Models for Sgr A* in the Context of Other Low-Luminosity Black Holes

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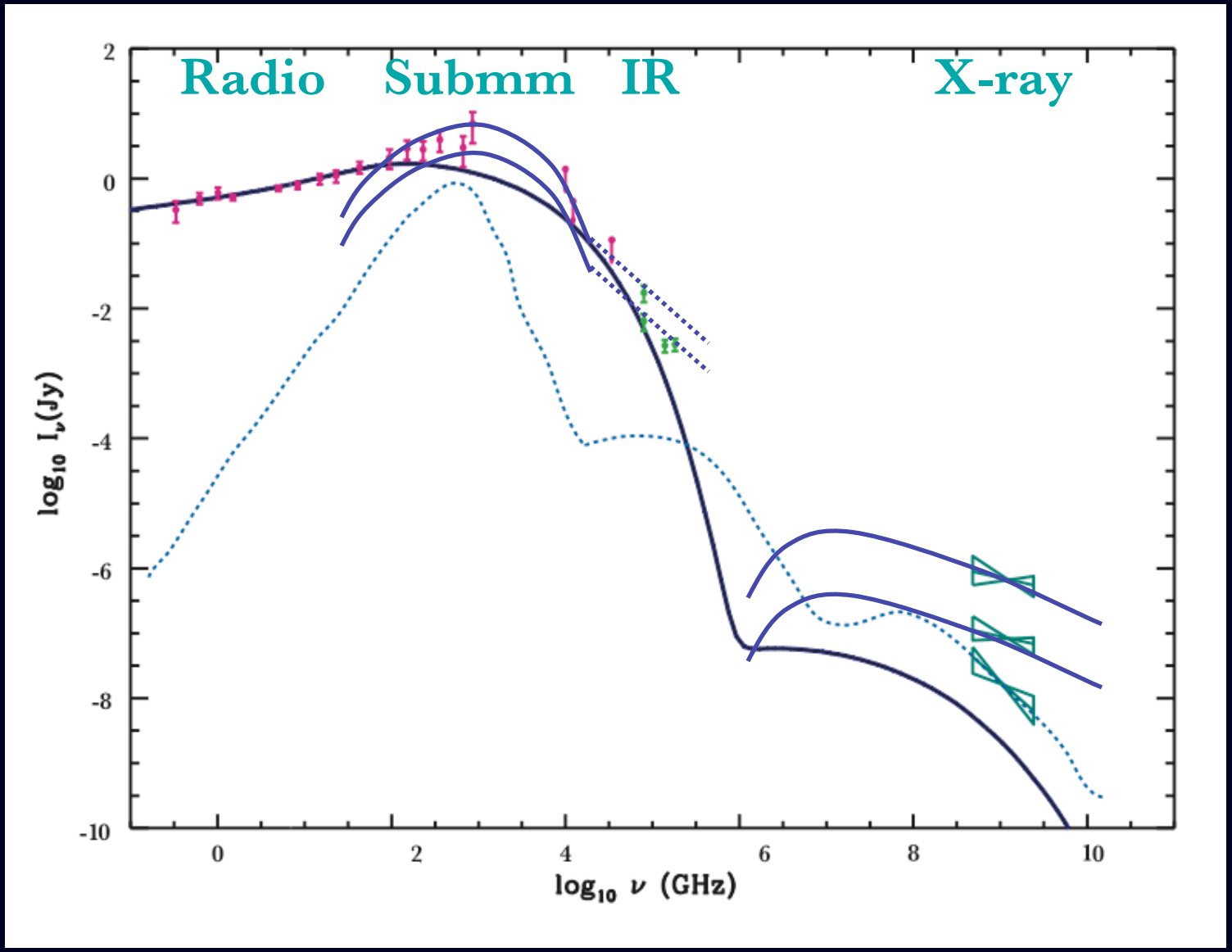
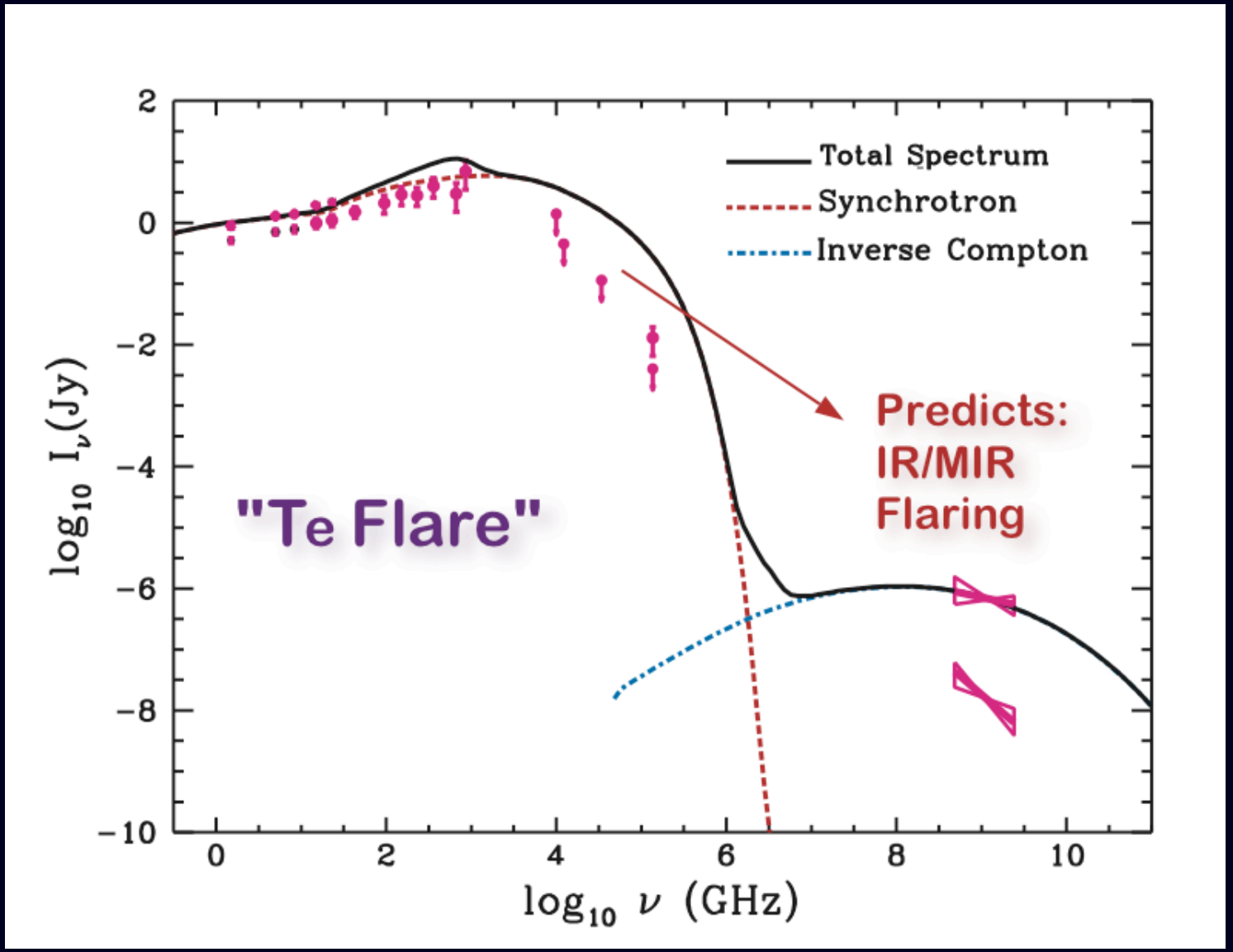
Phenomenology of flares



