



Technion
Israel Institute of
Technology



Combined X-Ray and mm-Wave Observations of Radio Quiet Quasars

Ehud Behar

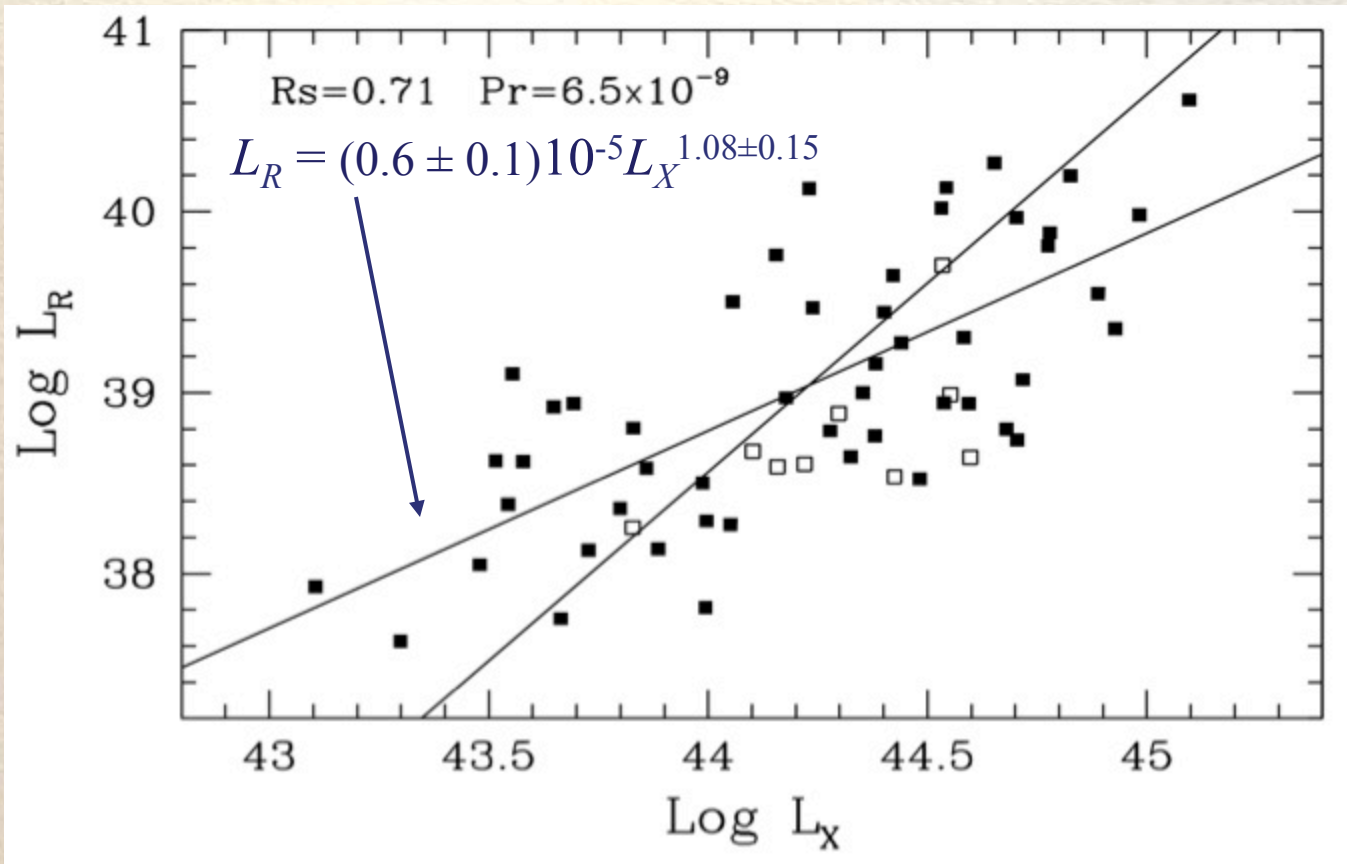
Department of Astronomy, UMD
visiting from
Department of Physics, Technion

