Spica science with two mid-infrared arms

スピカの二つの中間赤外線アームによる研究

ガンディ　ポシャク

Poshak Gandhi

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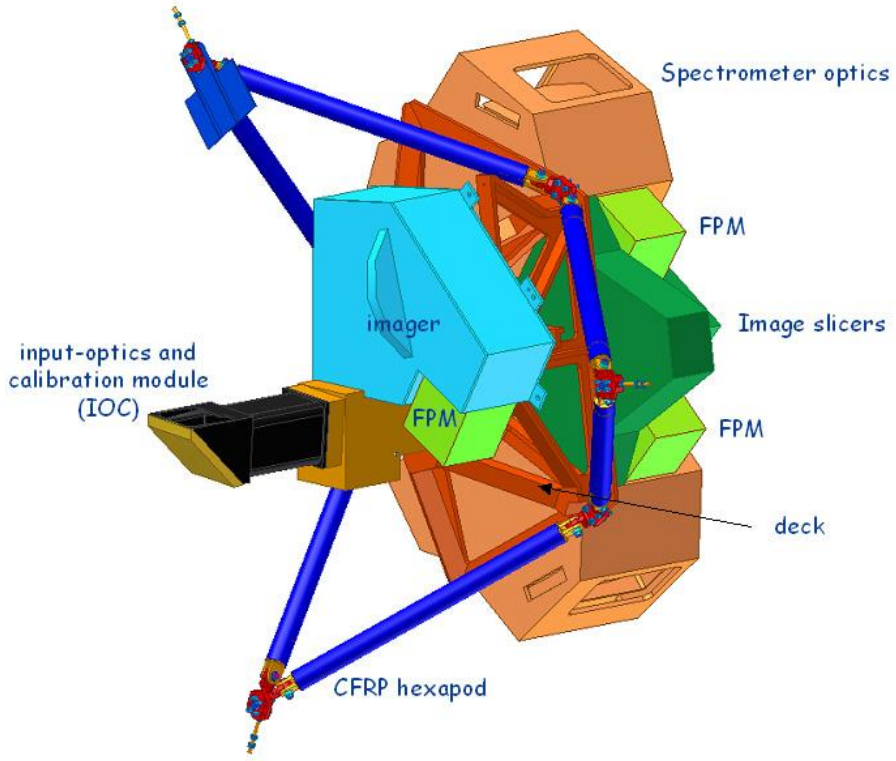
~10-20 μm and ~20-40 μm: both justified?

MIRI



Low resolution spectroscopy
(5-10 microns)

3000 nJy at 7.5 microns

Medium resolution spectroscopy
(IFU, 10,000s per setting)

Lamda (Microns)	Line Flux (W/m^2)
6.4	7.00E-21
9.2	1.00E-20
14.5	1.20E-20
22.5	6.00E-20

MIRI Camera

Lambda (Microns)	microJansky
5.6	0.2
7.7	0.28
10	0.7
11.3	1.7
12.8	1.4
15	1.8
18	4.3
21	8.6
25.5	28

Sensitivity (point source):
10σ 1000 s

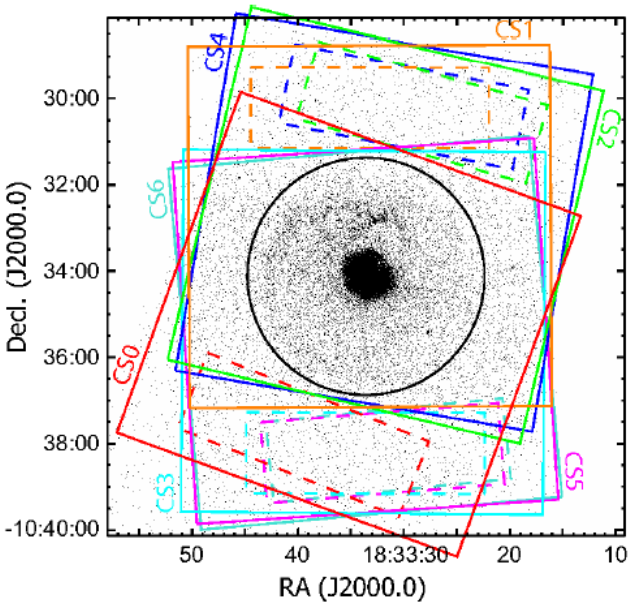
Contents

1) Cross-calibration
2) Angular resolution (source identification)
3) Low luminosity active galactic nuclei (LLAGN)
4) Stellar-mass accreting sources

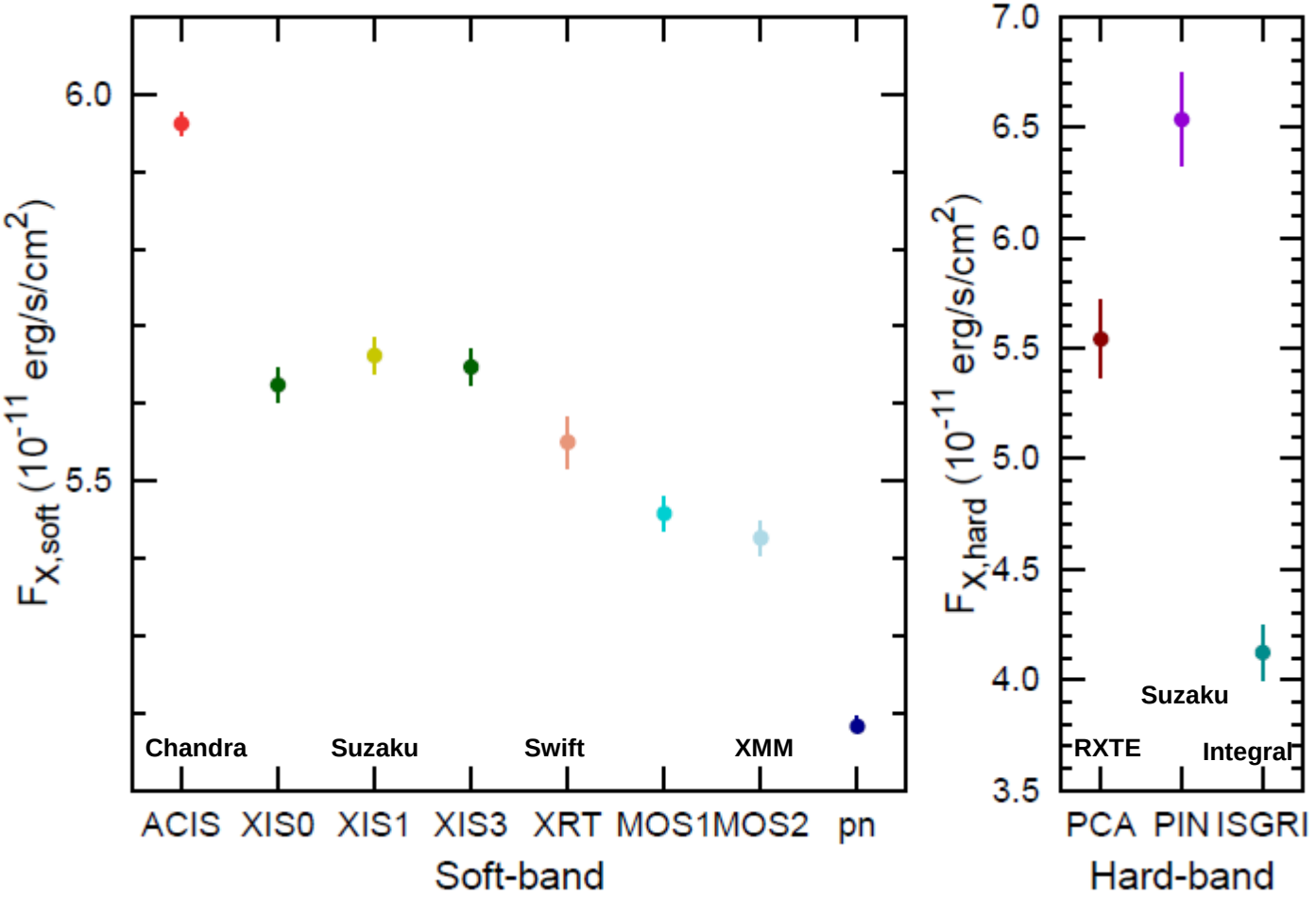
P. S.

- *Some* interesting science topics
- Personal and biased list
- Topics not covered by others, e.g. ~~high-z~~

1. Cross-calibration

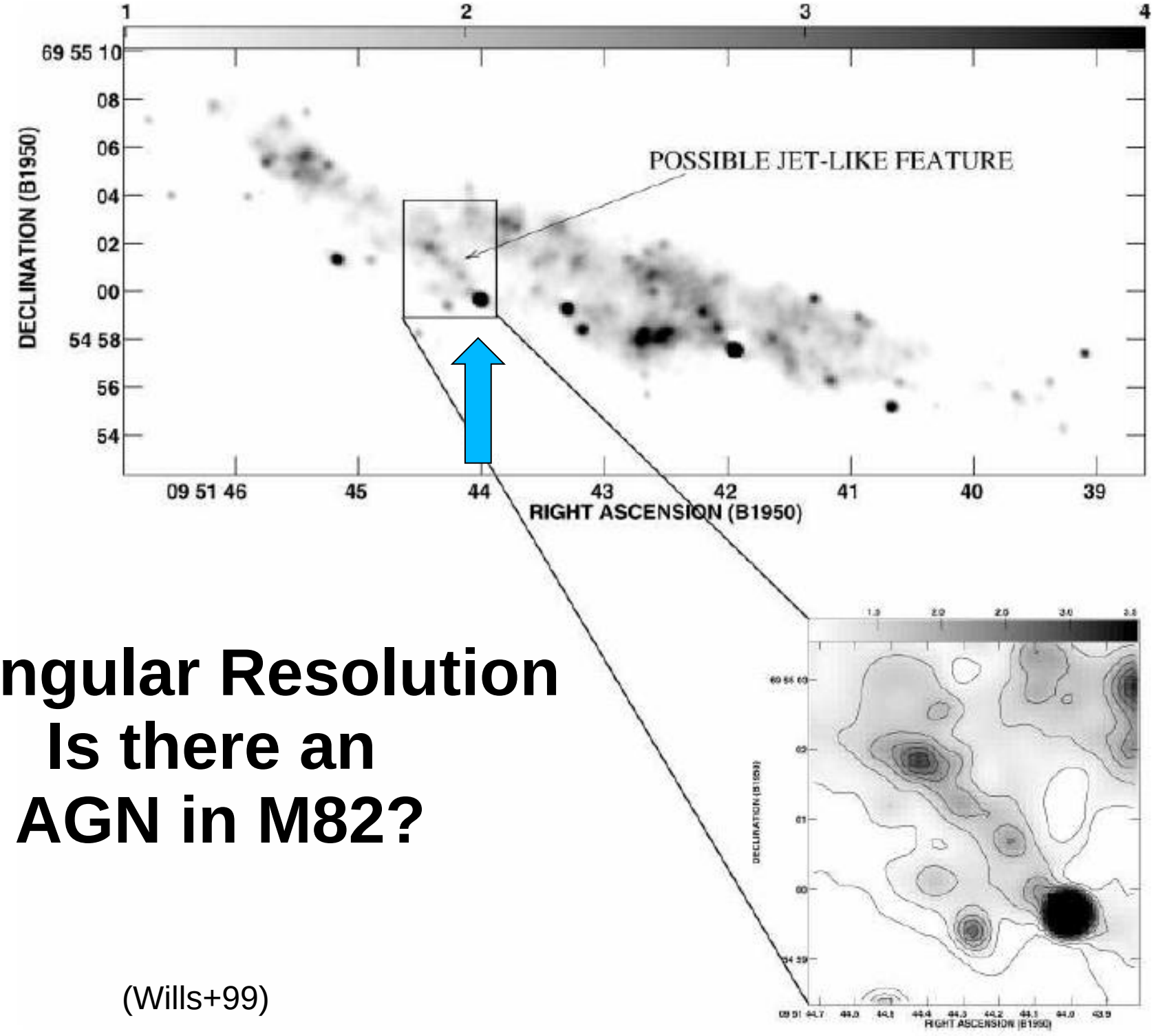


Crab Nebula
Chandra



Up to 46% cross-calibration flux uncertainty!

