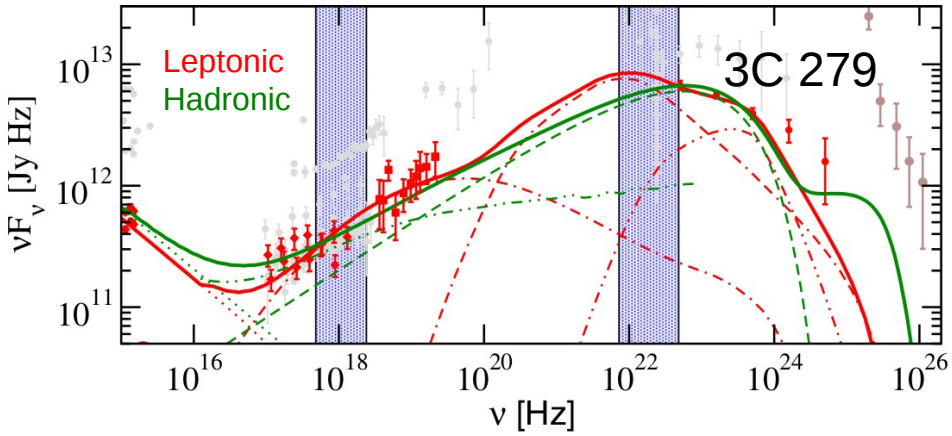
Abdo et al. 2010, Nature

# SEDs of orphan X-ray flares



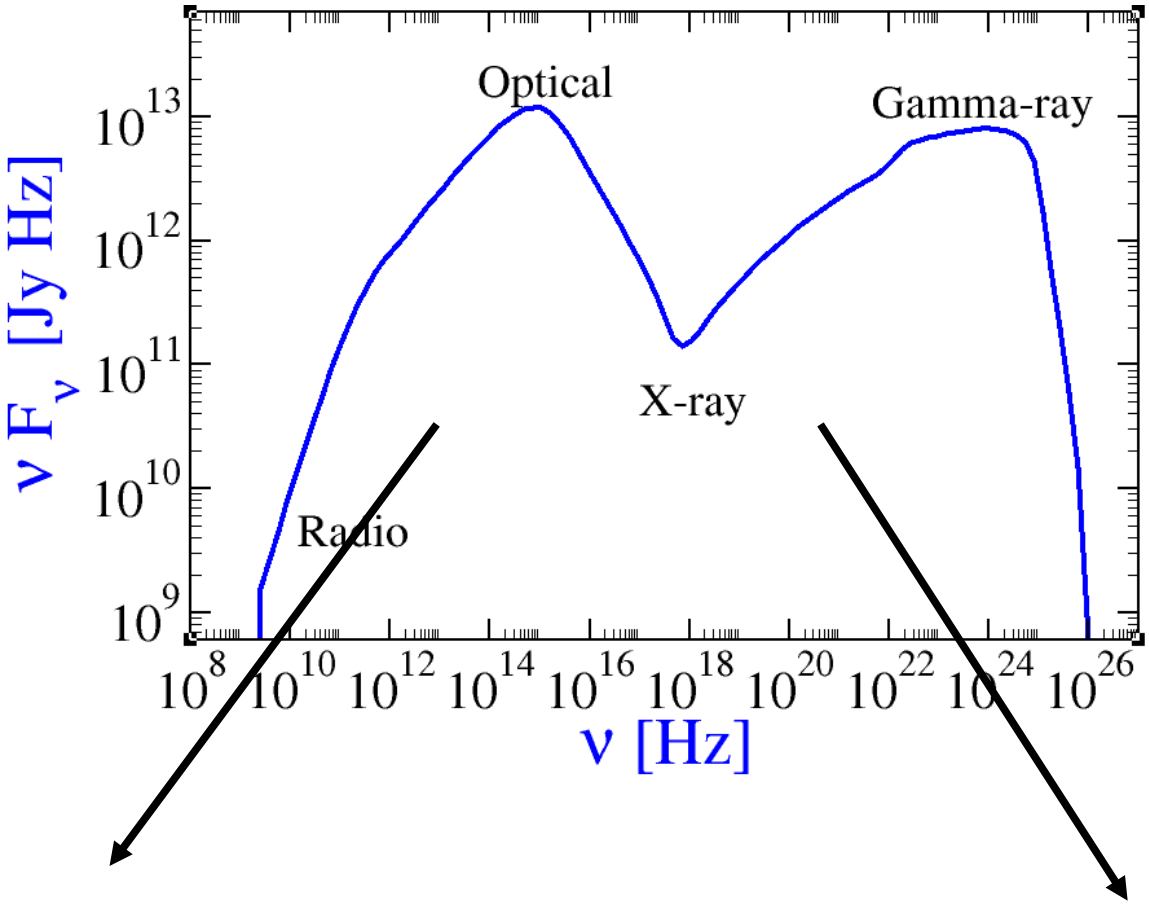

Possible scenarios :

