

A Multiwavelength Photometric and Spectroscopic Cross-Correlation Variability Study of Fermi/LAT Blazars

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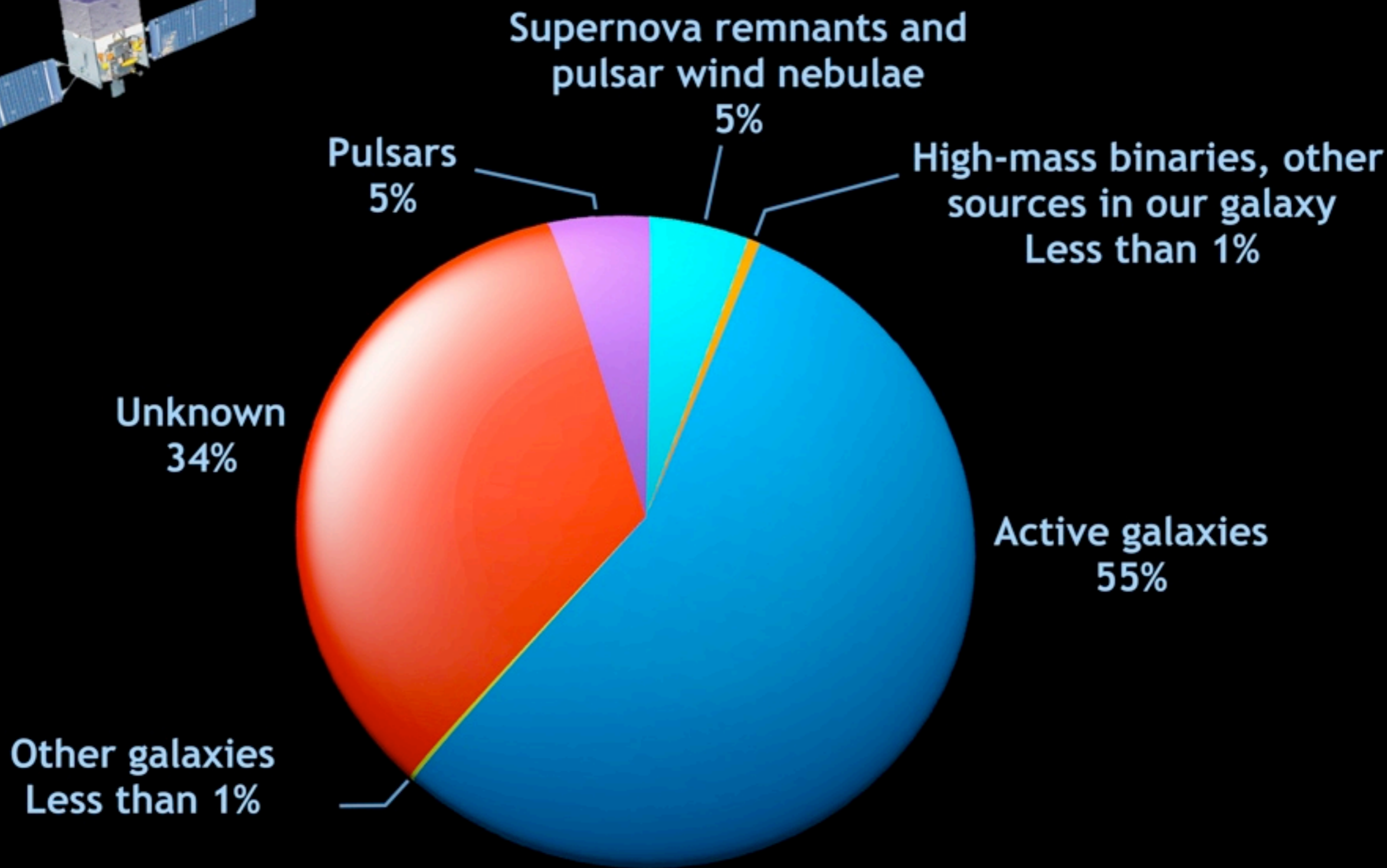
June 3th. Lewes, Delaware

Supervisors: Dr. Vahram Chavushyan, Dr. Alberto Carramiñana & Dr. Luis Carrasco

Outline

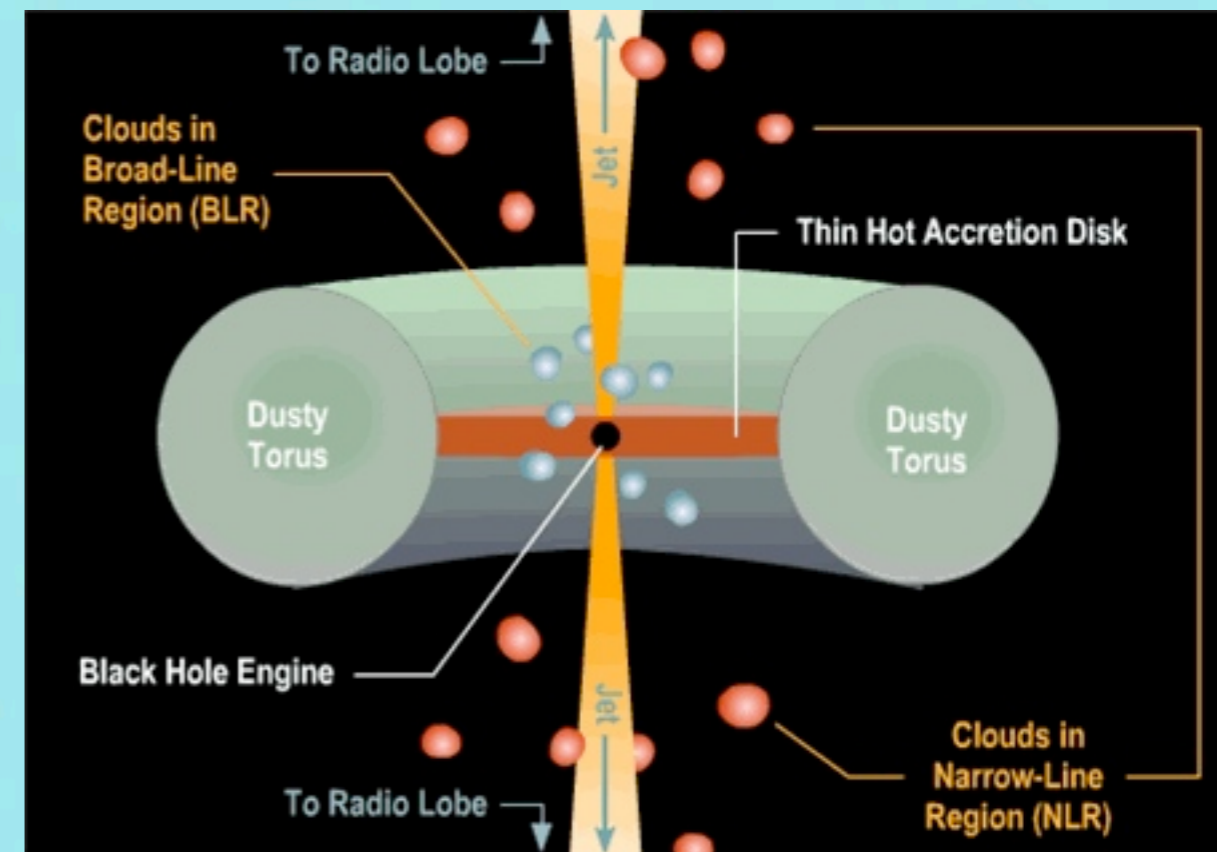
- * Introduction.
- * Multiwavelength Data.
- * The Sample.
- * Cross-Correlation Analysis.
- * 3C 454.3: A Special Case.

