Víctor Manuel Patiño Álvarez

3C 279 as a High Energy Astrophysics Laboratory

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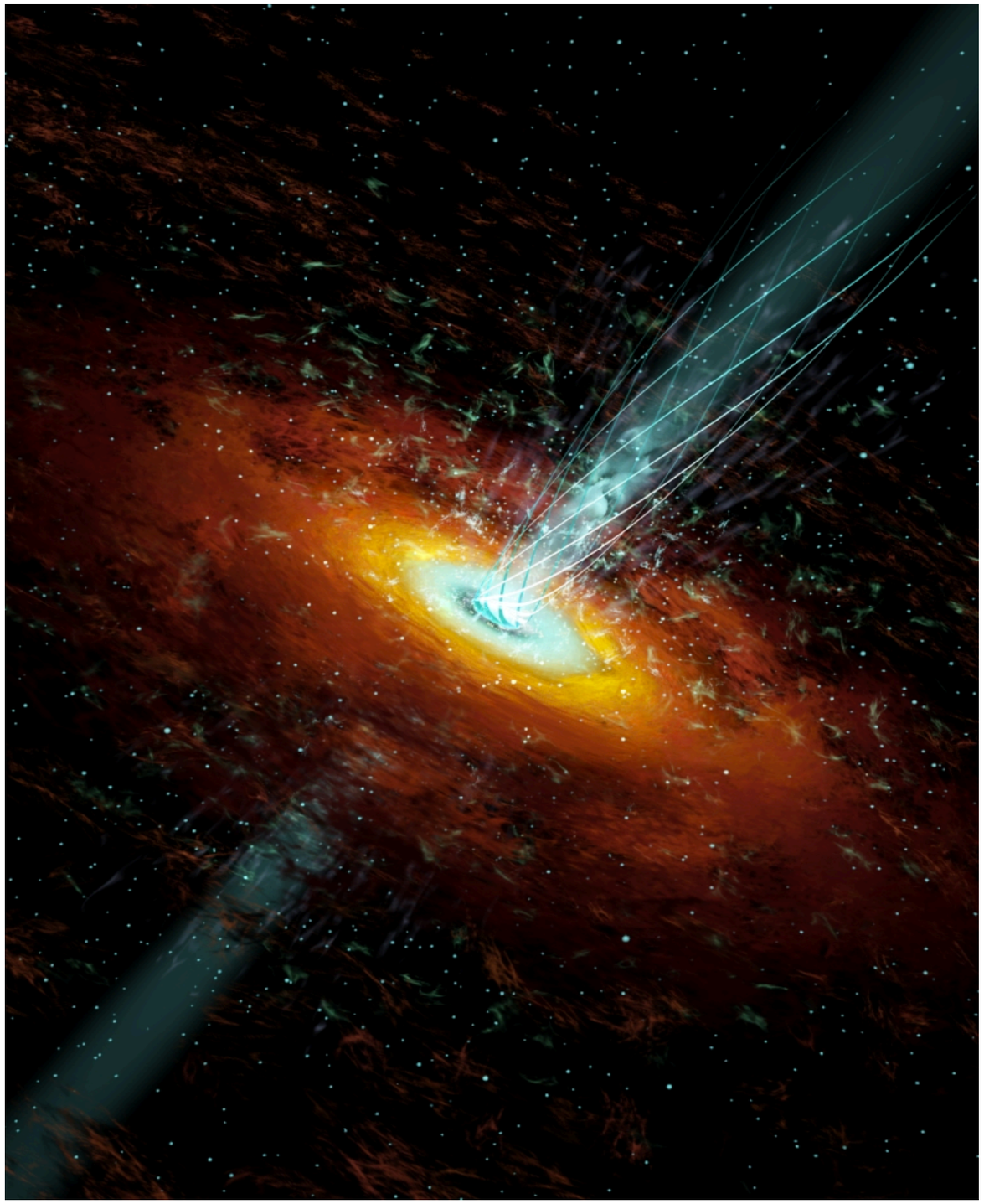
Guillermo Haro Workshop 2015
Tonantzintla, July 21th. 2015

Outline



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3. Multiwavelength Analysis
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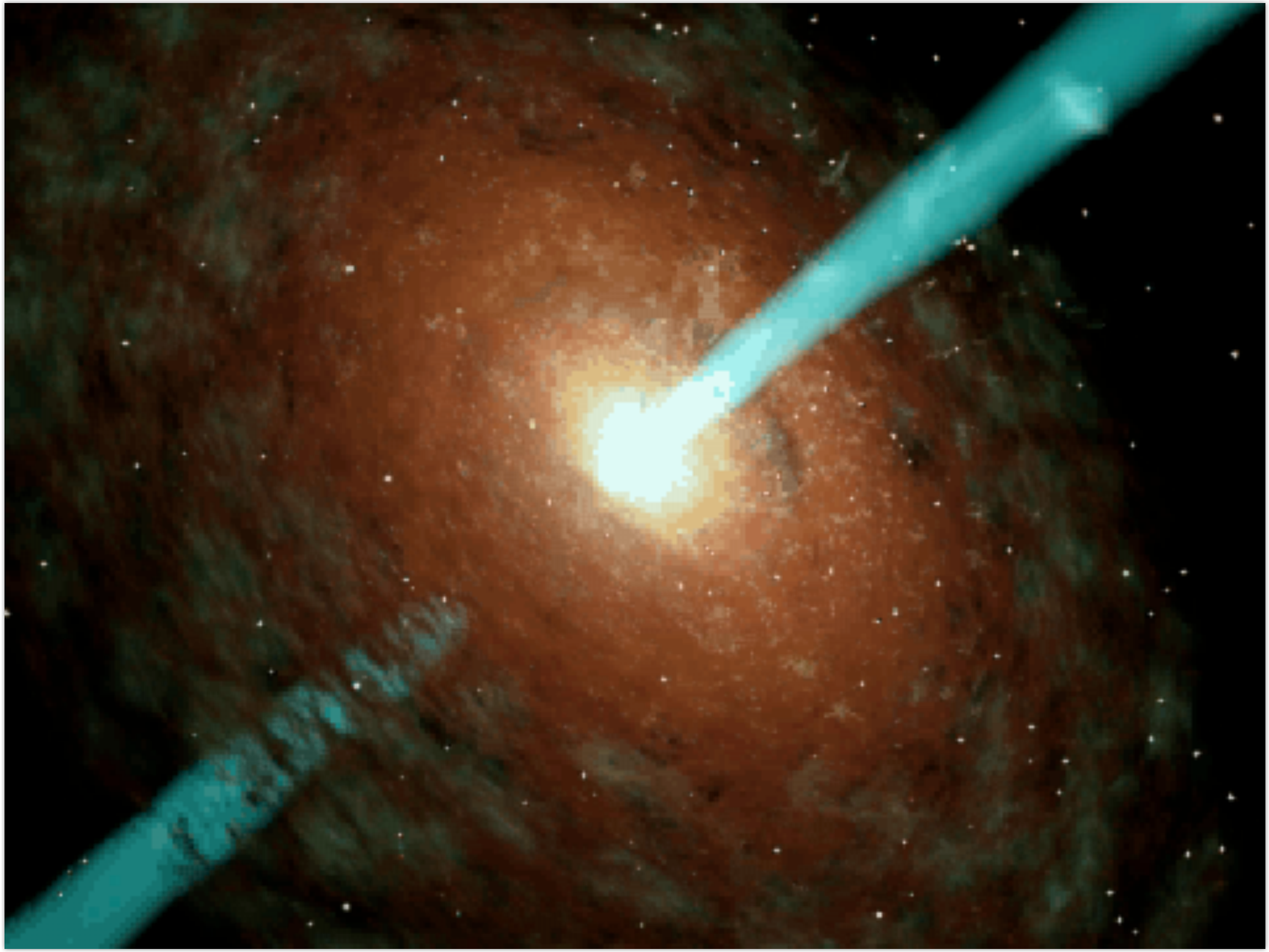
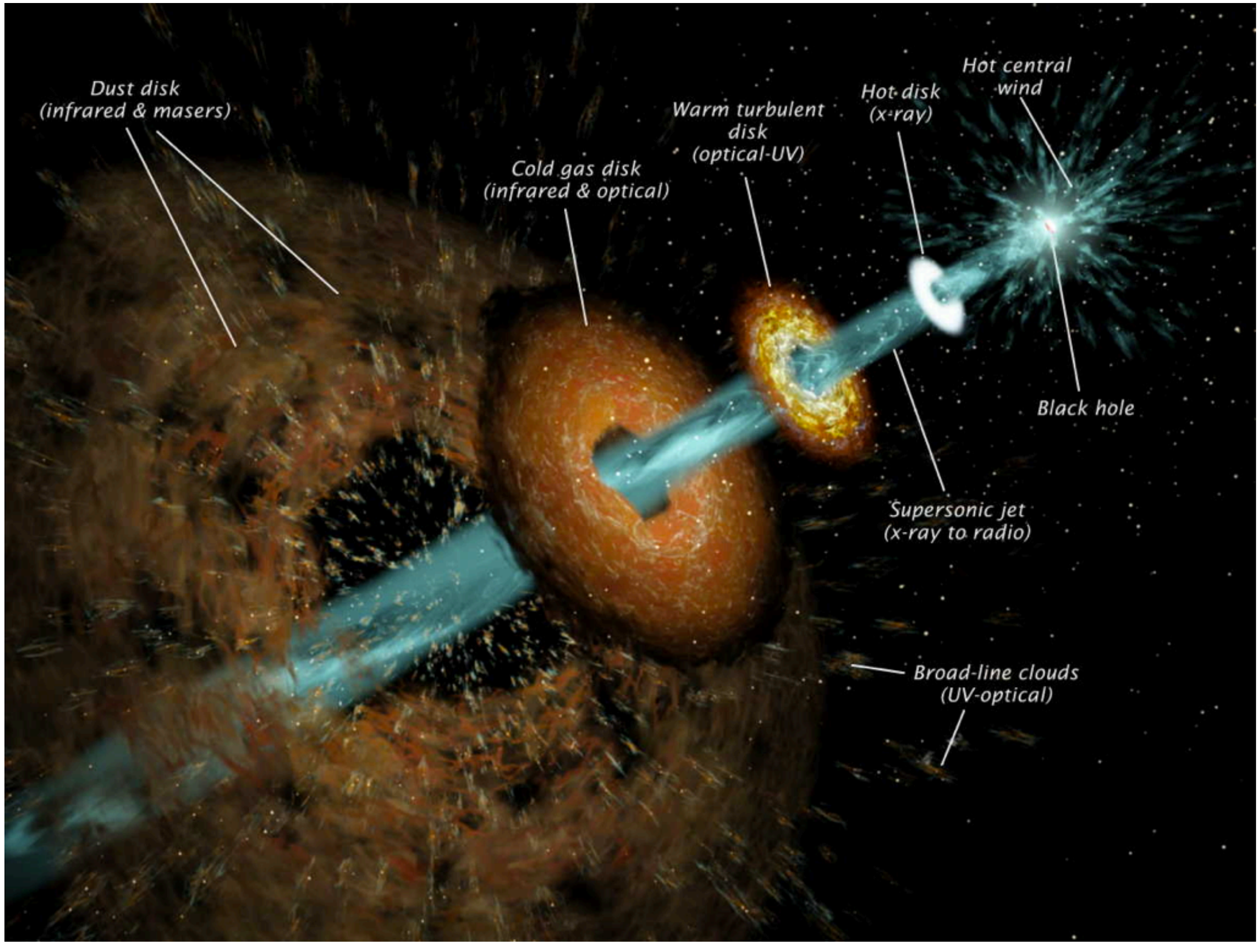
Introduction



