

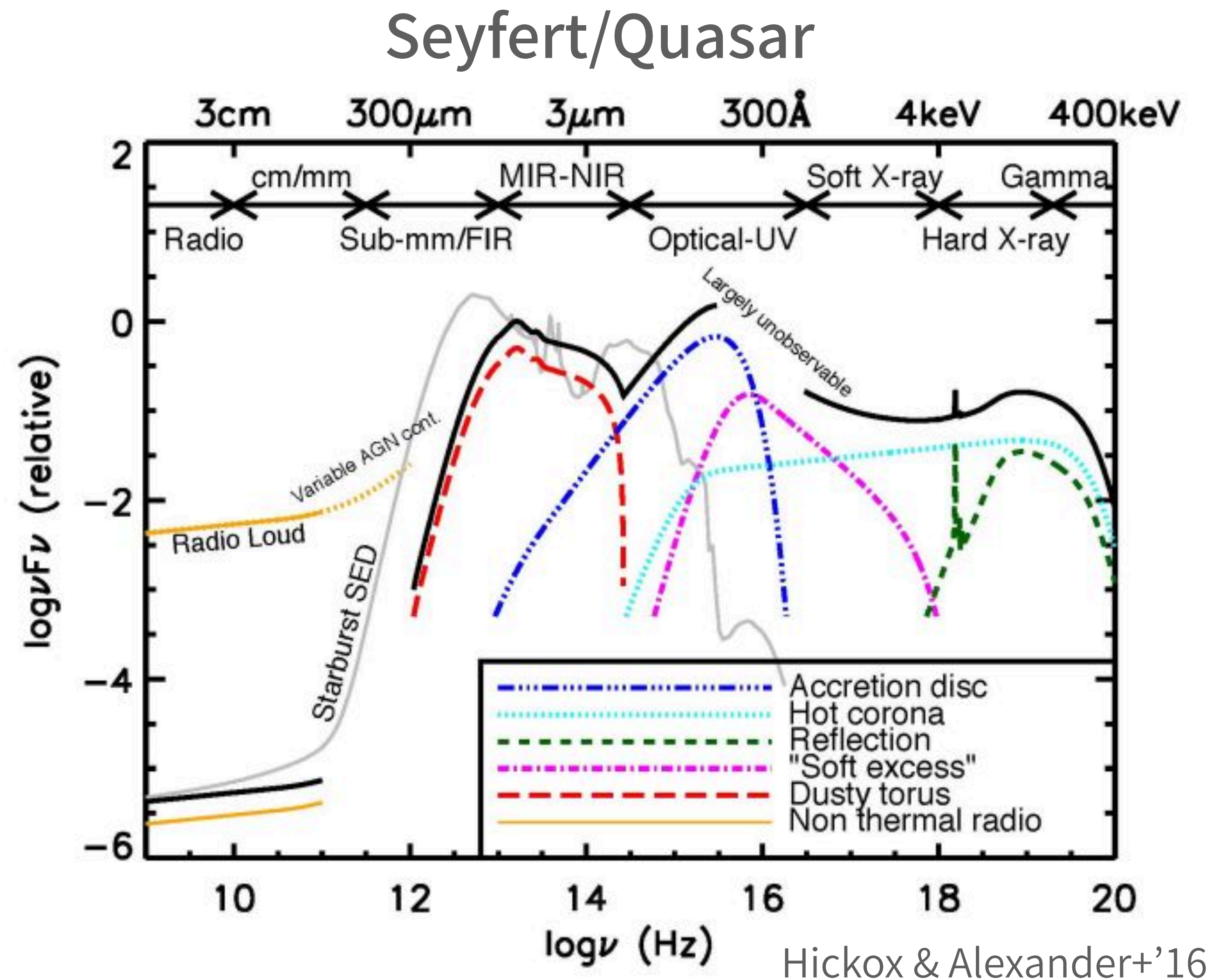
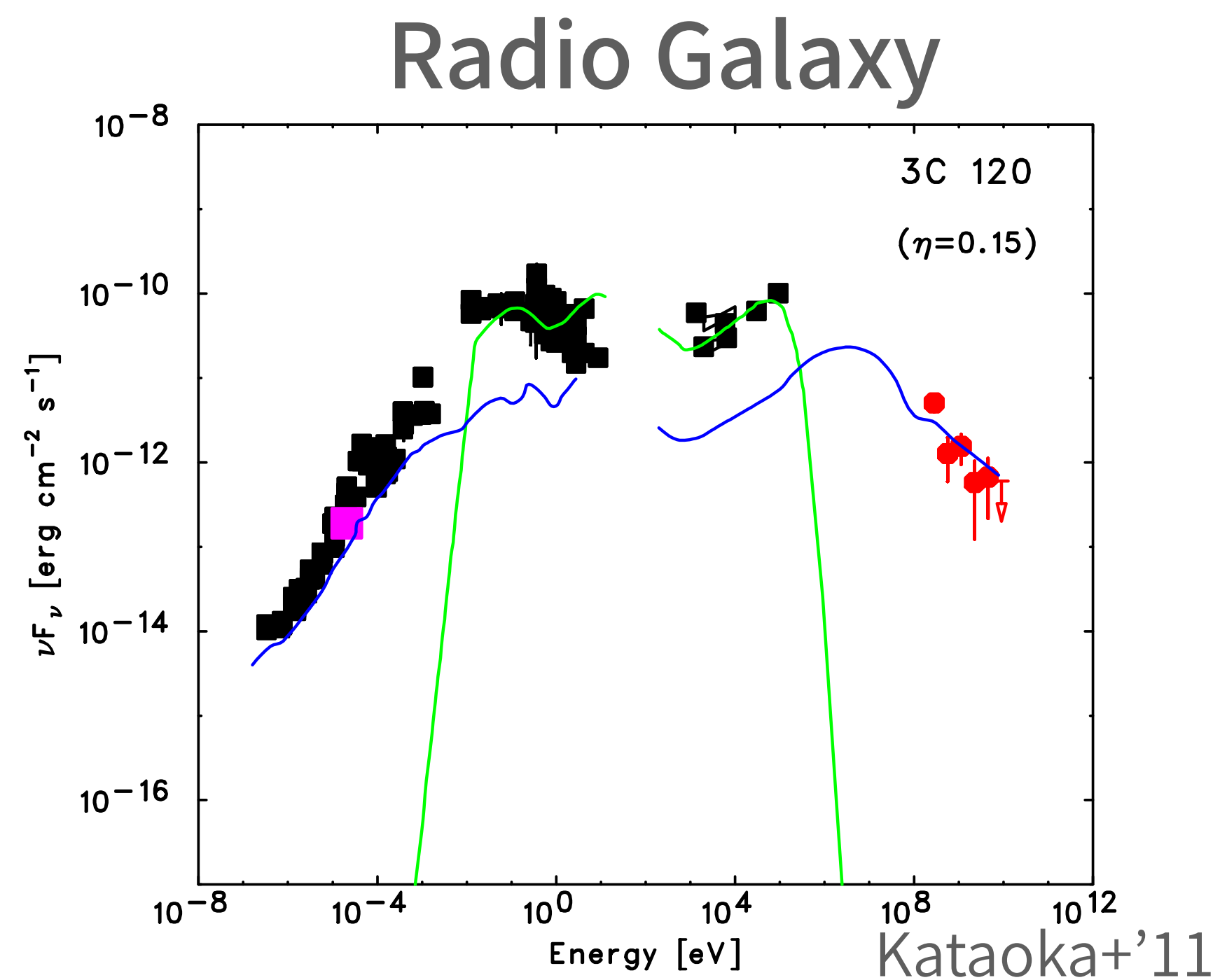
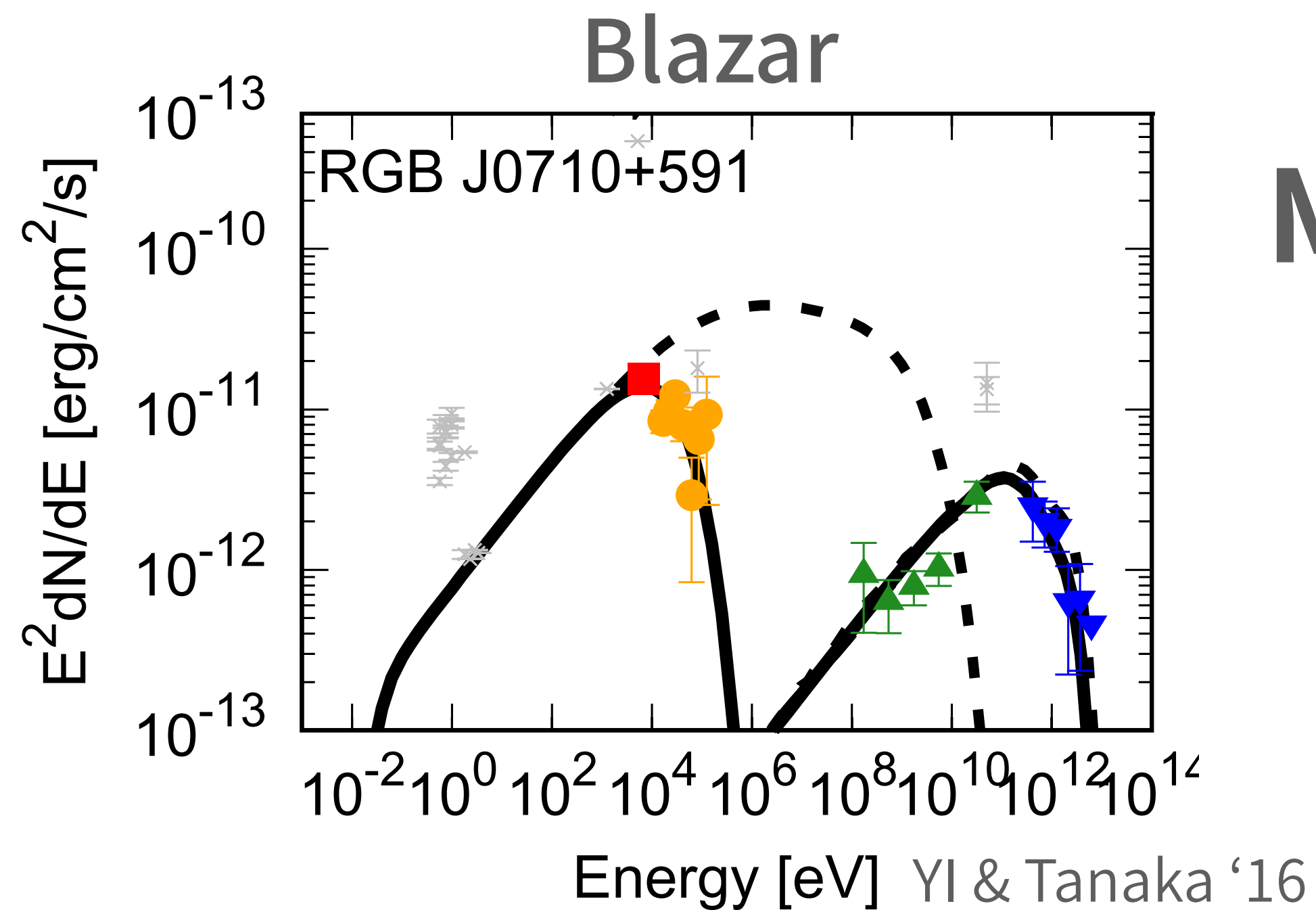
セイファートのミリ波超過成分の起源