Fermi reveals the universe above 10 GeV

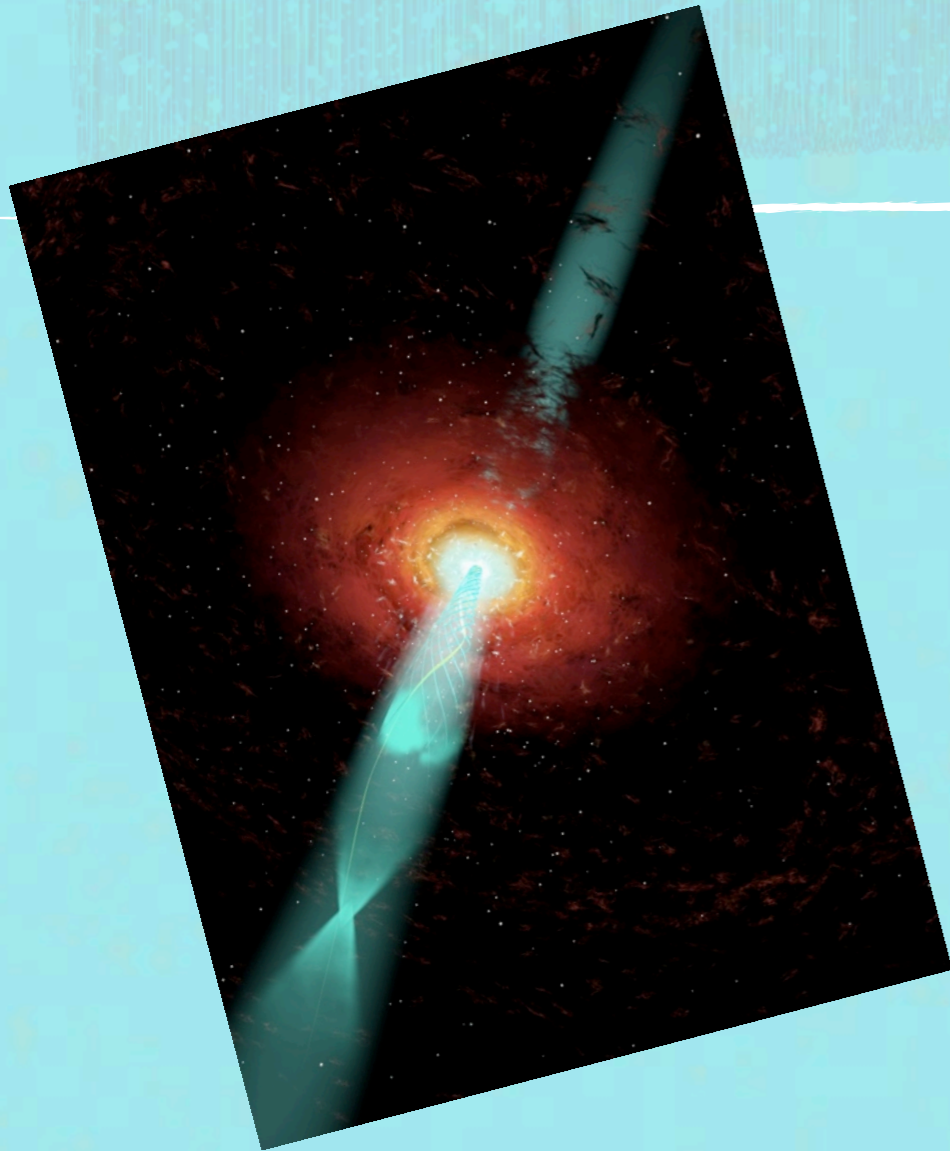


Credit: NASA/Goddard Space Flight Center

The Current AGN Paradigm



Blazar



- Abnormally high luminosity
- Fast variability
- Jet emission can dominate at all energies
- 2 types: FSRQ and BLLacs





Multiwavelength Data

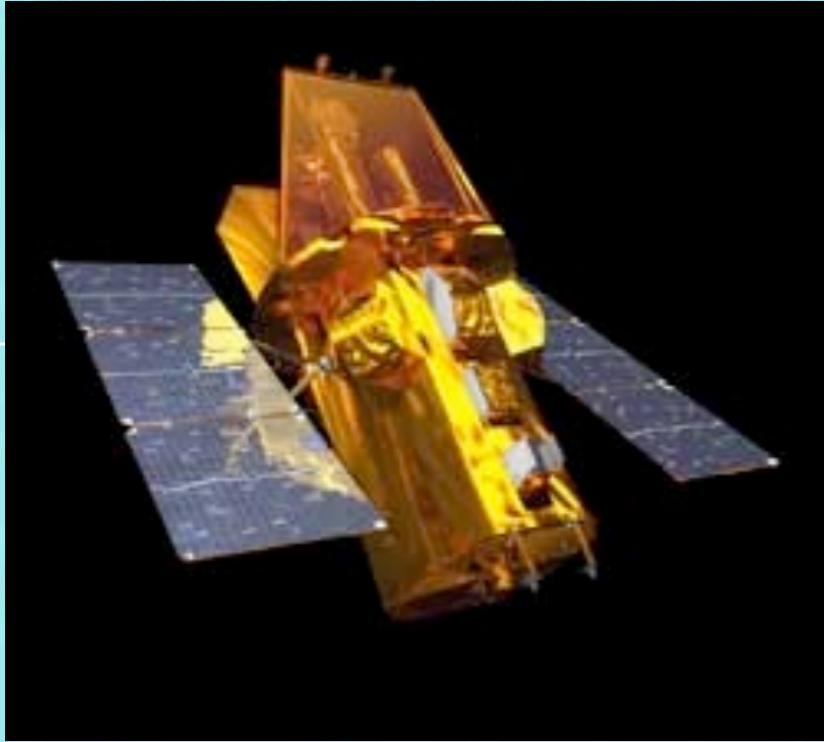


- * Gamma-Rays (Fermi)
- * Optical Photometry (Steward Observatory and SMARTS)
- * Near-Infrared Photometry (GHAO and SMARTS)
- * Optical Spectra (GHAO and Steward Observatory)