Credits: W. Steffen

Introduction



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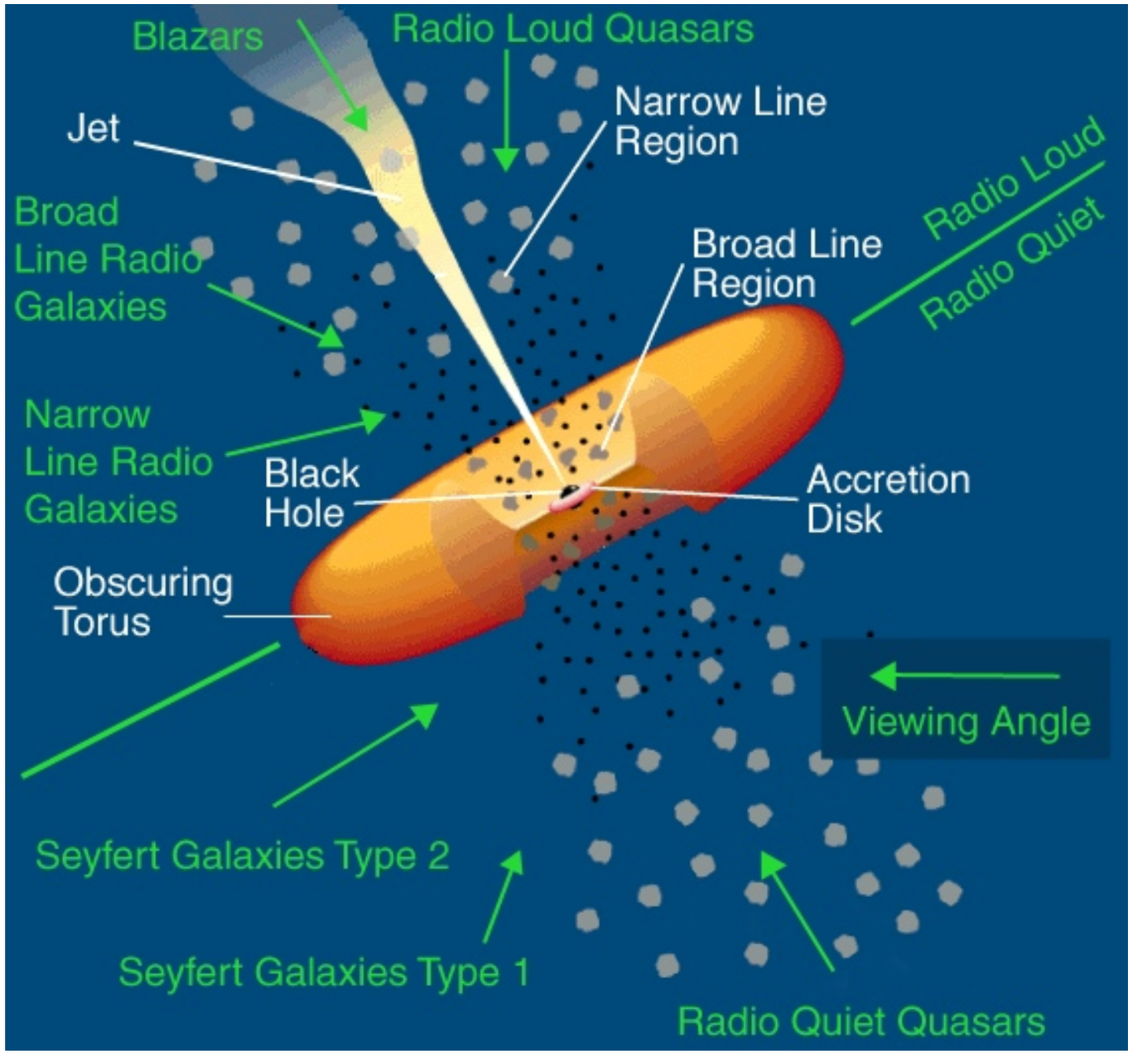
Introduction

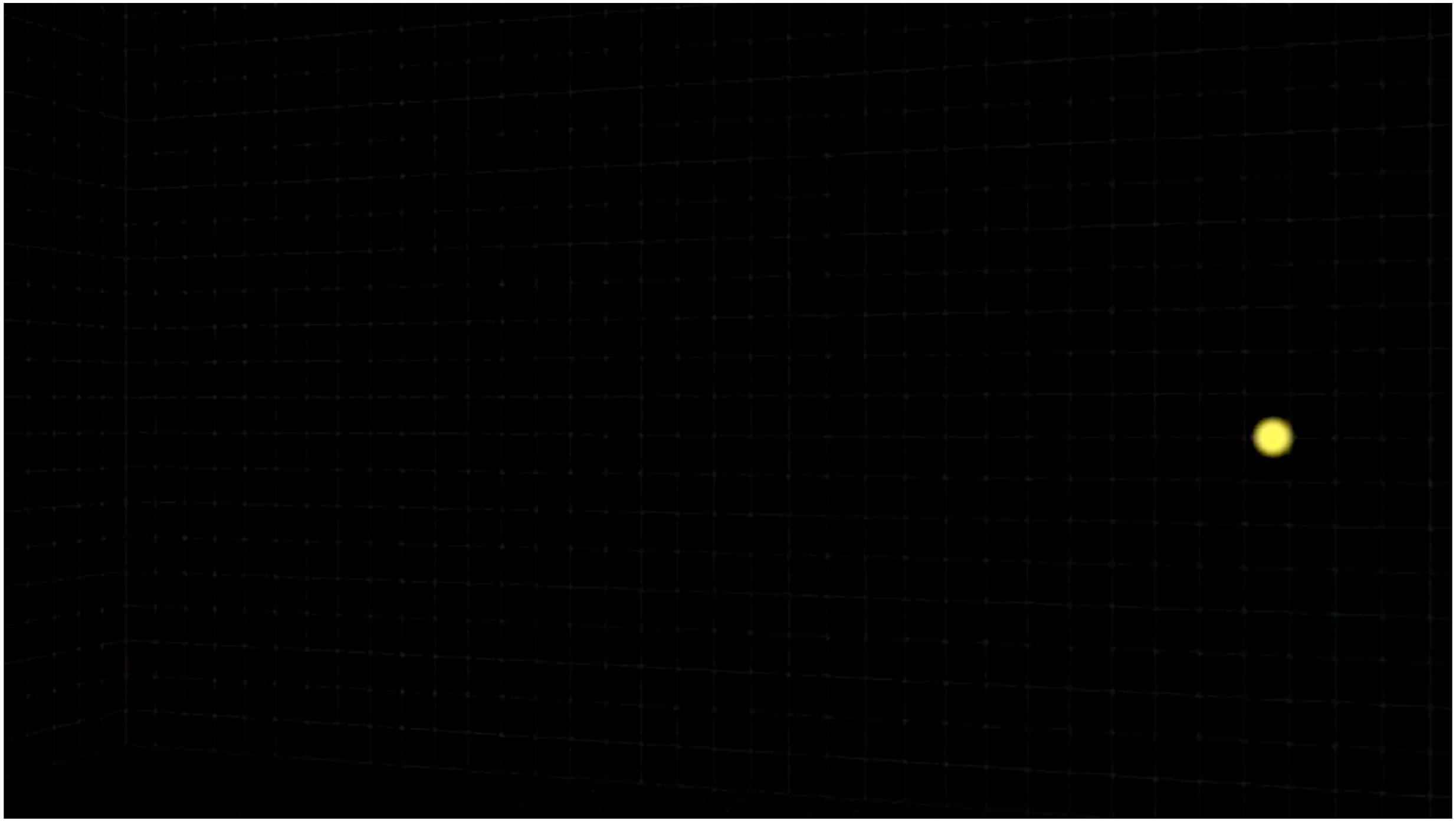


Credits: Urry & Padovani 1995

Emission Mechanisms

- Thermal:
  - Accretion Disk
- Non thermal:
  - Synchrotron
  - Inverse Compton

Inverse Compton Scattering



Motivation

EGRET ⟶ Location of γ-ray emission zone

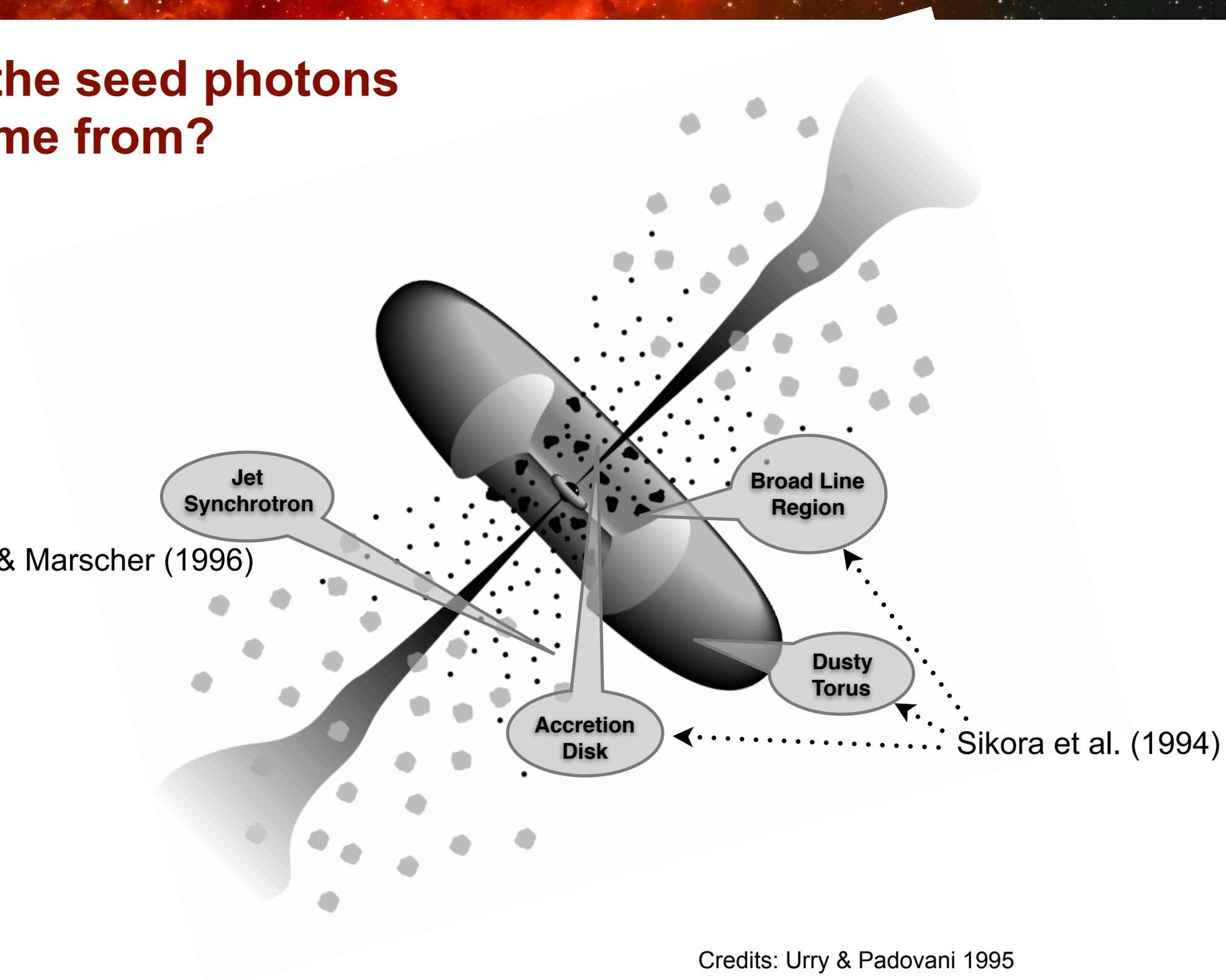
Fermi-LAT ⟶ Multiwavelength Campaigns

The γ-ray emission zone remains an open issue:

- Near the black hole (< 1 pc)
- Far from the black hole, into the jet.

Motivation

Where do the seed photons come from?

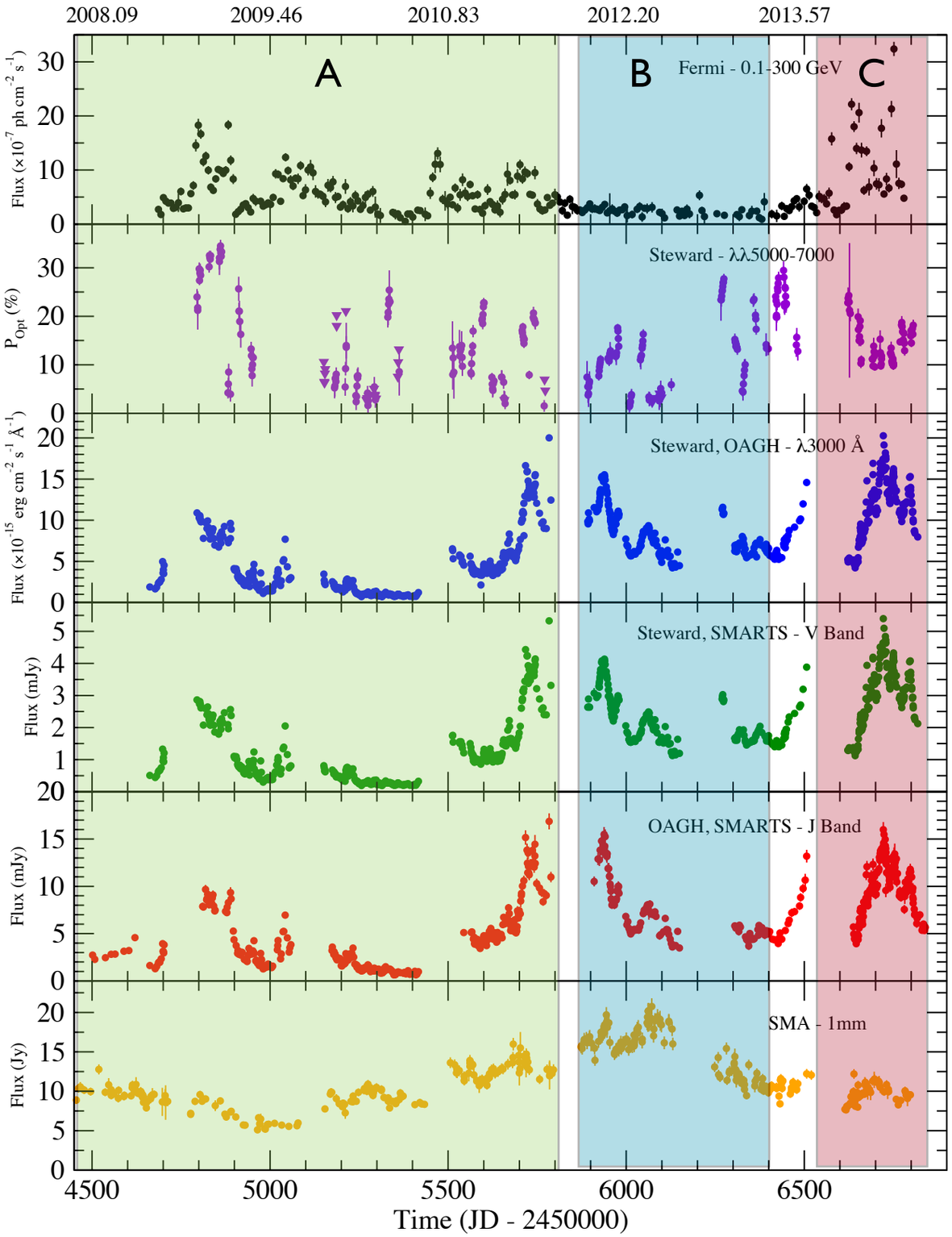


Bloom & Marscher (1996)

Sikora et al. (1994)

Credits: Urry & Padovani 1995

Multiwavelength Analysis



0.1-300 GeV - Fermi

P_{opt} (%) - Steward

UV cont. - Steward,OAGH

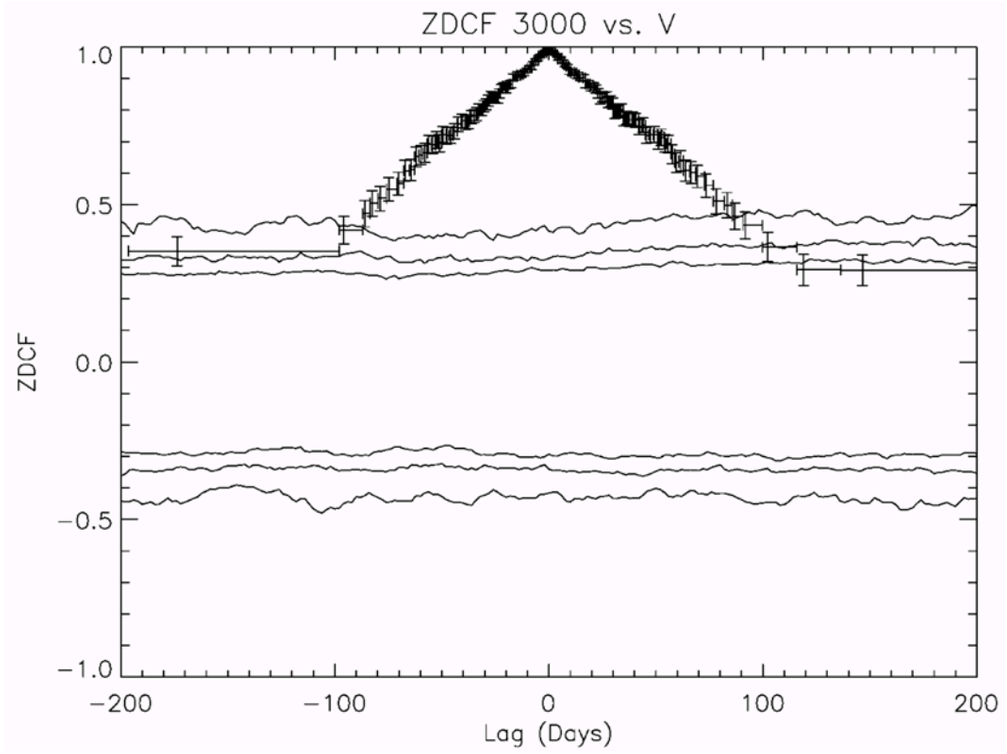
V band - Steward, SMARTS

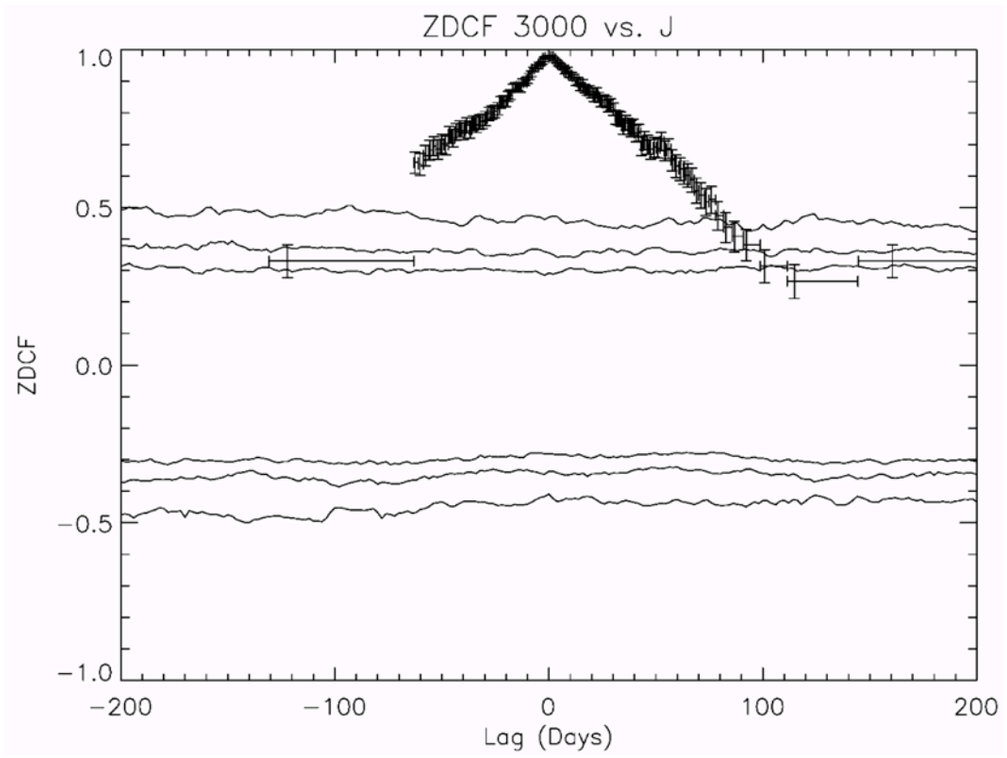
J band - OAGH, SMARTS

1mm- SMA

Patiño-Álvarez et al. (in preparation)

Multiwavelength Analysis





Origin of UV/Optical/NIR Emission

- UV to NIR Simultaneous Variability
- UV - 1mm correlation (suggest non-thermal emission)
- This tells us that the emission from UV to NIR has a non-thermal origin