Collaborators on this work

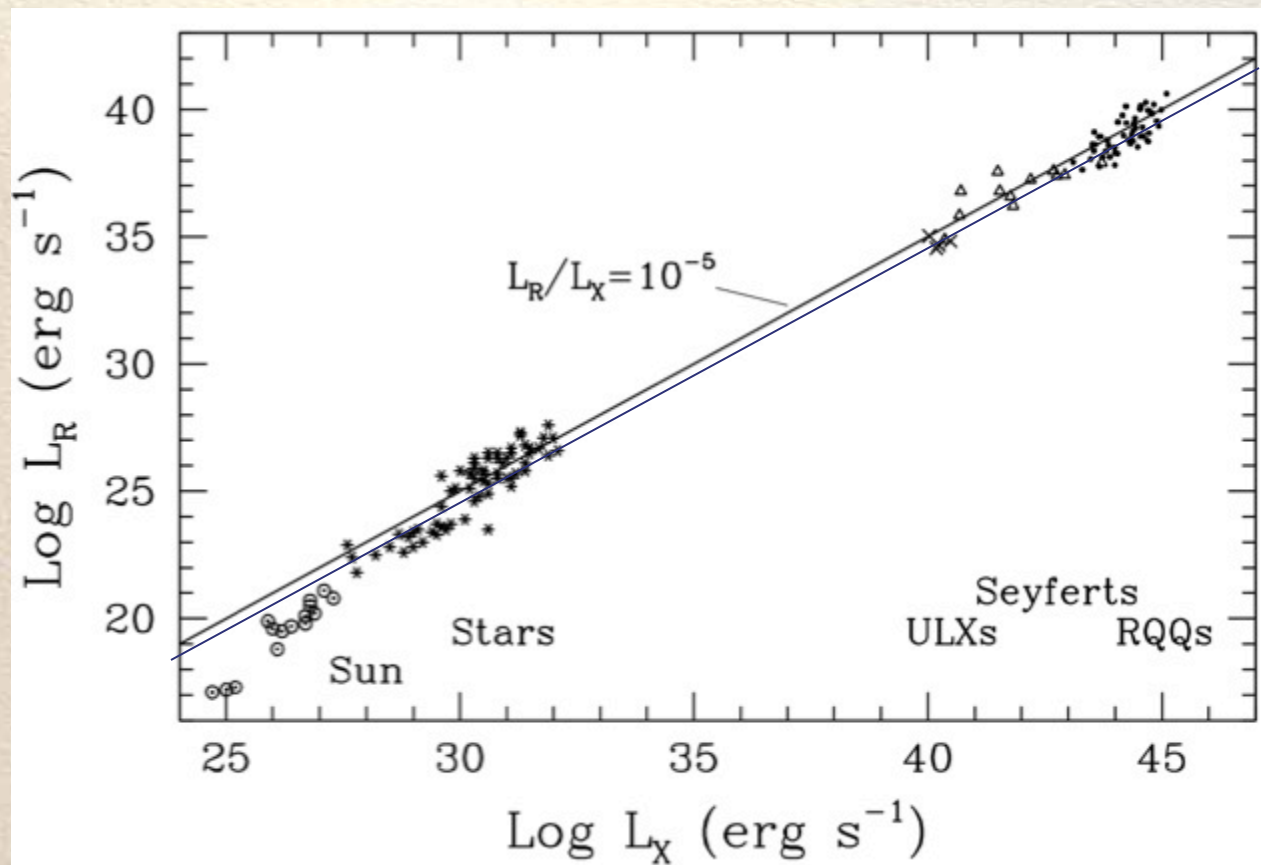
- *Ari Laor*
Technion

- *Ranieri Baldi*
former post doc. and now at