Multiwavelength Data

Working on it

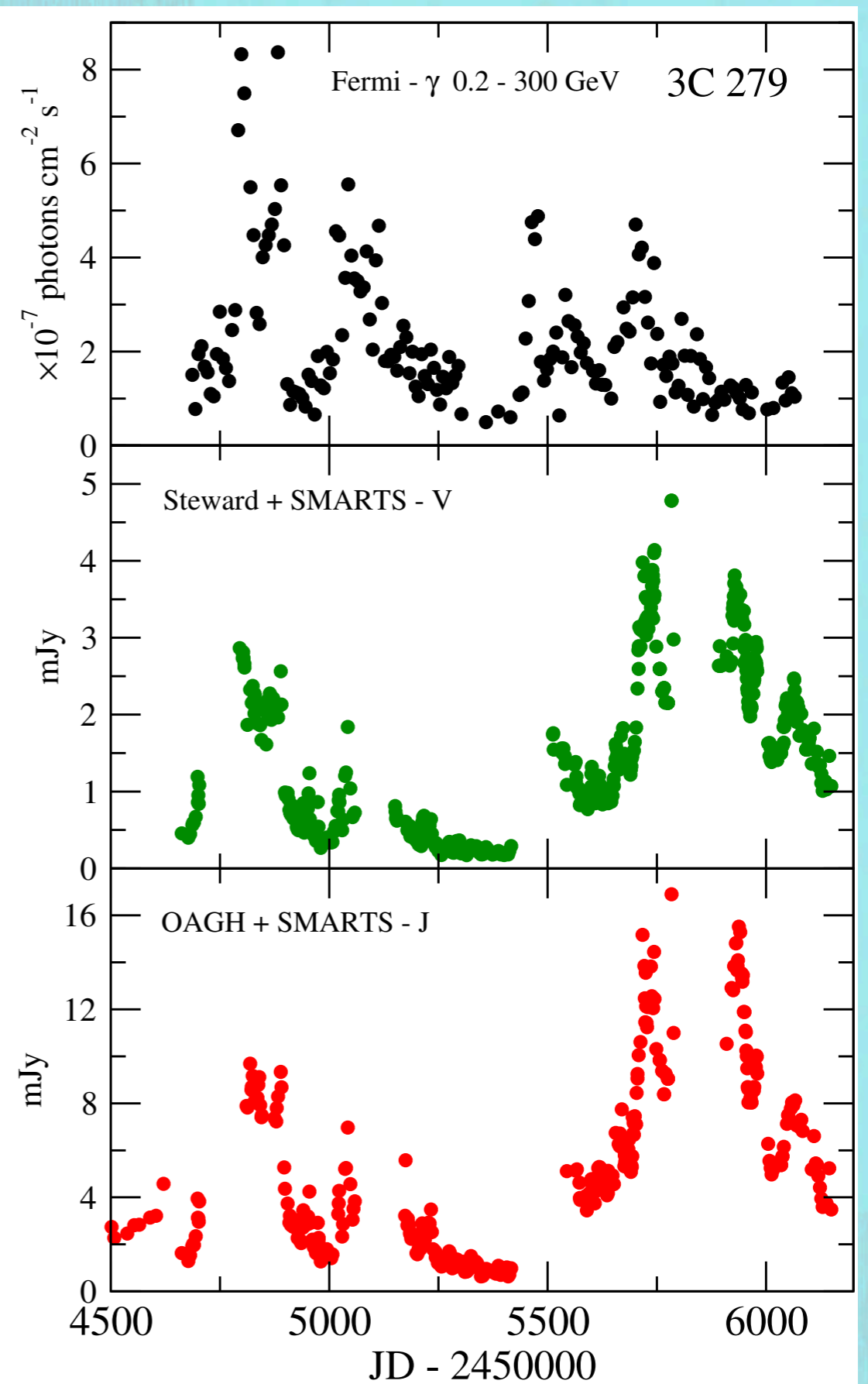
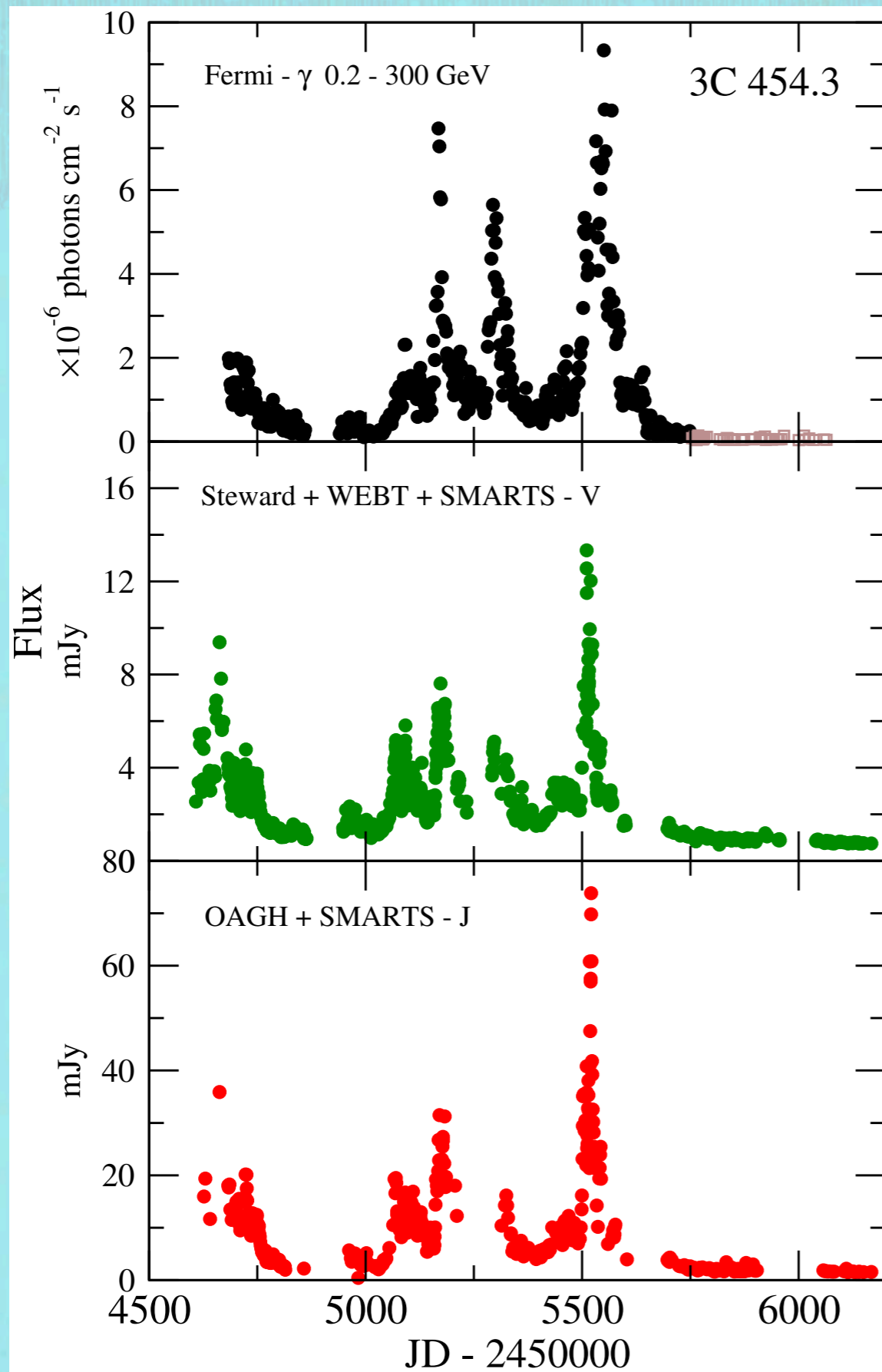