(Markoff et al. 2001, Yuan et al. 2002)

Big *Chandra* flare (50x)



(Markoff et al. 2001)

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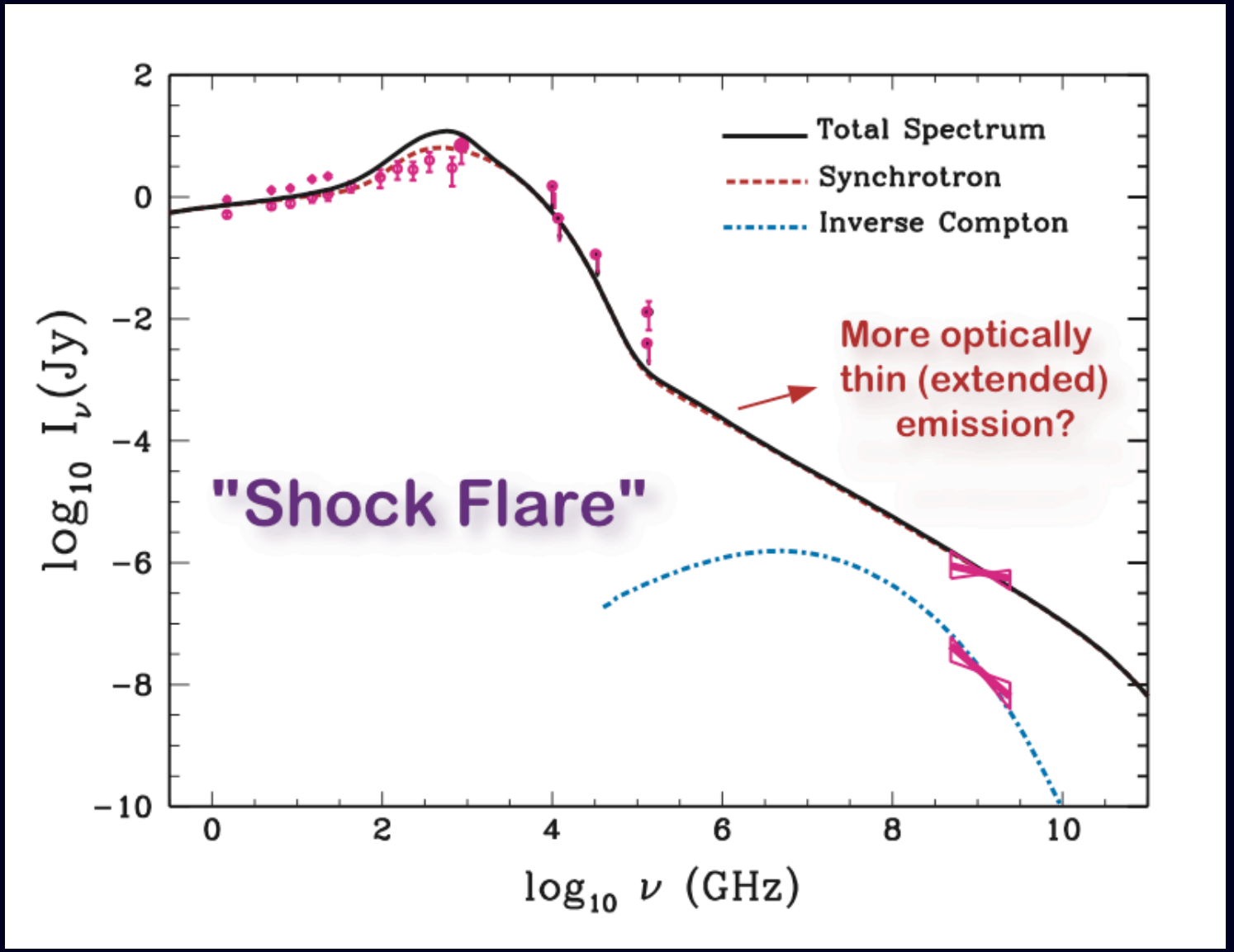
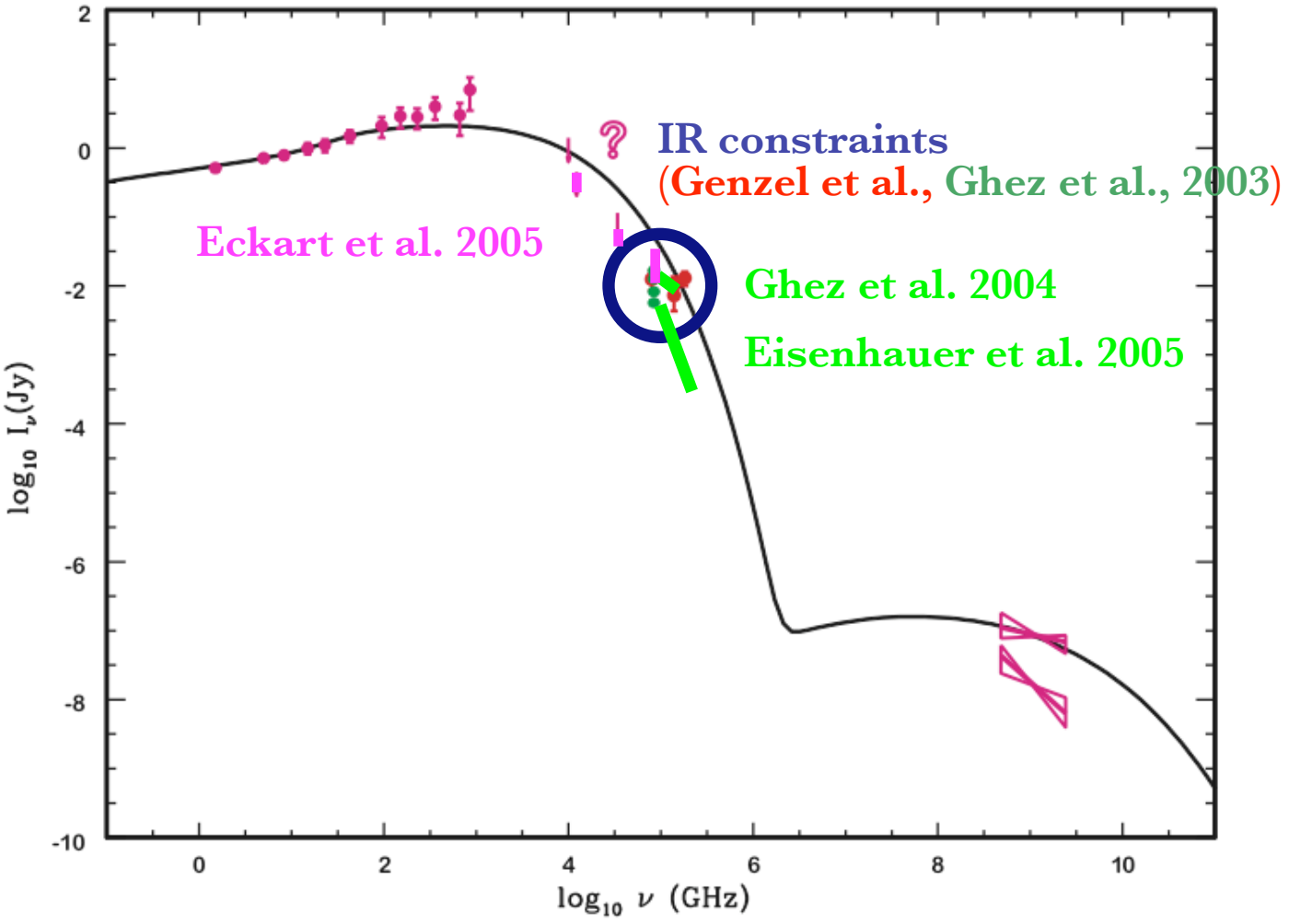


