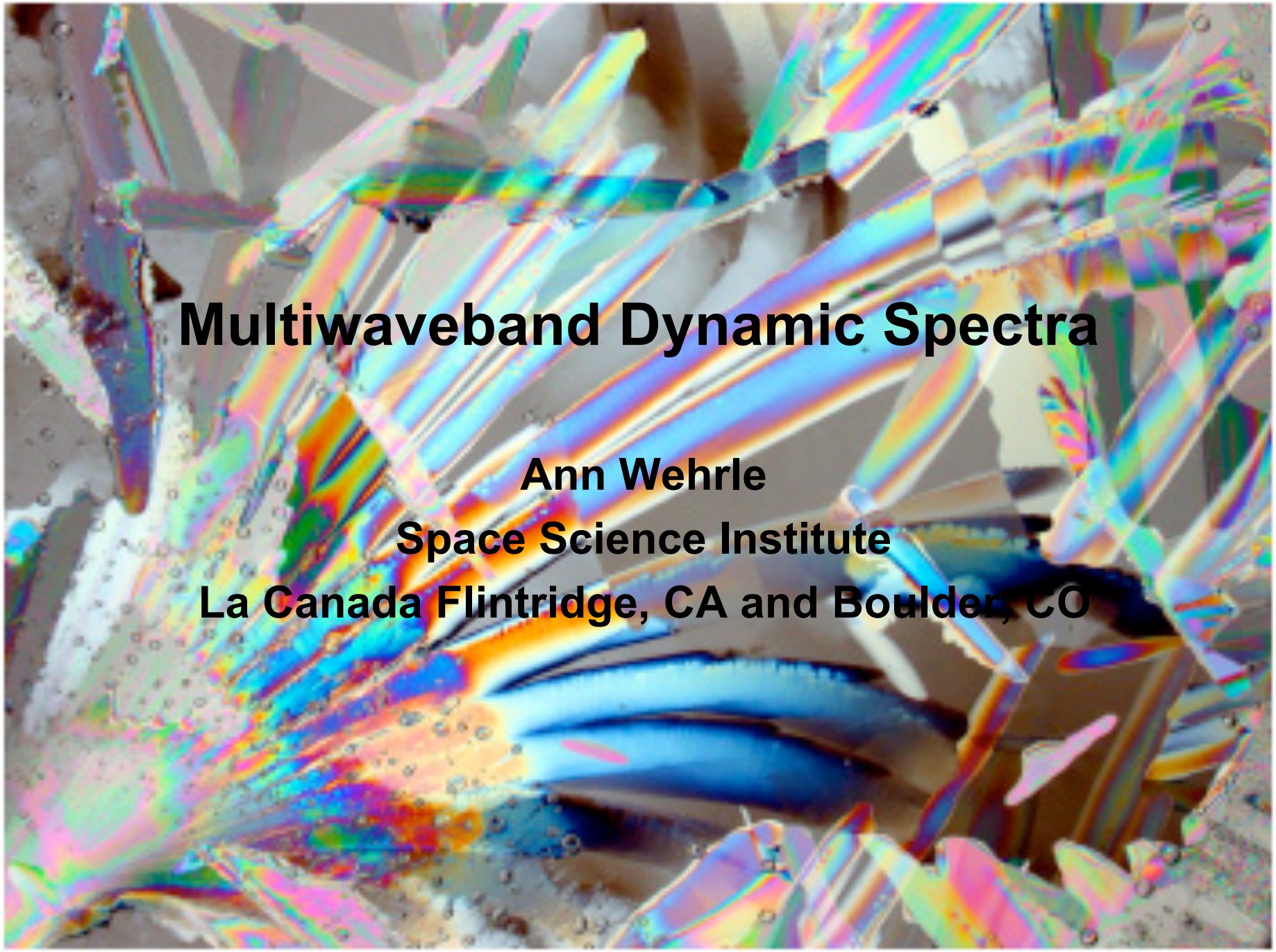


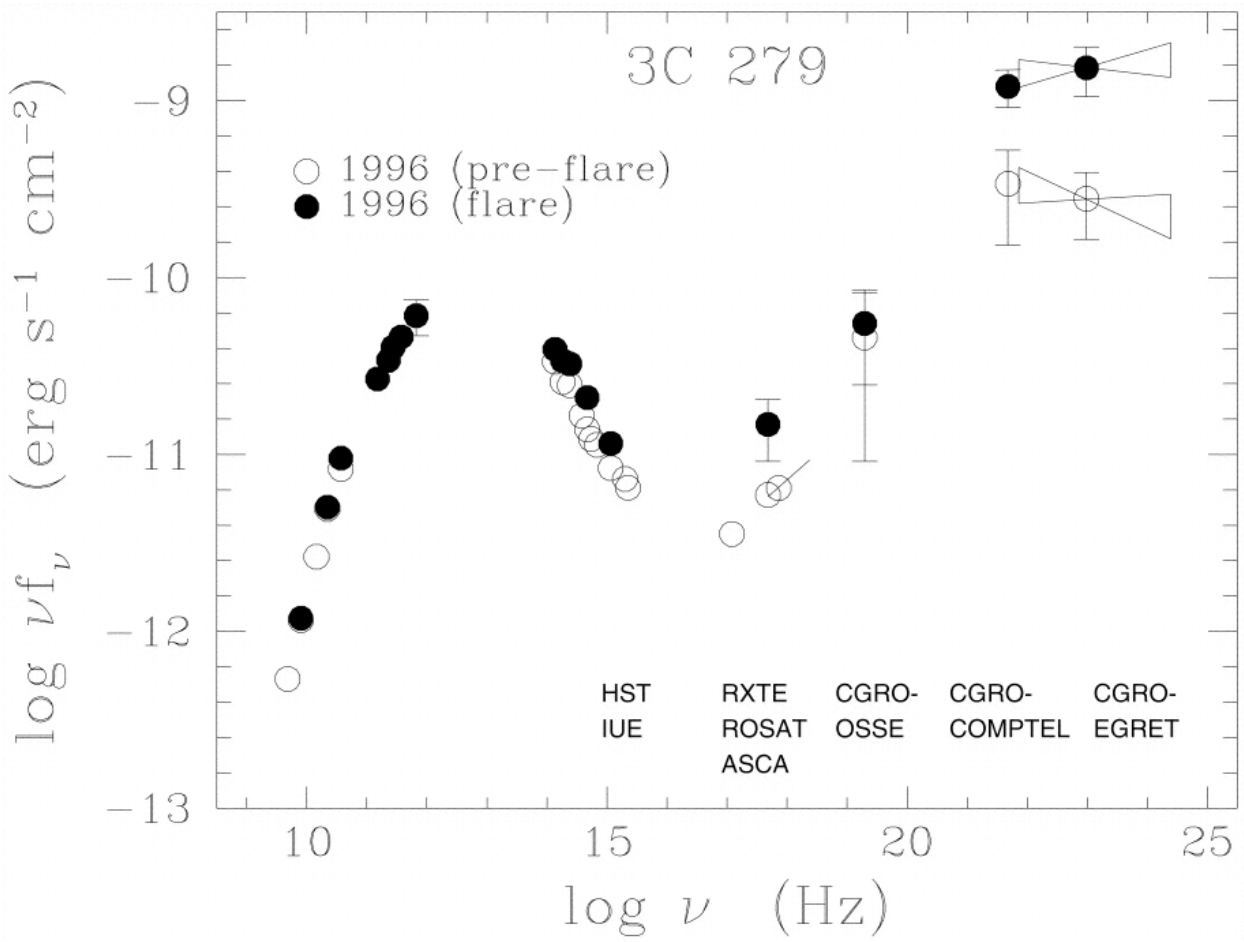
Multiwaveband Dynamic Spectra

Ann Wehrle

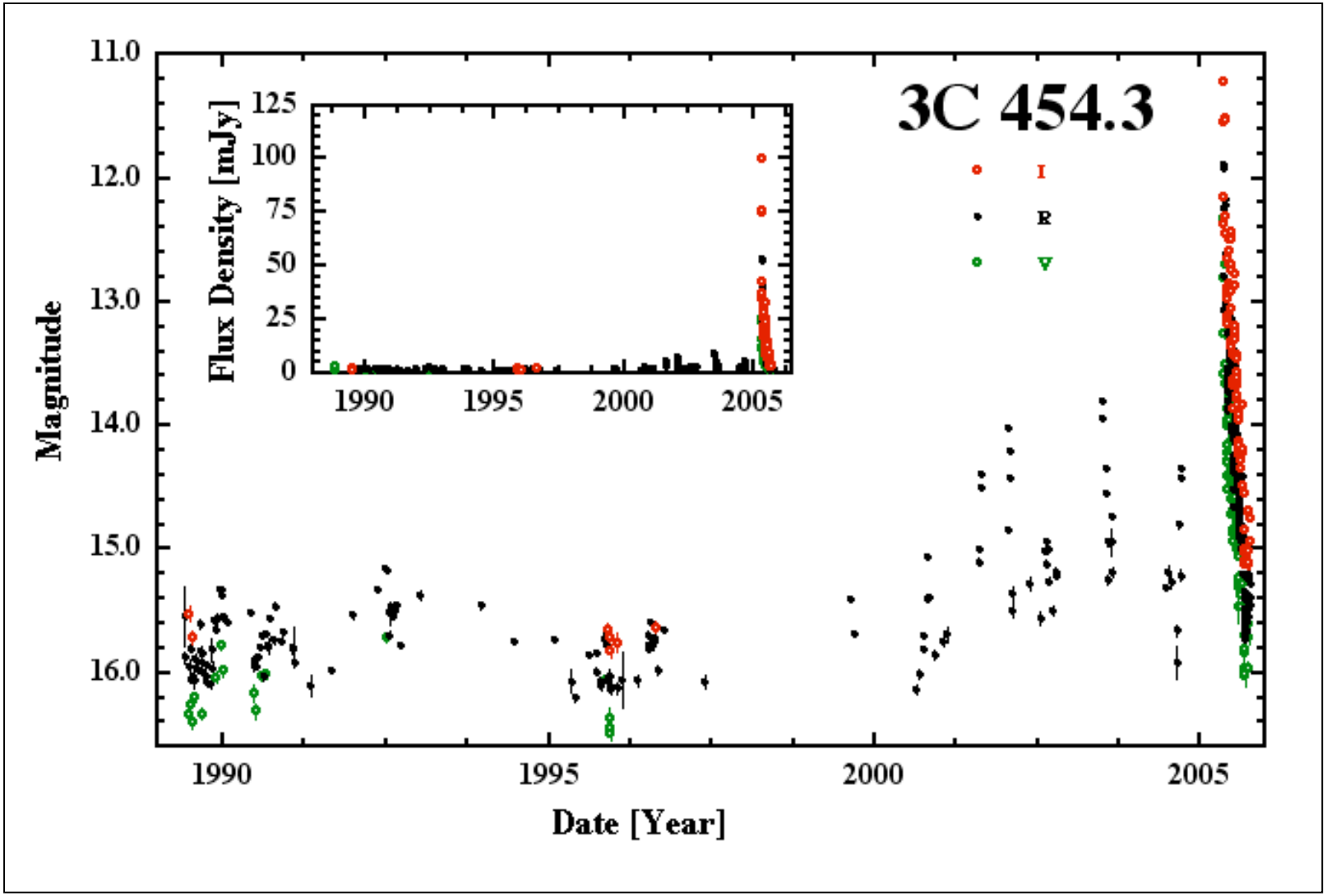
Space Science Institute

La Canada Flintridge, CA and Boulder, CO