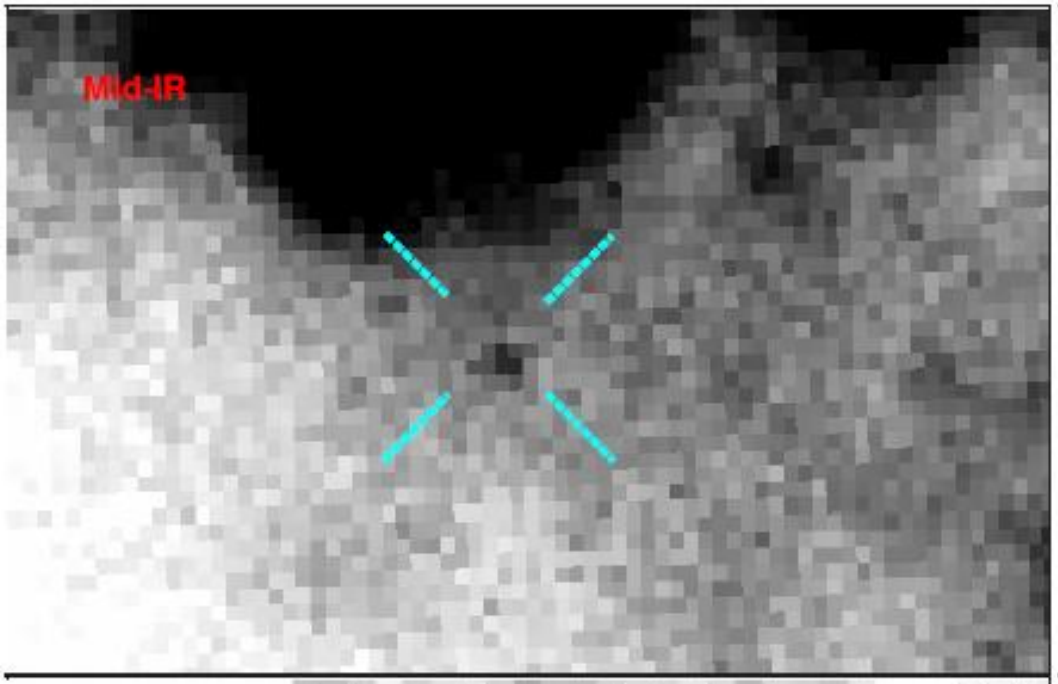
Tsujimoto et al. (2010)

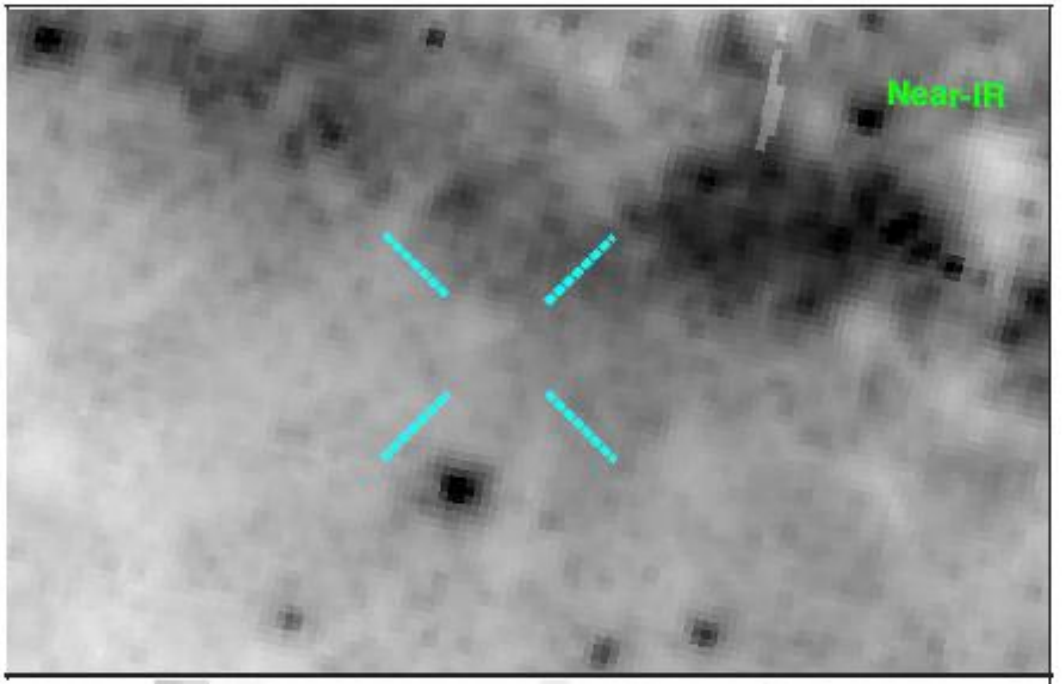


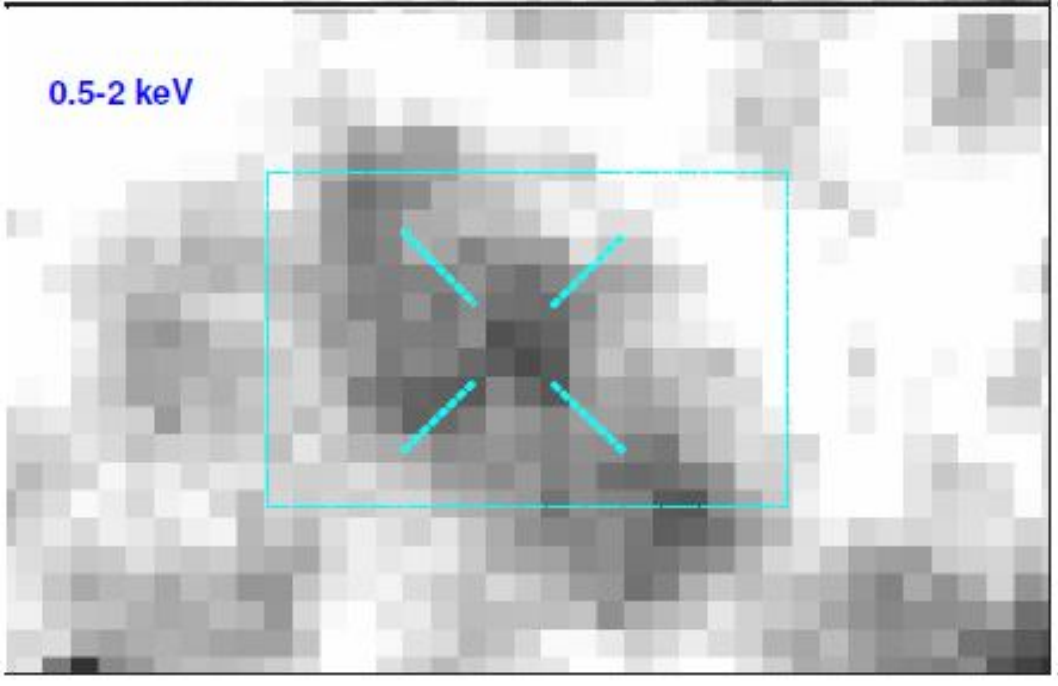
2. Angular Resolution
Is there an AGN in M82?

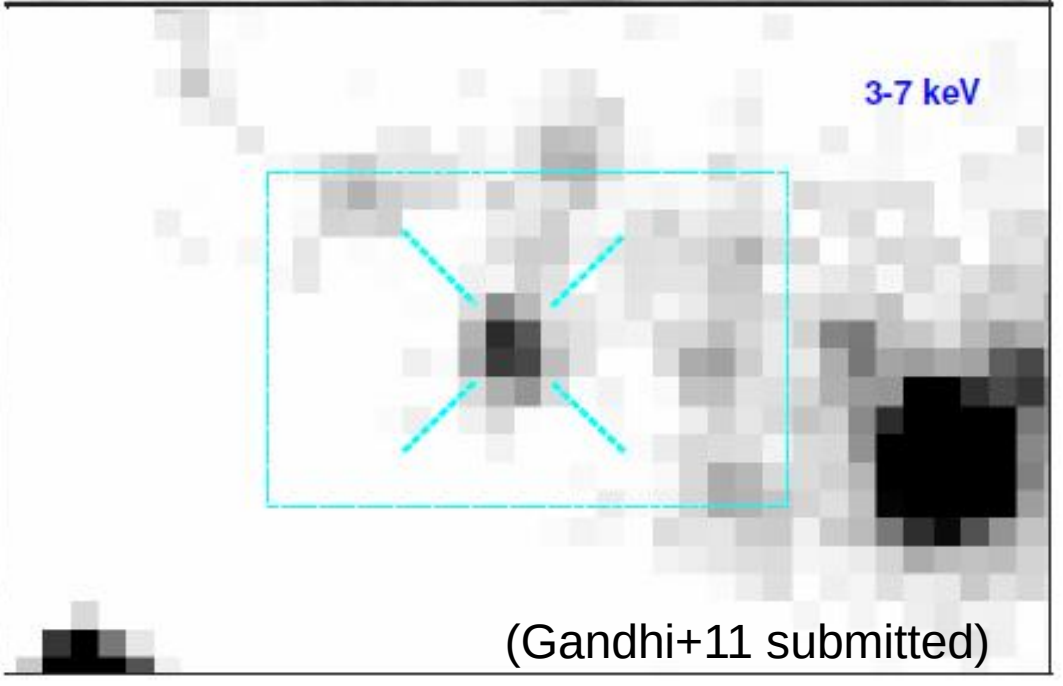
(Wills+99)