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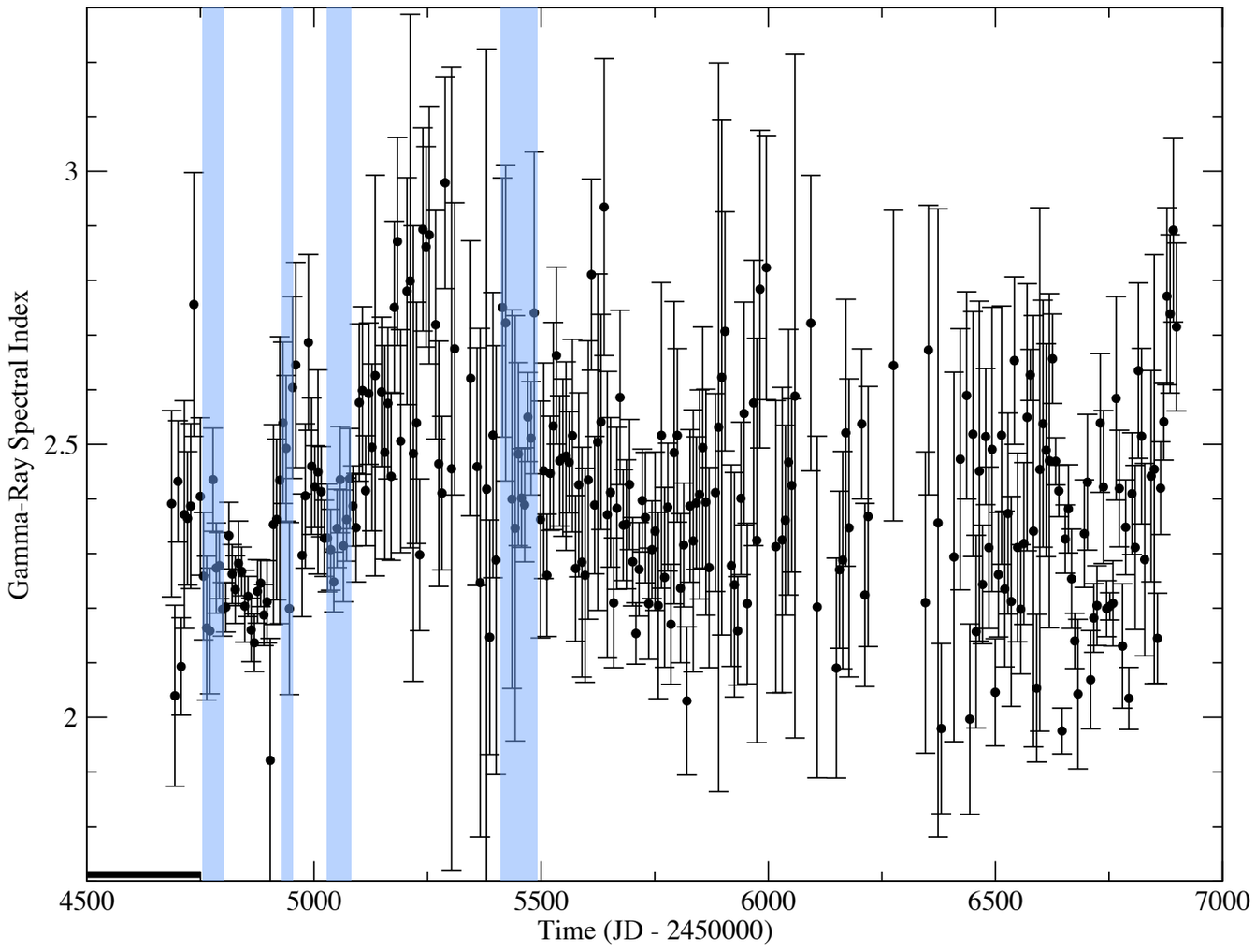
Variability



Variability detected at
$P \sim 10^{-31}$

γ-rays photon index

$$\frac{dN}{dE} = N_0 \left(\frac{E}{E_0} \right)^{\gamma}$$

- Fermi Light curve with power law.
- Run variability test on γ-rays photon index. Significant variability was found.

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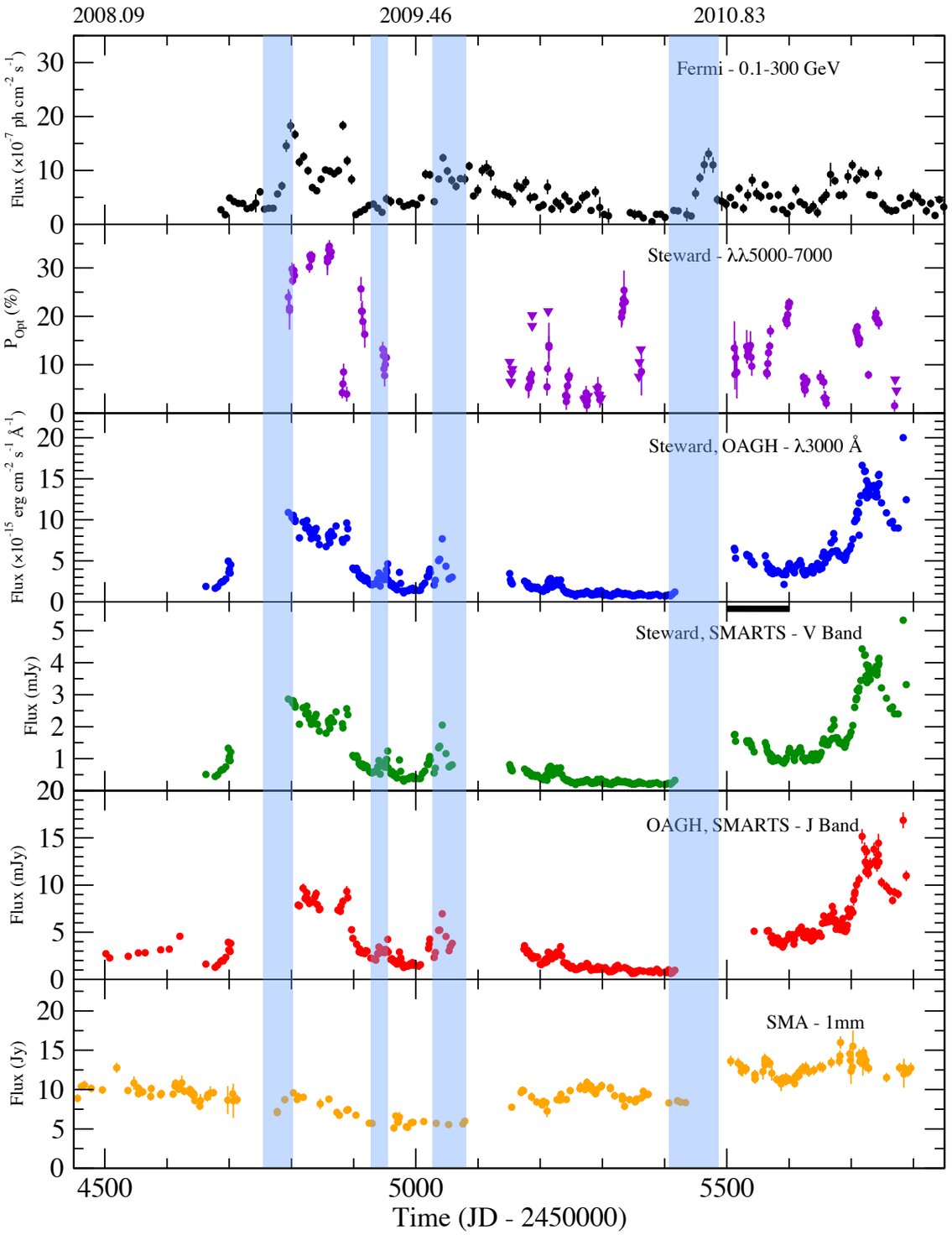
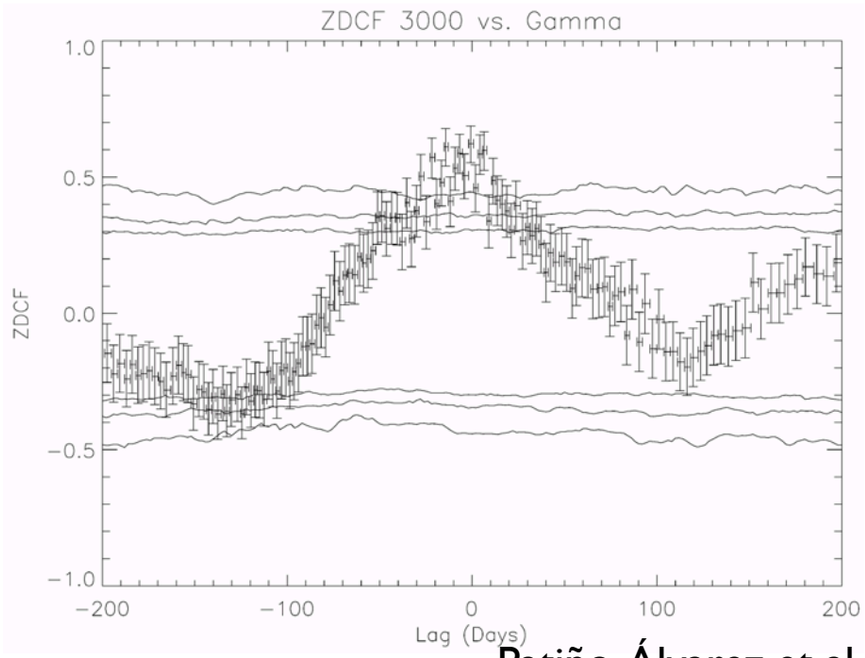
Multiwavelength Analysis: Period A



- Cross Correlation shows a delay between γ-rays - UV continuum
- A delay consistent with 0 is in agreement with the predictions from SSC models. (e.g. Tavecchio, Maraschi, & Ghisellini, 1998)
- This tells us that the emission from UV to NIR has a non-thermal origin