(Markoff et al. 2001)

"Average" daily flares (5-10x)



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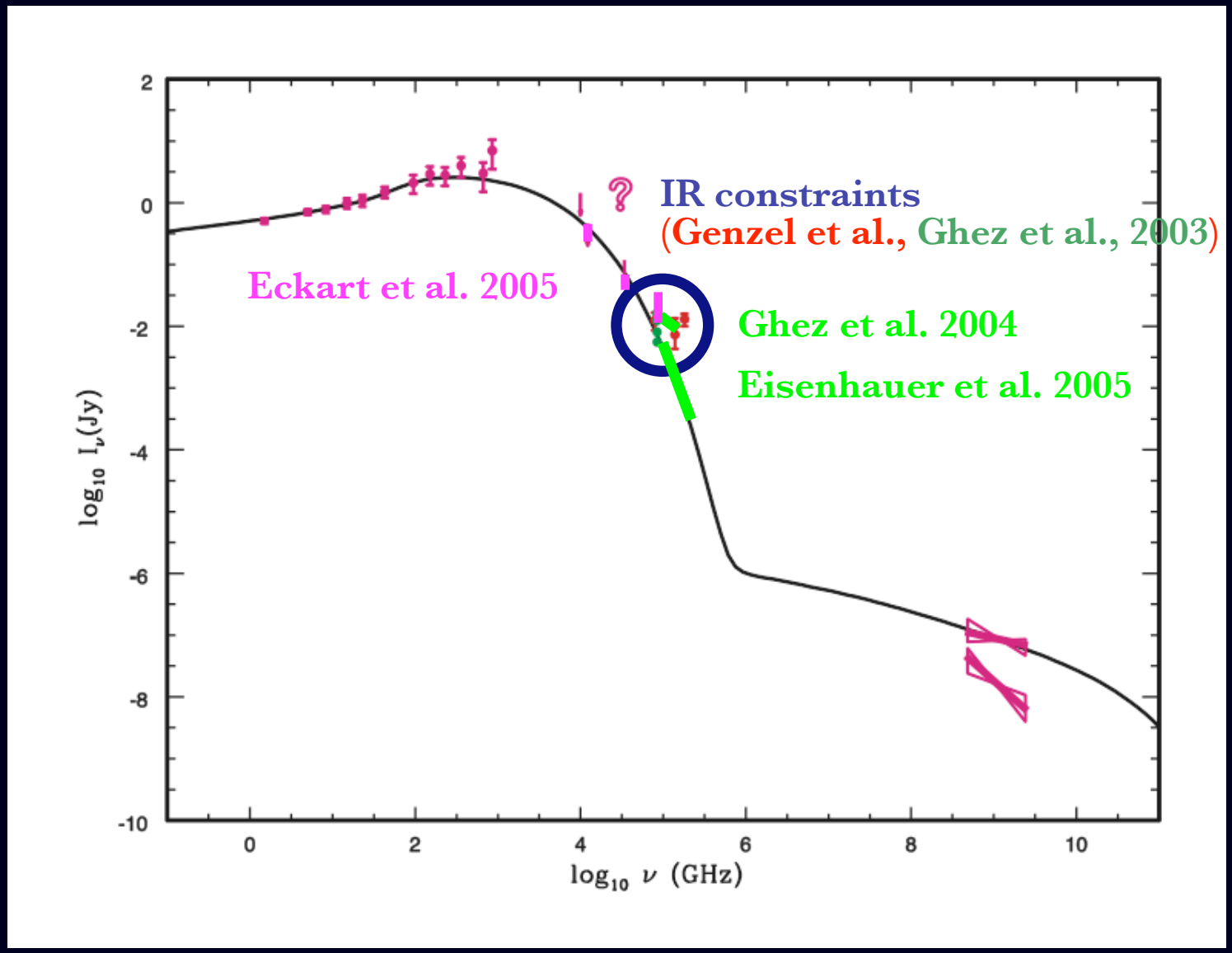


Flares: Key Points

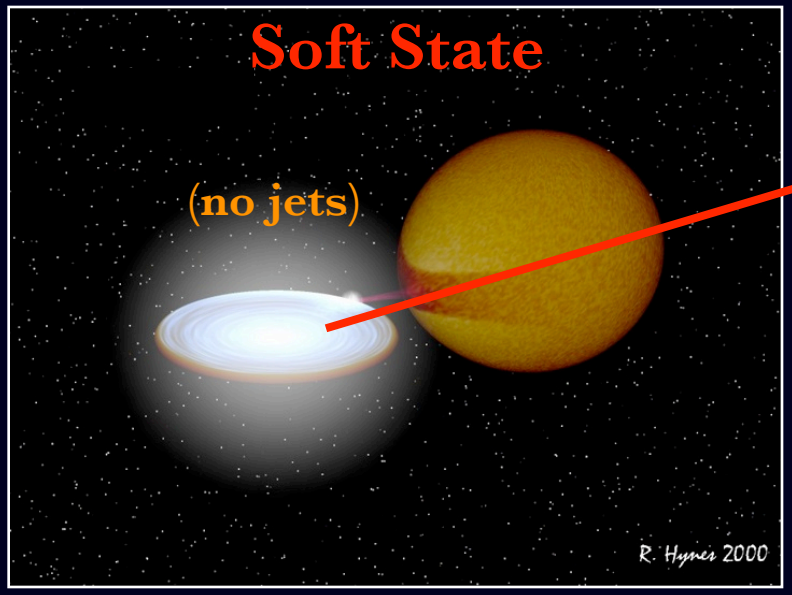
- Observations have confirmed theoretical predictions of a SSC/synch [i.e., magnetic-related nonthermal] mech.
- "Overcoming X-ray quiescence": not all flares are seen in X-rays! For SSC in particular:
  - ➡ $\forall$ X-ray Flare $\exists$ NIR Flare, X-ray Flares $\subset$ NIR Flares
- Very subtle differences in T_e/γ_e and particle distribution shape can account for differences in NIR/X-ray amplitudes
- We still do not know what leads to the flares
- These things are really weird!!