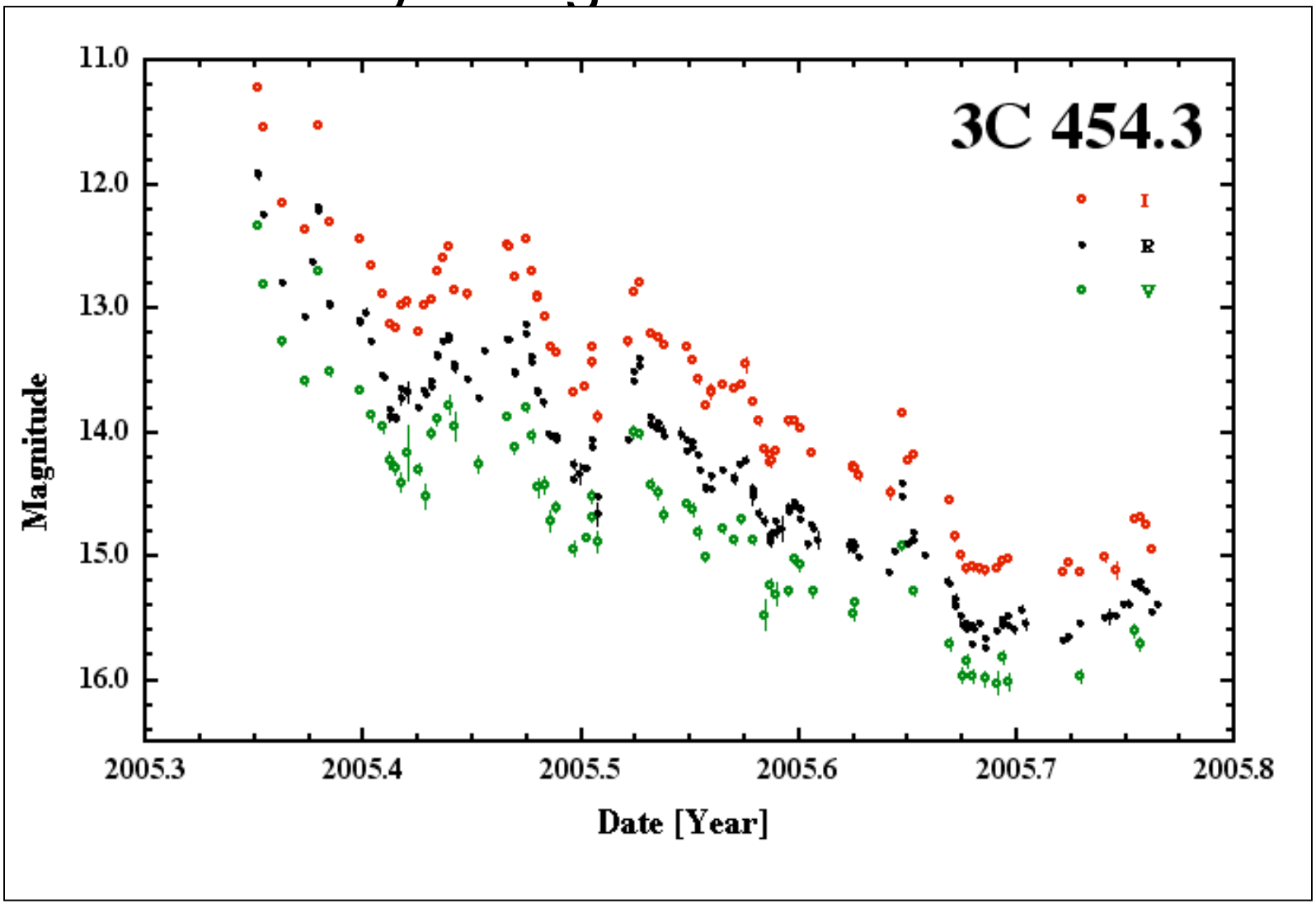
Dramatic Variability Defines Blazars



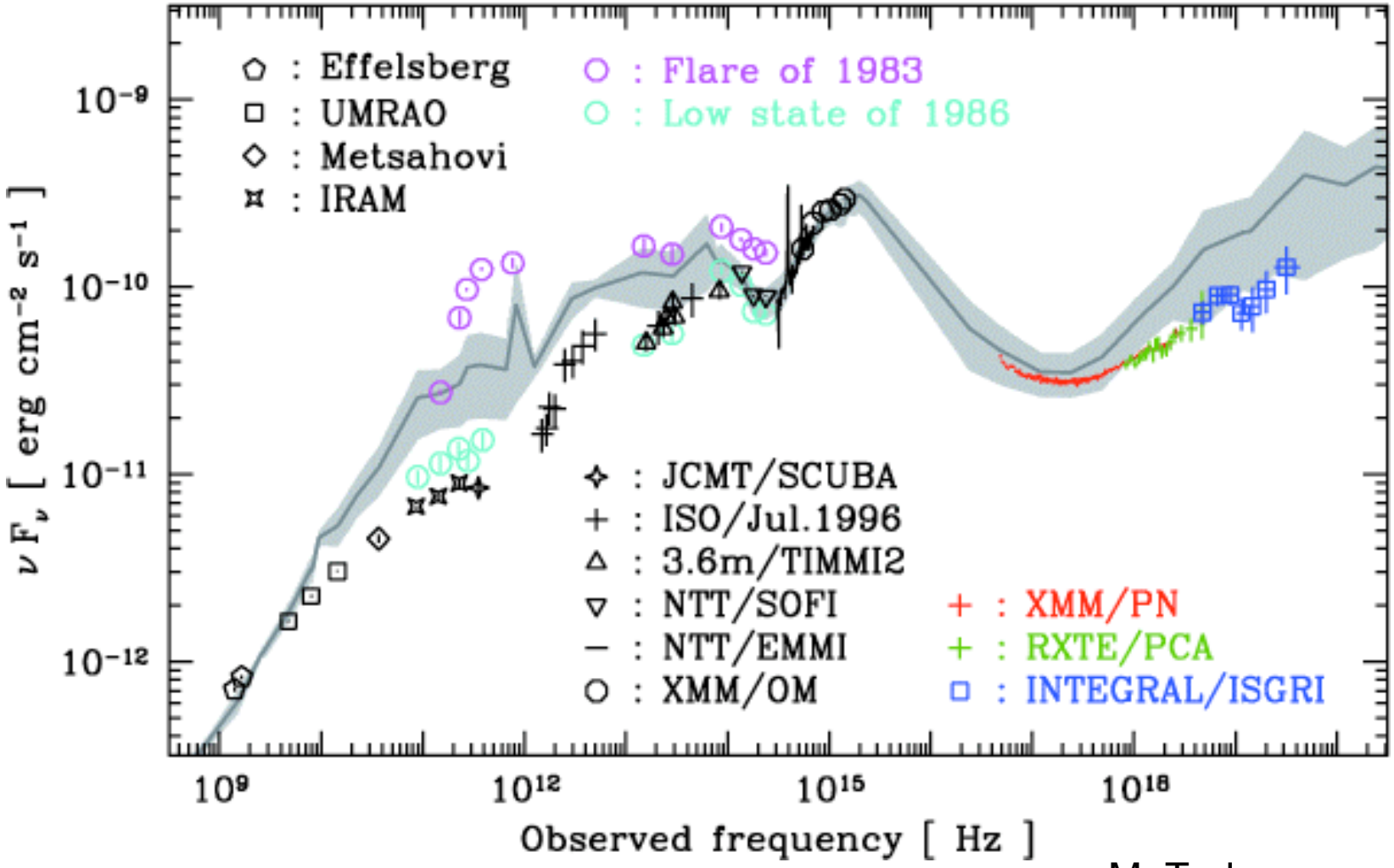
Variability on all timescales



Variability: Colgate Summer 2005

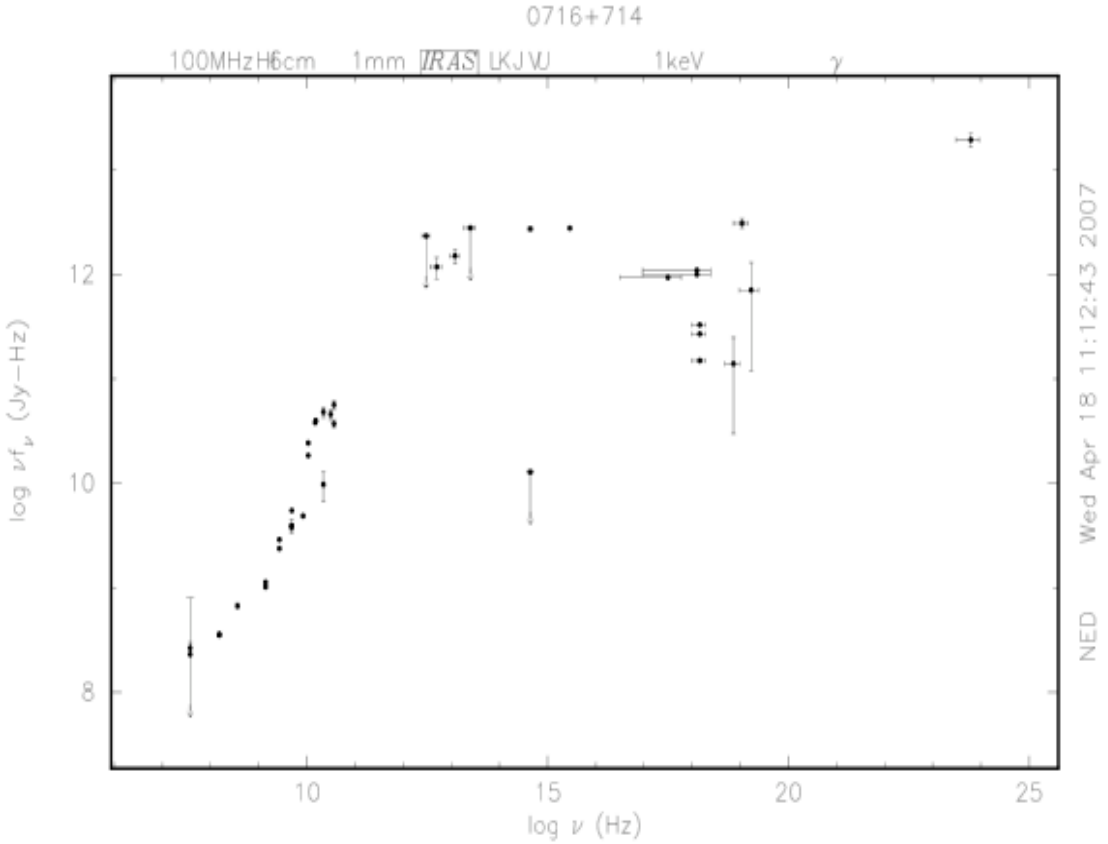


