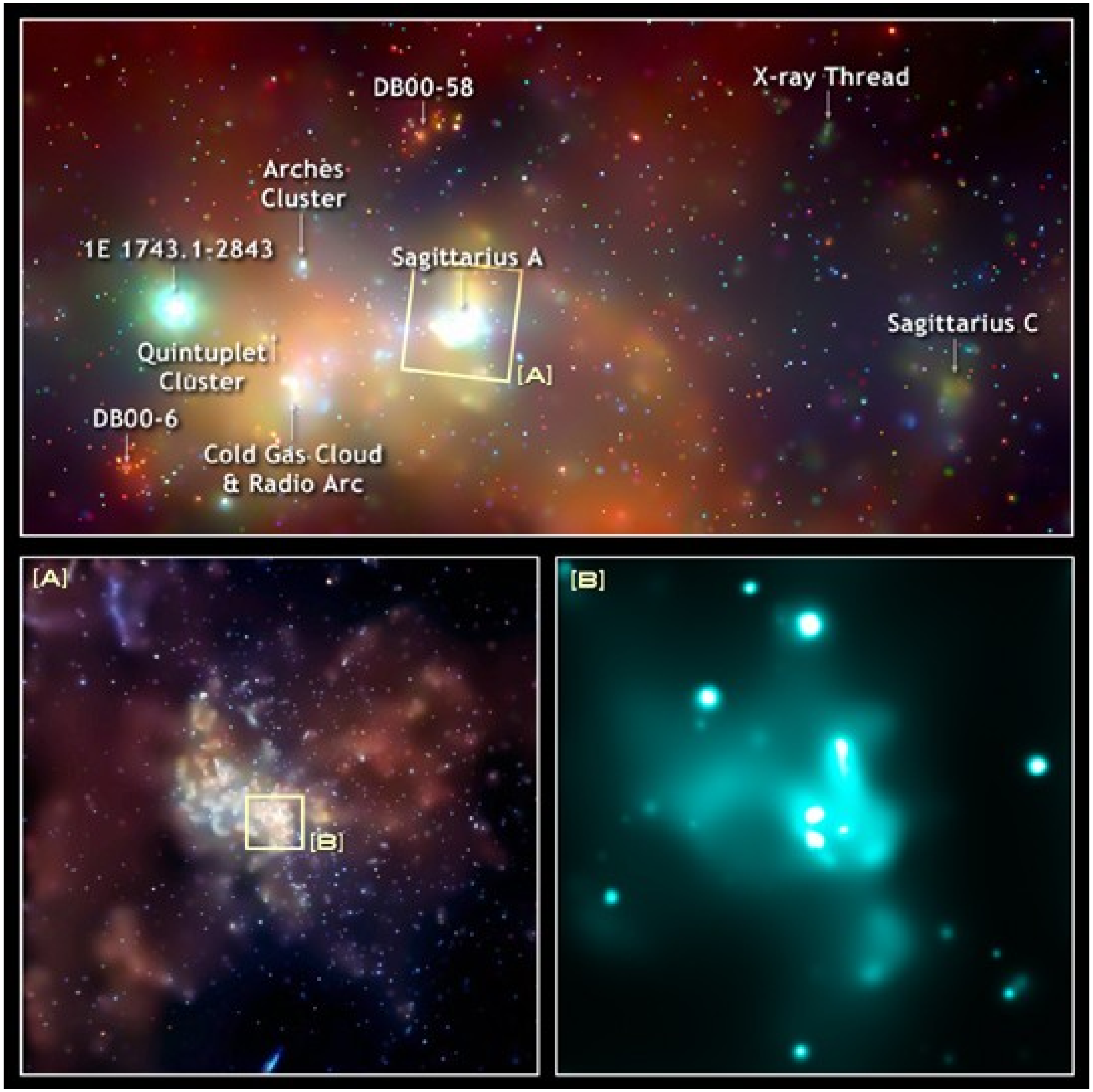
Radiative Transfer Calculation of Accretion Flows around Supermassive Black Holes