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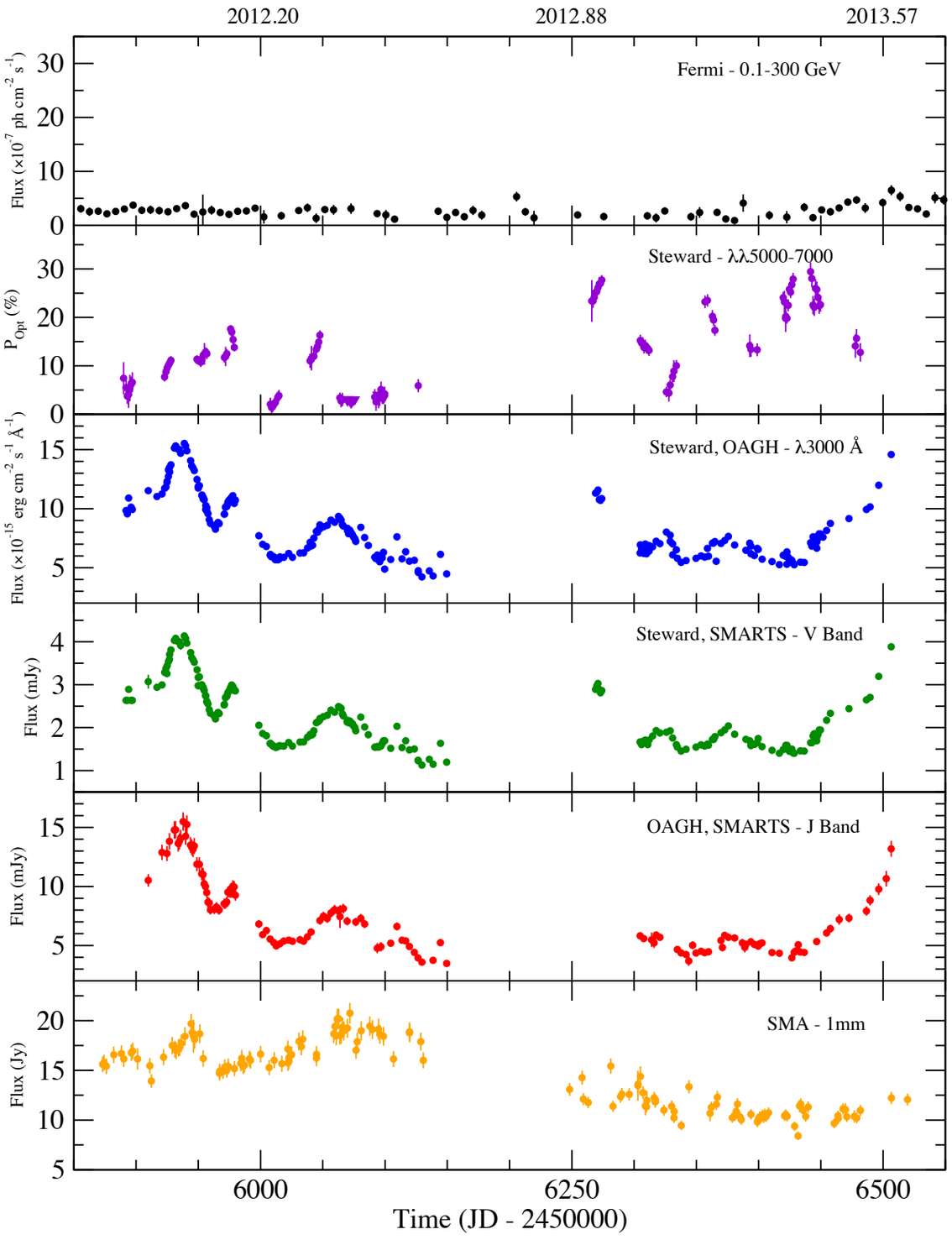
Multiwavelength Analysis: Period B



Only precedent: Chatterjee et al. 2013

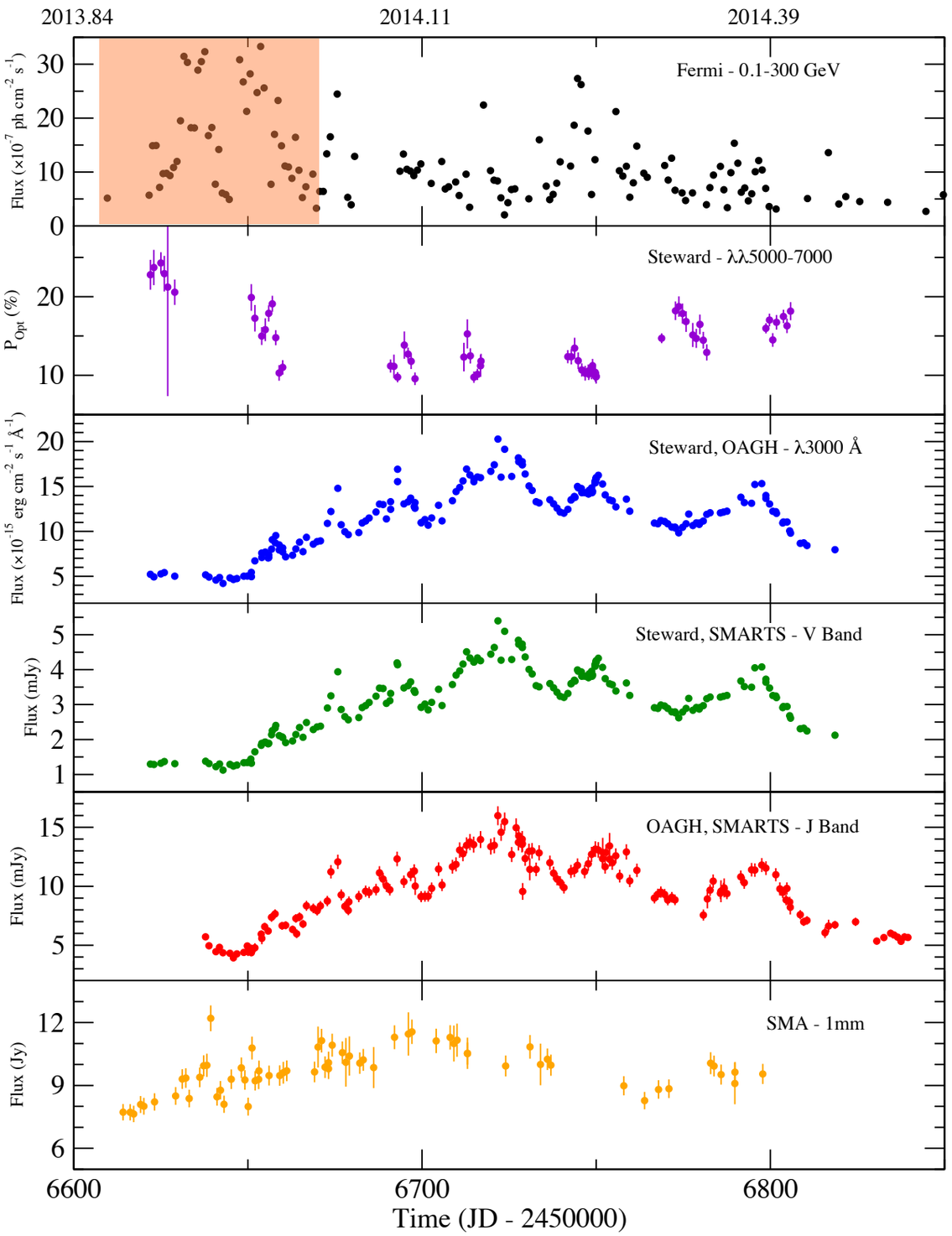
- High levels of polarization.
- Highest levels of 1mm emission of our entire time range.
- Prominent flares in the UV, optical and NIR continuum.
- Probable ejection of a component from the radio core.

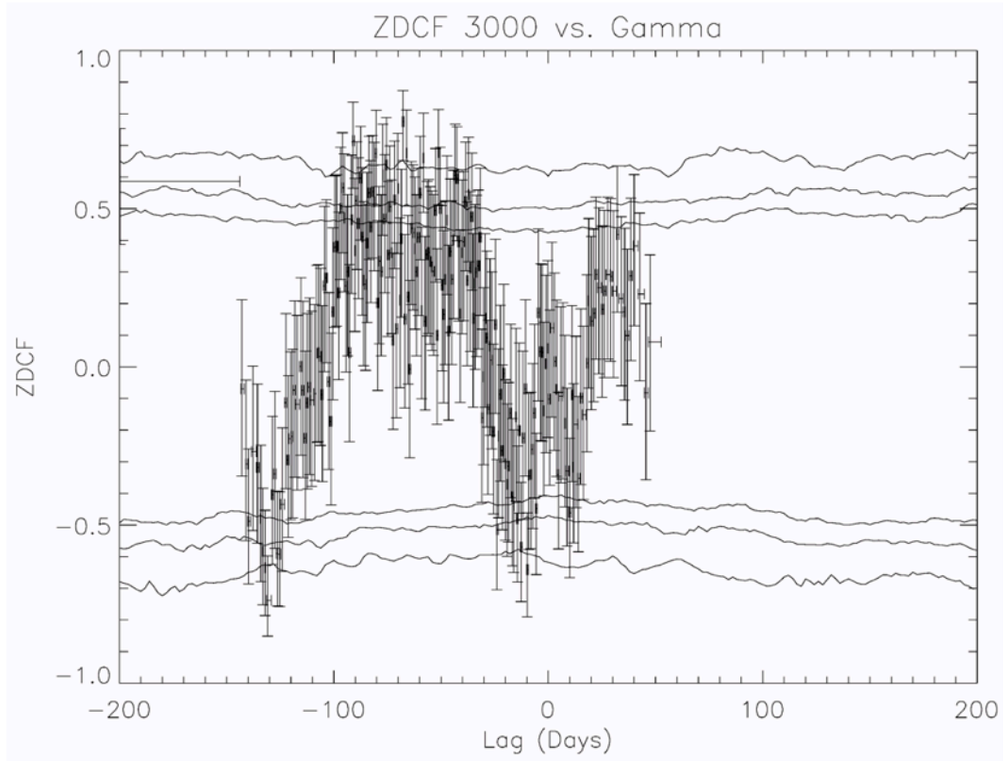
Lorentz Factor (Γ):

20.9	Hovatta et al. (2009)
22.5 - 37.2	Dermer et al. (2014)

Patiño-Álvarez et al. (in preparation)