2. Source identification



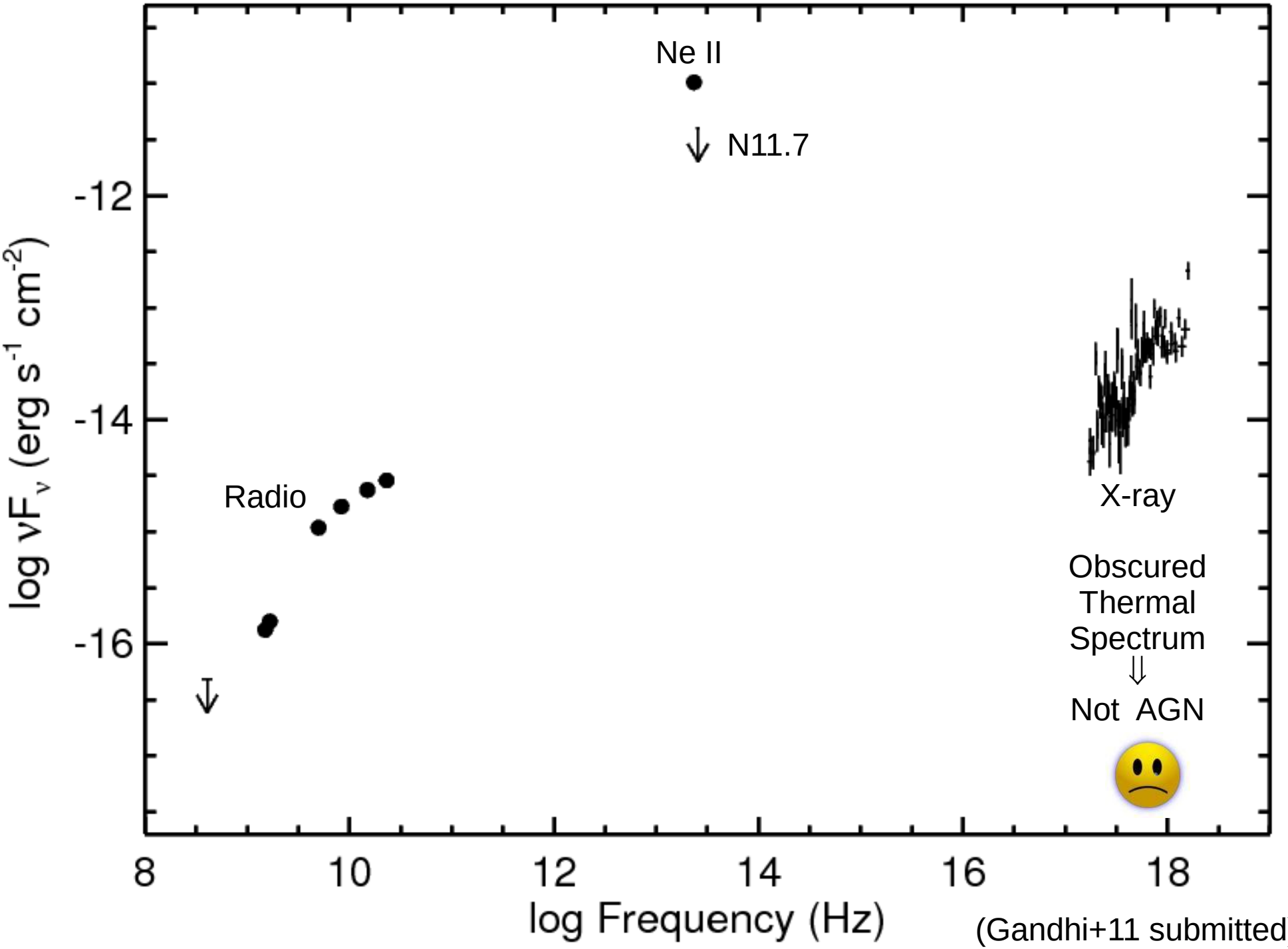






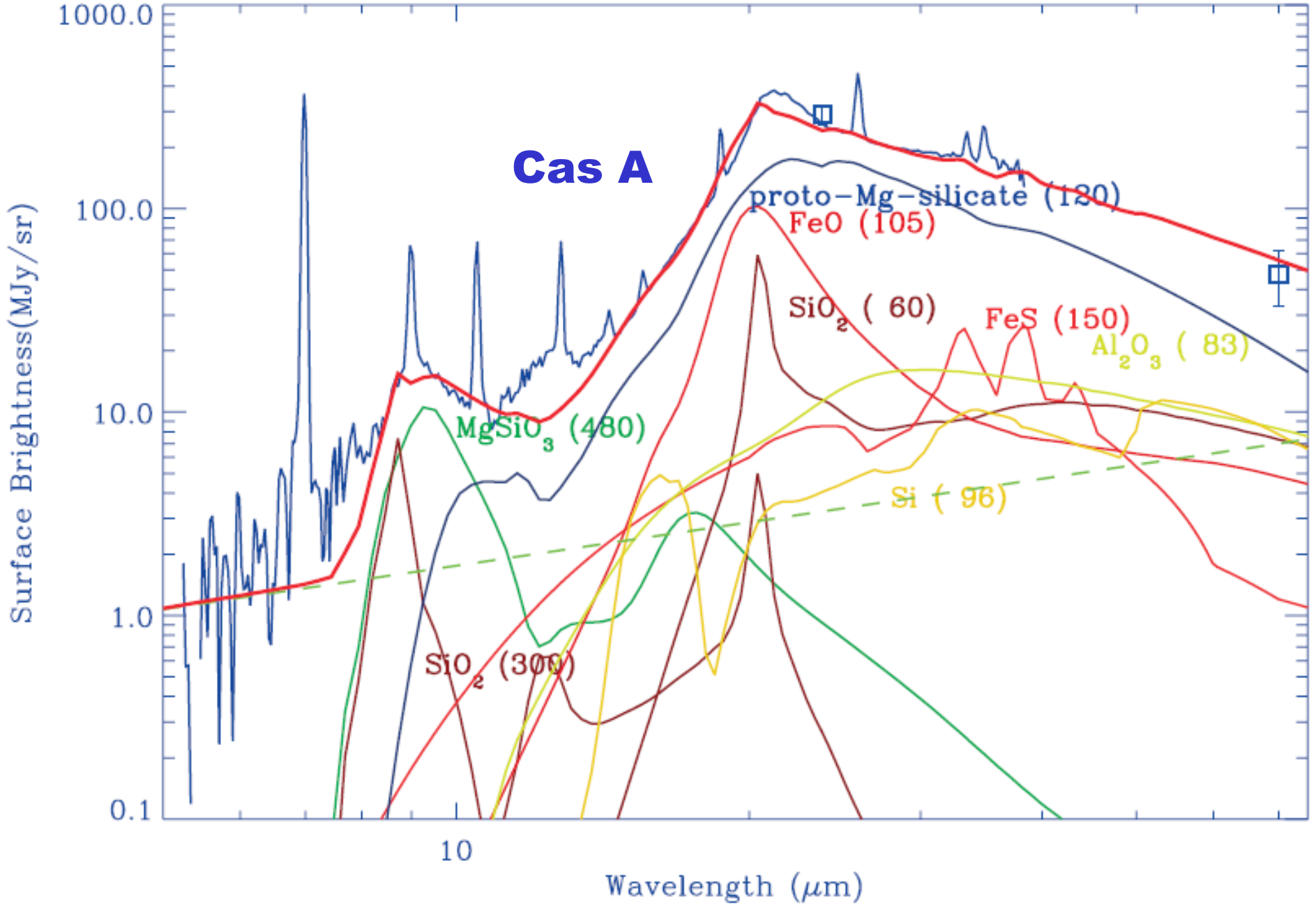
(Gandhi+11 submitted)

2. Source identification

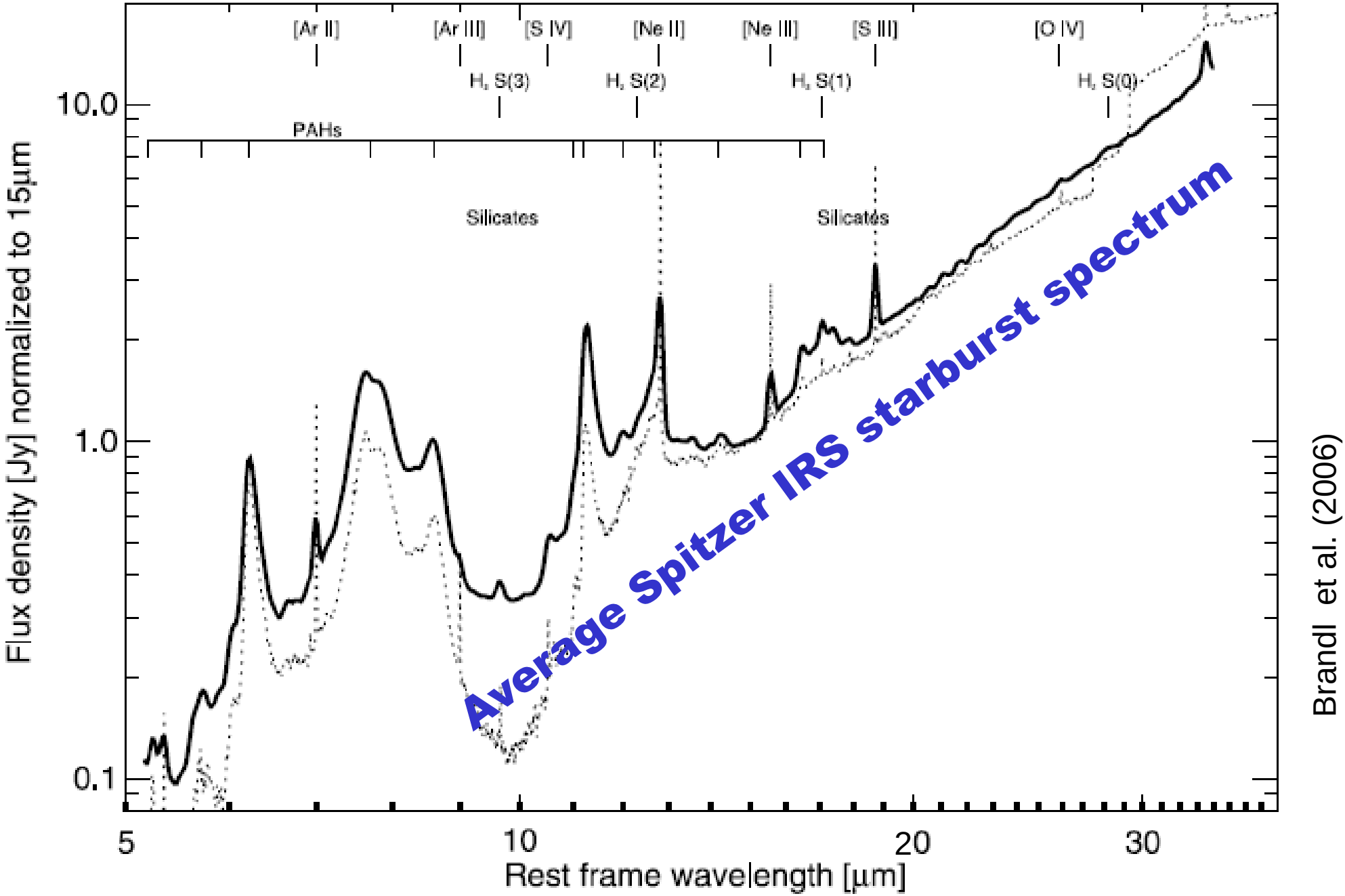


(Gandhi+11 submitted)

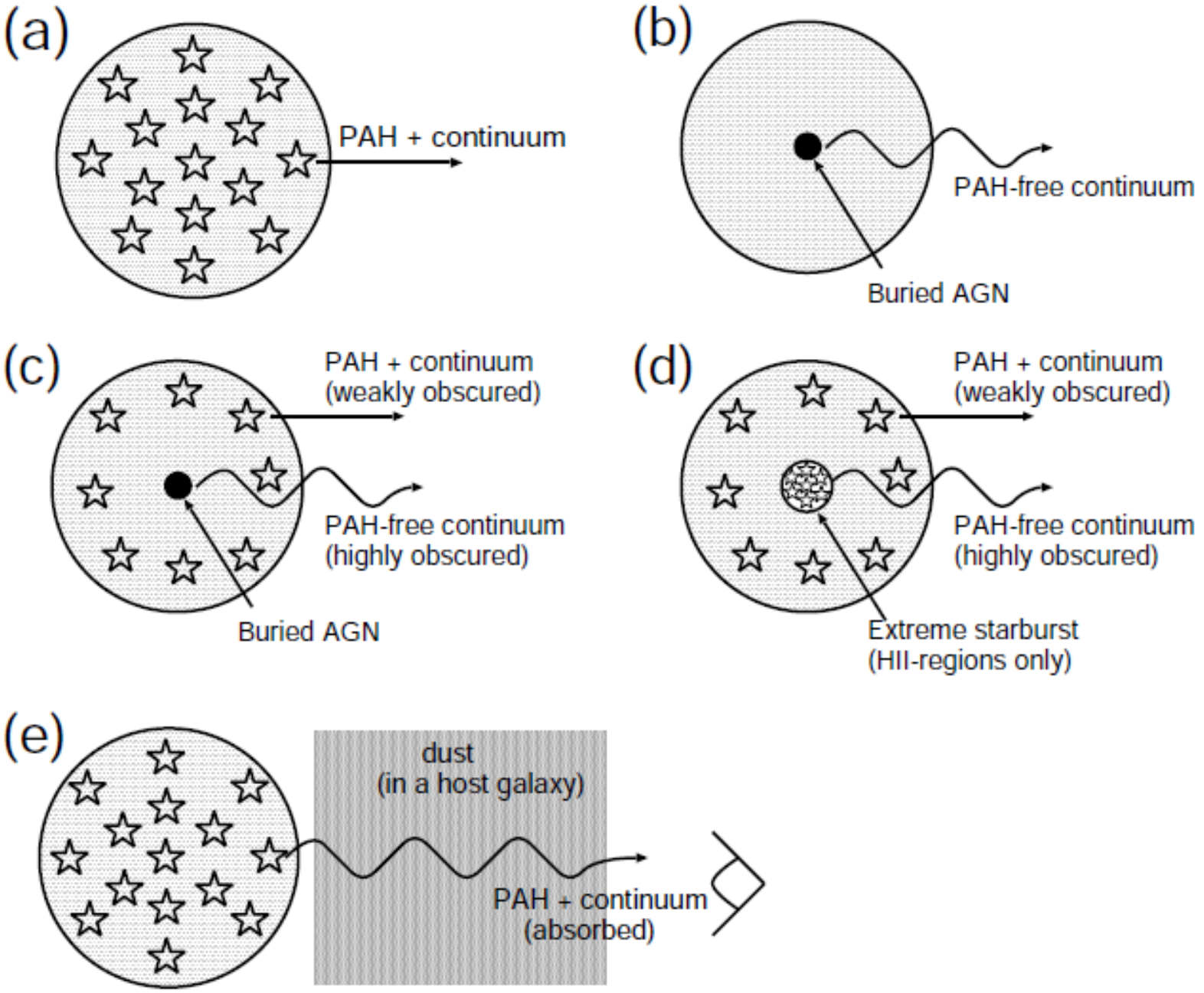
2. Source identification: supernova (remnant) ?