井上芳幸 (理研) ・ 土居明広 (宇宙研)

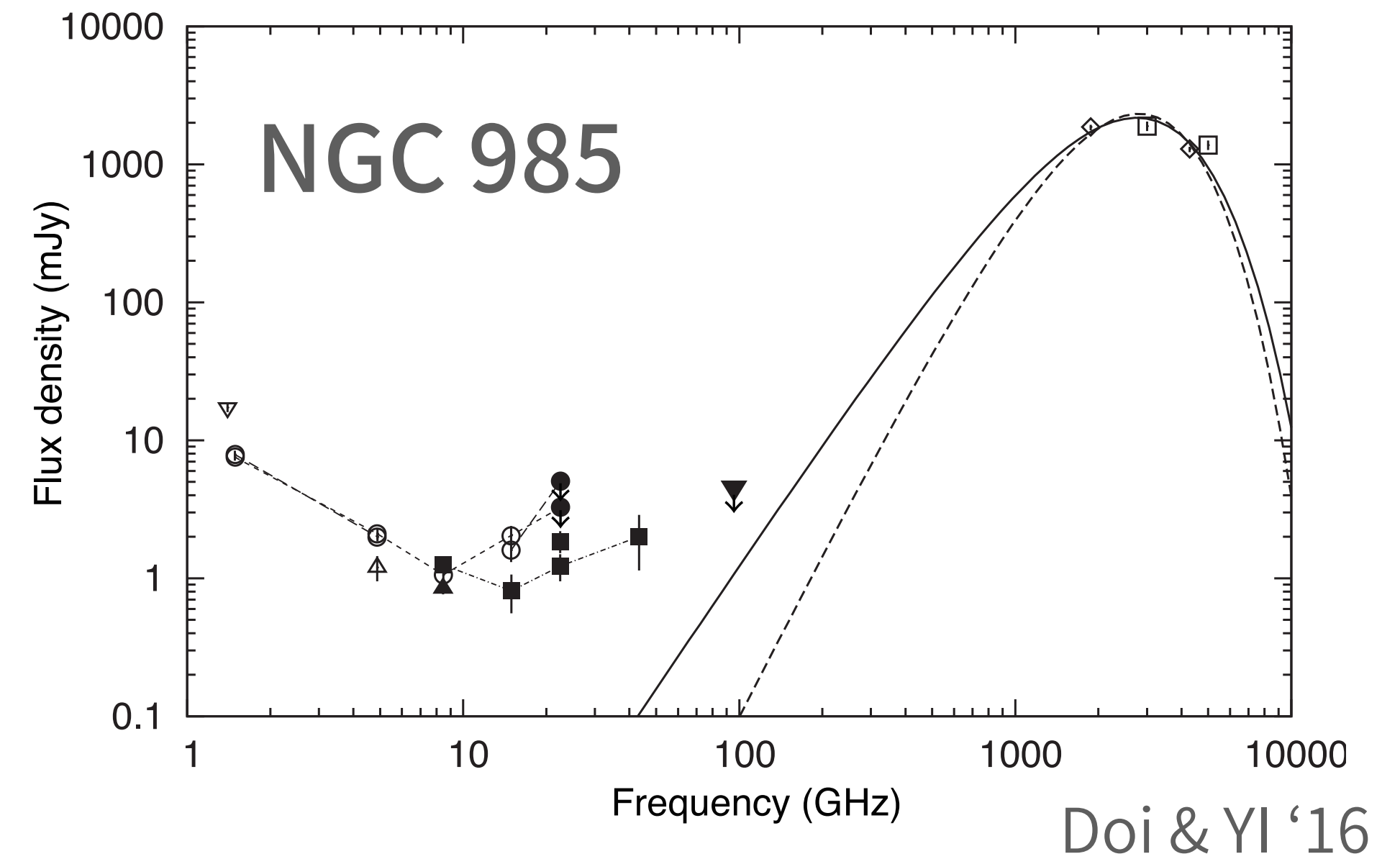
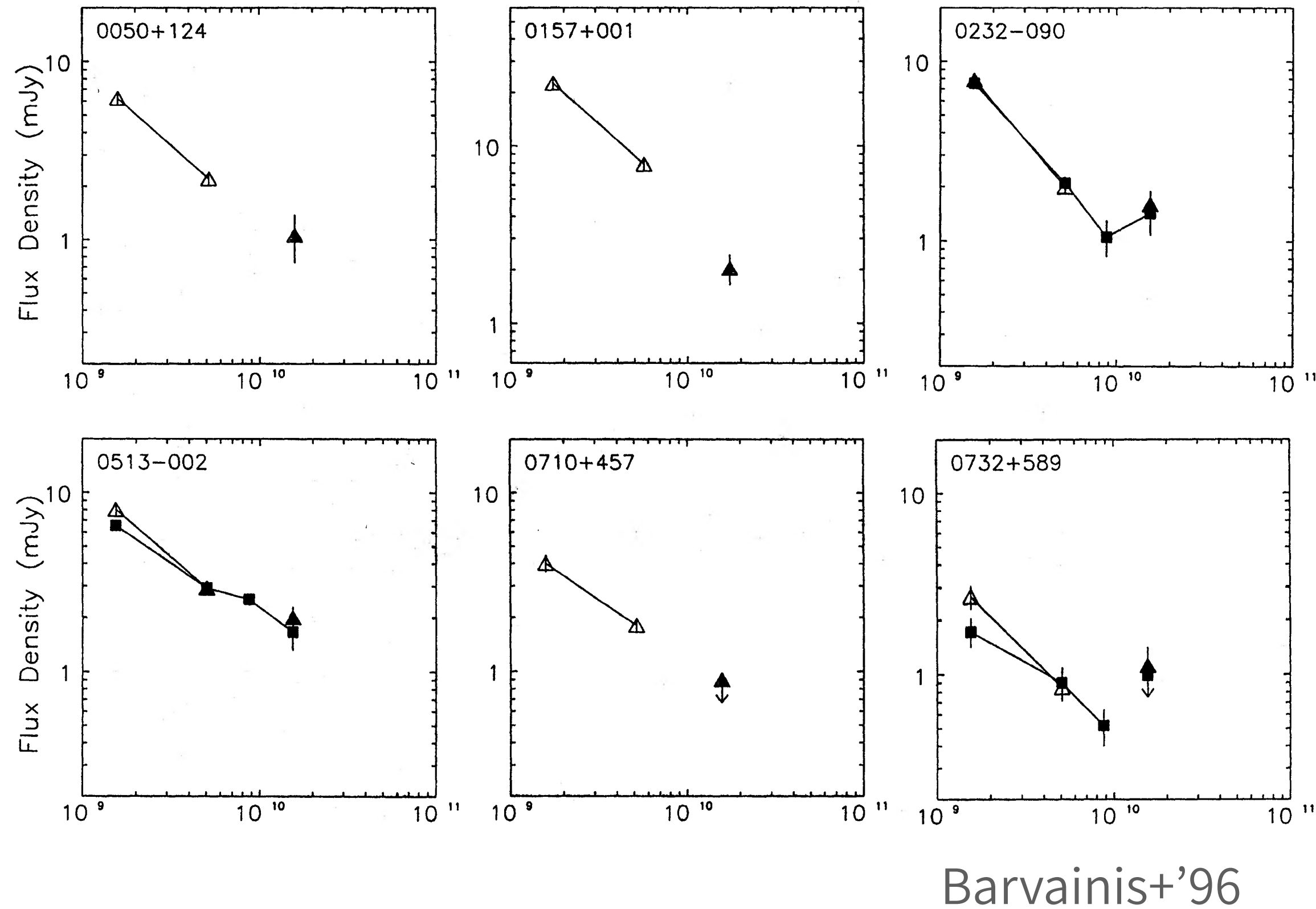
ASJ Meeting @ Online, 2020-09-09