Multiwavelength Analysis: Period C





-67.8 ± 2.4 days

Removing the shadowed parts γ-rays

~24 days

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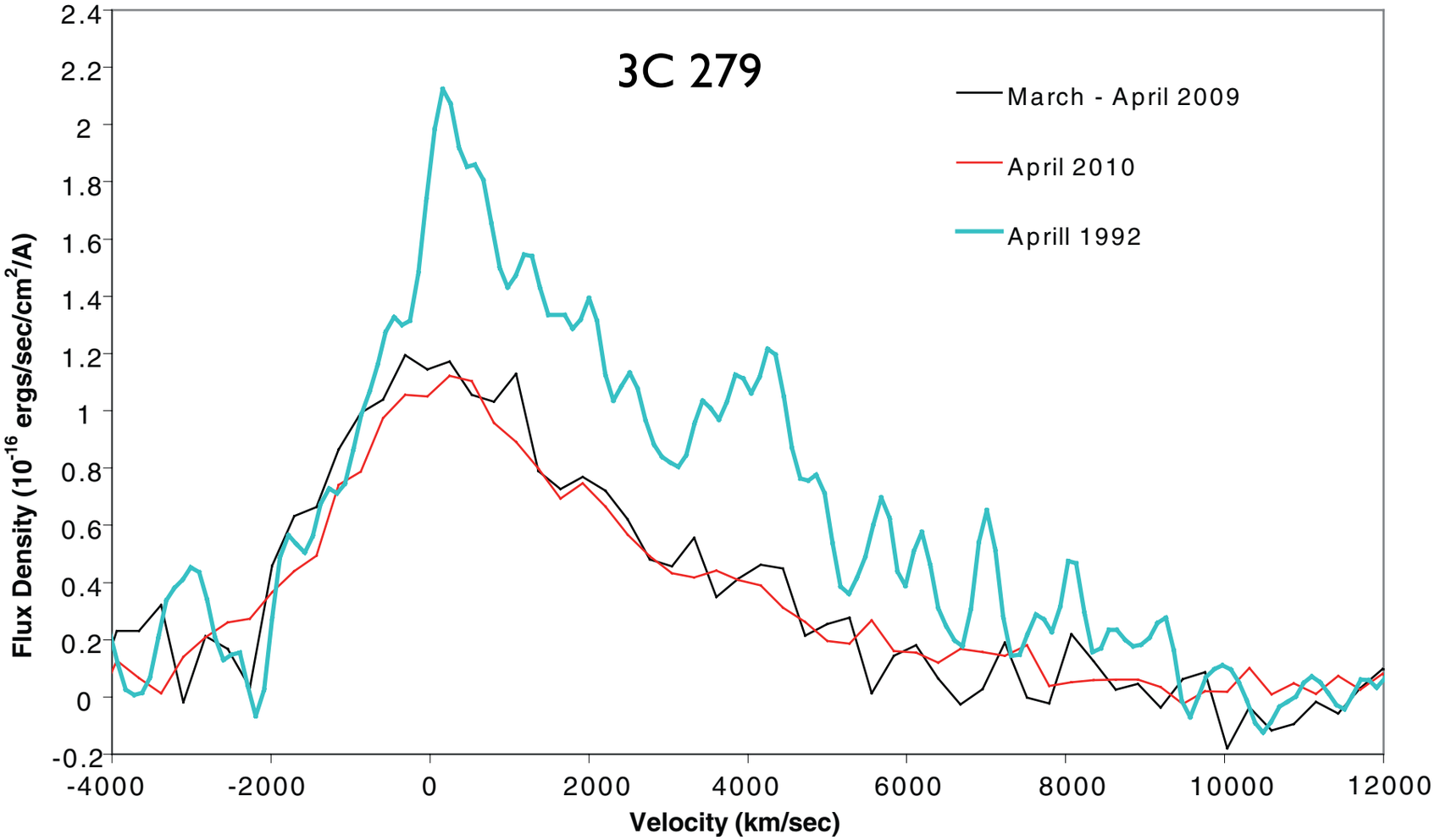
Work in Progress

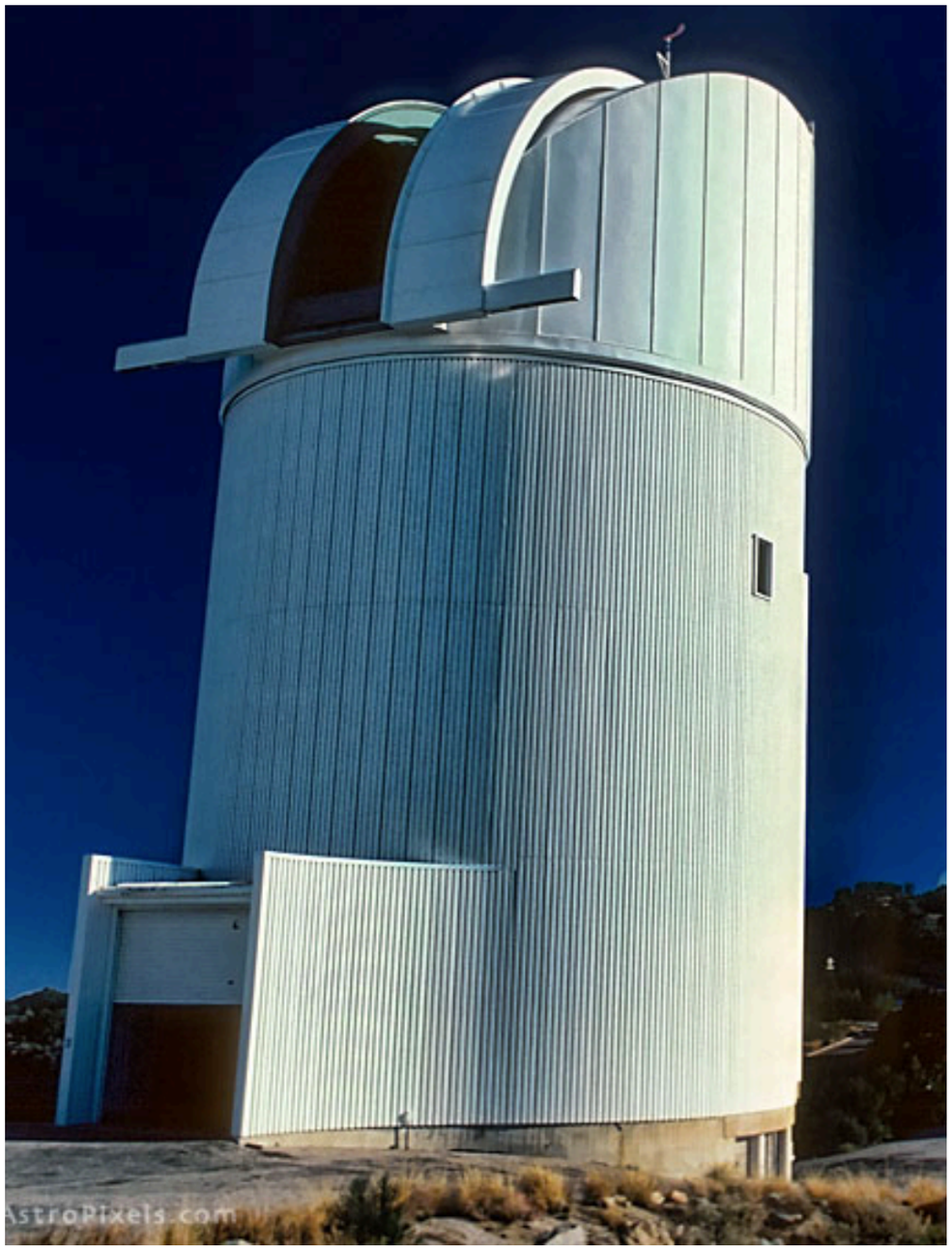
Emission Line Variability



Punsly (2013)