Range of 3C273 Variability



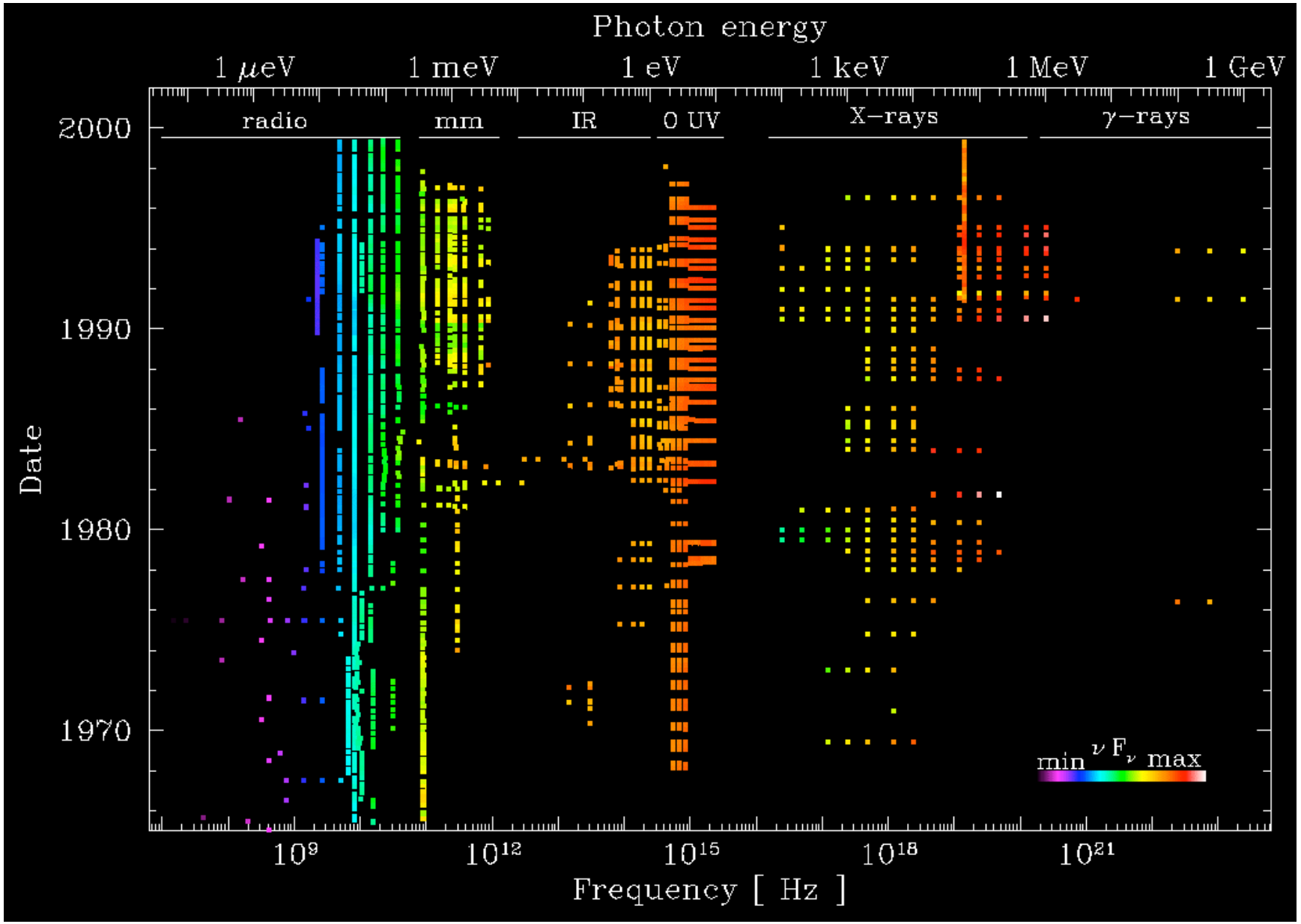
M. Turler

Few Sources have Simultaneous SEDs



- *A NED SED is not a simultaneous SED, viz. IRAS, CGRO*

3C273- M. Turler et al.