University of Southampton

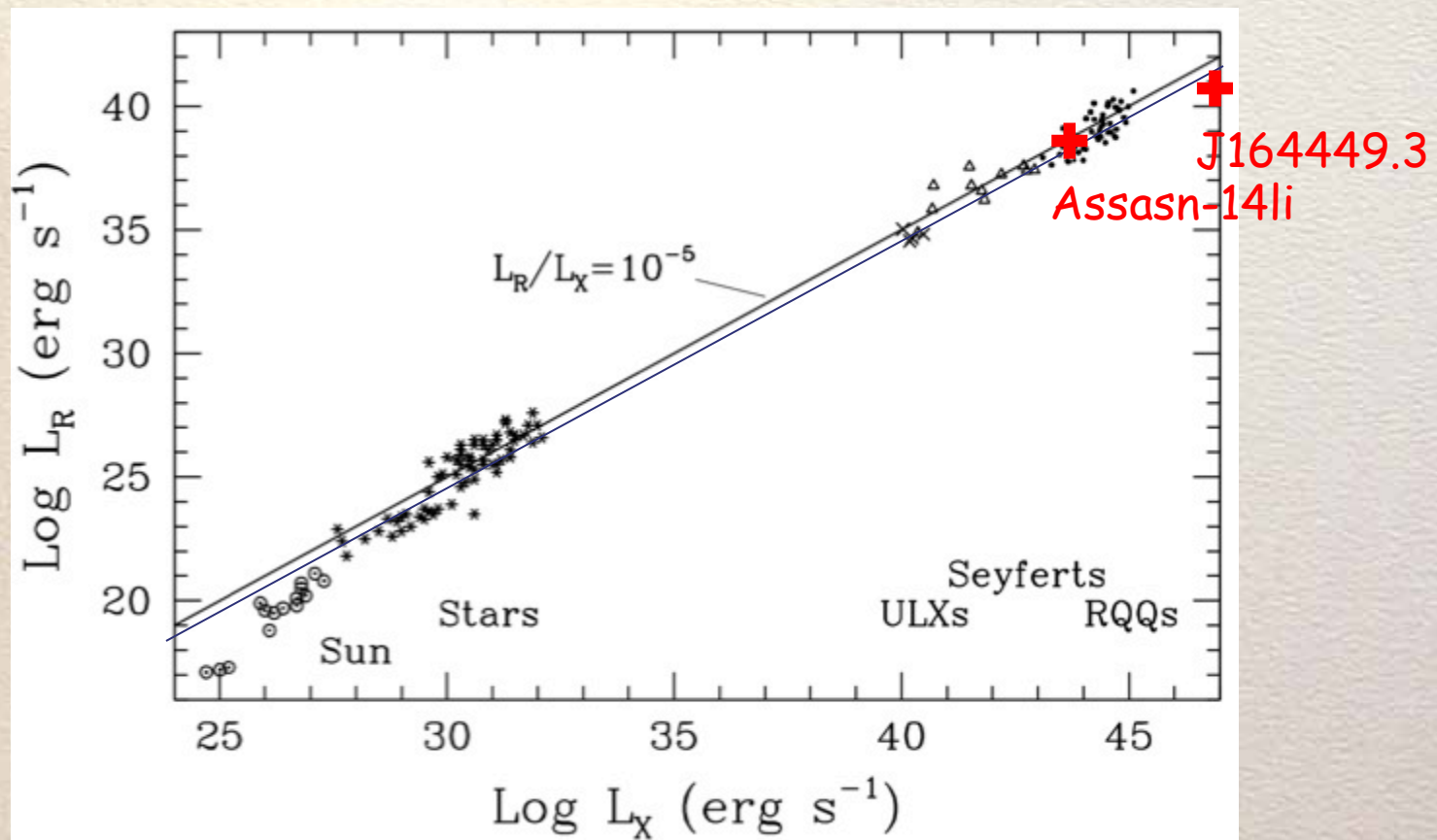
Radio Quiet PG Quasars



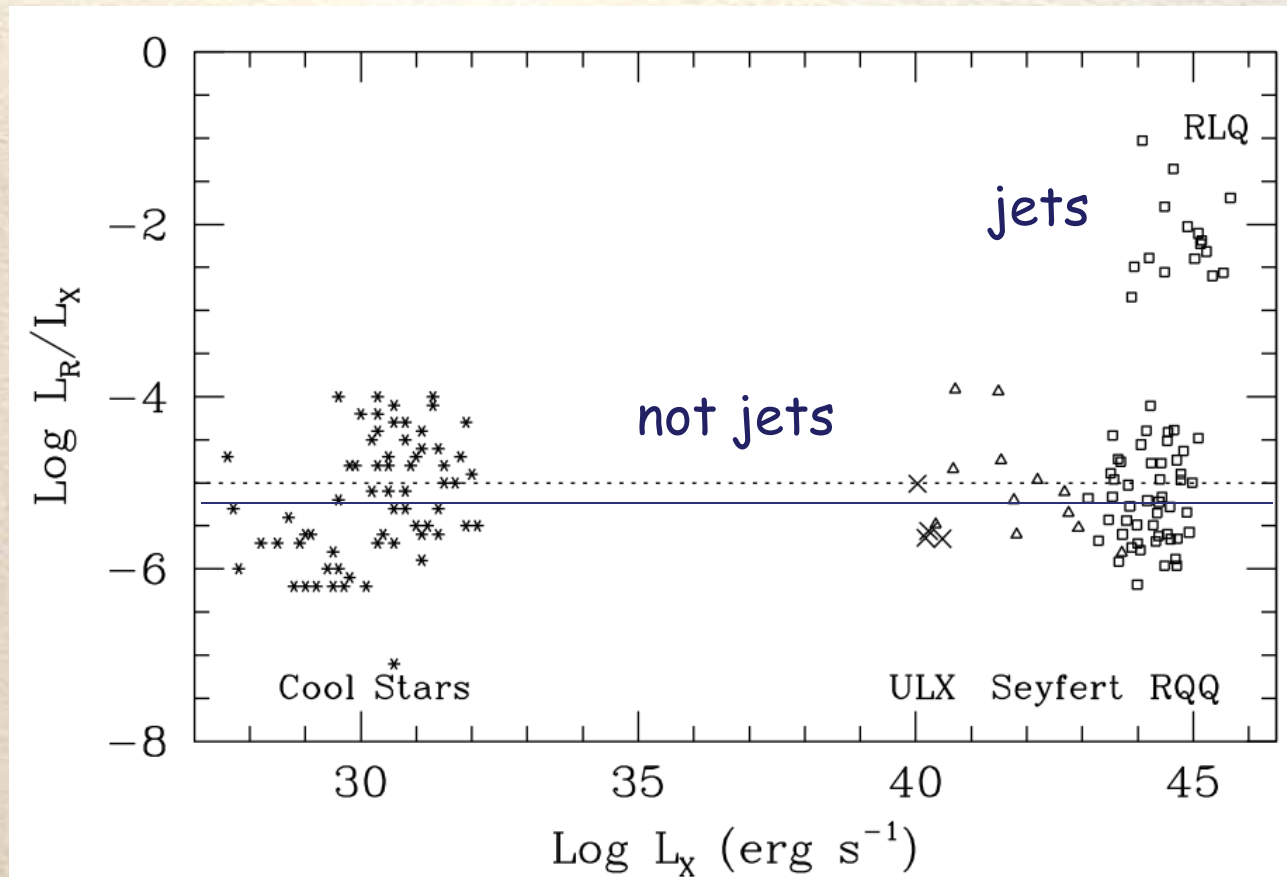
The Big (Scale) News