2. Source identification: starburst ?



2. Source identification : buried AGN ?



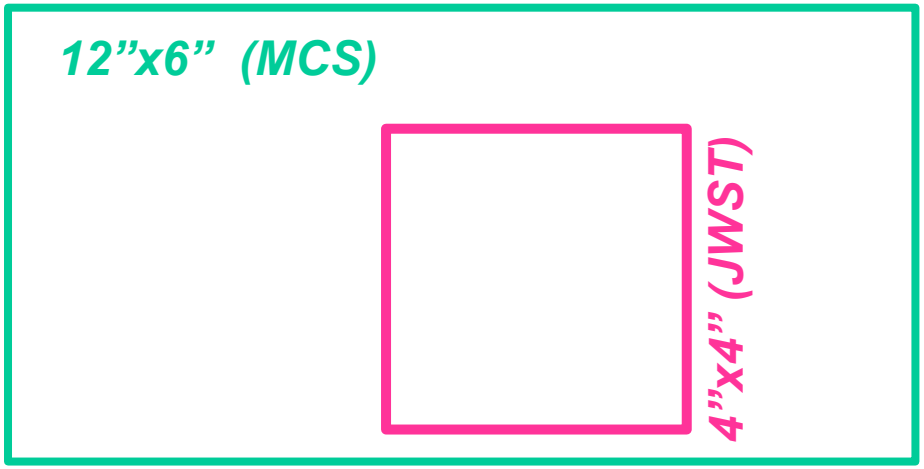
Imanishi et al. (2010)

Requirements:

1) <~1”-2” PSF

2) LR spec *R*~ few 100

3) broad spectral coverage with single mission to avoid confusion.



Red: Subaru COMICS Nell

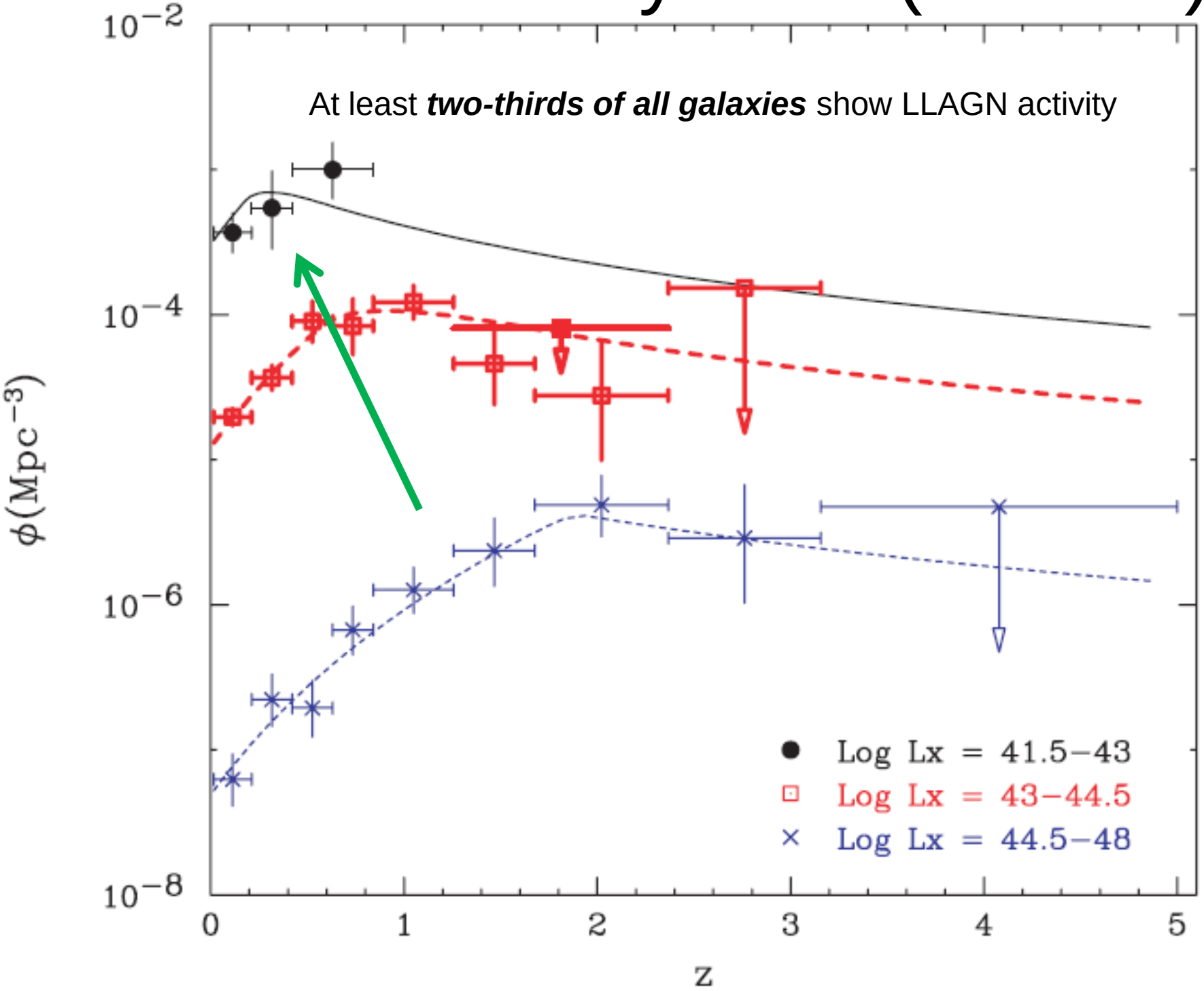
Green: HST WFPC 1 μm

Blue: Chandra ACIS

Magenta and white: Radio

(Gandhi+11 submitted)

3. Low Luminosity AGN (LLAGN)



Ueda et al. (2003)

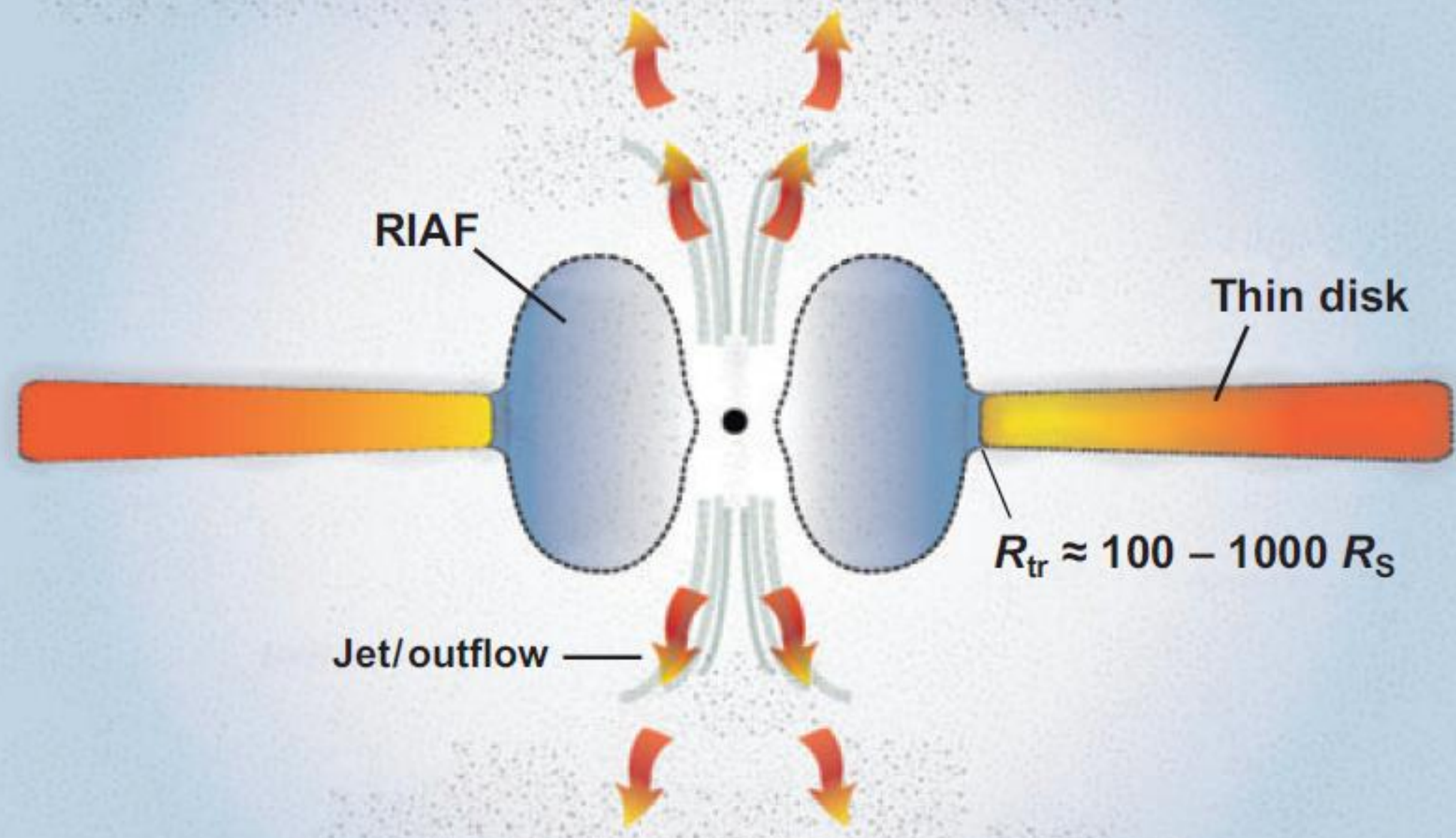
3. Low Luminosity AGN: important questions

- Do *100%* of (bulgy) galaxies possess black holes?

- Are they simply scaled down versions of Seyferts and quasars?
  - Intrinsically low luminosity?
  - Obscured?

- Can they bridge the gap between stellar-mass black holes and super-massive sources?

State transition in low-luminosity AGN?



(Ho 2008)