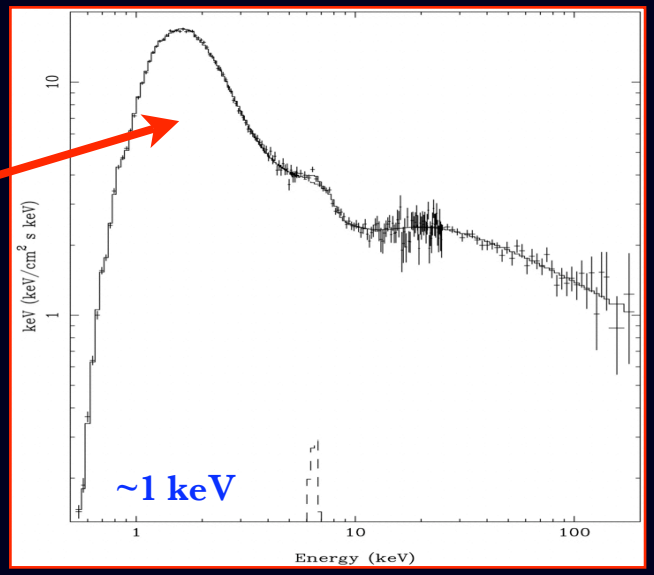
Other Low-Luminosity Black Holes

XRB Accretion States

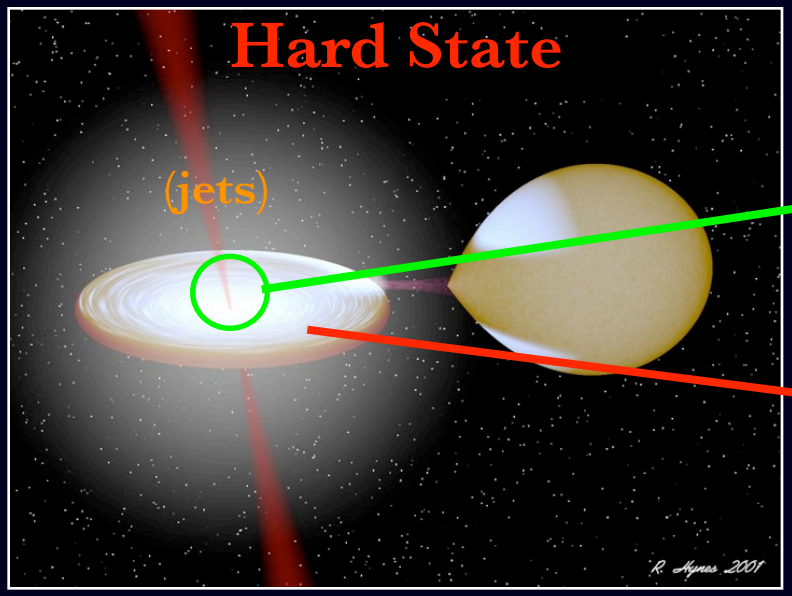