Multi-wavelength spectrum of AGNs

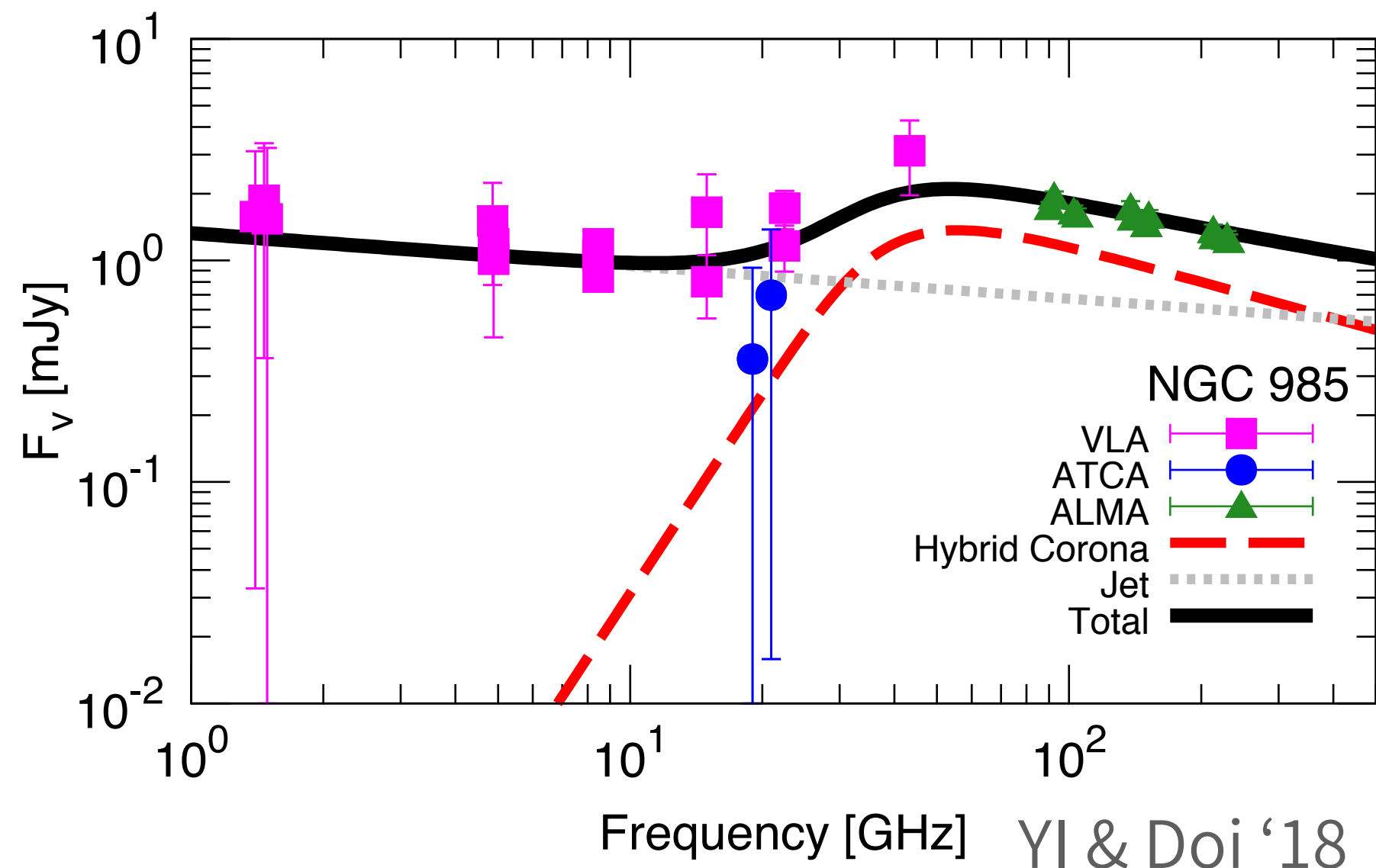
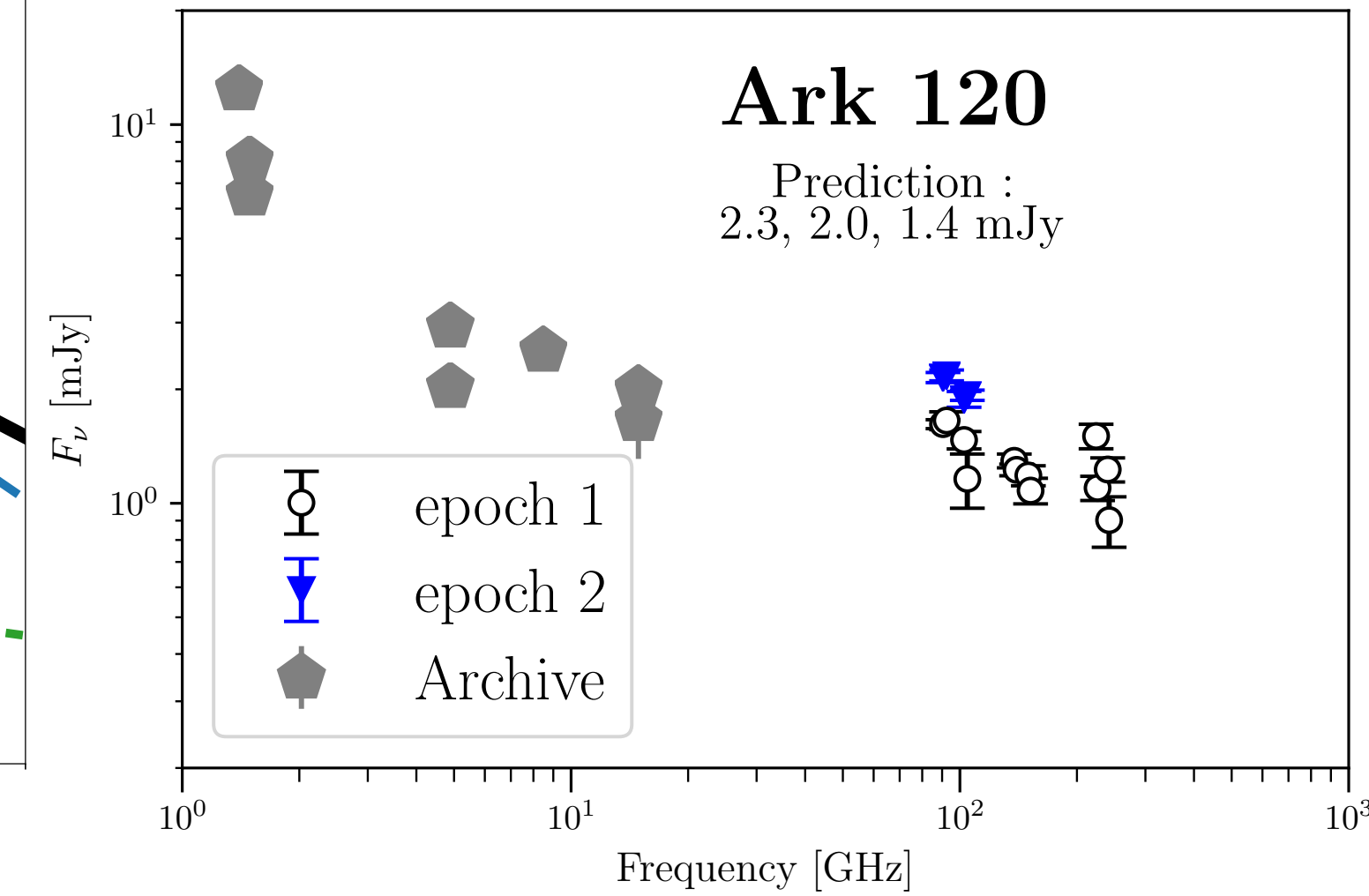