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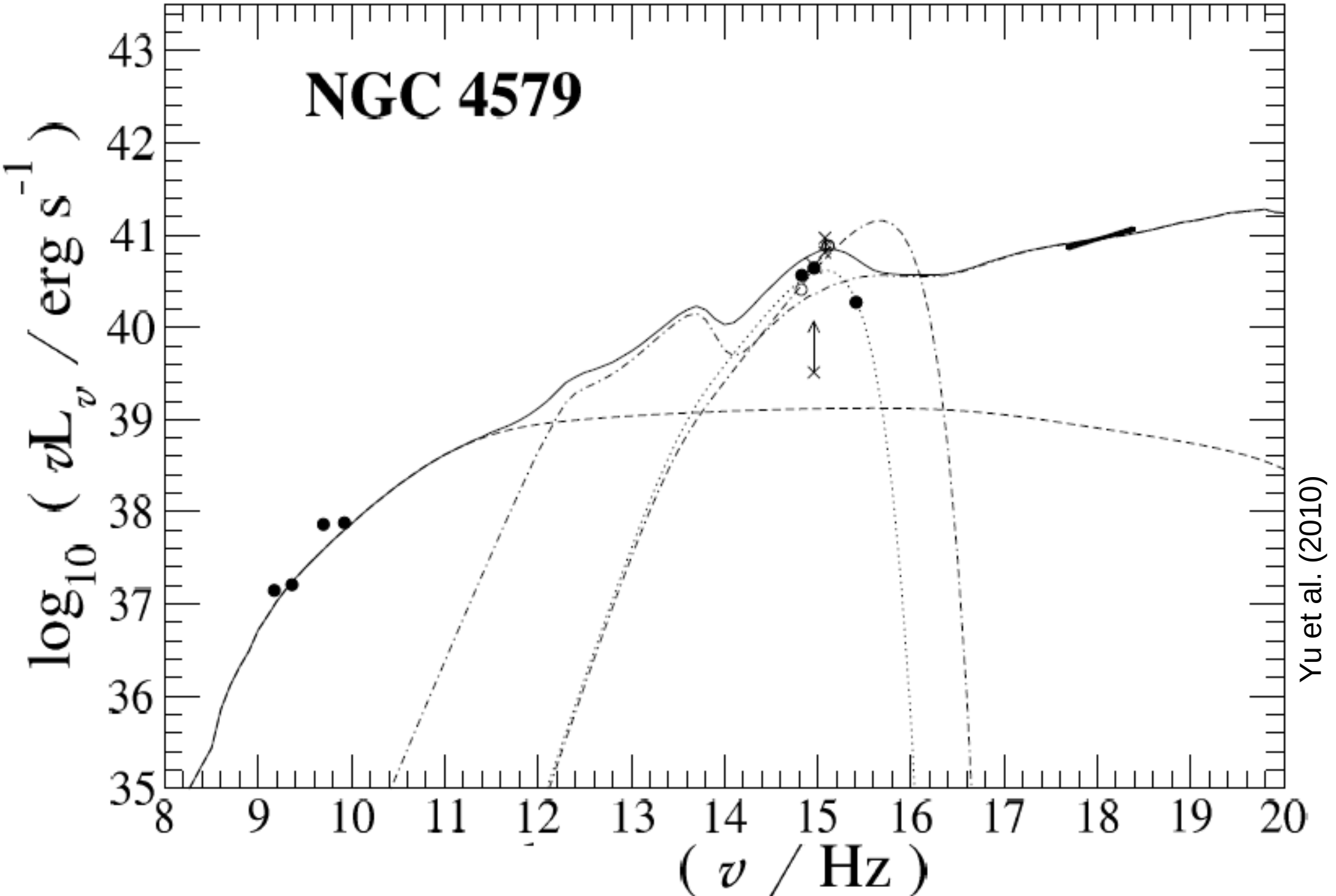
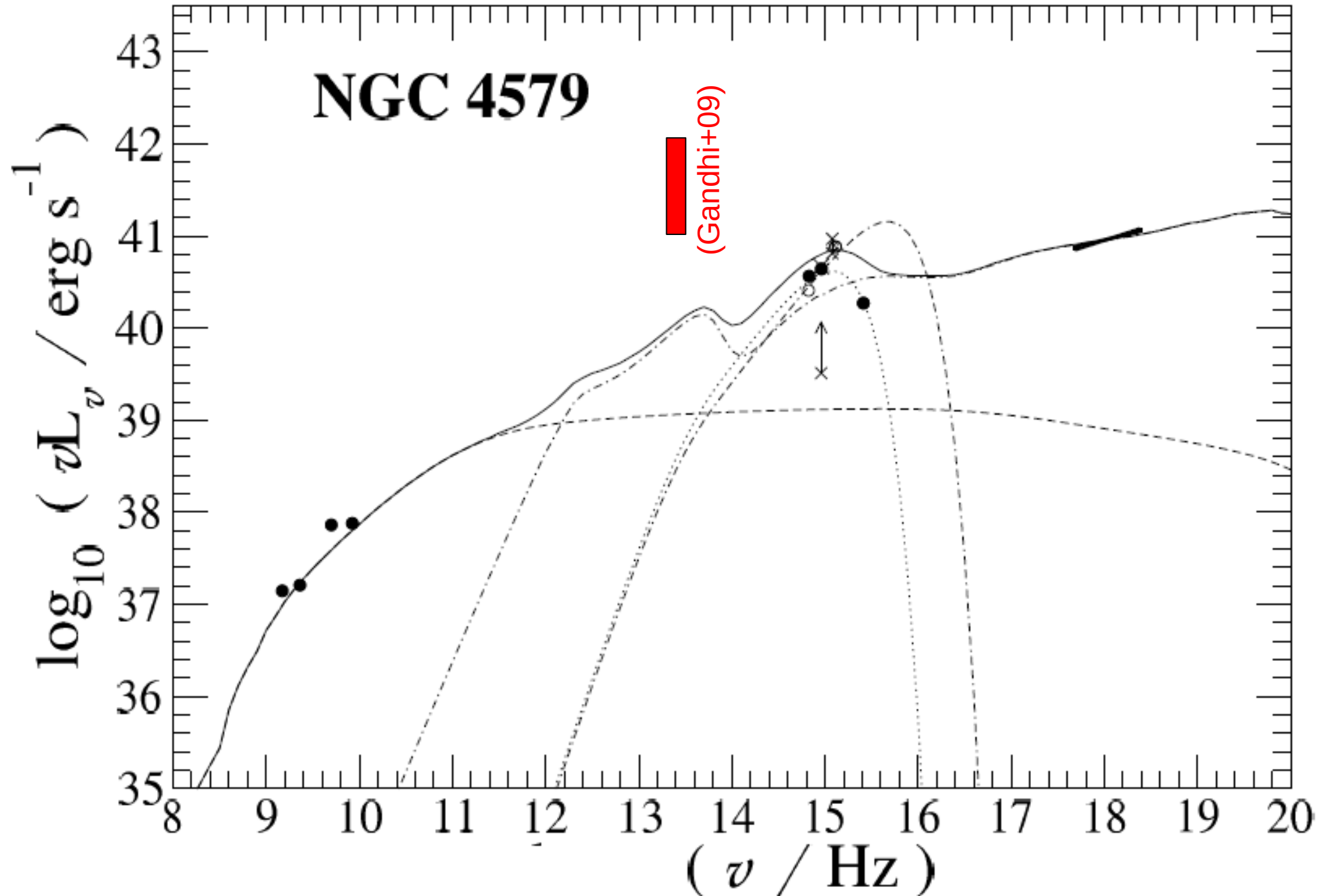
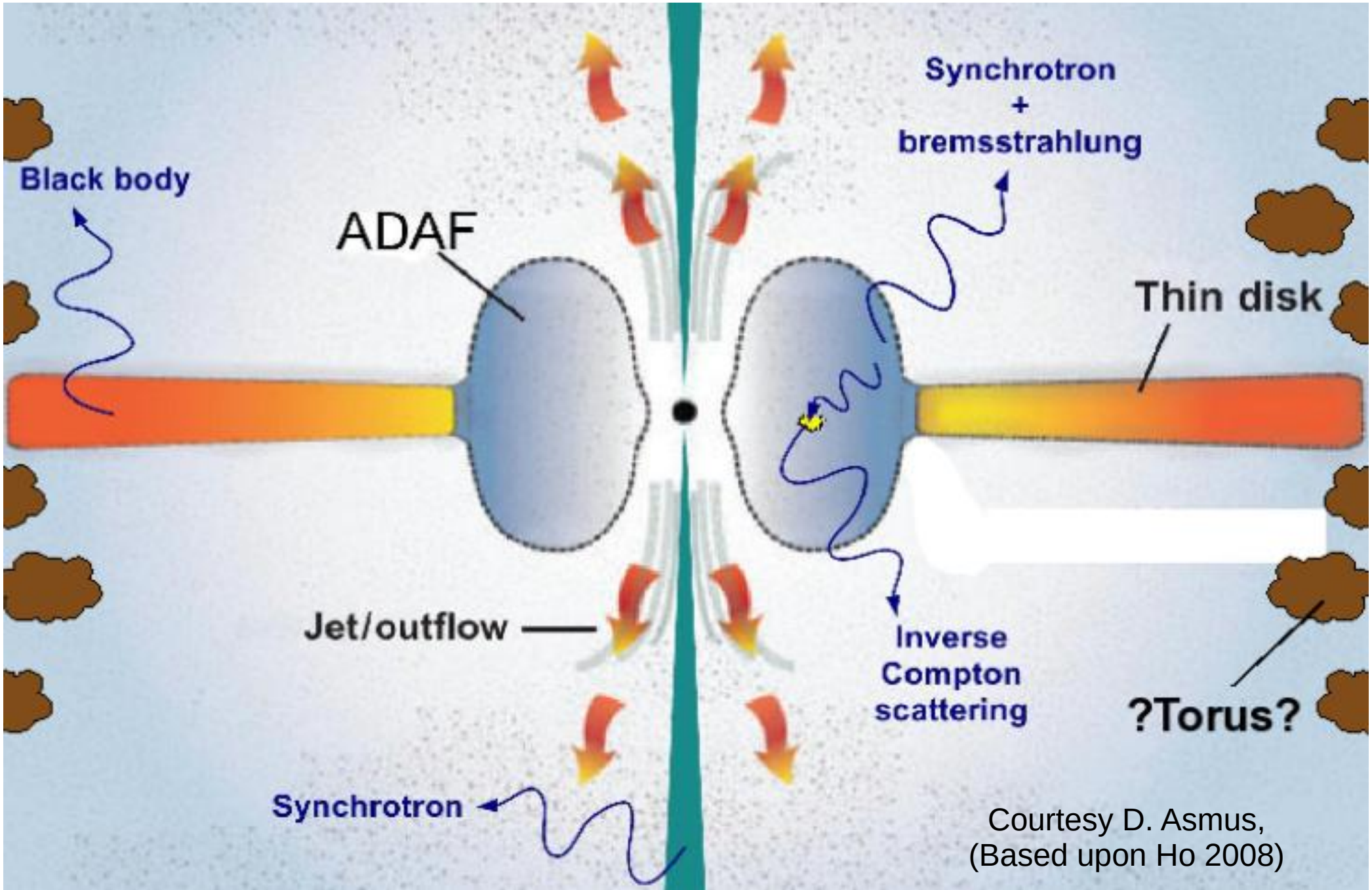
Power source in LLAGN?



Power source in LLAGN?

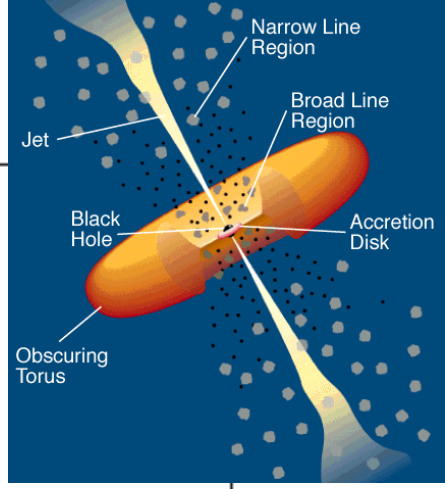


What is IR power source in LLAGN?

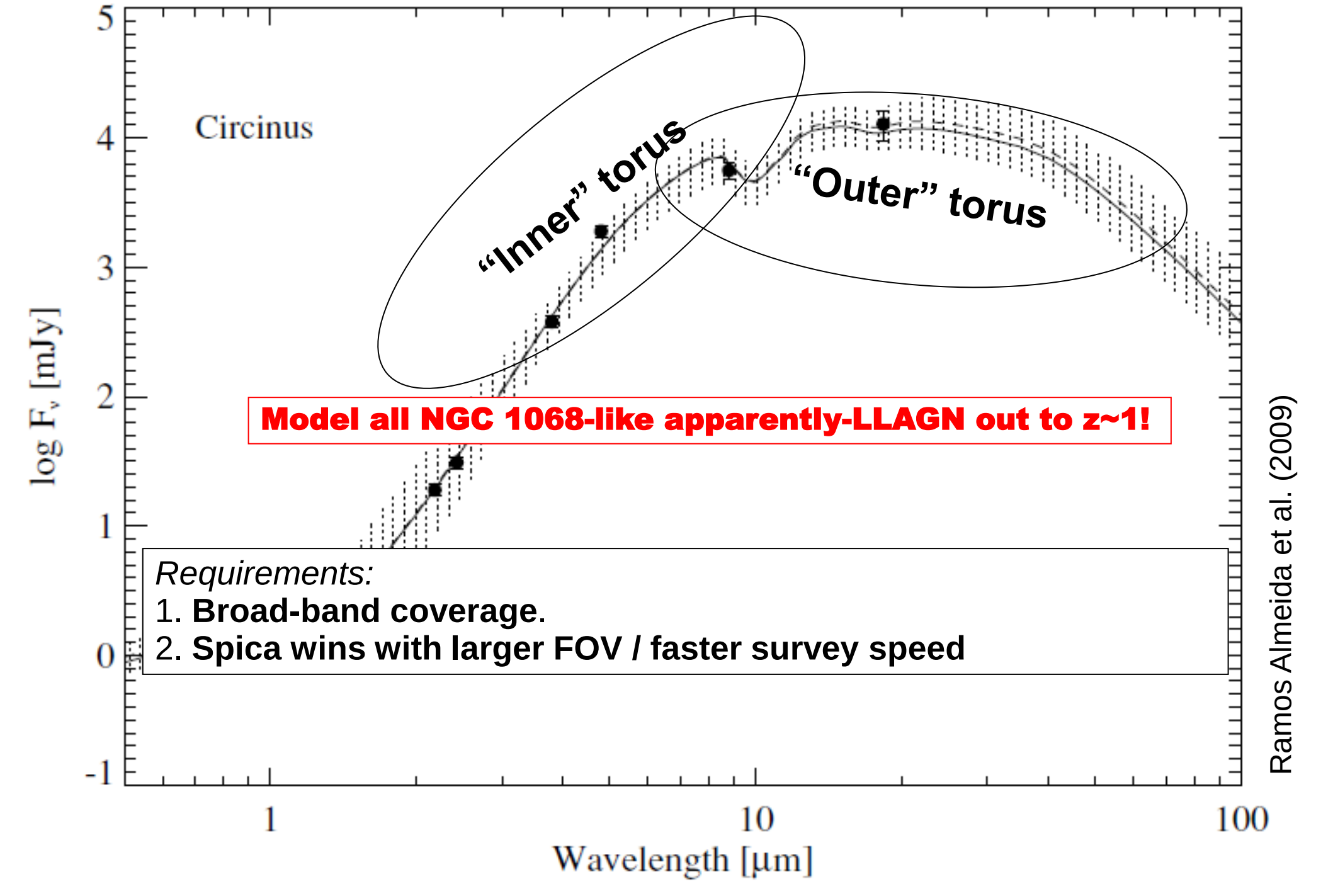


Courtesy D. Asmus,
(Based upon Ho 2008)

Where does torus emission peak?