Luminosity

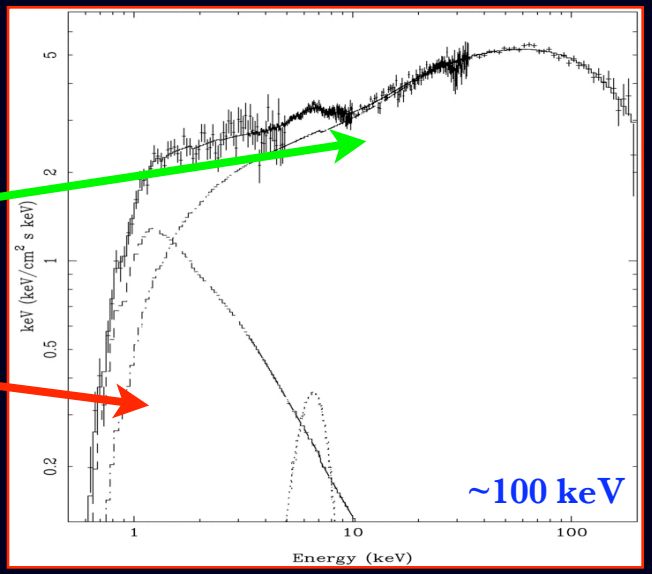
≈ L_{Edd}



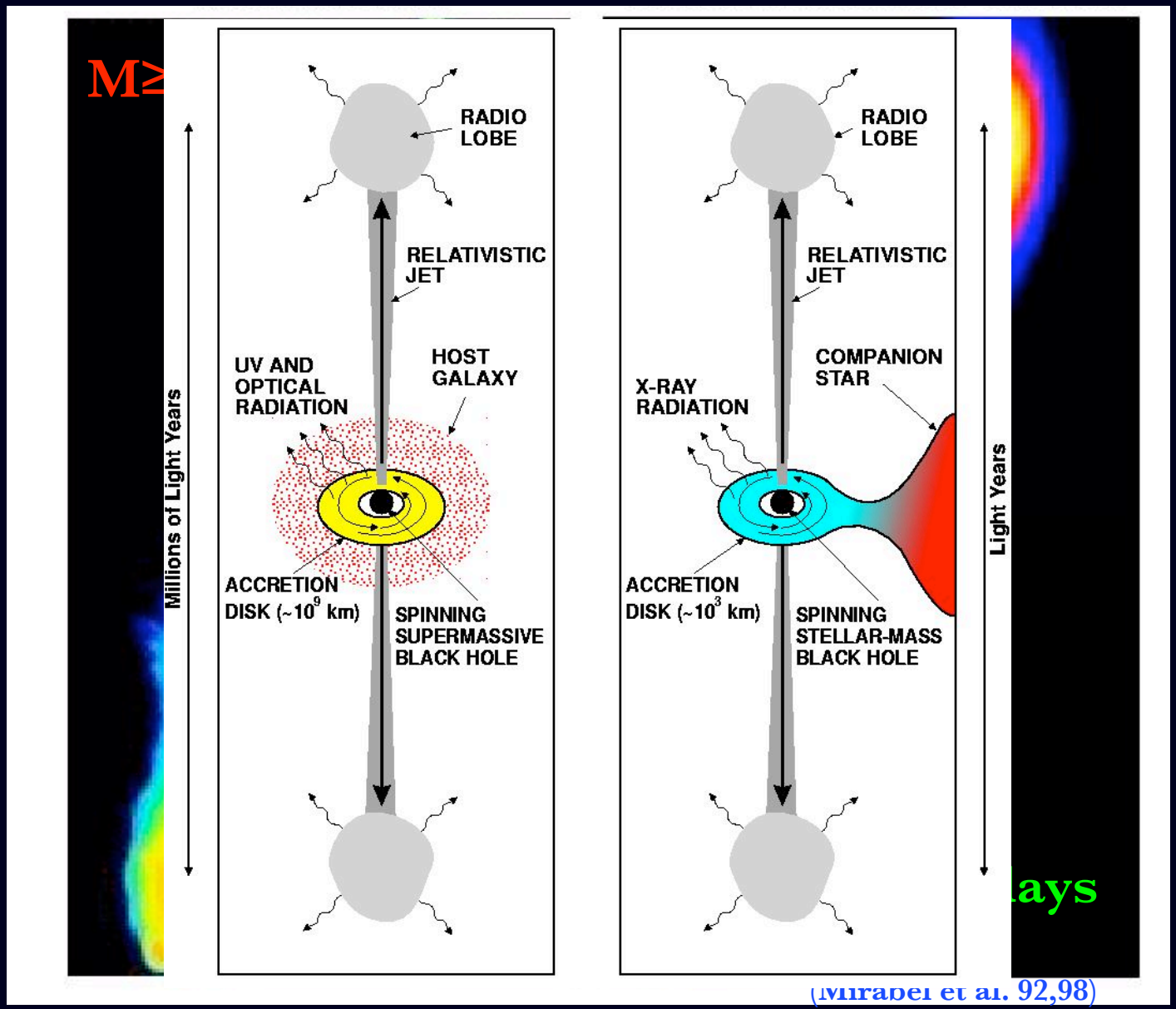