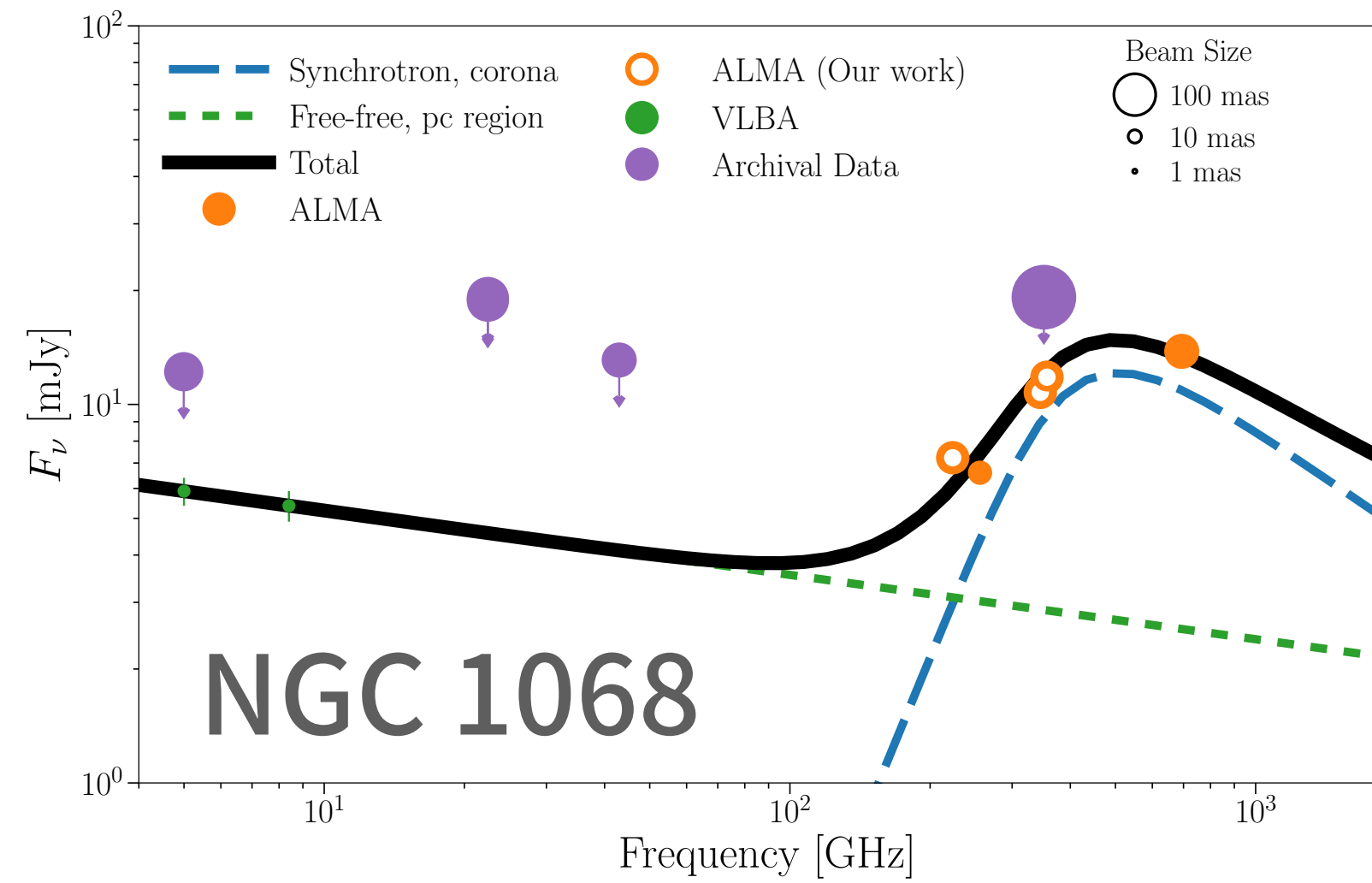
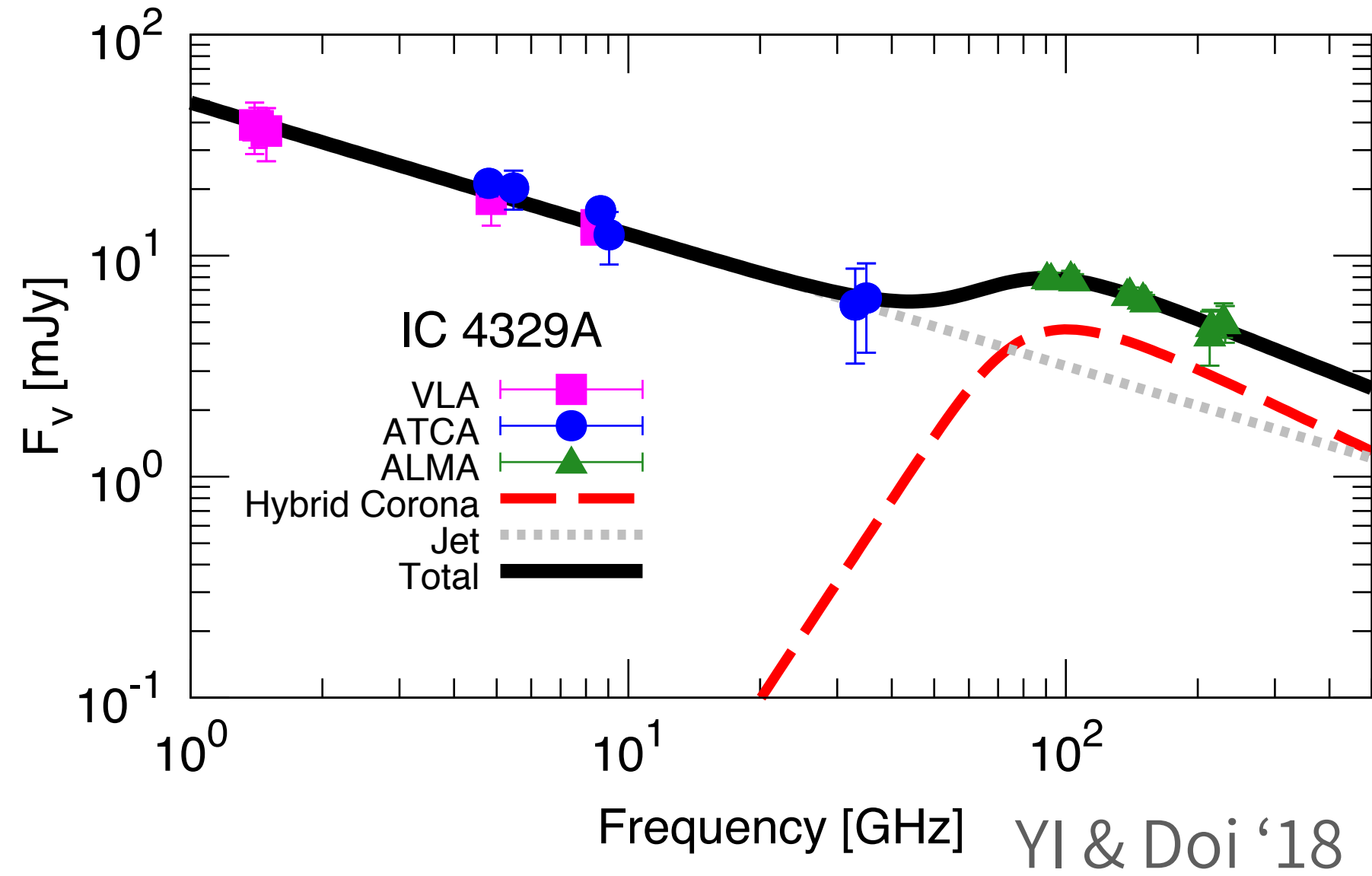