Modelling AGN tori



Model all NGC 1068-like apparently-LLAGN out to z~1!

Requirements:

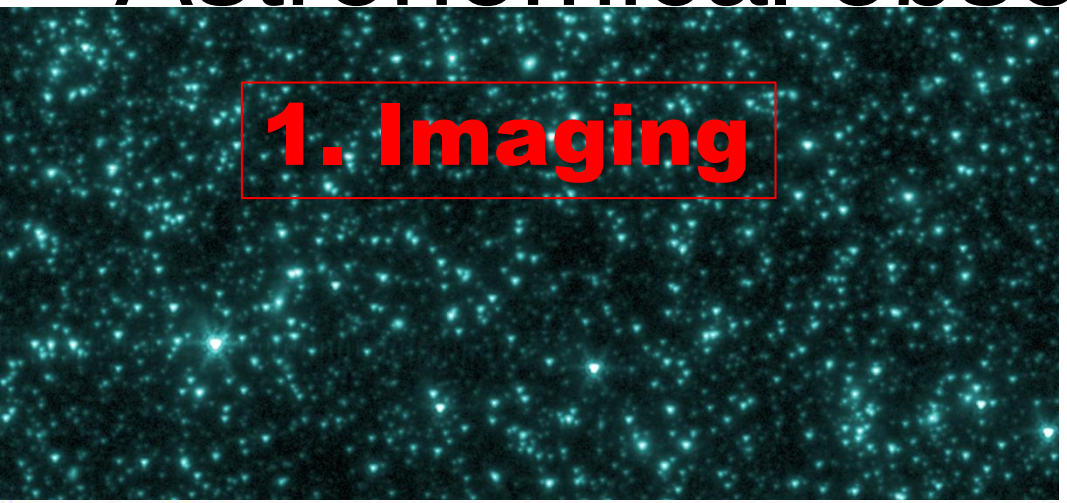
1. **Broad-band coverage**.
2. **Spica wins with larger FOV / faster survey speed**

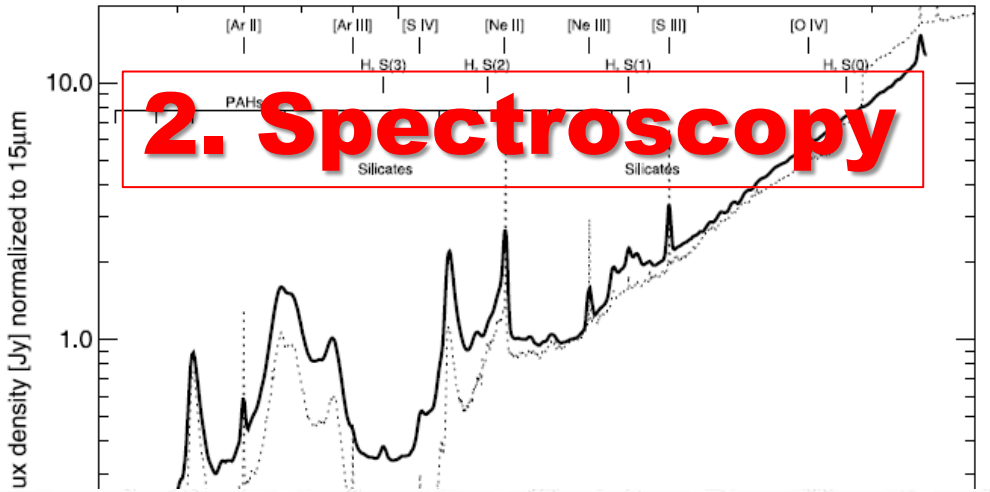
4. Variability / Transient studies:

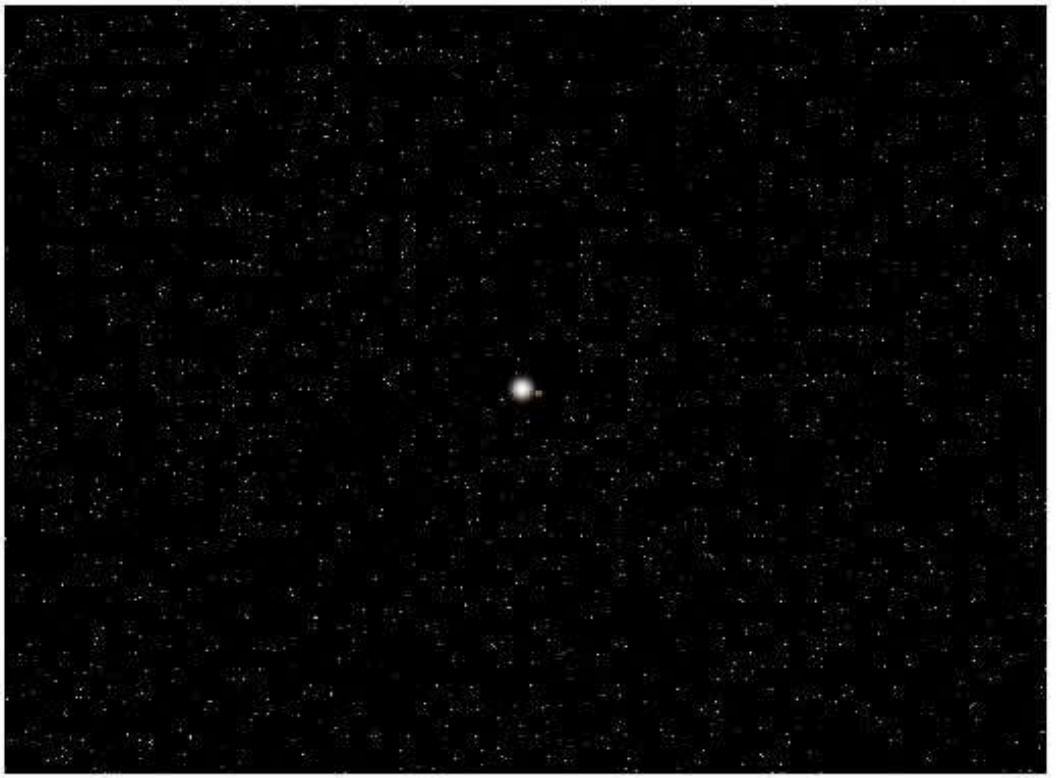
best case for broad band coverage?

- Jets in accreting X-ray binaries
- Gamma ray burst afterglows
- Transits / eclipses
- Microlensing events
- Supernovae

Astronomical observational domains







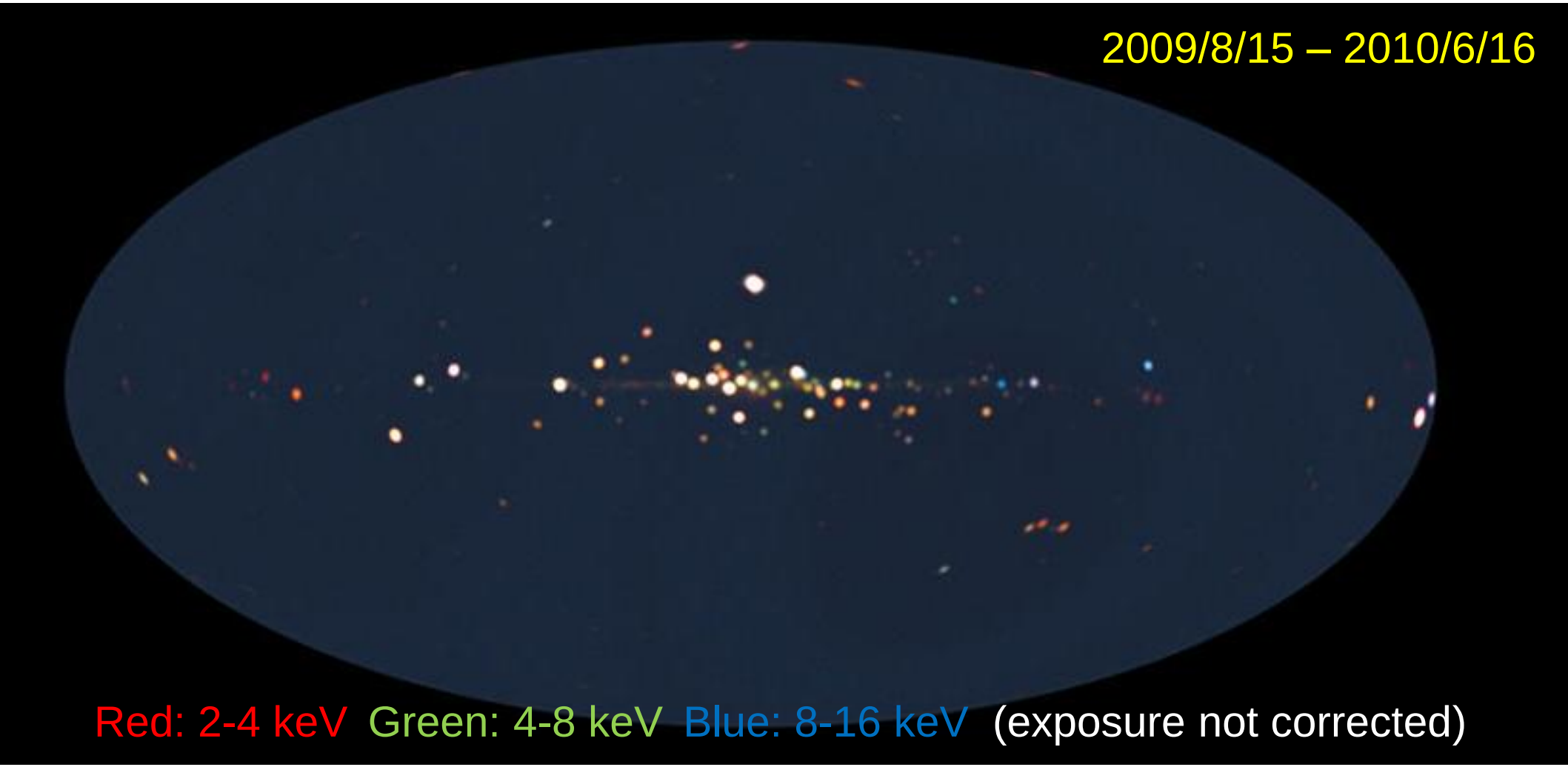
3. Time domain is least explored:
"unknown unknowns"

4. Variability / Transient studies:

best case for broad band coverage?