* X-Rays (Swift)

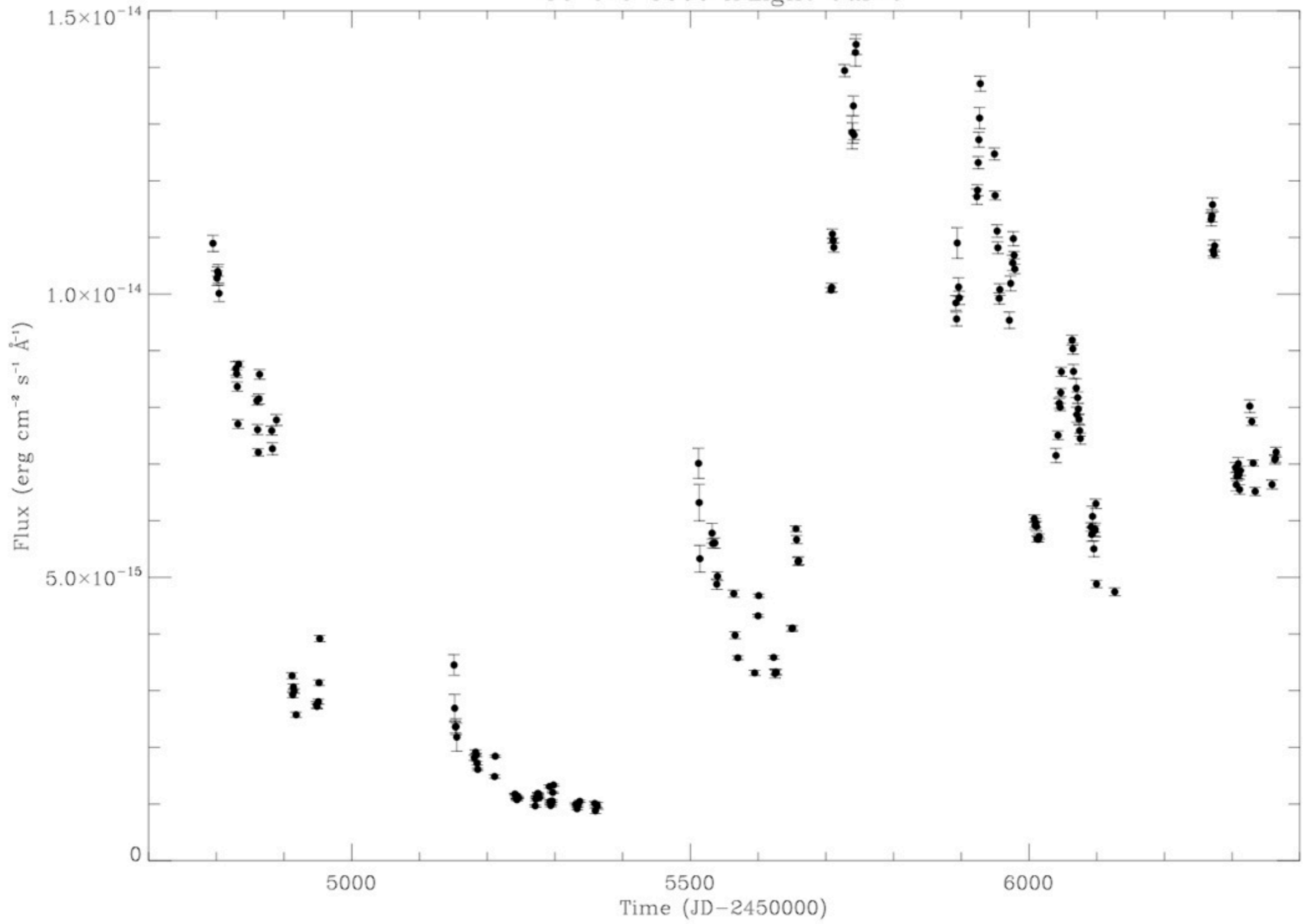
* Millimeter (SMA, Metsahövi and LMT)