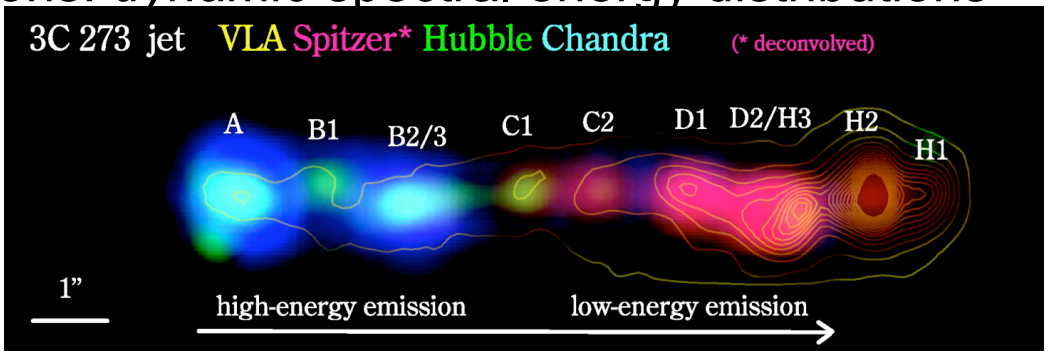
How do we form SEDs?

- Sources observed at various wavebands by dedicated observers (large or small **n**)
- Concerted efforts: Compton Observatory campaigns, ENIGMA, VHE