- **Jets in accreting X-ray binaries**
- Gamma ray burst afterglows
- Transits / eclipses
- Microlensing events
- Supernovae

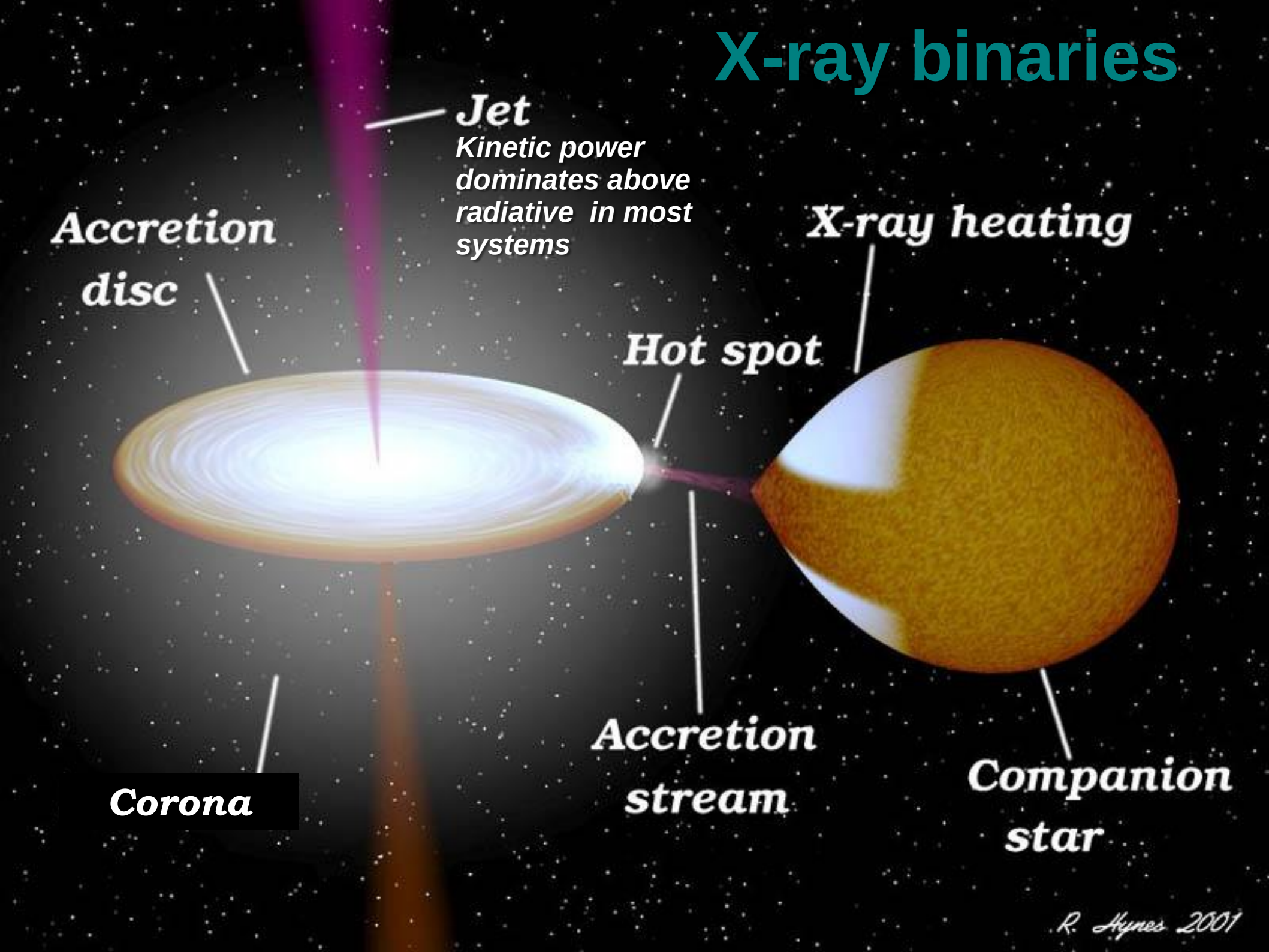
MAXI/GSC All-sky map: first 10 months



300+ Galactic X-ray binaries known (growing fast)

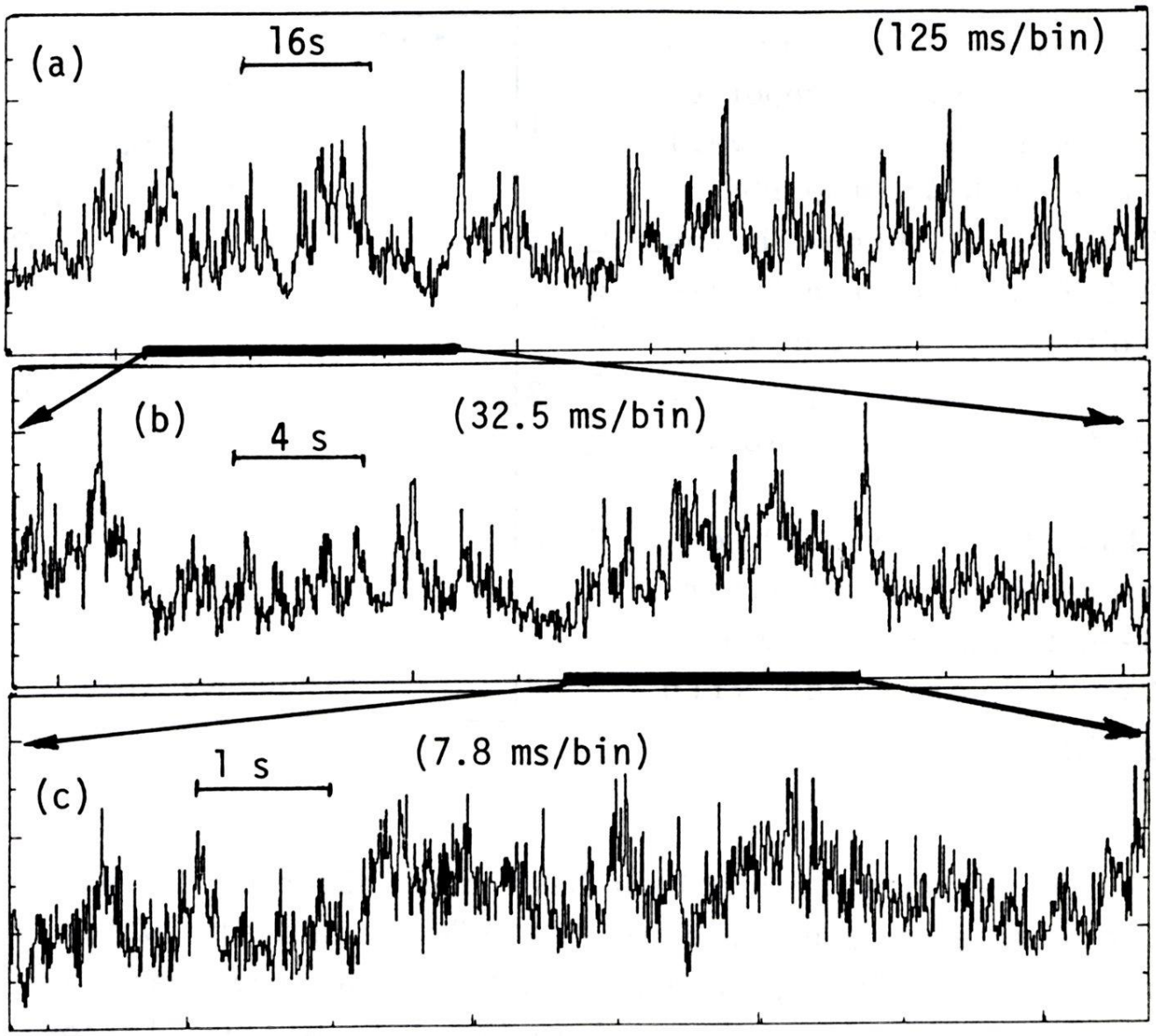
(Slide : MAXI First year symposium. N. Kawai)

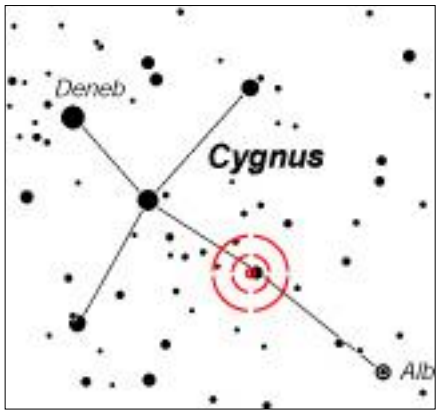
X-ray binaries



Timing studies of Galactic black holes

Rapid aperiodic flickering commonly seen in **X-rays**



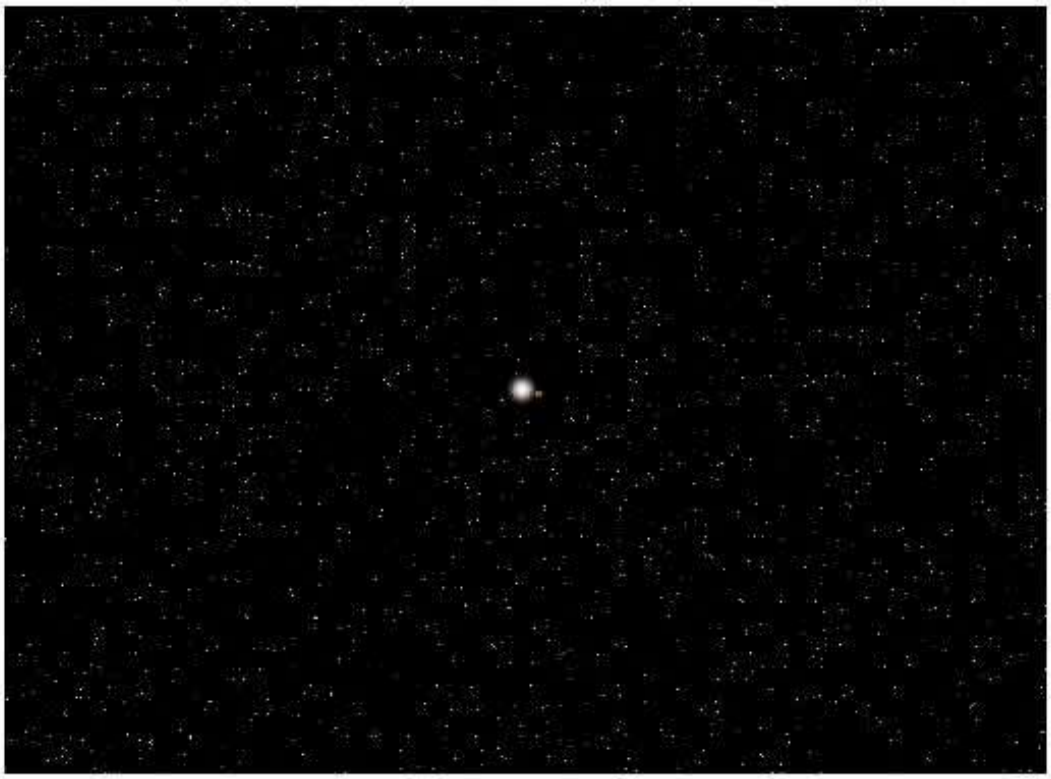


Black hole
Cygnus X-1

(Makishima 1988)
(Ginga data)