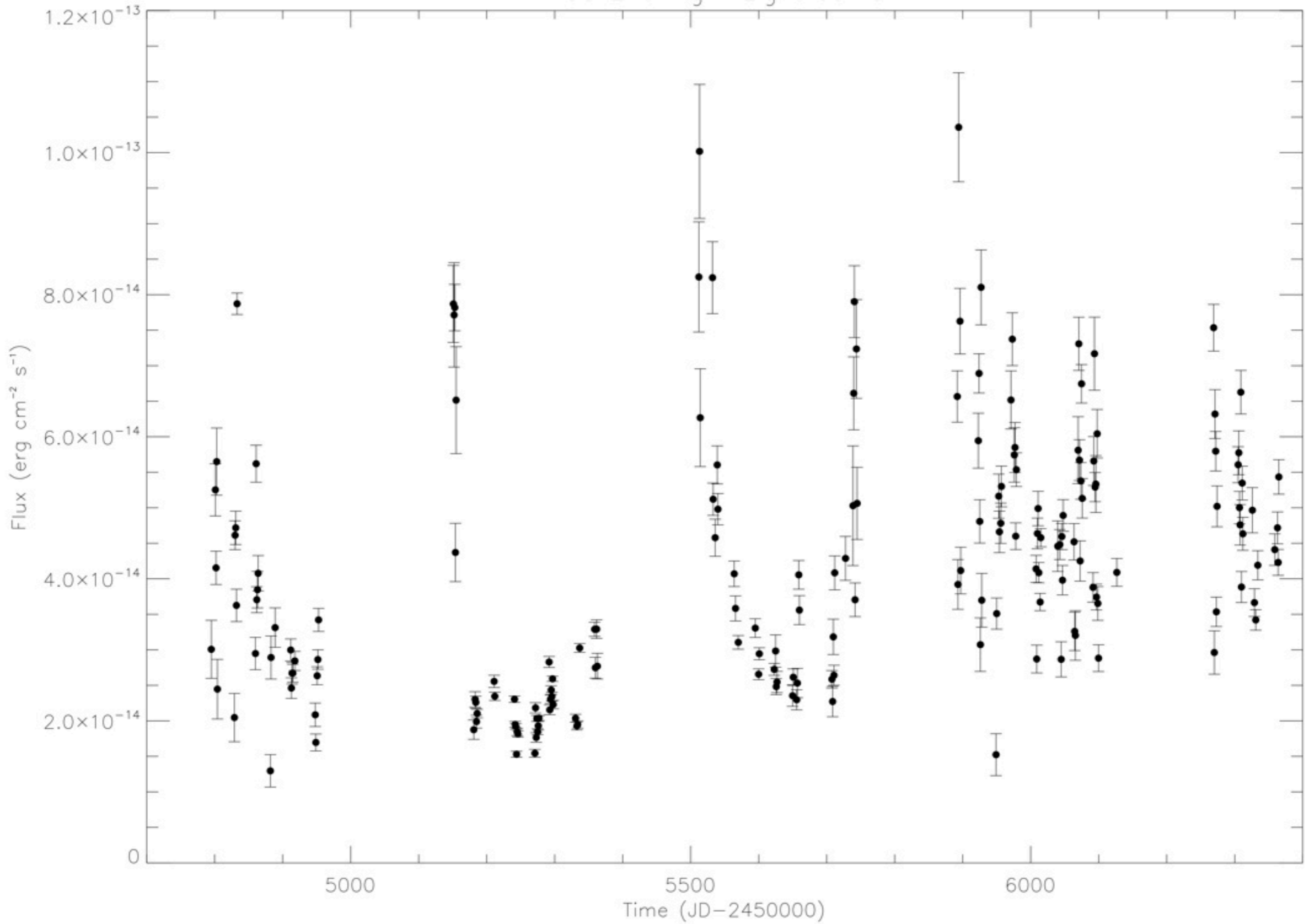
LMT, Sierra Negra, Mexico



3C 279 3000 Å Light Curve



3C 279 Mg II Light Curve



Iron emission subtracted

The Sample

- * Initially 16 objects.
- * Dragged as a subsample of a cross match catalog between EGRET and WMAP.
- * The Sample to perform cross-correlation analysis will be increased to 35.

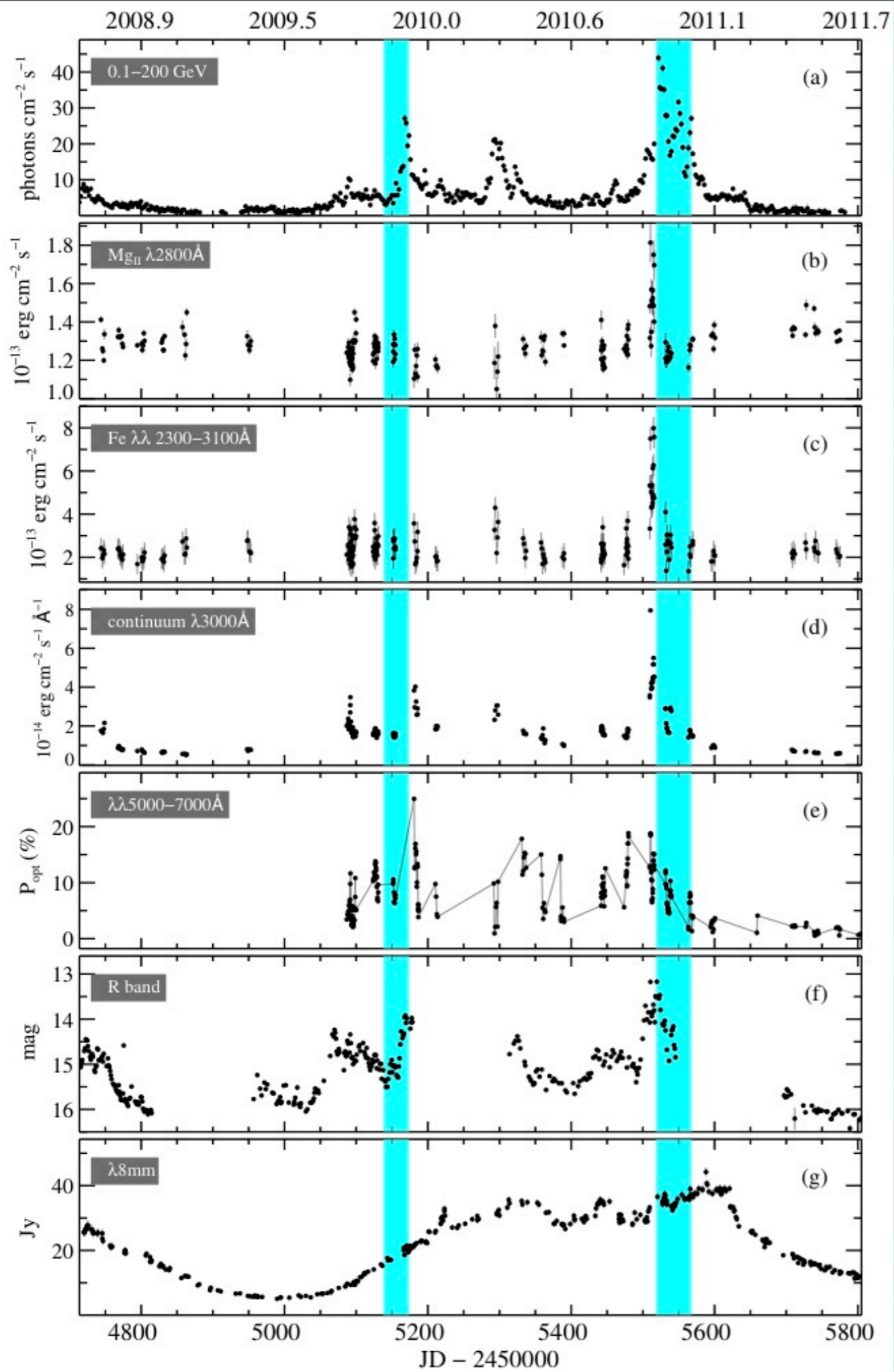
Cross-Correlation

- * Used in astrophysics, primarily to find delays between two different emissions from celestial objects (e.g. reverberation mapping).
- * Three main methods to perform such statistical analysis:
 - * Interpolated Cross-Correlation Function (ICCF).
 - * Discrete Cross-Correlation Function (DCF).
 - * Z-Transformed Discrete Cross-Correlation Function (ZDCF).