  - Simultaneous SEDs: “all your friends and all your friends’ friends”: Bacon, Erdos, Hartman
- Result: Handful of well-sampled SEDs

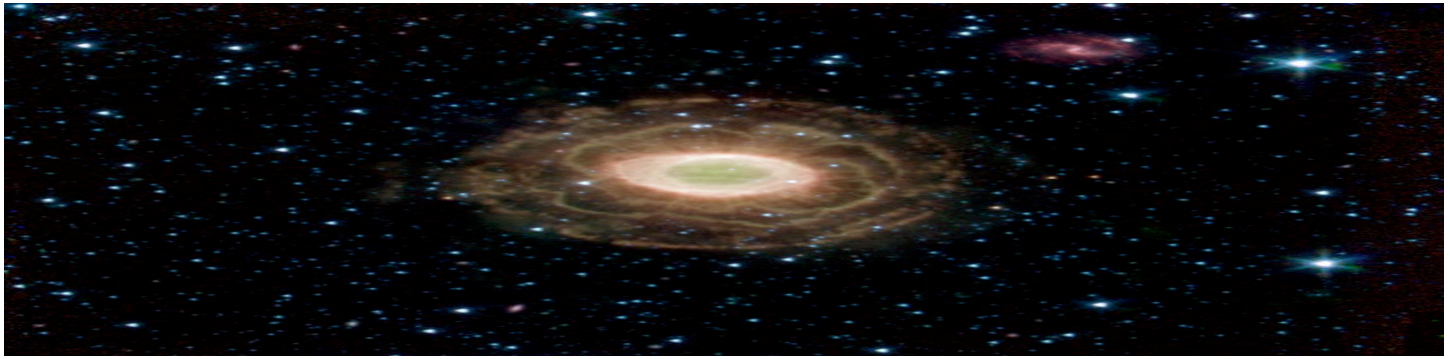
  - N.b.: Infrared gap since IRAS, (ISO); now Spitzer