Millimeter excess in nearby Seyferts



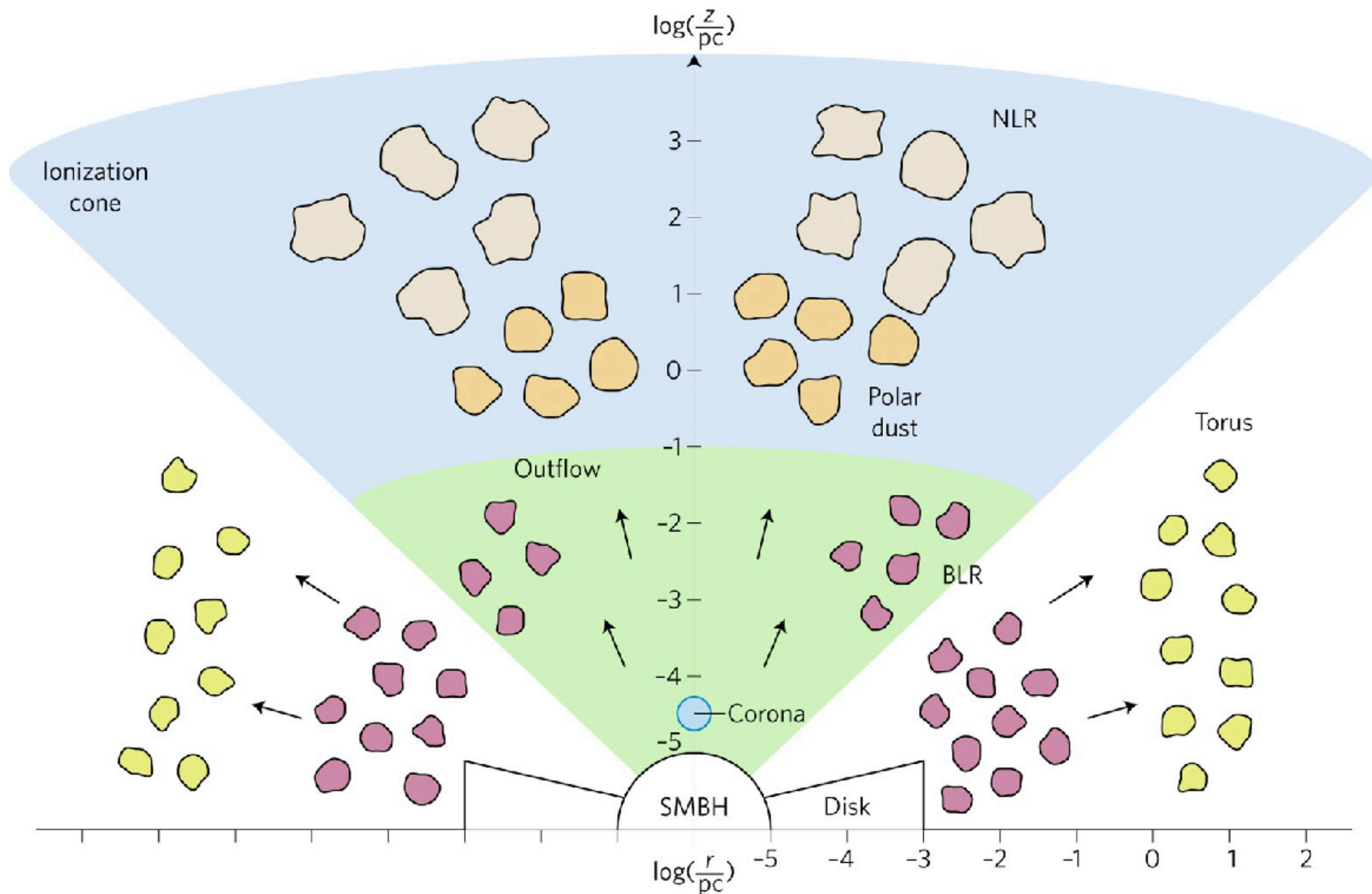
- Spectral excess in the mm-band
(e.g., Antonucci & Barvainis'88; Barvainis+'96; Doi & Inoue '16; Behar+'18).
- Contamination of extended components?
- Multi-frequency property?