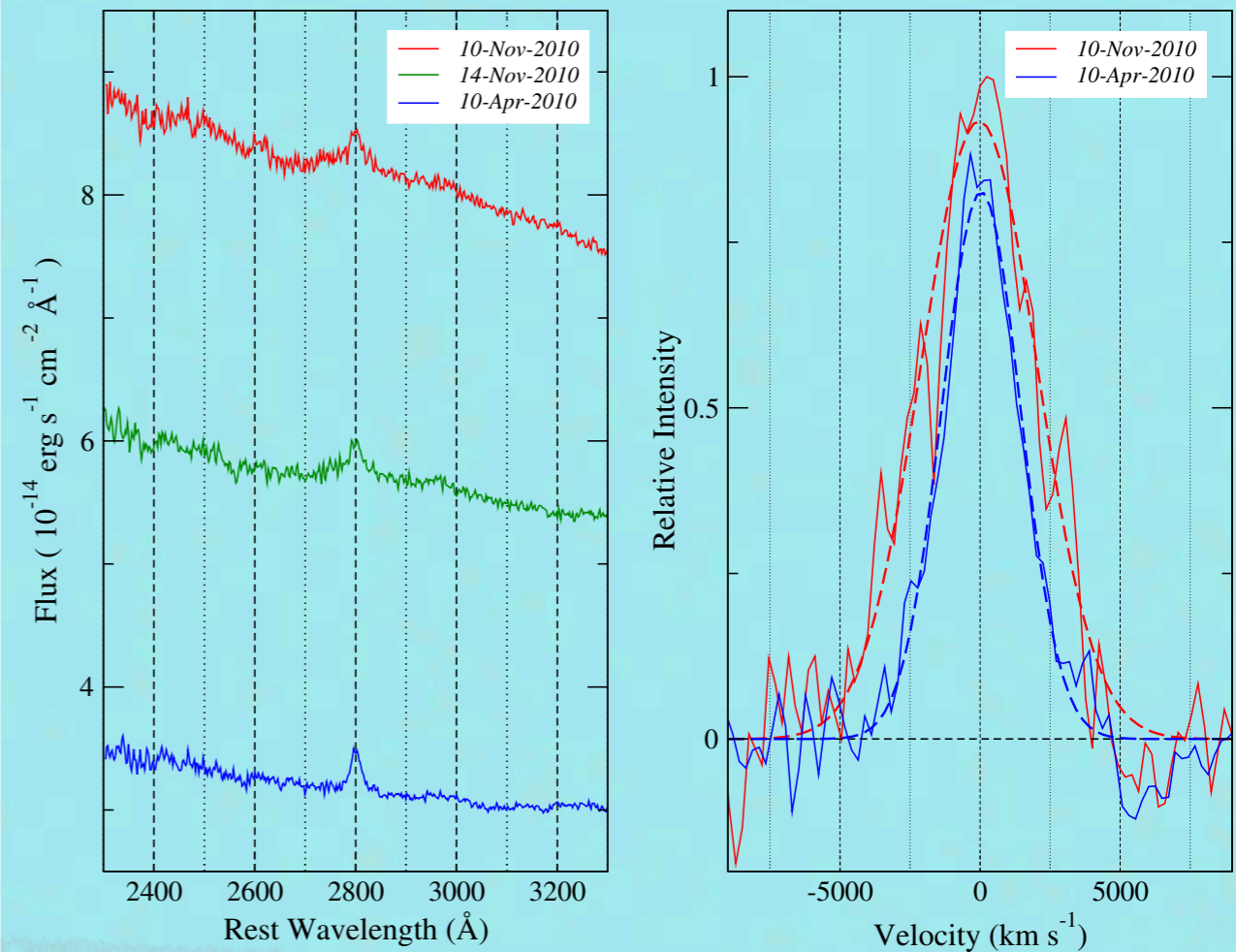
Flare-like Variability of the Mg II λ 2800 Emission Line in the γ -Ray Blazar 3C 454.3

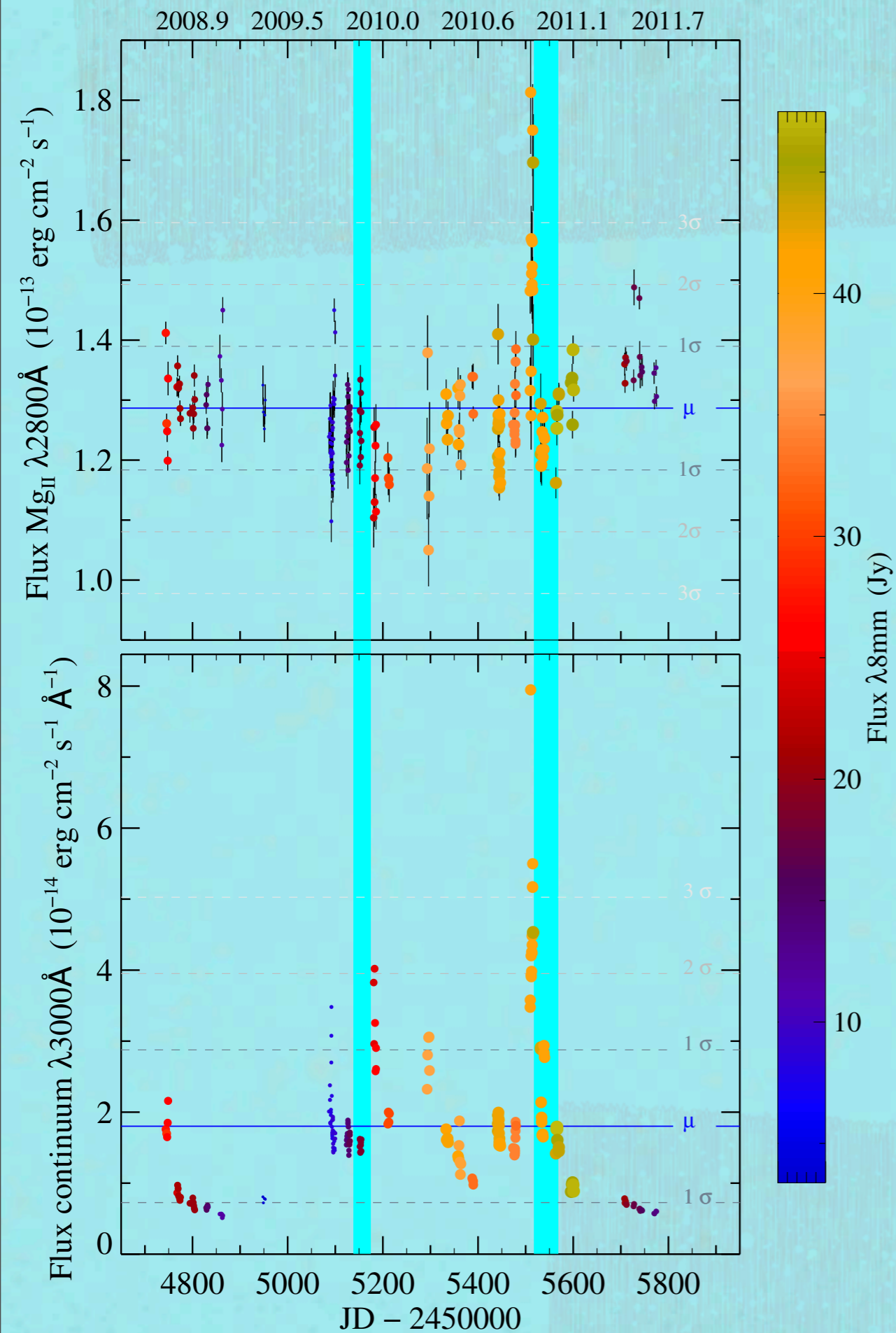
León-Tavares, J.; Chavushyan, V.; Patiño-Álvarez, V., et al. (2013) ApJL, 763, 36