What we learn from changes in the SEDs

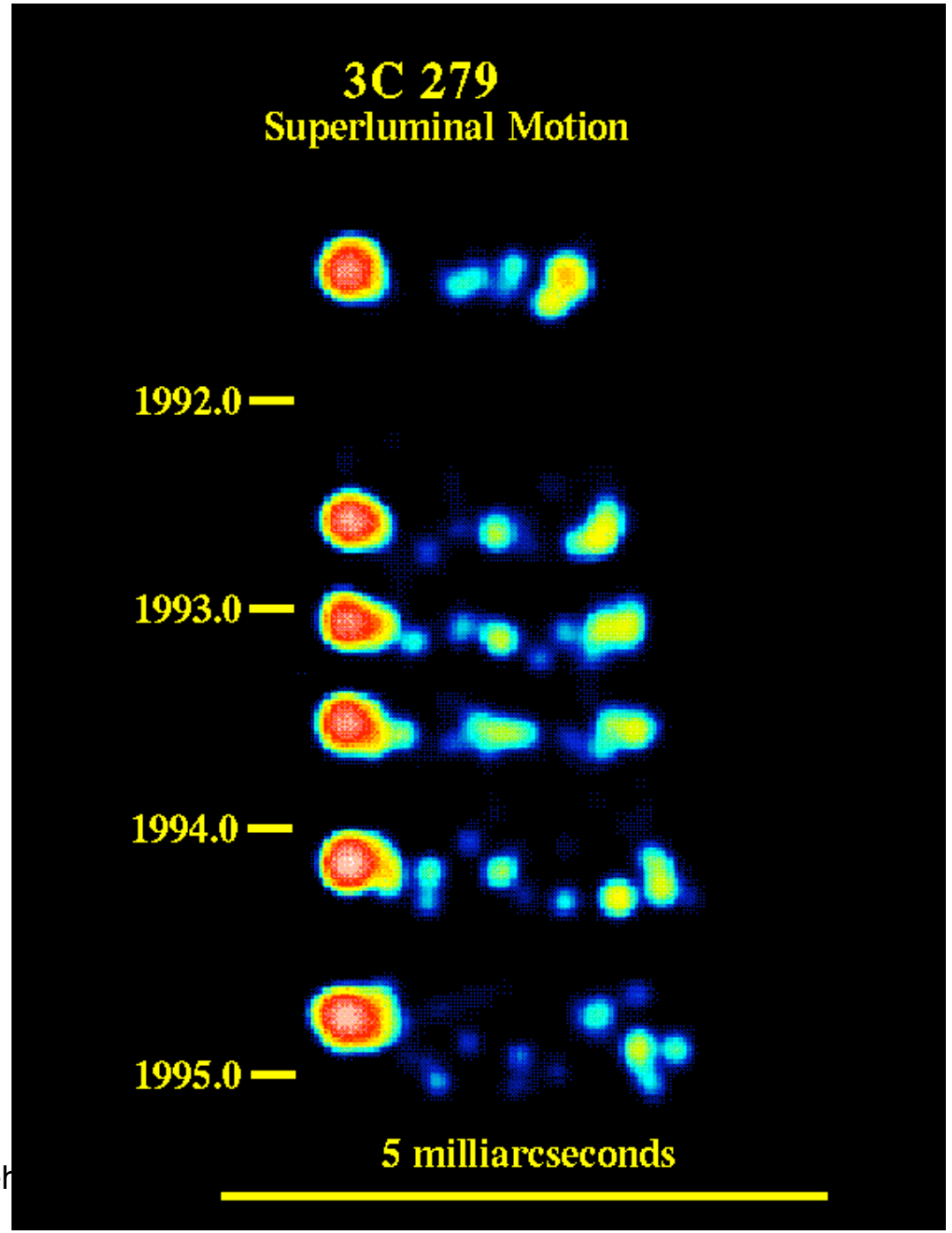
1. Amplitude, timescale of variability, time delays yield information on *changing* dominance of physical processes and their locations: *dynamic* spectral energy distributions



2. The *accretion disk* (and perhaps dust) can be studied without overwhelming glare of nonthermal emission from the jet when the sources fades to a very low state.



3. Changes in parsec scale structure (VLBI) related to flaring events in the two peaks? E.g. Wehrle- 3C279, Jorstad et al.- dozens of gamma ray blazars