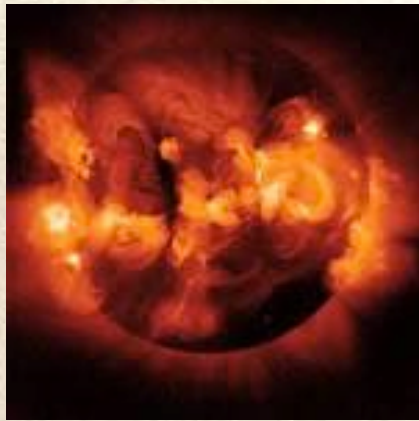
The Big News



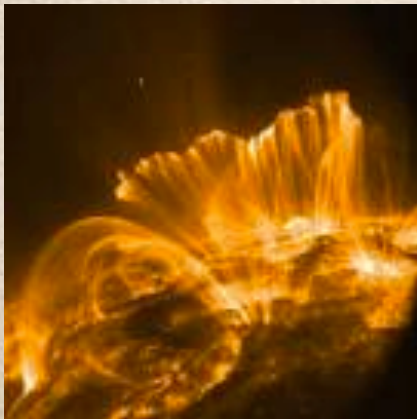
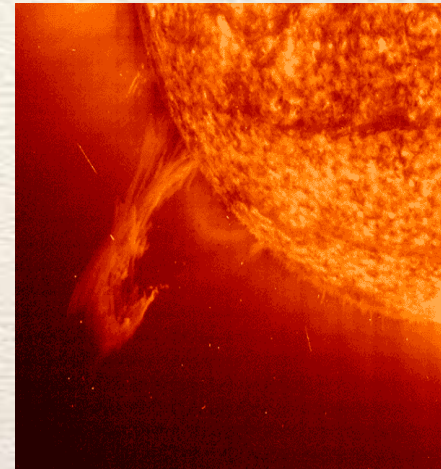
Maybe Radio Emission is also from X-Ray Corona?



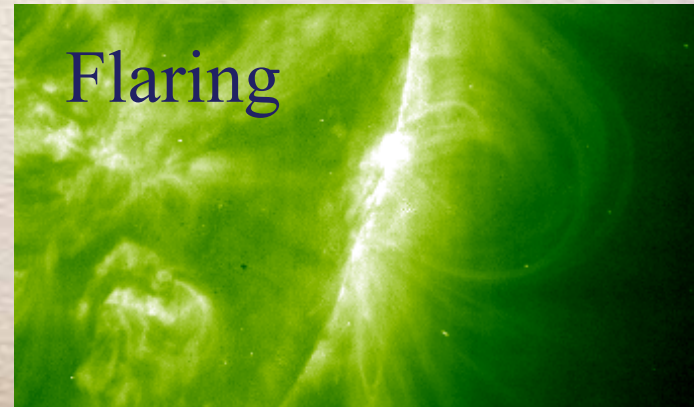
Like AGN (in X-rays) Stellar Coronae are Dynamic