- * We report the detection of a statistically significant flare-like event in the Mg II λ 2800 emission line of 3C 454.3 during the outburst of autumn 2010.
- * The optical spectra used in this work are taken from the Ground-based Observational Support of the Fermi Gamma-ray Space Telescope at the University of Arizona monitoring program.



Vertical Stripes - Jorstad, S. G., Marscher, A. P., et al.
2012 [arXiv:1205.0520]



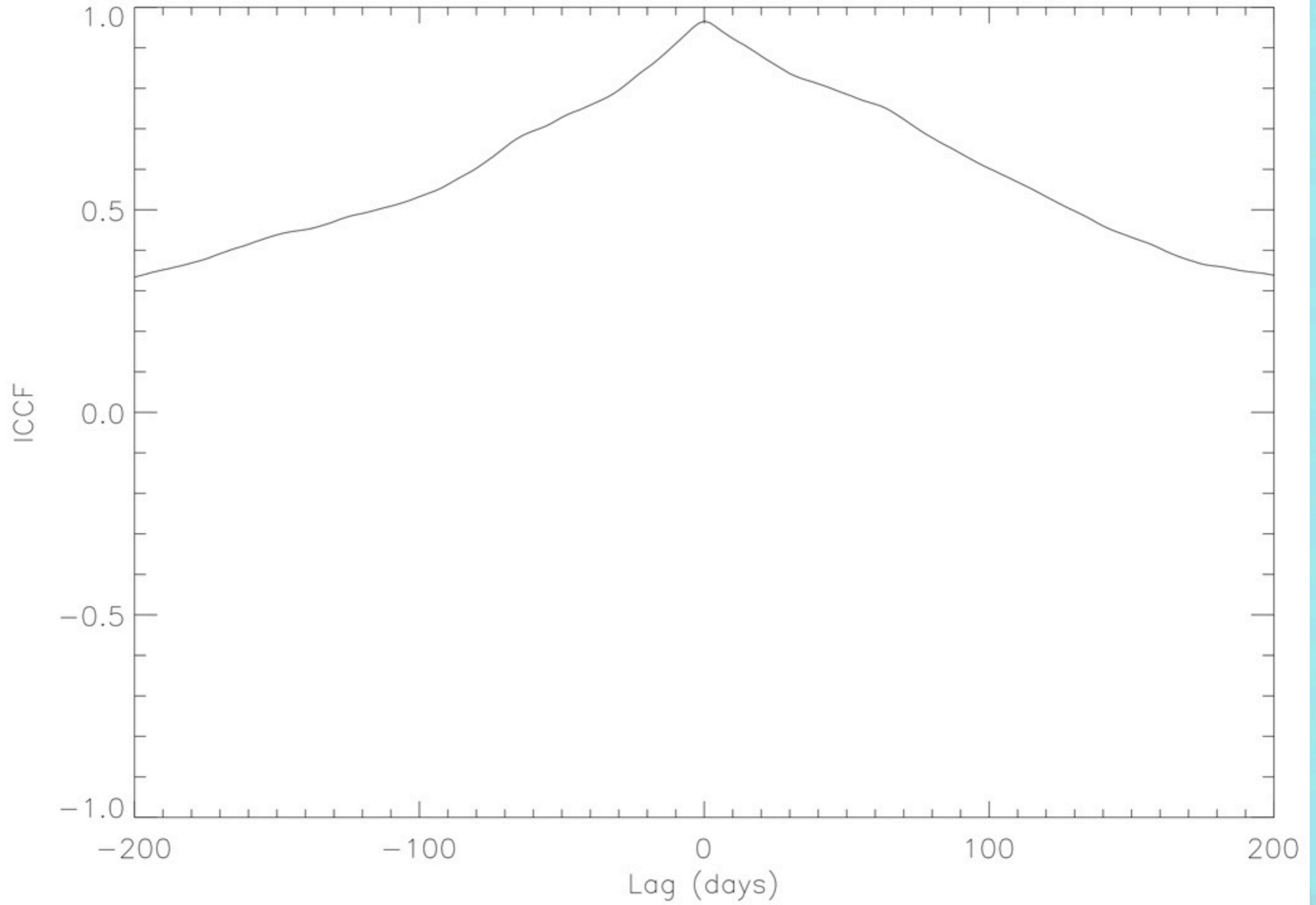


This finding crucially links the broad emission line fluctuations to the non-thermal continuum emission produced by relativistically moving material in the jet and hence to the presence of BLR clouds surrounding the radio core.

- * AGN models: BLR is complex and may have other components (e.g inflows, outflows).
- * BH mass: estimates using reverberation mapping relations (assume BLR is virialized).
- * γ -rays: Outflowing BLR may serve as a source of seed photons for inverse Compton scattering?