ALMA observations toward nearby Seyferts



- Clear excess in nearby Seyferts
(YI & Doi '18; YI, Khangulyan, & Doi '20; YI+in prep.)
- Flux ~ 1-10 mJy peaking @ a few tens GHz
- Some shows time variability ~1 month
(see also Behar+'20)
- Size : < 10 pc → Nucleus

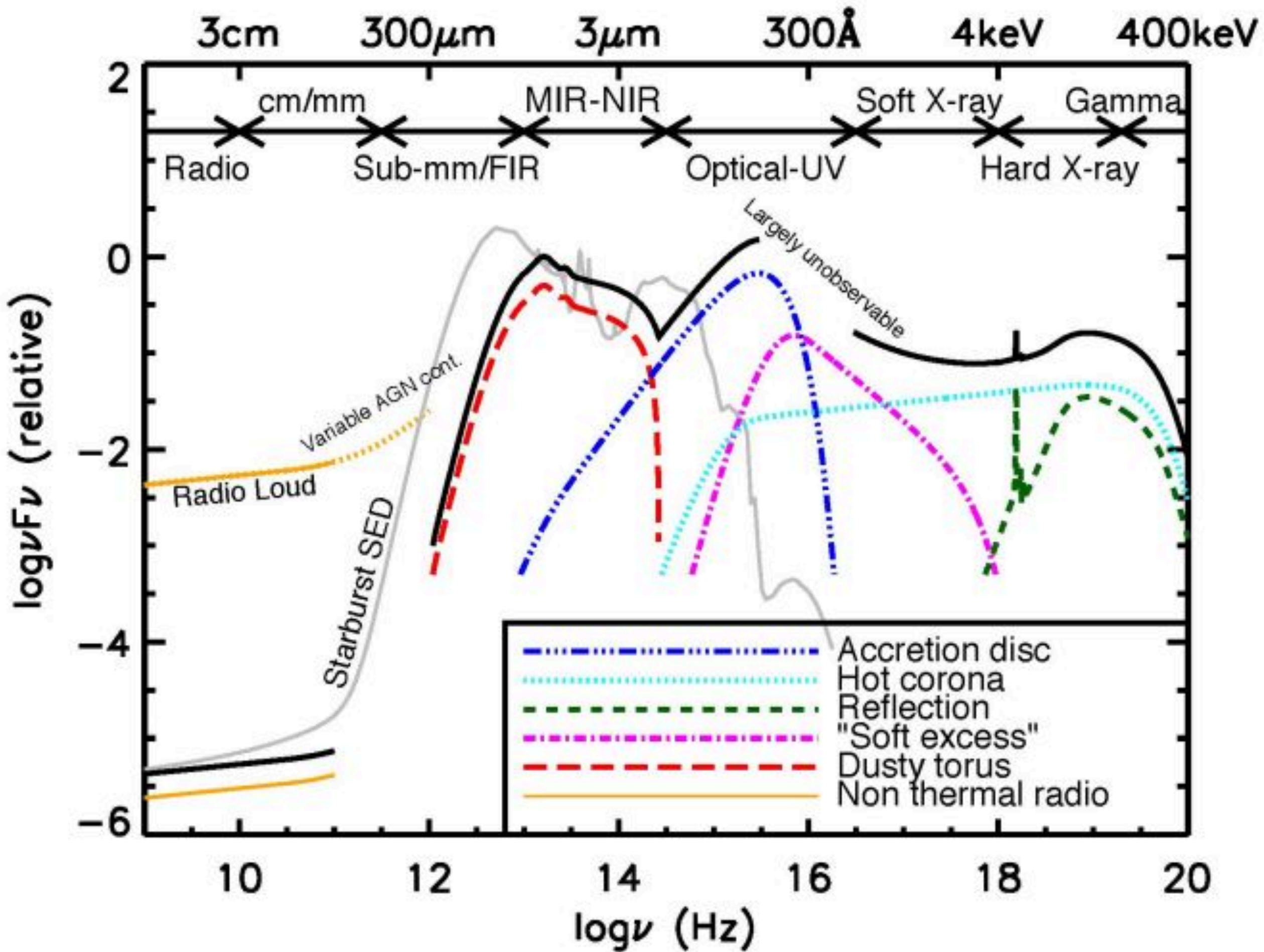
Structure of AGN core in the <10 pc scale



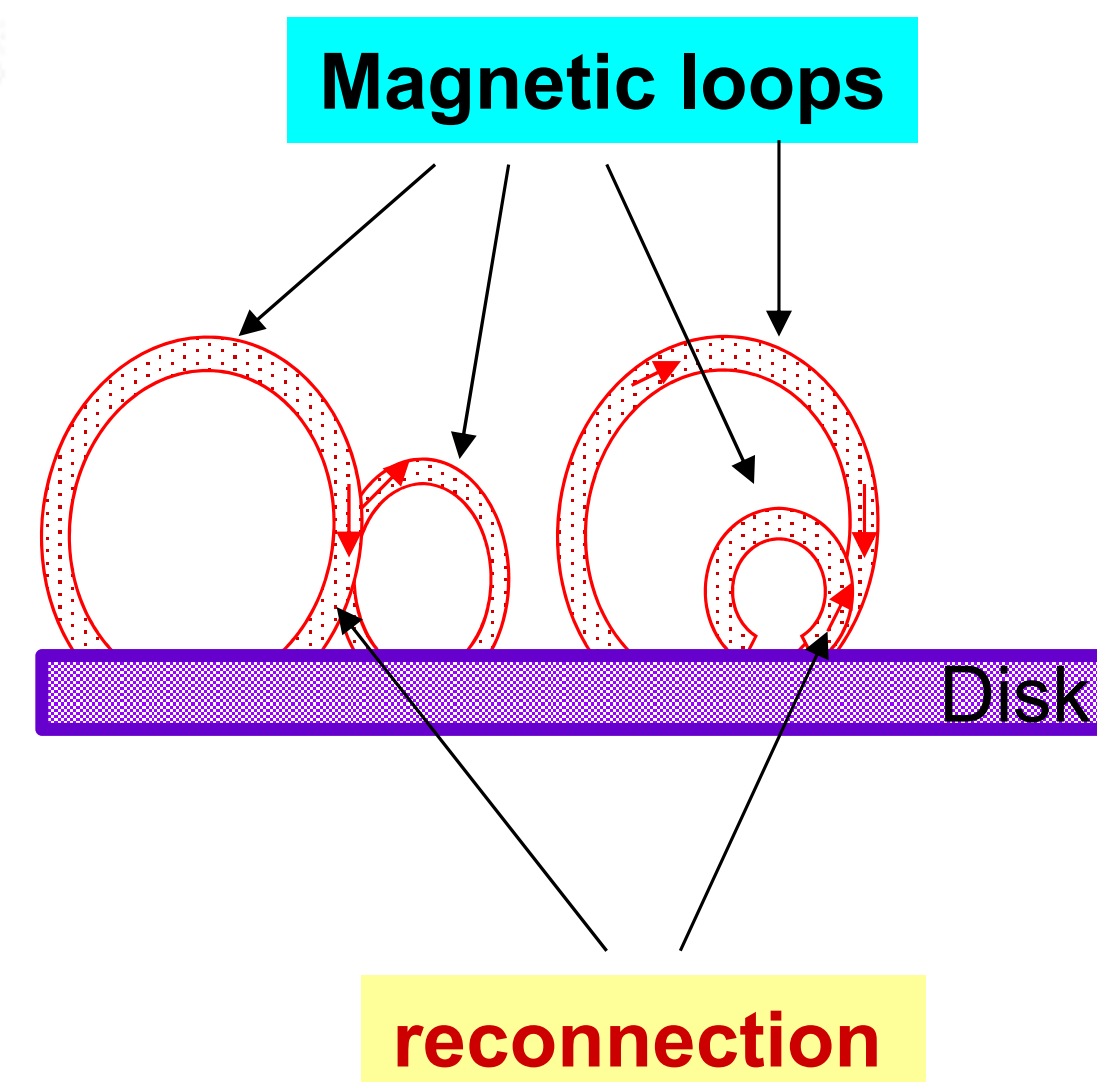
Ramos-Almeida & Ricci '17

- Dust torus?
- spectral shape, not enough, variability
- Free-free?
- spectral shape, not enough
- Jet?
- radio-quiet, no blazar like activity
- Corona?

