Working Group 2

Multi-Wavelength Studies to Determine the SEDs and Probe the Physics of the Blazar Zone in Gamma-Ray Bright Extragalactic Radio Sources

- Open questions about the γ-ray emitting zone
- Model-specific predictions on observables
- Observational strategies desired to make progress?
- Observational Challenges → Feasibility
- What does radio tell us?

Open Questions about the γ-ray Emitting Zone

- Composition (electrons/pairs vs. electron/proton)

- Source parameters (radius, particle density, particle distributions, B-field, …)

- X-ray – γ-ray emission mechanisms (leptonic/hadronic)

- Radiative transfer – optical depth effects?

- Particle acceleration mechanisms (shocks / shear layers / …)

- Complex structure? (Internal shocks / spine-sheath / …?)

- What causes flares (if they are really flares …)?

Model Predictions

- Composition (electrons/pairs vs. electron/proton)
  - Total power requirements → Large-scale radio structures
  - Polarization
  - Bulk Compton
  - 511 keV line?

- Source parameters (radius, particle density, particle distributions, B-field, black-hole mass…)
- X-ray – γ-ray emission mechanisms (leptonic/hadronic – SSC vs. EC?)
  - SED shapes
  - Variability time scales / shape of the PSD
  - Spectral variability (spectral hysteresis [X, γ])
  - Inter-band time lags

Model Predictions

- Particle acceleration mechanisms (shocks / shear layers / …)
  - Particle spectral indices
  - Acceleration time scales → flare rise times
  - Energy dependence of acceleration time scale -> time lags
  - Signatures of plasma waves? Plasma hot spots in accretion disks? -> Signatures in the PSD?
  - Can one distinguish between acceleration mechanisms?
    - distinguish from coherent plasma emission?

- Complex structure
  - Multiple EC/SSC components in SED?
  - Time-dependent evolution of Compton/Synchrotron flux ratio.
  - Signatures of shear acceleration (hard particle spectra)?
  - Time lag signatures of internal shocks?
  - Contamination by thermal components, especially in the low state

Challenge to modelers: Model random process time series!

Desired Observations

- As complete MW coverage as possible
  - Fill in microwave – IR, MeV region (sy. peak of LSP blazars), more complete TeV coverage
  - Optical – X-ray – γ-ray coverage essential
  - Do more optical polarimetry.
  - All-sky optical monitor (PANSTARRS / LSST)

- Simultaneity!
  - Variability down to a few minutes $\rightarrow$ Ideally, all measurements should be taken within a few minutes

- Time coverage
  - Cover at least a typical flare time across the entire IR – γ-ray SED: At least a few weeks (maybe many years)
  - Dense coverage; coordination between experiments: Make plans clear to all collaborators.
  - Long-term monitoring with X-ray satellites
  - Continue VLBA, expand to higher frequencies; include ALMA in VLBI

- Observe large sample of sources / many source classes.

Observational Challenges

- Often distinguishing individual flares in complex light curves is difficult/impossible.
- Are those individual flares at all? Or random fluctuations? (Analogy to Galactic X-ray sources: “Flares don’t exist!”)
- Different kinds of variability behavior / time scales
- Need LONG term multiwavelength light curves!
- Spectral components lack direct evidence of their nature
- Multiwavelength (optical, radio, VHE) data (even source lists) not public
- Virtual Observatory under-utilized
- Coordination of observing strategies / goals
- Gaps in SEDs (mm – far-IR, far-UV, MeV) – difficult to fill
- Cross-talk with IR (Spitzer / Herschel) community
- Optical spectroscopic monitoring difficult to get
- Scheduling constraints (especially satellites)
- Weather conditions (→ WEBT/GASP)

Feasible (?) Observing Strategies

- As complete MW coverage as possible
  - IR - Spitzer?
  - ToO monitoring in X-rays/UV (Swift), ground-based radio, optical, VHE γ-rays; Fermi.
  - Planck survey

- Simultaneity
  - X-ray/γ-ray integration times of at least a few hours; Fermi: often > 1 week.
  - Quasi-continuous monitoring in optical, X-rays, average over Fermi integration time.
  - Weather conditions → GASP/WEBT, Swift UVOT

- Time coverage
  - Long-term monitoring (many years: optical, radio, Fermi);
  - Dedicated monitoring programs with Swift (Spitzer???)

What Does Radio Tell Us?

- Low-frequency radio emission region is probably further out than γ-ray emission region (Radio - γ-ray delays)

- Most optical – γ-ray SED models are optically thick at low Radio frequencies

→ Fermi divorces Jansky?

- Constraints on Γ and Θ_{obs} (-> Doppler factor) – Same as for blazar zone?

- Can get reasonable estimates of B and D from equipartition arguments. Use high-frequency radio data.

- Radio can help distinguish between intrinsic and geometrical effects causing variability