Speedy optical variability

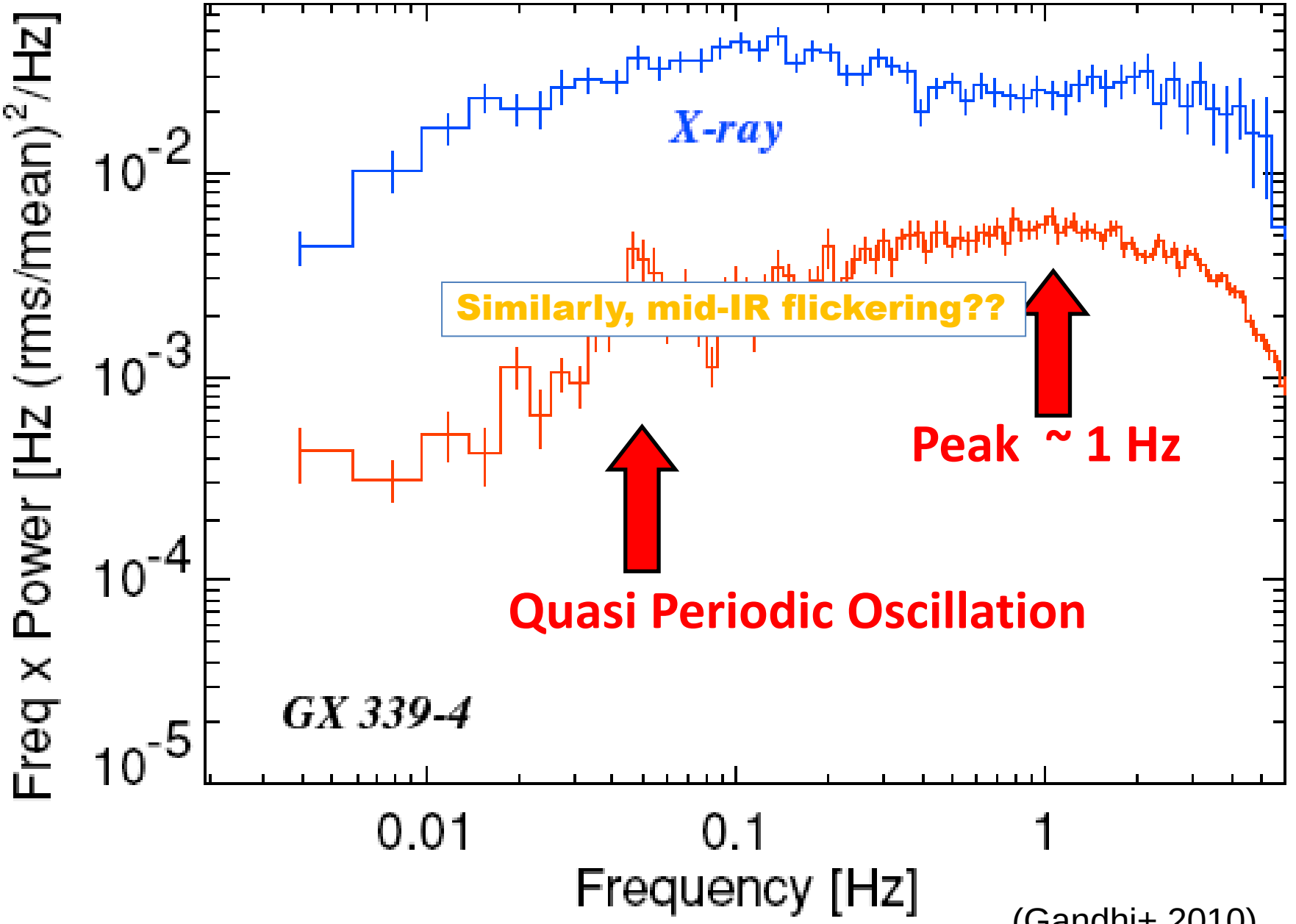
GX 339-4 : Galactic black hole binary (mass > $6M_{sun}$)



VLT / ULTRACAM *ΔT=50 ms* *Animation: binsim*

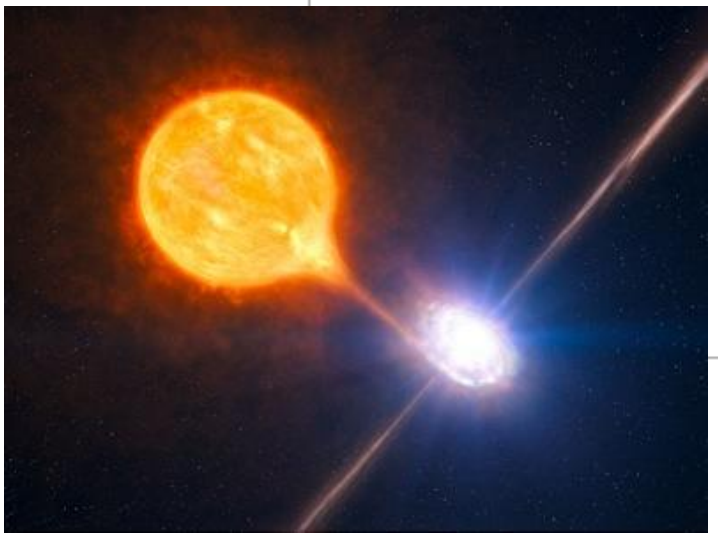
(P. Gandhi et al. 2008, 2010)

Power spectra of variations



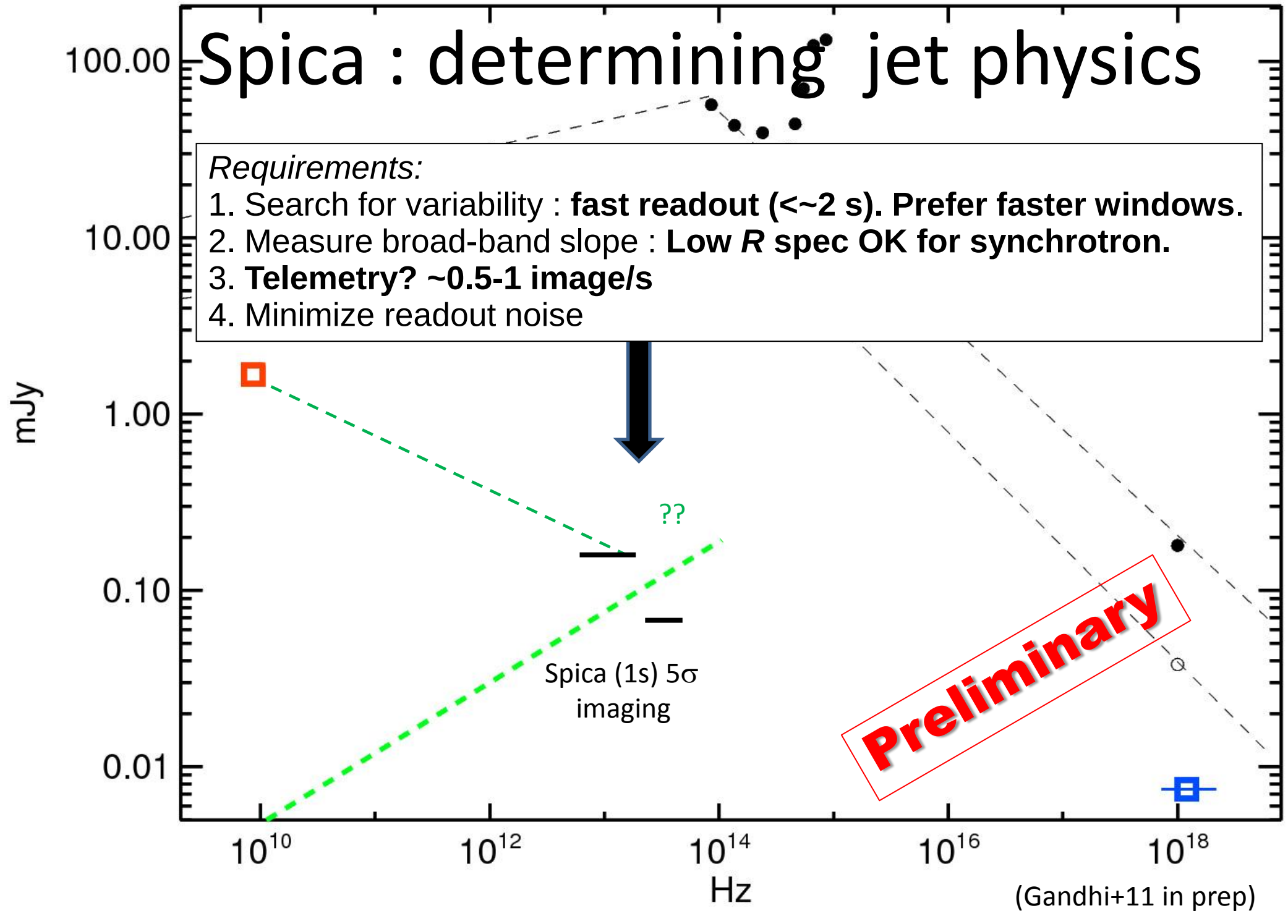
(Gandhi+ 2010)

Next step: IR jet still completely unexplored



Corbel & Fender 2002

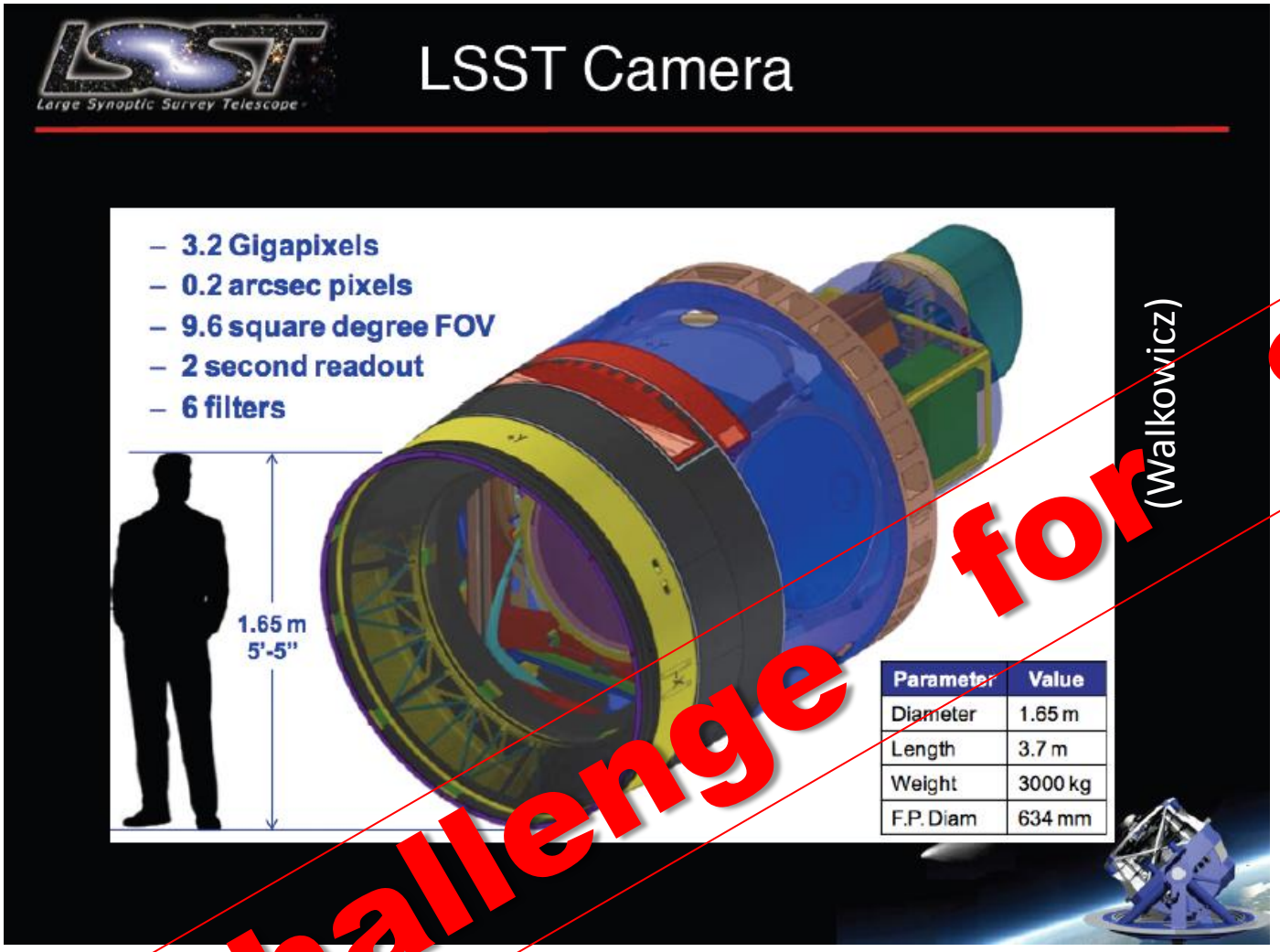
Spica : determining jet physics



Requirements:

1. Search for variability : **fast readout (<~2 s). Prefer faster windows.**
2. Measure broad-band slope : **Low *R* spec OK for synchrotron.**
3. **Telemetry? ~0.5-1 image/s**
4. Minimize readout noise

ca. 2018 : Variability boom ?



Challenge for Spica!

MAXI

LOFAR/
E-VLA

次世代赤外線天文衛星
SPICA
Space Infrared Telescope for Cosmology and Astrophysics

Super **i**nfrared s**C**ience w/2 **a**rms

- Avoid cross-calibration problems
- Make full use of high angular resolution
- Revolutionise LLAGN studies
- Study transient phenomena