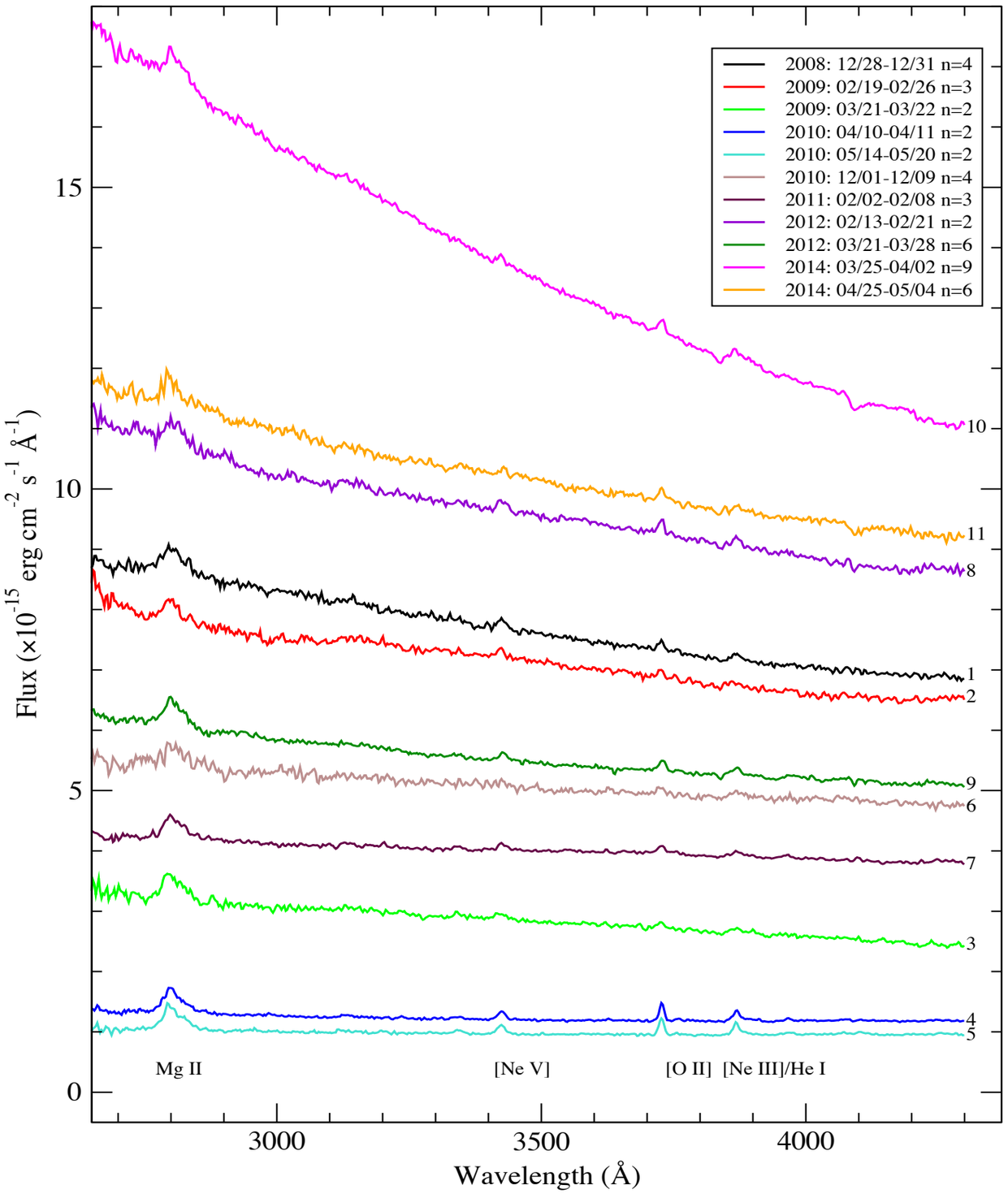
Work in Progress

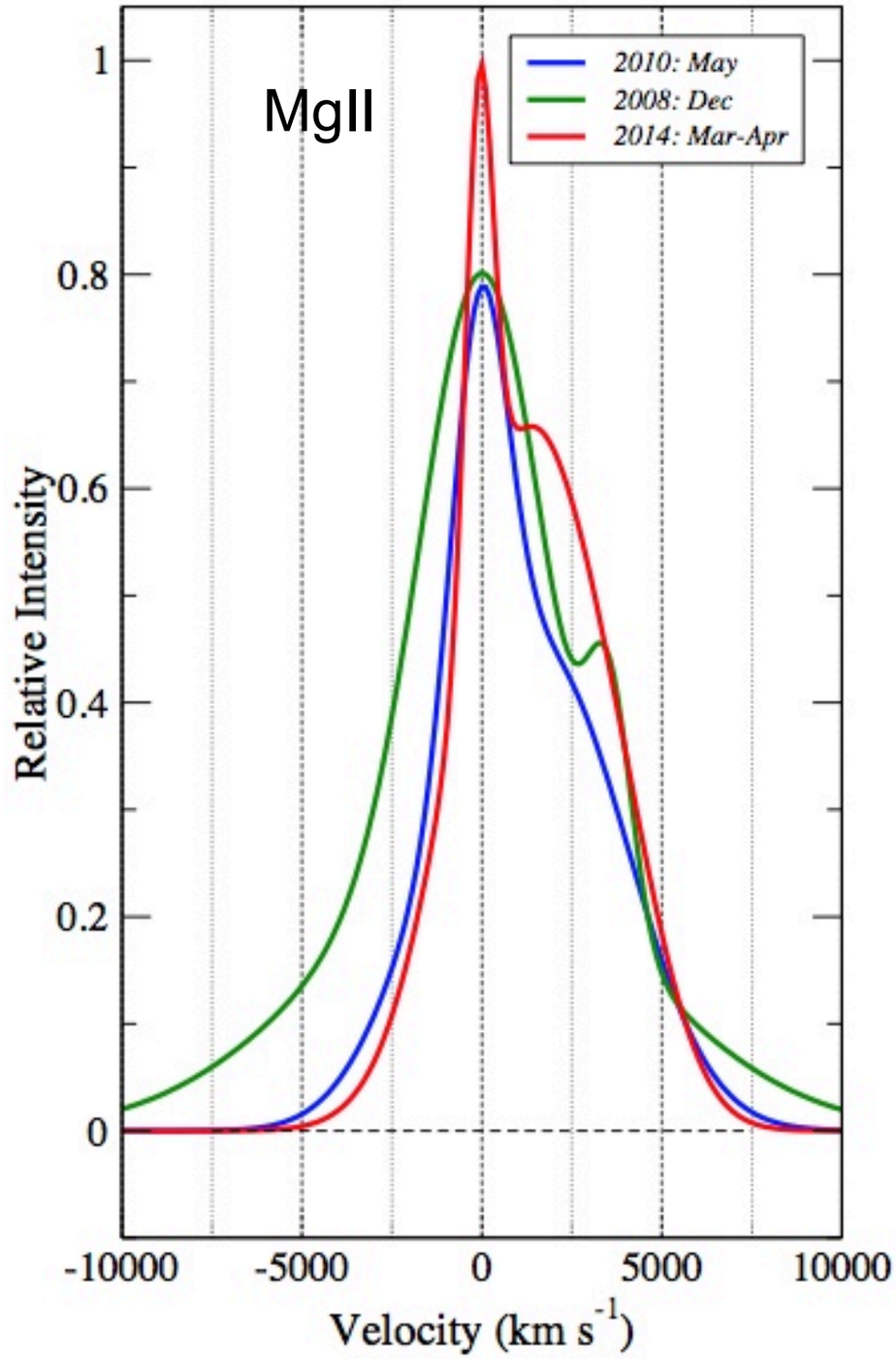
Steward Observatory



OAGH

Work In Progress





Patiño-Álvarez et al. (in preparation)

Summary

- UV continuum V band and NIR emission are simultaneous and co-spatial.
- Continuum from UV to NIR is dominated by non-thermal emission.
- During Period A the delay between the γ-rays emission and the UV continuum is consistent with 0. This supports a synchrotron self-Compton scenario.
- During Period B there is an anomalous emission period, where there are flares in all the bands that we analyze, with exception of the γ-rays. We propose an scenario of γ-rays absorption by pair production.
- Period C shows a possible External Compton Scenario.

References

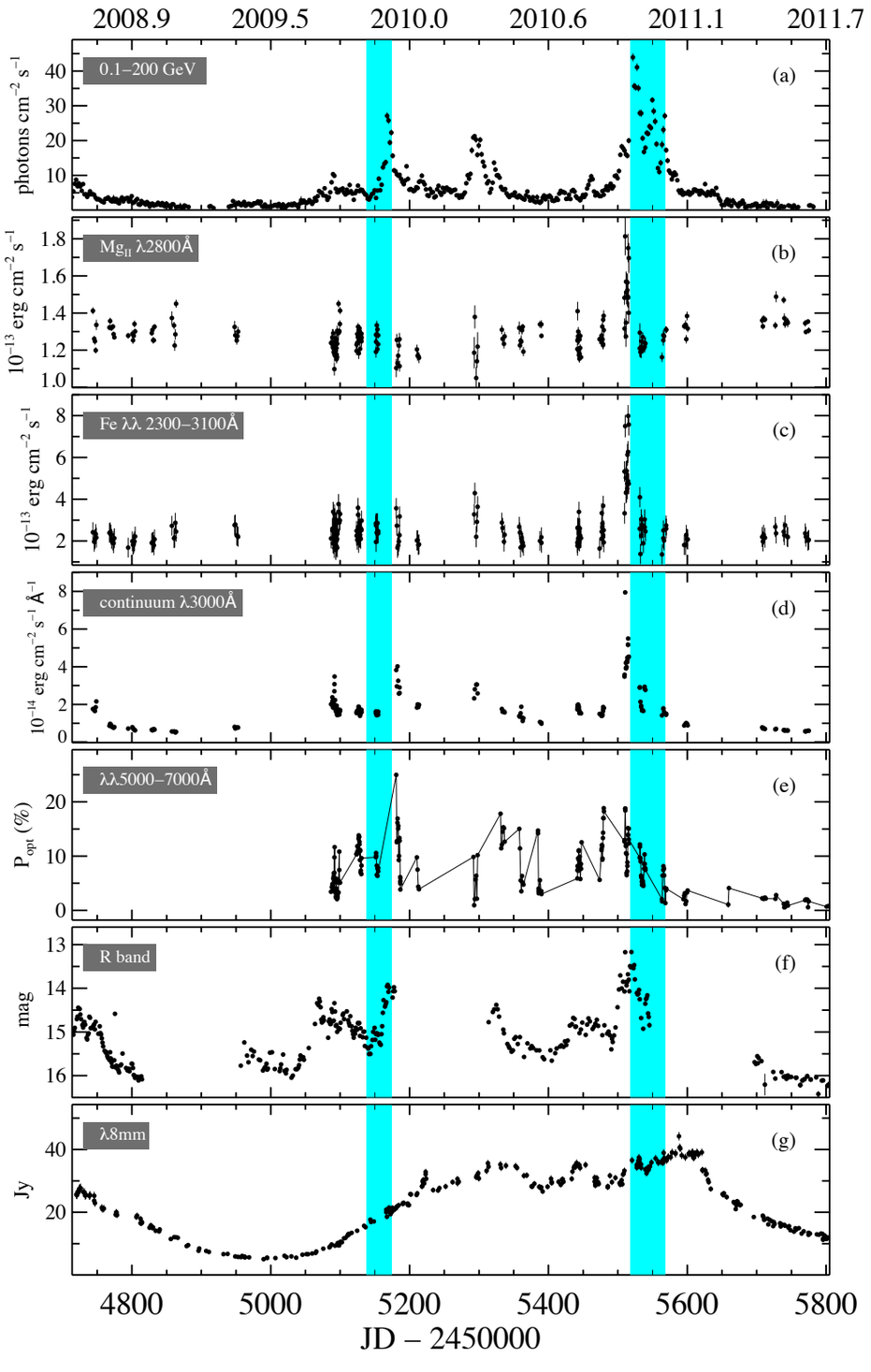
Synchrotron Self-Compton

- Mukherjee et al. 1999
- Hartman et al. 2001
- Sikora et al. 2001

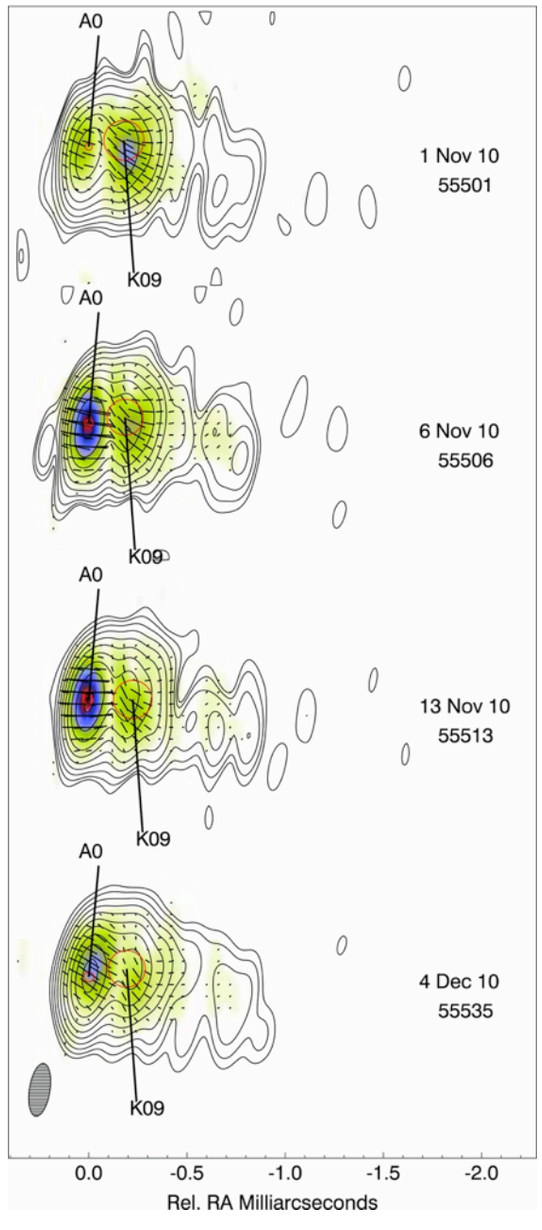
External Compton Models

- Dermer & Schlickeiser 1993
- Sikora, Begelman & Rees 1994
- Blazejowski et al. 2000