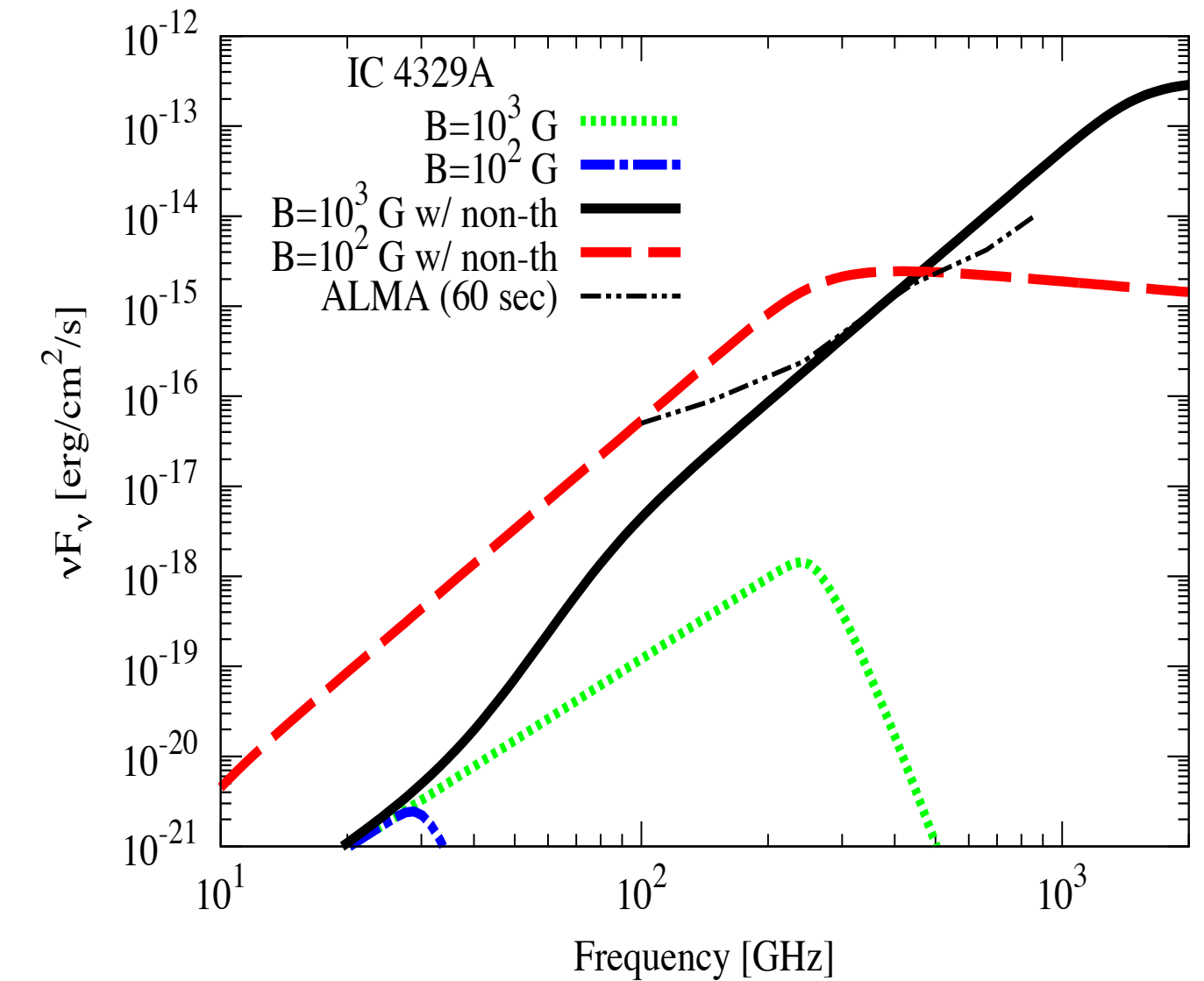
Supermassive black hole corona?



Hickox & Alexander+'16



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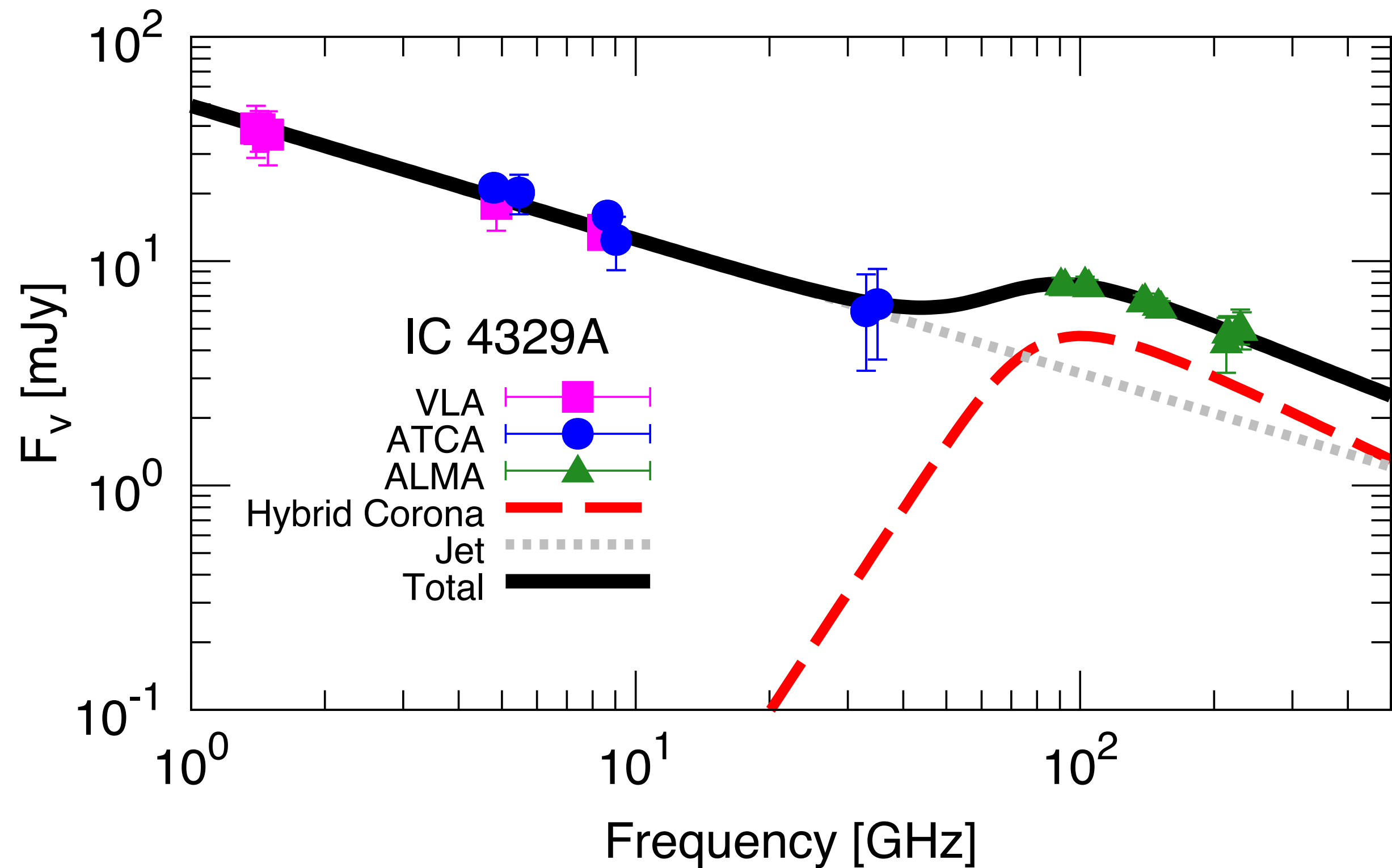