Hot
Mass
Ejection

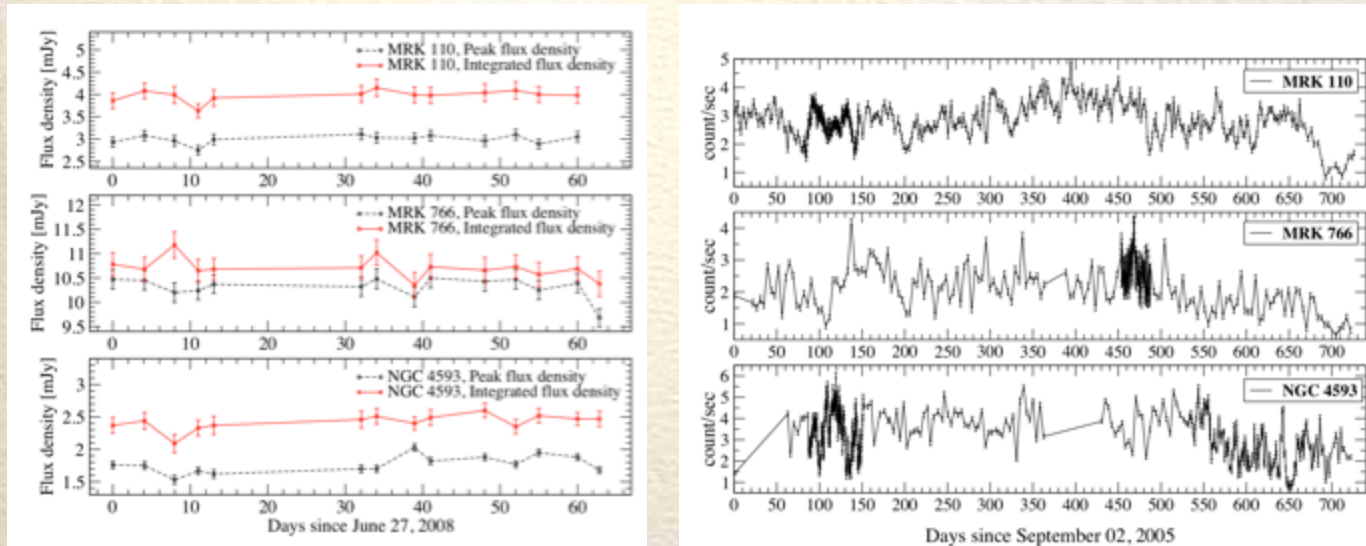


Magnetic



Flaring

(not much) Radio Variability



- X-Ray: factor few over days
- Radio at 5 GHz: Maybe 10% over month

The Explanation for No Variability: Opaque Radio-Sphere

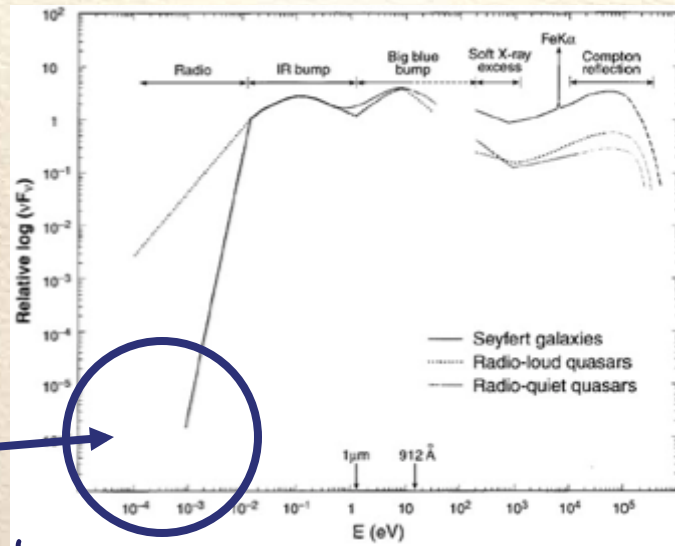
- Synchrotron self absorbed source

$$L_\nu / 4\pi d^2 = S_\nu \Omega R^2 / d^2$$

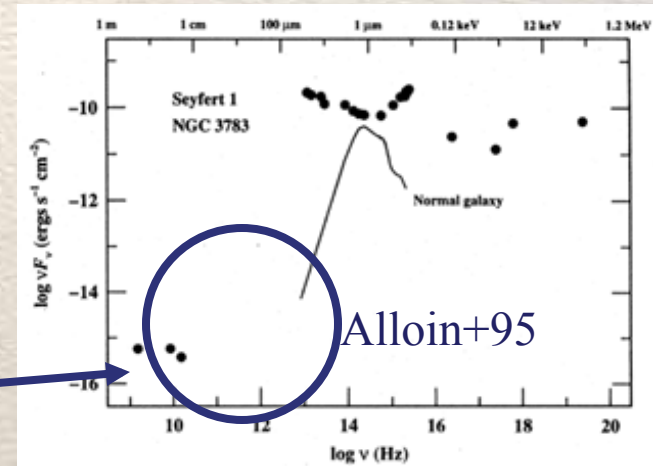
$$R_{ssa} = 0.1 \left(\frac{\nu L_\nu}{10^{40} \text{ erg s}^{-1}} \right)^{1/2} \left(\frac{B_\perp}{\text{Gauss}} \right)^{1/4} \left(\frac{\nu}{5\text{GHz}} \right)^{-7/4} \text{ pc}$$

- At 5 GHz $R_{ssa} = 0.1 \text{ pc}$
- Light crossing times of 100 days
- For rapid variability, want to
OBSERVE AT HIGHER FREQUENCIES
namely in the mm-band

Schematic AGN Spectrum



$T_{\text{dust}} > 30\text{K}$
 30 - 300 GHz
 1 - 0.1 mm
 (unexplored)
 sweet spot