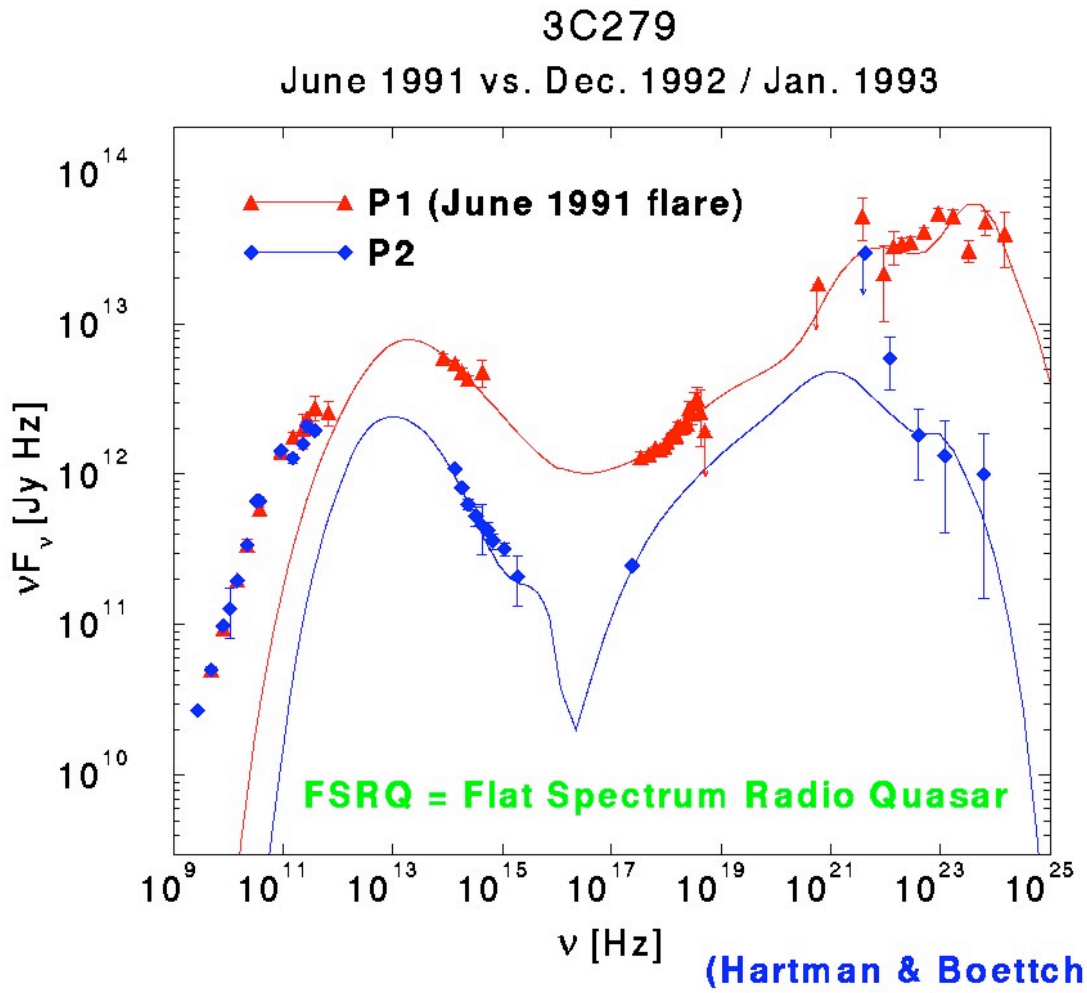


A new twist to variability: polarization

- Most promising new idea is to look for correlation of optical polarization direction and VLBI radio polarization direction (recent papers by Gabuzda et al., Jorstad et al.). Pseudocore and first blob.
- We don't know how a correlation of radio blob birth and gamma ray flares works, but optical polarization data gets us very close to the core. Optical is correlated with mid infrared, and mid infrared is probably correlated with gamma rays.

The action is in the shocks.

4. Theoretical modelling depends on getting good simultaneous SEDs- before, during, after flares -energy injection, propagation, and loss



(Hartman & Boettch

Waveband sampling

- GLAST - near-continuous, ~ 1000 sources

- Cm- UMRAO days-weeks ~50 sources (adding MOJAVE)
- Cm- OVRO days ~1000 sources
- Mm- Metsahovi ~ 100 sources
- VLBI- various programs proposed (note overlap with ICRF)
- No formal program yet: phase calibrators -CARMA, SMA, VLBA, VLA, Geodetic VLBI network
- Infrared- various programs proposed with Spitzer
- Optical- Robotic telescopes in Italy, Chile, SARA possible, SMARTS possible, Palomar 60-inch possible, many other possibilities (e.g., Balonek Colgate program), (GTN)

Waveband Sampling, con'd.

- Many x-ray telescopes are up and running; various proposals submitted (RXTE: weeks, Chandra and XMM occasional)
- Concurrent observations with AGILE (launched yesterday!)
- Contemporaneous or even simultaneous optical, uv, x-ray observations with Swift (blazar key project led by P. Giommi)
- VHE telescopes, e.g., Veritas, HESS, MAGIC

Best-ever sampling for constructing dynamic SEDs

Priorities

1. Study a few sources thoroughly. Put most resources here, also scarcest resources. It does **no good** to have only an x-ray point on 3C273, only an infrared point on 3C279, and only a mmVLBI image of 3C454.3. VLBI sampling interval is critical. Spacecraft dictate schedule.
2. Study a lot of sources lightly. Use abundant time on private telescopes to study a large number of potentially interesting sources, for eventual high payoff. VLBI snapshots are fine, but may not have time-resolved polarization information near the core.

Getting a well sampled SED is like getting a global VLBI experiment to work: we decide what to do well in advance and coordinate with other observers.

SED coverage holes that need filling

- Submillimeter (SMA? IRAM? Herschel?)
- Infrared (Spitzer, Herschel, Sofia)
- Optical sampling on hour-long timescales (1-2 meter class telescopes)
- Optical polarization (1-2 meter class telescopes)