YI & Doi '14

- Hot corona (~100 keV)
- Heated by magnetic activity ?
(e.g., Haardt & Maraschi '91; Liu, Mineshige, & Shibata '02)
- If so, coronal synchrotron radiation is expected
(Di Matteo+'97; YI & Doi '14; Raginski & Laor '16)

cm-mm spectrum of AGN core

A case of IC 4329A



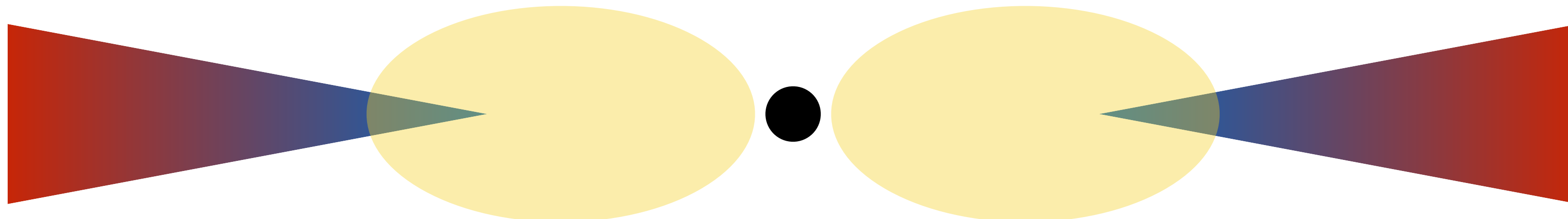
YI & Doi '18

- Hybrid corona model (YI & Doi '14)
- Non-thermal electron fraction : $\eta = 0.03$ (fixed)
- Consistent with the MeV gamma-ray background spectrum (YI, Totani, & Ueda '08; YI+'19)
- Non-thermal spectral index: $p = 2.9$
- Size: $40 r_s$
- B-field strength : 10 G

Reconnection Corona Heating?

Implication for the truncated accretion disk structure.

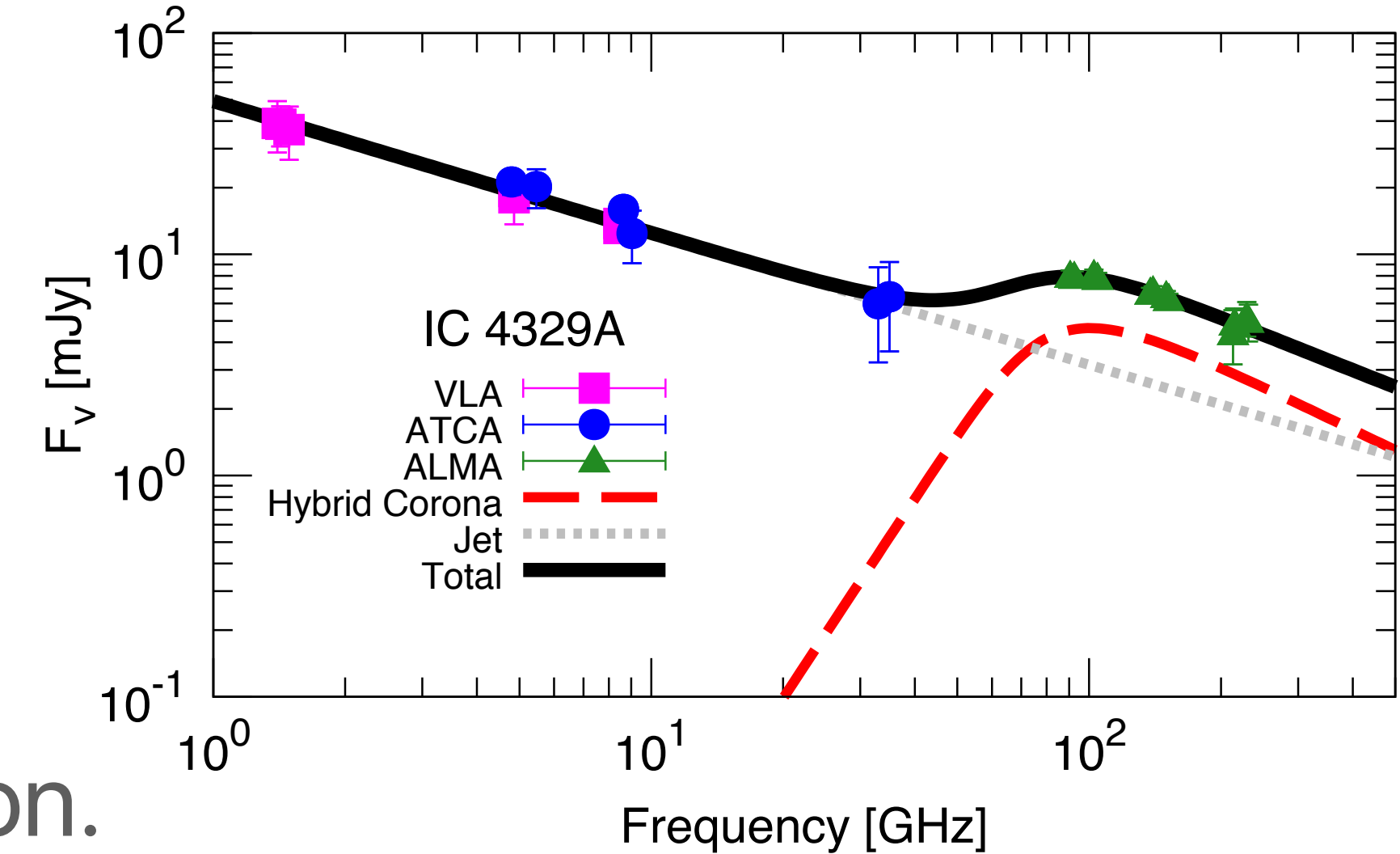
- Heating and Cooling
 - Magnetic Heating: $B^2 V_A / 4\pi$
 - $Q_{B, \text{heat}} \sim 10^{10} \text{ erg/cm}^2/\text{s}$
 - Compton Cooling: $4kTn_e\sigma_T c U_{\text{rad}} l / m_e c^2$
 - $Q_{\text{IC, cool}} \sim 10^{13} \text{ erg/cm}^2/\text{s}$
 - Magnetic field energy is **NOT** sufficient to keep coronae hot.
- Disk truncation at some radii (e.g. $\sim 40 r_s$)
 - The inner part = hot accretion flow (Ichimaru '77, Narayan & Yi '94, '95).
 - Heated by advection.
 - Suggested for Galactic X-ray binaries. (e.g. Poutanen+'97; Kawabata+'10; Yamada+'13).
- Simultaneous model fitting to X-ray and radio data is required.



Summary

- Radio spectra (mm-band) of Seyferts are still not well understood.
- The mm-excess seems exist ubiquitously in nearby Seyferts.

- ~1-10 mJy
- Spectral peak at ~a few tens GHz.
- Variable (at least monthly time scale)
- Probably, originated from coronal synchrotron emission.
- Magnetic field are not strong enough to keep coroneae hot.



YI & Doi '18