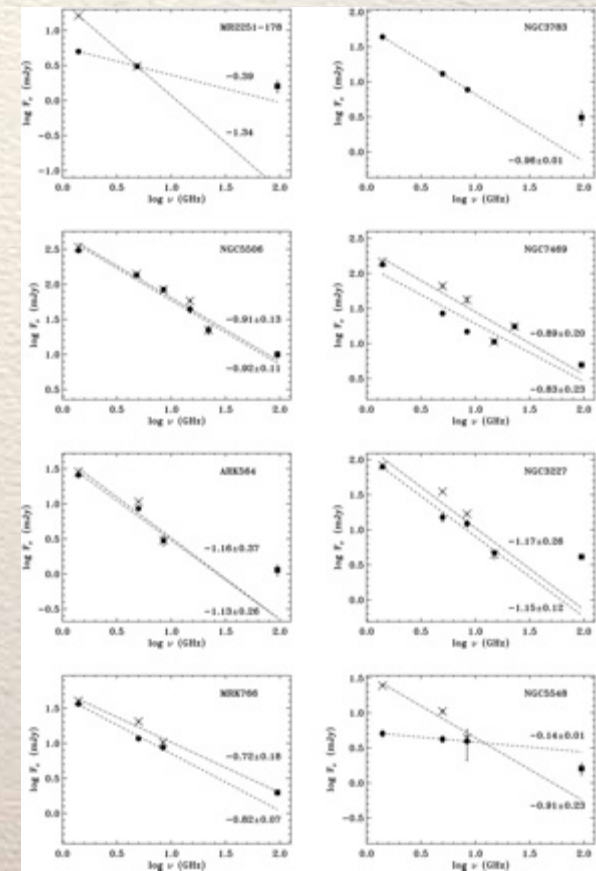




Exploratory Sample w/ ATCA & CARMA

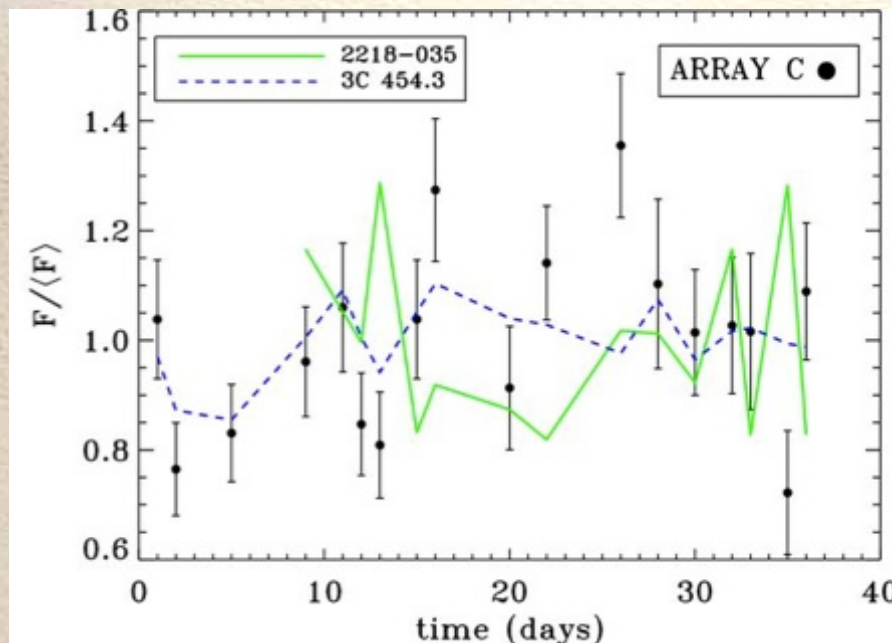


- All detected at 95 GHz
- Above the low- ν slope.
- High- ν excess
- Implied self-absorbed 95 GHz synchrotron size
 $(R = 0.1 L_{40} B^{1/4} \nu_5^{-7/4} \text{ pc})$
 is $< 10^{-3} \text{ pc}$ ($< \text{mas}$)
 - of order of X-ray variability
 time $<$ light day
- But do they vary?



Measuring Variability

NGC 7469 - CARMA's Swan Song



But is it the X-ray corona?