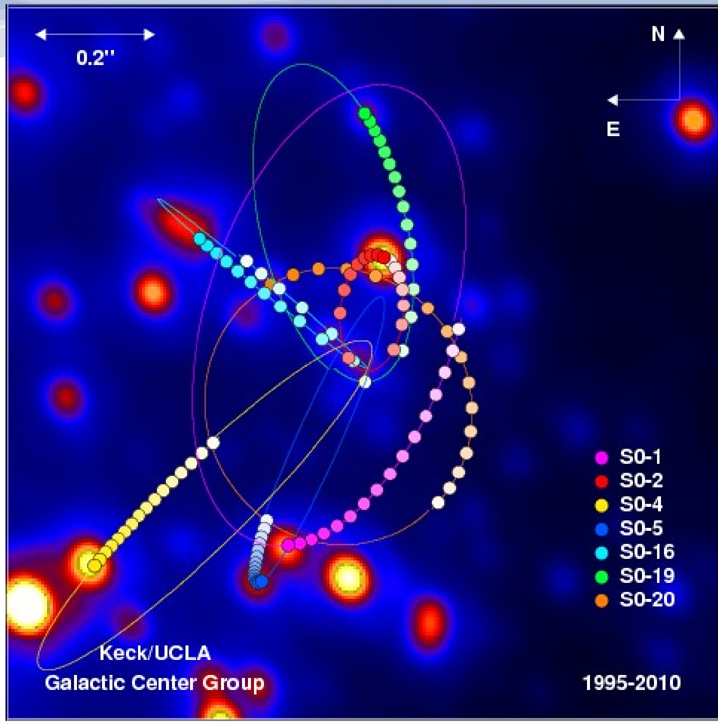
Chandra

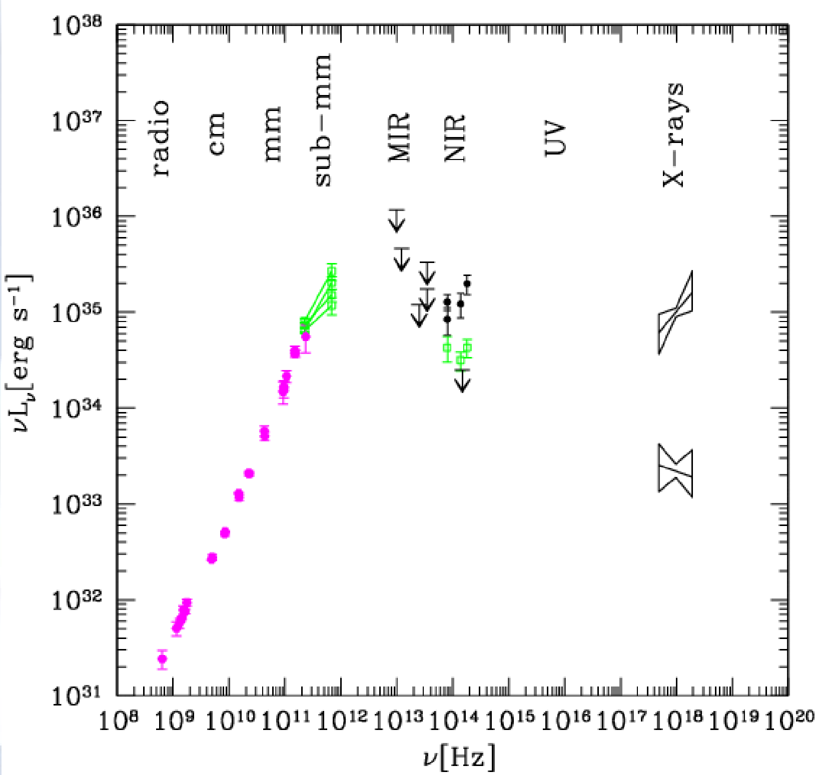
Po Kin Leung (UCSB)

Future of Astrocomputing Conference

Dec 17, 2010

Collaborators:
Charles Gammie,
Joshua Dolence,
Monika Moscibrodzka,
Hotaka Shiokawa,
Omer Blaes





- Stars around Sgr A*
- Supermassive BH

  $M_{\rm BH} \sim 4 \times 10^6 M_\odot$
- Broadband spectrum observed
- $L \sim 10^{-9} L_{\rm edd}$