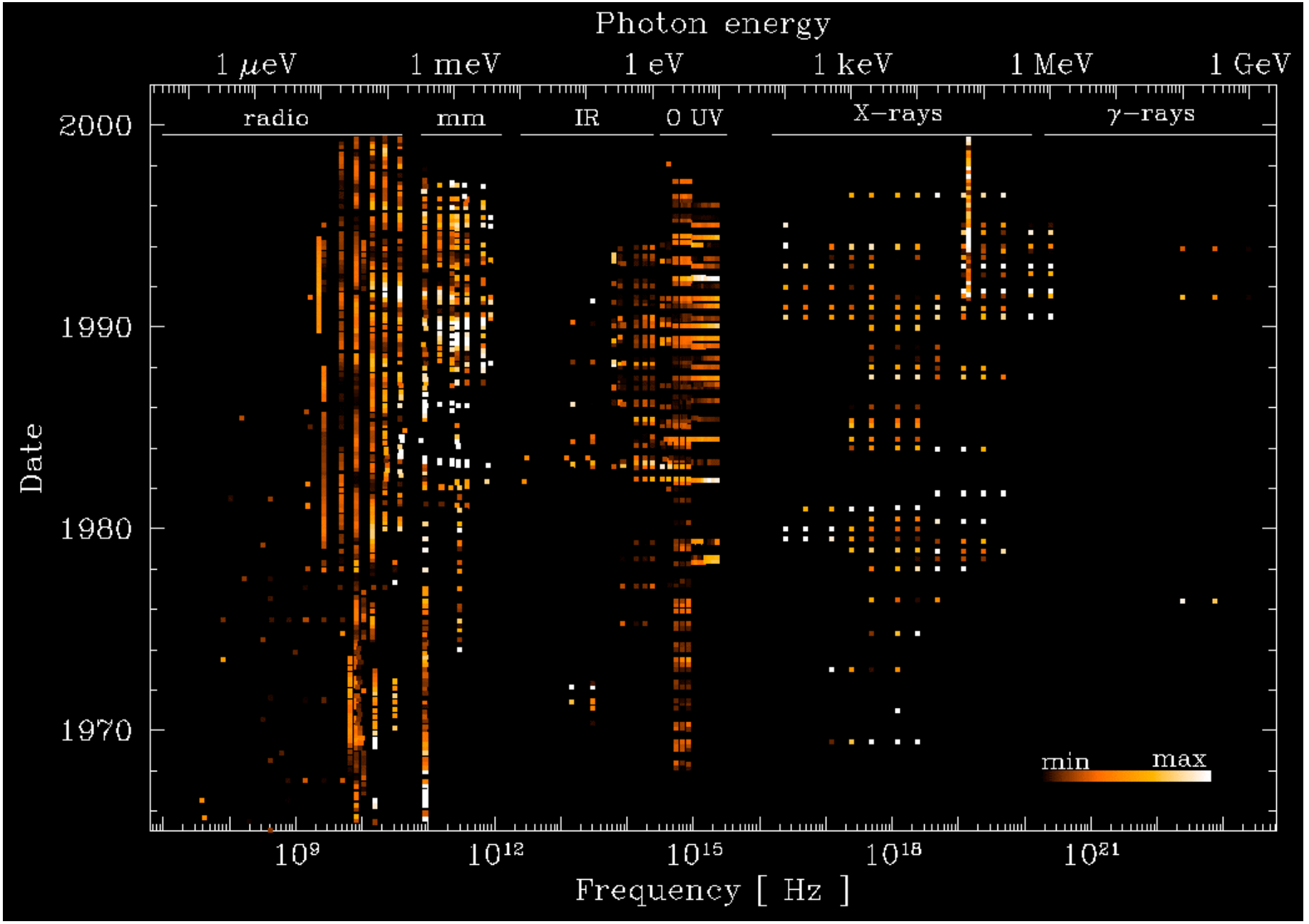
Making the variability data useful in 3 steps

1. **Put it in a form we can access**.
   - SED contributions are easy but fussy and time consuming to convert units in data from multiple sources (dereddening? N_H?)
   - NED style: retain published (observer's units), but *observers* provide homogenized units
   - ***no microns, no milliCrabs***
     - Date in fractional year (2008.15), Frequency (Hz), Flux Density (Jy)
     - Decide *in advance* how to retain observer credit and data security (underestimates common, mistakes easy)

2. Put the data in context

- Historic: Use a NED SED in working plots; construct in advance for Top 20 (or your favorite) sources
- Theoretical: If you have a theoretical model for a particular or generic source, use that to compare with incoming data
- Unifying: Use a class model, e.g., Fossati et al. 1998 model

Historical Context: Normalized SEDs



3. If you need to fill in gaps in SED, alert the astronomical world

- Very high and very low states will get attention, but we have to put them in context: “3C273 is fifteen times brighter than during 1990-2000” not just “3C273 flux at xx GeV exceeded yy ergs/sec/cm^2” because **no one** can remember the “typical” flux for everything at every waveband.
- Ask for what you need- if you need optical data, ask for VBRI, state expected range of brightness (e.g., 14-16 magnitude); if you need a radio position, ask specifically. Do not ask for generic “followup at all wavebands.” Give a link to a finding chart. *Grad students already at telescopes are particularly eager to observe fun new things, it pays to ask.*
- Consider using ATEL or something like burst network
- Write a Director’s Discretionary Time proposal, or activate a TOO proposal. Turnaround can be within days (Swift), or weeks (Spitzer).

Our opportunities to collect variability data

Mission	2008	2009	2010	2011	2012
GLAST	X	X	X	X	X
SPITZER	X	END APRIL			
HERSCHEL	LATE 2008	X	X	END	
PLANCK	LATE 2008	X	X	X	
SOFIA			TESTING	TESTING	TESTING
HUBBLE	SM4	X	X	X	X
RXTE	X	END APRIL			
SWIFT	X	X	X	?	?
XMM-NEWTON	X	X	X	X	X
CHANDRA	X	X	X	X	X
AGILE	X	X	X	X	X
INTEGRAL	X	X	X	X	X
SUZAKU	X	X	X	X	X
KEPLER	MID 2008	X	X	END	
(VLBA)	X	X	X	END?	

Four Recommendations

Q. All the sources all the time with all the telescopes? Alas, no.

1. Study “best and brightest”, also study “best and dimmest”
2. Strengthen phase calibrator programs at SMA, CARMA, VLBA, VLA so that flux data is useful out of the box; need formal collaborators and access policies. Add polarization information if possible.

3. First Year:
   a) Concentrate on Top 20, with one or two SED campaigns each. Center on viewing period windows for Spitzer; consider windows for Swift, RXTE, Integral, Agile, Chandra. Consider dawn/dusk observations- e.g., Spitzer visibility is a doughnut on the sky. VHE requires moonless nights. Sampling for VLBI needs to be high enough to avoid strobe and aliasing effects. Coordinate short timescale observations (hours) between optical/VLBI polarization, others
   b) Acquire some data on 100 or more sources if there are dedicated, robotic telescopes available, e.g. G. Tosti's, A. Readhead's programs, plus VLBI programs
4. Second Year-
   a) Revise the list and observing strategy based on first year's data from GLAST.
   b) Recruit synoptic telescopes: Pan-STARRS, Skymapper
   c) Make a case for continuing to operate the VLBA