- Different location
- Two or more component models
- Leptonic vs. Hardronic models




Zhang & Böttcher (2010), ApJ

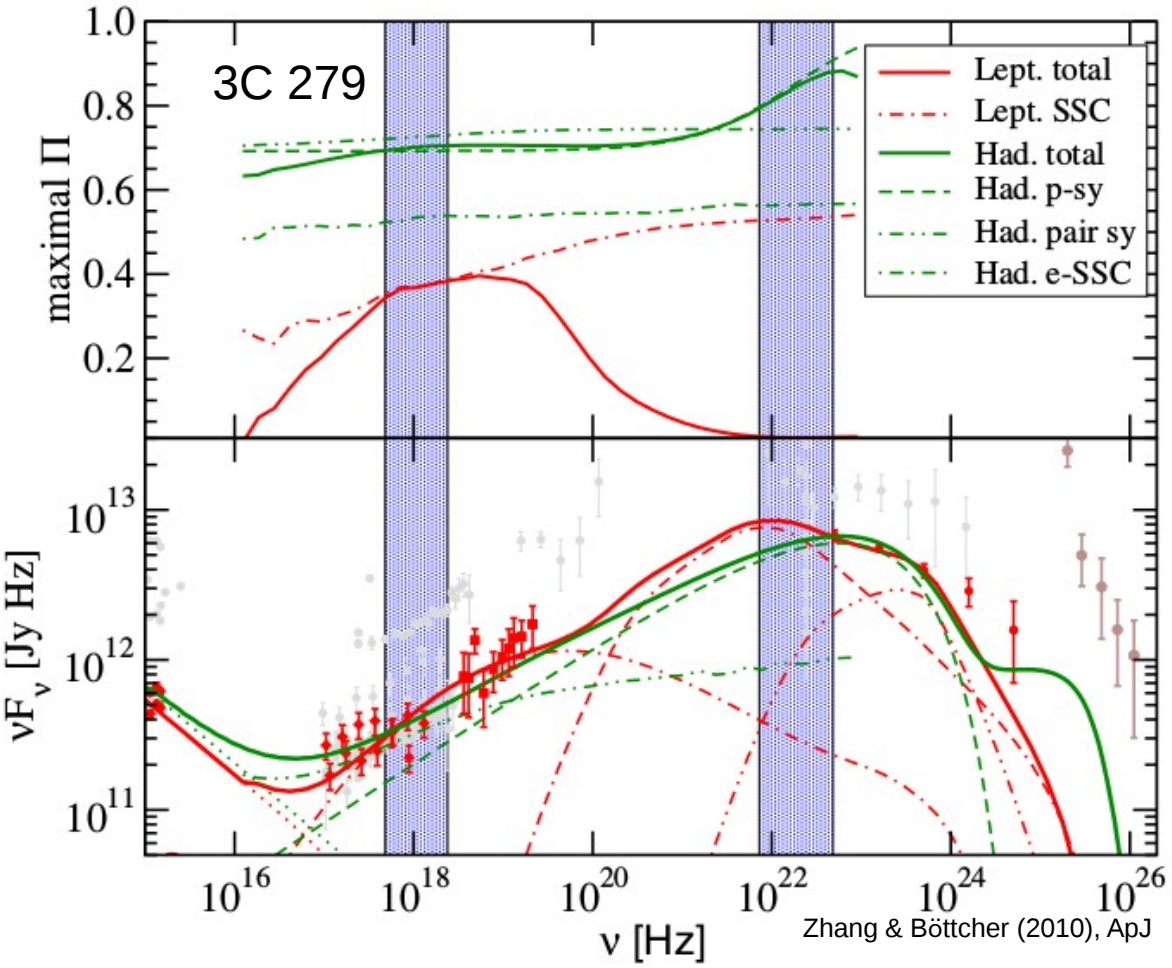
# High-energy polarization




**Similar polarization for Leptonic and Hadronic models**

**Could have different polarization properties depending upon the emission mechanism**

# High-energy polarization