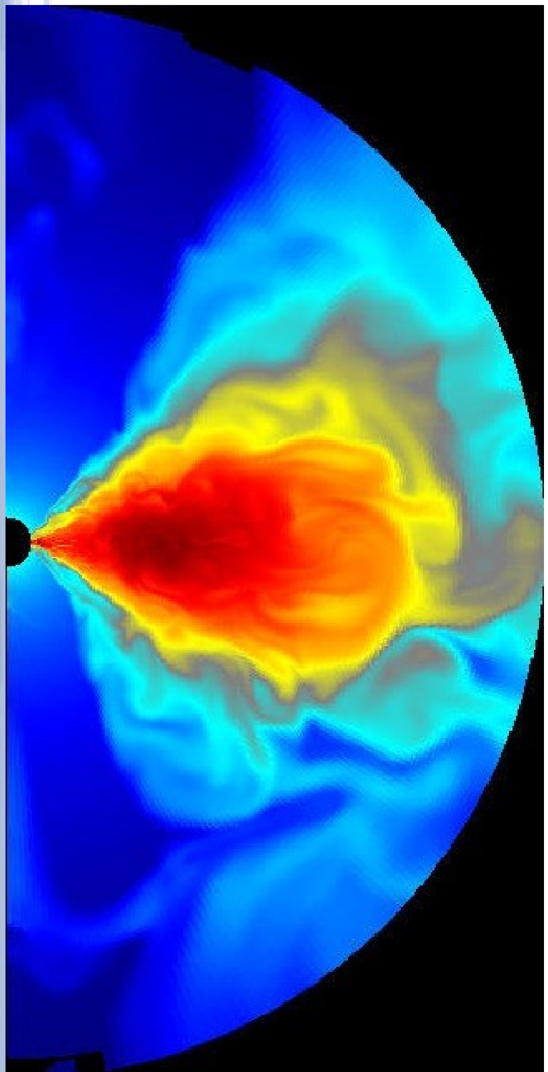
  Low Luminosity AGNs
- Accretion disk around supermassive BH
- Radiatively Inefficient Accretion Flow (RIAF)

Disk Model (HARM 2D: Gammie et al. 03,
3D: Noble et al. 06, 09)

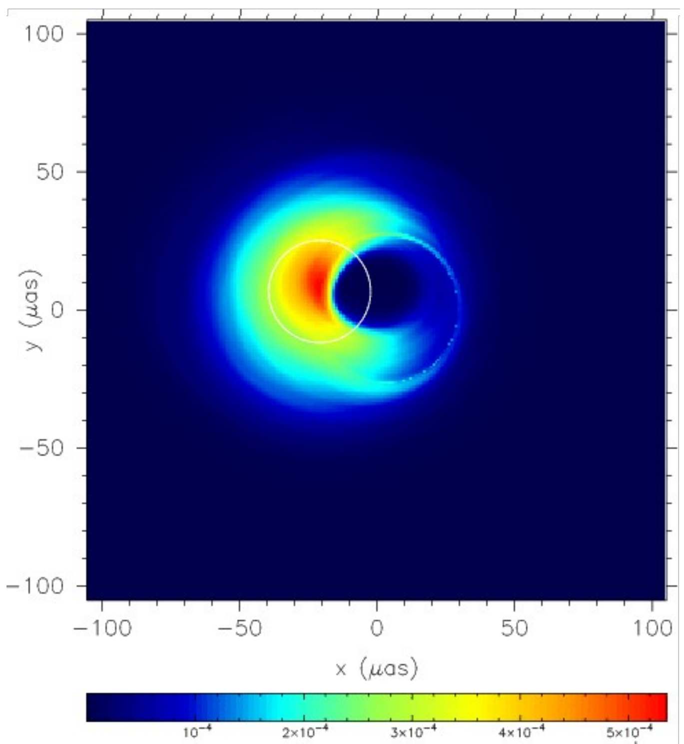
+ Emission (harmony: Leung et al. 09)