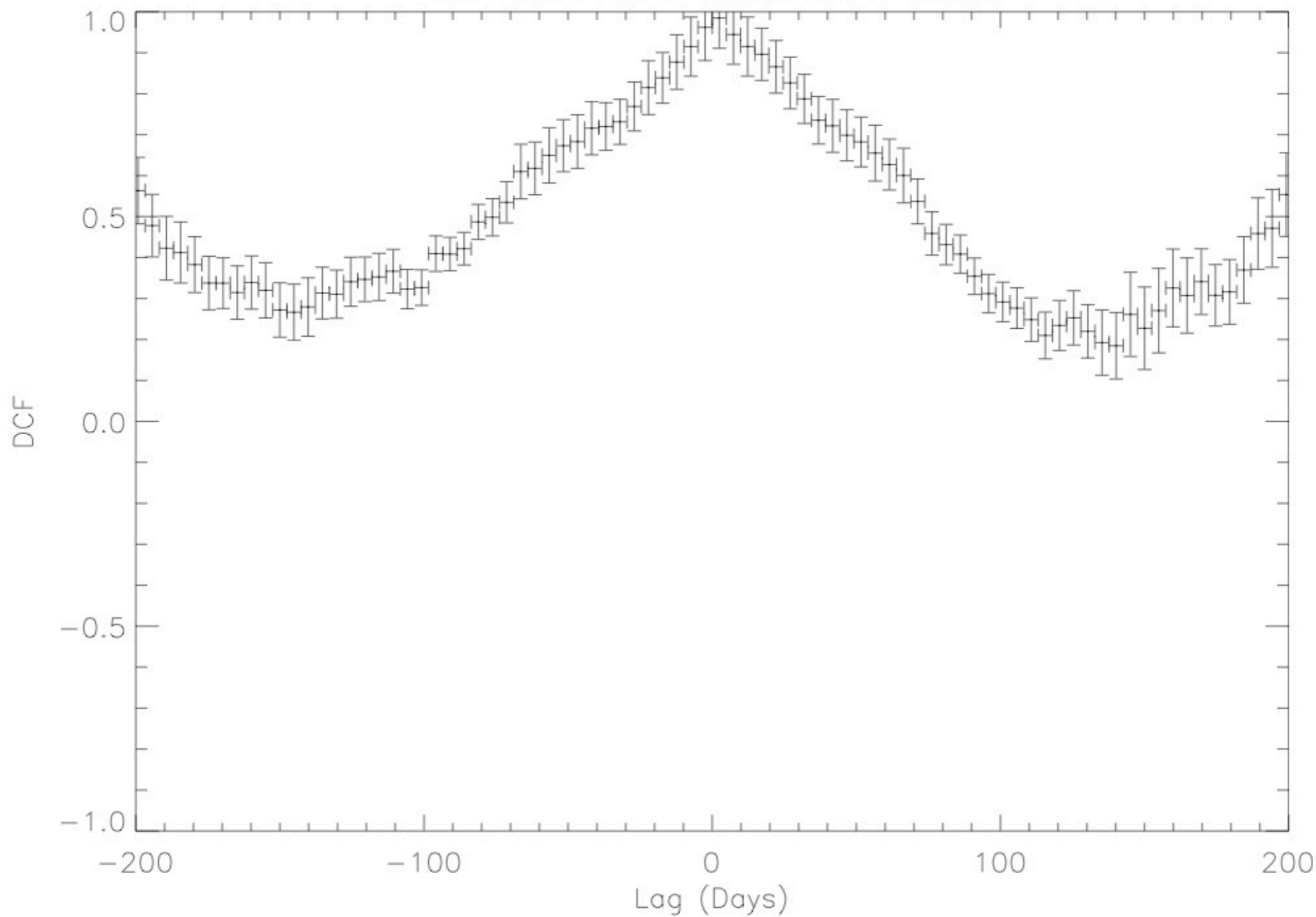
THANKS FOR YOUR
ATTENTION

ICCF 3C 279 V Band vs. J Band



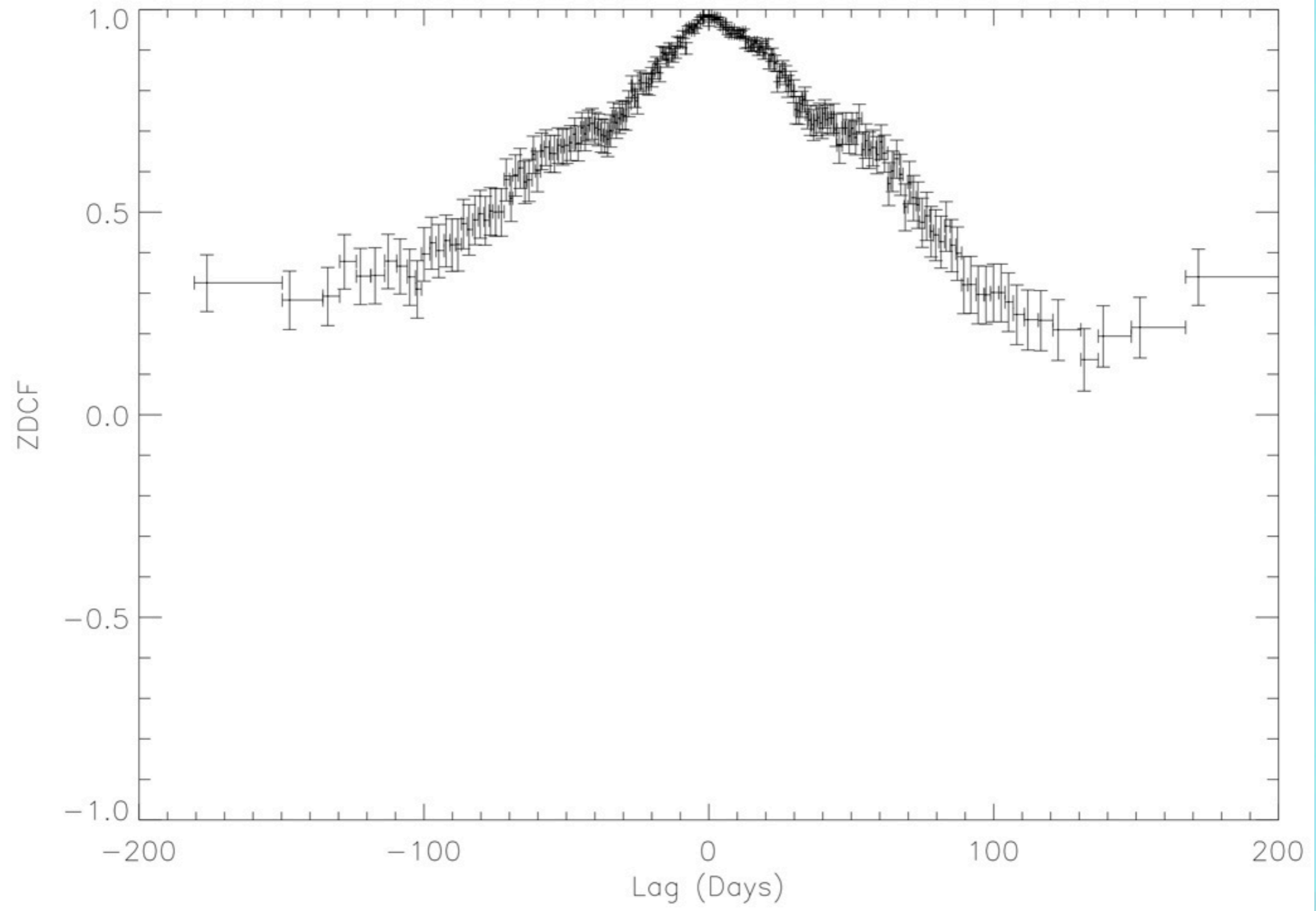
ICCF

DCF 3C 279 V Band vs. J Band



DCF

ZDCF 3C 279 V Band vs. J Band



ZDCF