3C 454.3: Multiwavelength data

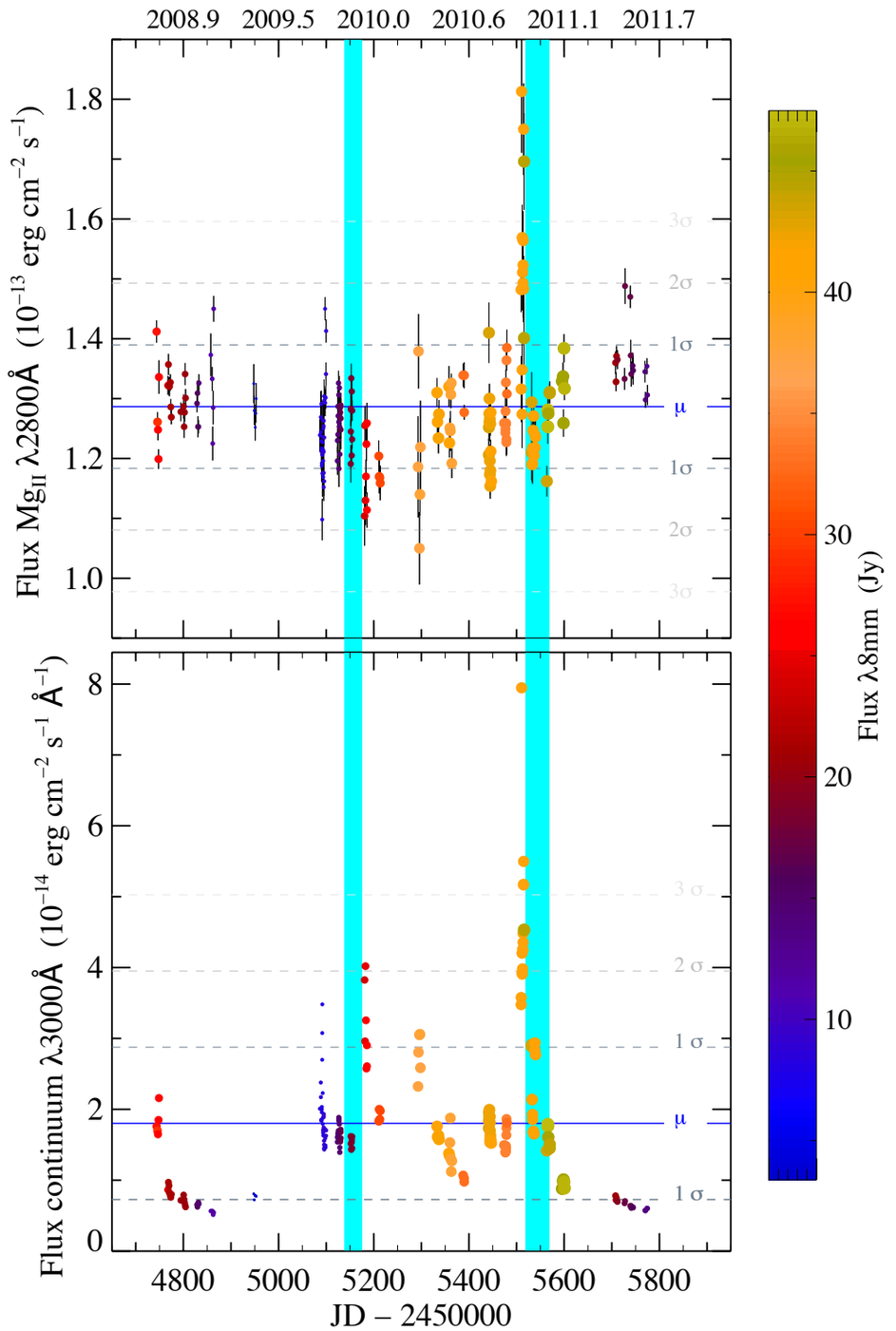


- The *vertical stripes* show the time when *new blobs* were ejected from the *radio core* and their widths represent the associated uncertainties



Wehrle +2012

Flux evolution of MgII 2800 Å



León-Tavares, Chavushyan, Patiño-Álvarez, ApJL, 763L, 36

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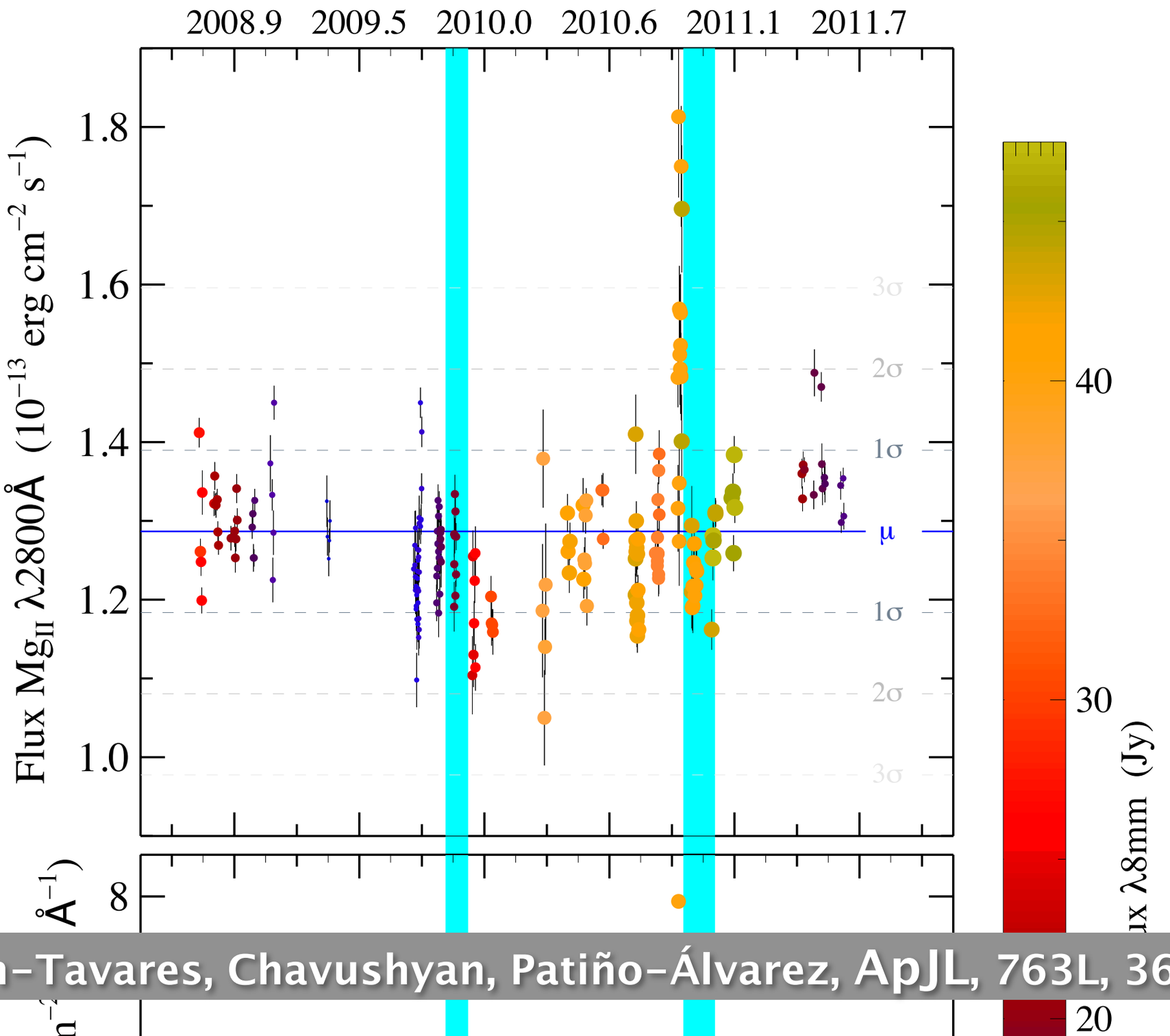
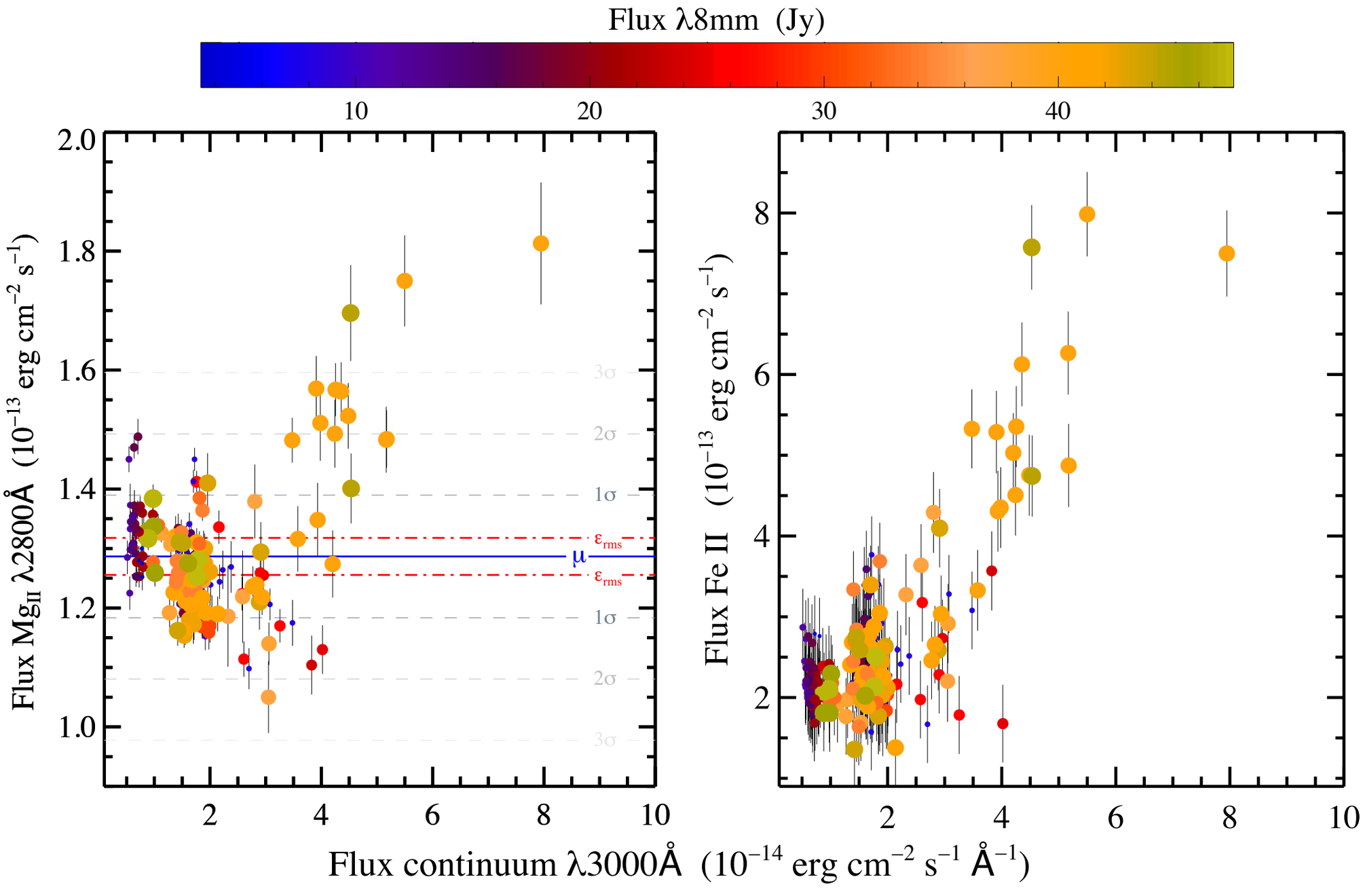


León-Tavares, Chavushyan, Patiño-Álvarez, ApJL, 763L, 36

Response of MgII and Fe II to non-thermal continuum



León-Tavares, Chavushyan, Patiño-Álvarez, ApJL, 763L, 36