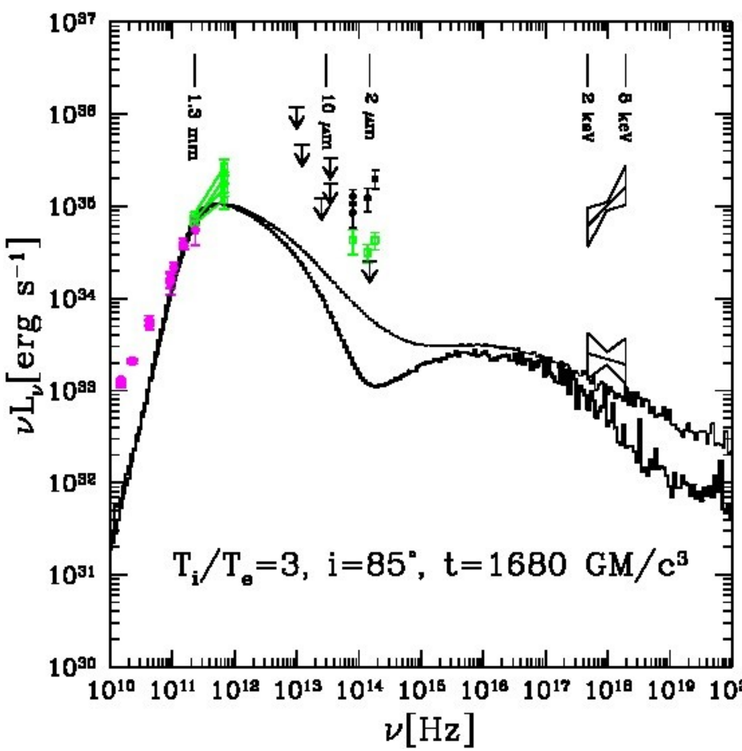
+ Radiative Transfer (bothros: Noble et al. 09,
grmonty: Dolence et al. 09)

= image , spectrum



HARM 2D
(Gammie et al. 03)

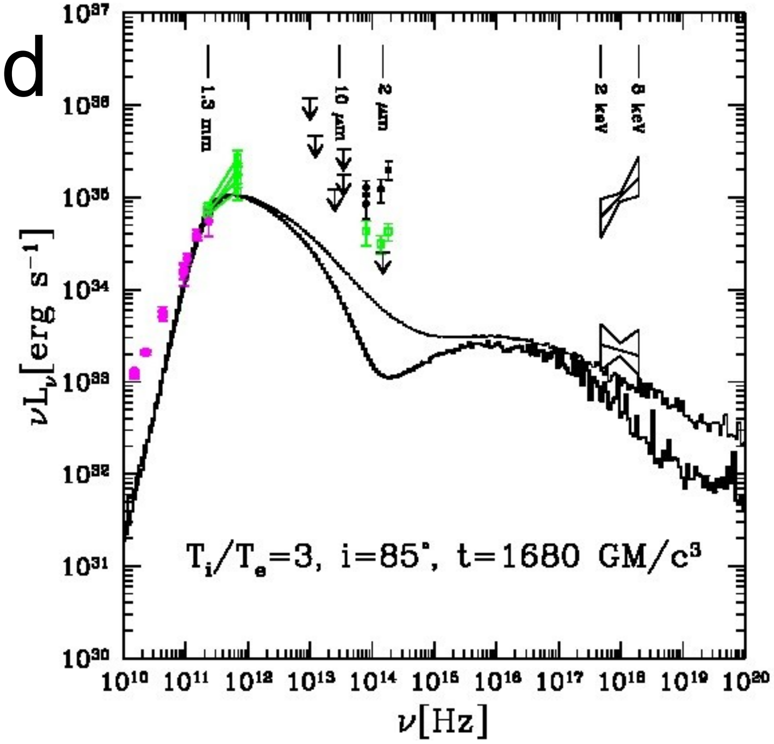




Moscibrodzka et al. 09

Flaring events

- NIR flares occur ~4 times/day,
  X-ray flares occur ~1 times/day
- X-ray flare must come with NIR flare, not vice versa
- NIR flares are highly polarized
- Strong NIR flares have spectral slope $\sim 0.4 \pm 0.2$ (Hornstein et al. 2007)
- Spectral slope of X-ray flares is less certain