in Leptonic and Hadronic models :




Zhang & Böttcher (2010), ApJ

Leptonic ≤ 30 – 40 %

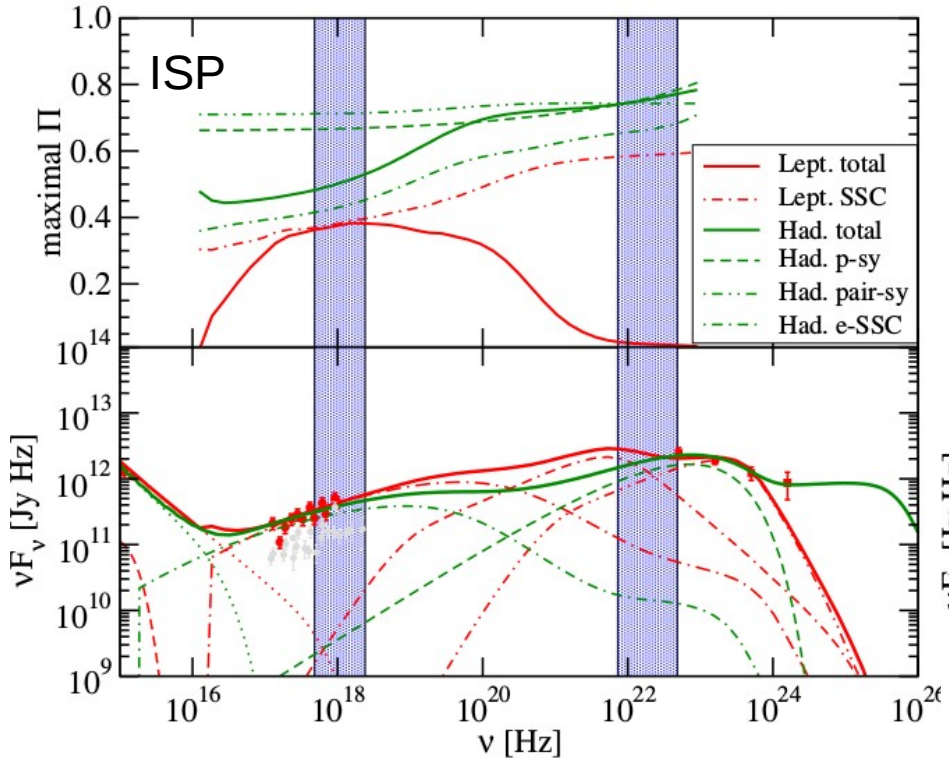
Hadronic ≤ 70 – 75 %

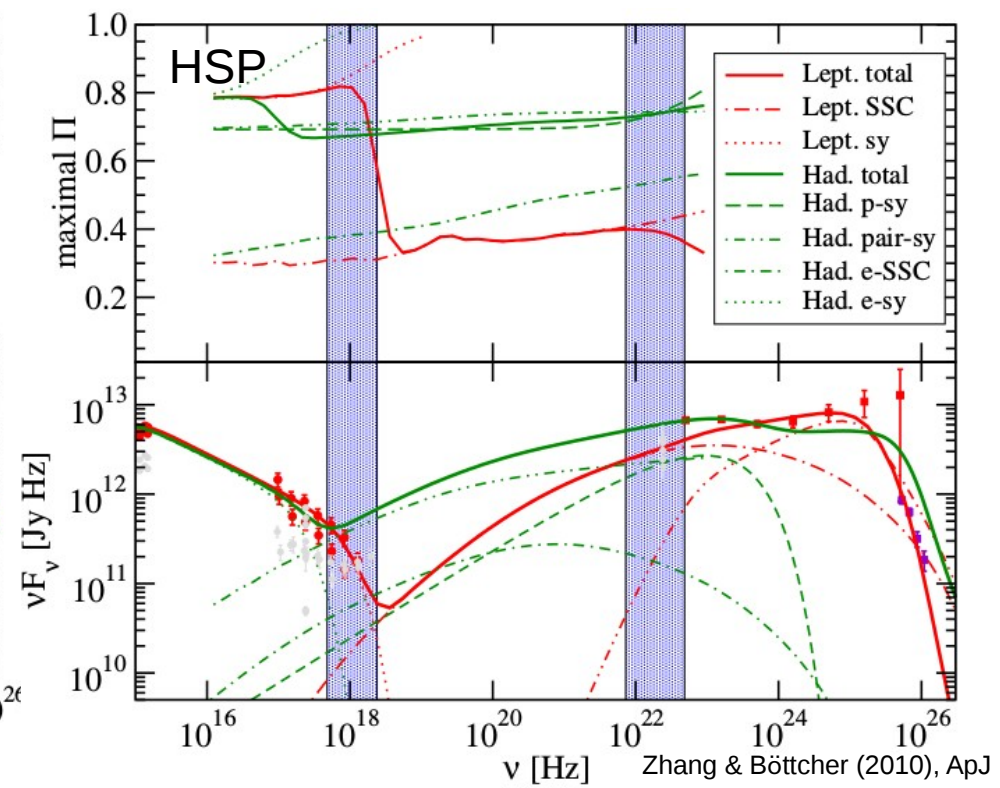
Highly ordered B-field perpendicular to the line-of-sight

**Low synchrotron peak blazars :**

High polarization is expected in Hadronic models compared to Leptonic ones.