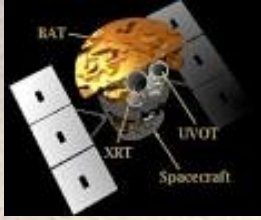
Need simultaneous observations

- χ^2 variability test
99.9817% confidence

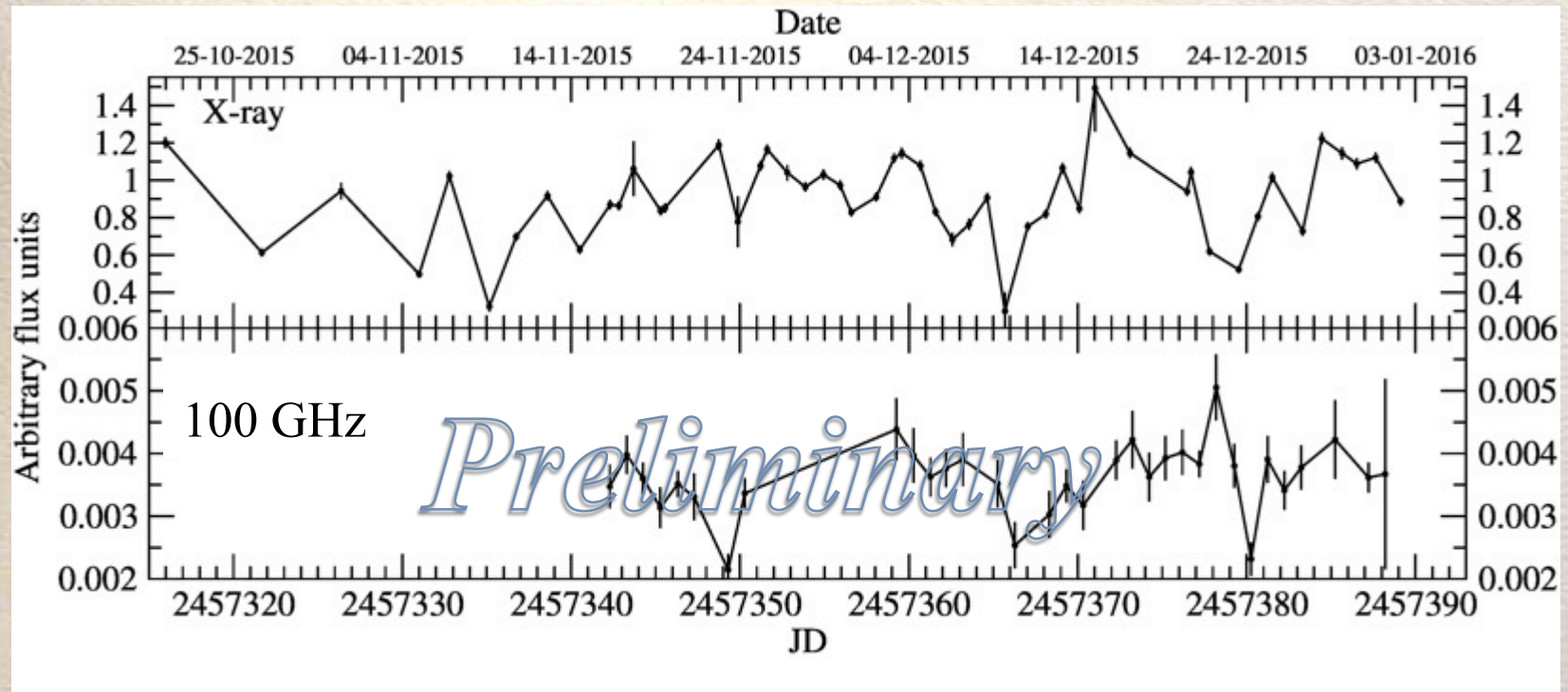
$$F_{VAR} = \sqrt{\frac{std^2 - \sigma_{measure}^2}{\langle F_v \rangle^2}}$$

- Over 36 days
 - $F_{VAR} = 12.8 \pm 2.5 \%$
 - X-rays* $16.0 \pm 0.4 \%$
- Over 6 day periods
 - $\langle F_{VAR} \rangle = 12.5 \pm 6.3 \%$
 - X-rays* $12.3 \pm 0.4 \%$

- *RXTE (2-12 keV)
Markowitz & Edelson 2004



NGC 7469 w/ Swift and IRAM



Photometric **stability** of single dish is **questionable**.
Need to go for shorter times with interferometers.

Conclusions

- mm-Wave Observations could be another way to study the **inner-most** high-energy AGN **accretion** component that we observe regularly in X-rays (**Corona**)
- We have detected many sources, possibly one that varies, but what we really need ...
- Simultaneous monitoring of **XMM-Newton** and **ALMA** (or **IRAM/PdB**) - the only way to conclusively verify this connection

THANK YOU
FOR YOUR ATTENTION