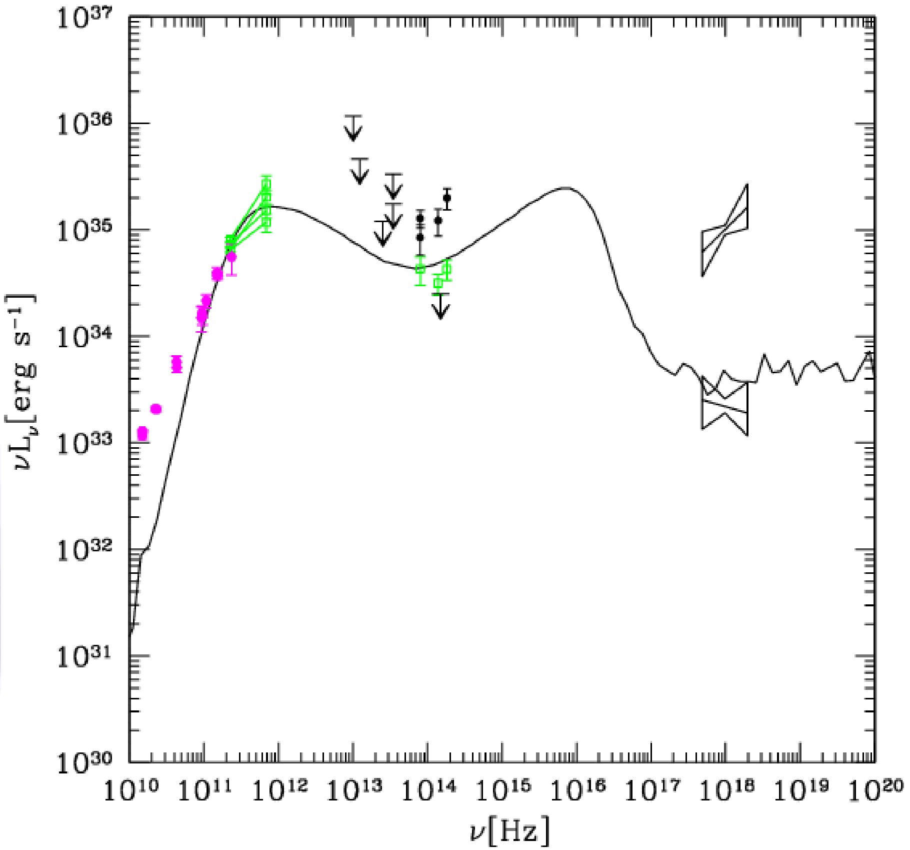


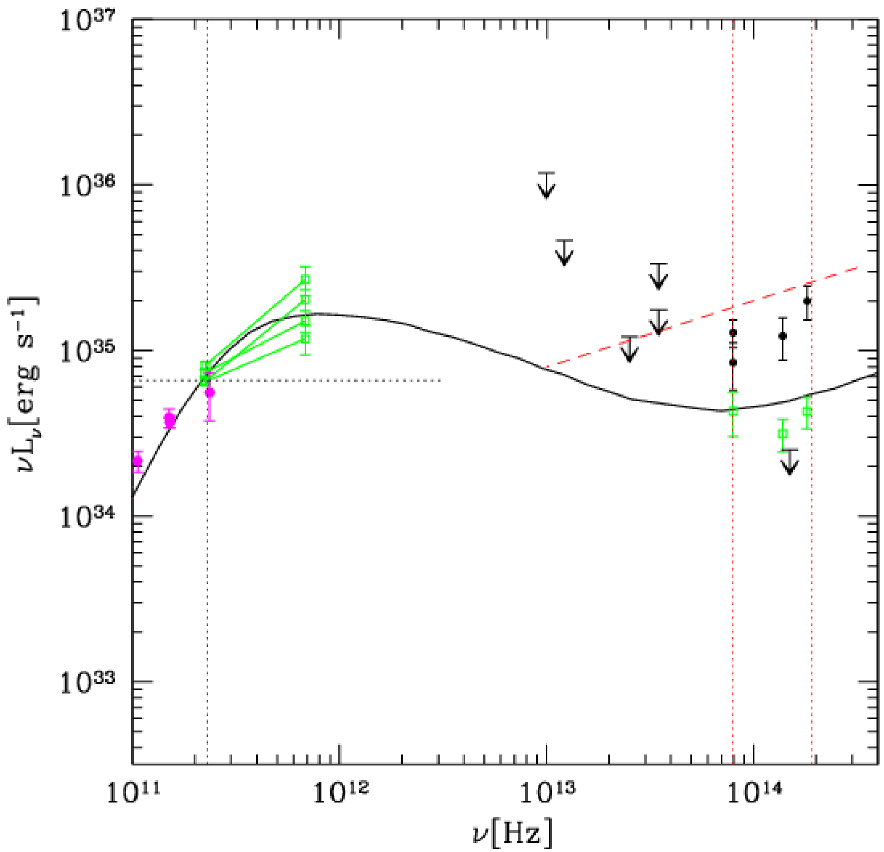
Adding non-thermal electrons

- Power-law distribution with single index

$$n_{\rm nth}(\gamma) \propto \gamma^{-p} \quad \text{for } \gamma_{\rm min} \leq \gamma \leq \gamma_{\rm max}$$