# High-energy polarization in Leptonic and Hadronic models :




Zhang & Böttcher (2010), ApJ

Intermediate and high synchrotron peak blazars : similar degree of X-ray polarization

Higher gamma-ray polarization in Hadronic models compared to Leptonic models

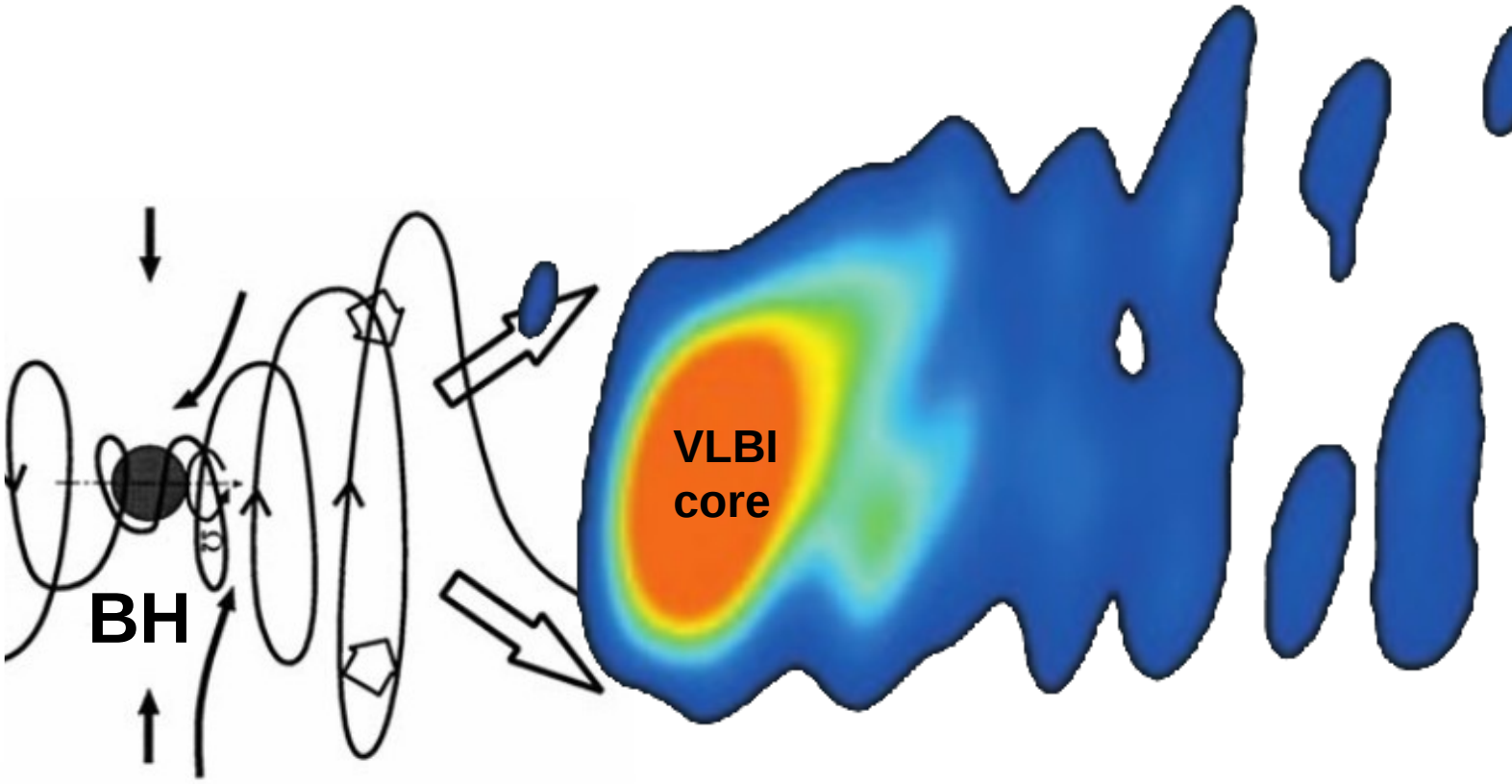
# Summary

- **Hadronic models generally predict high degree of high-energy polarization**
- **In LSPs, the expected X-ray polarization is substantially higher for Hadronic models (70 – 75 %) compared to Leptonic models (30 – 40 %), which may be within the reach of existing X-ray polarimeters.**
- **Combined optical, X-ray and gamma-ray polarimetery therefore will help in understanding**

**the degree of ordering of magnetic field in jets**

**to distinguish between leptonic and hadronic models**

# Summary



***Thank you for your attention***