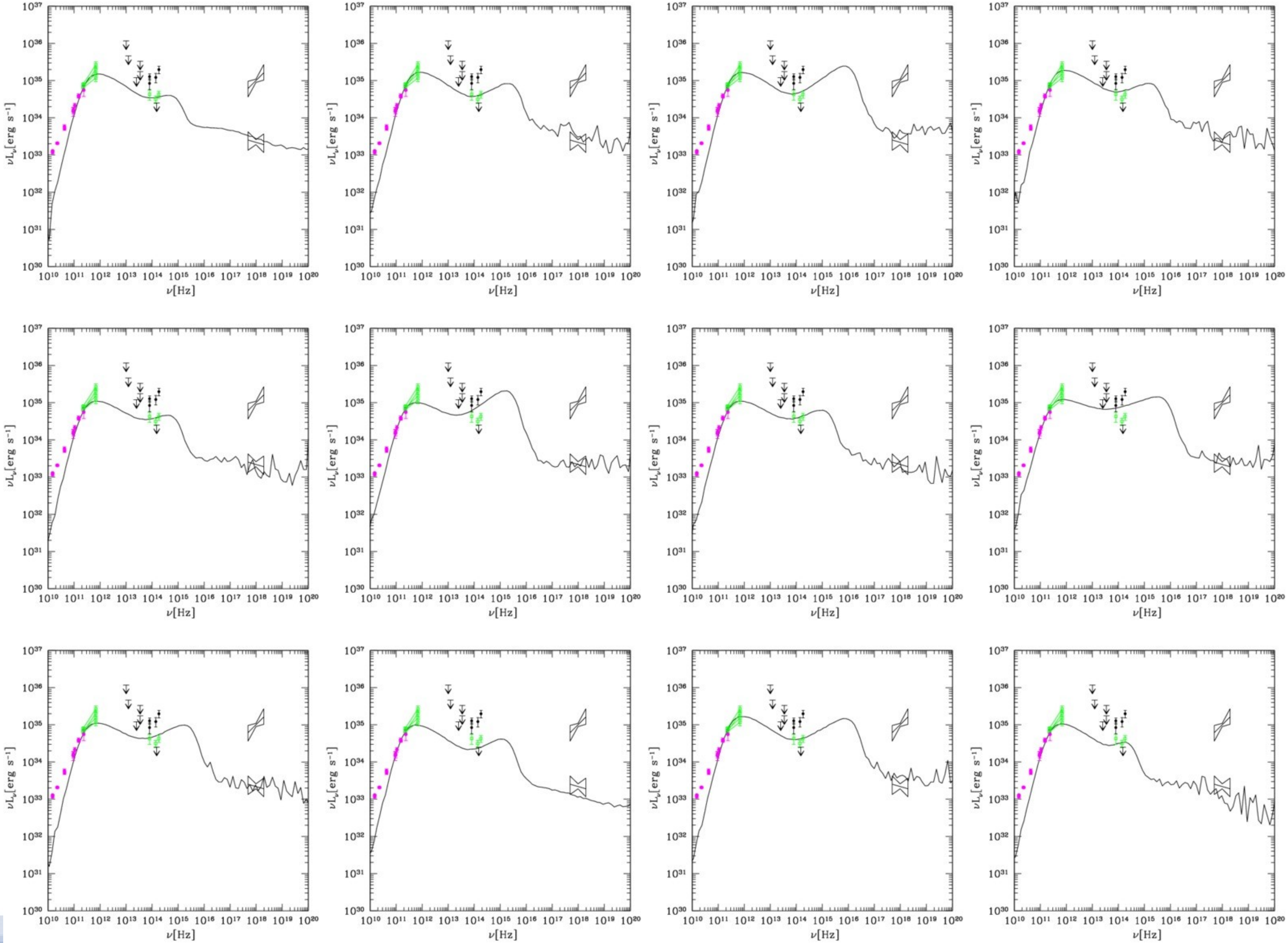
- Either use X-ray flares as upper limit, or fit them
- Parameters are $p, \gamma_{\rm min}, \gamma_{\rm max}, \eta \equiv u_{\rm nth}/u_{\rm th}$





Leung et al., in prep.

Degeneracy of parameters



Conclusions

- GRMHD and RT simulations of accretion disk around black hole
- Consider non-thermal electrons for flaring event
- Degeneracy of parameters
- Take-home message:

  Positive spectral slope observed in strong NIR flares of Sgr A* can be explained by synchrotron emission of small amount of non-thermal electrons

Thank you!