≪ L_{Edd}

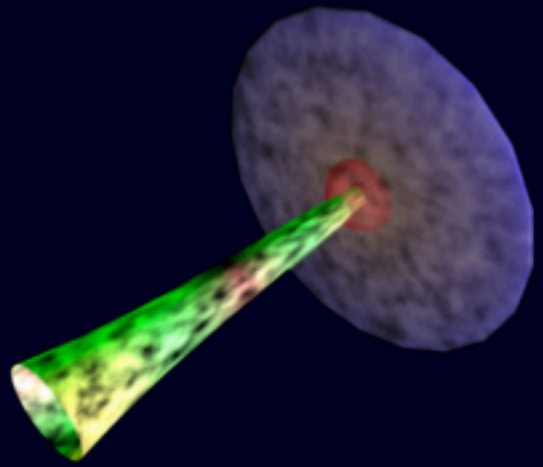




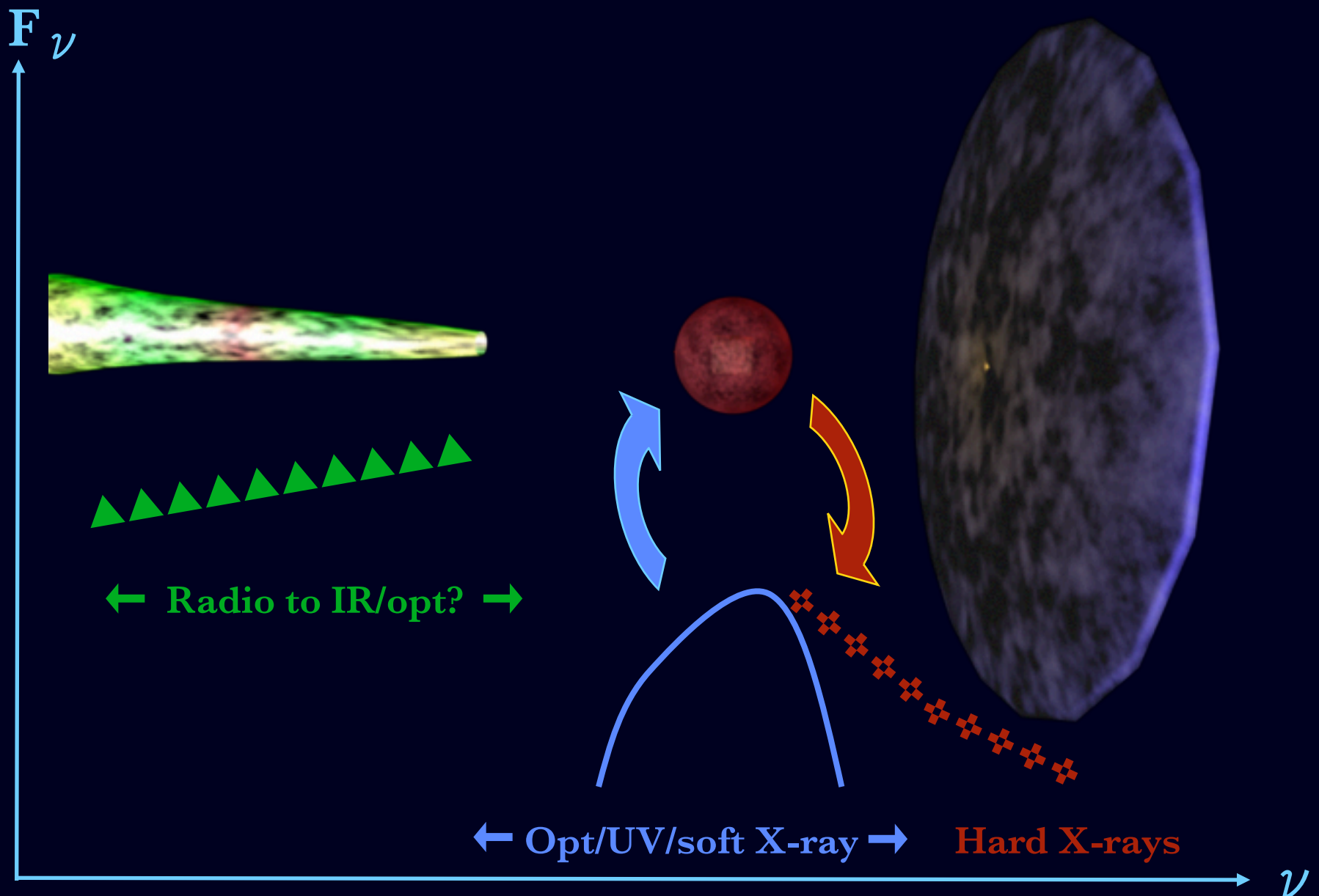
Low Luminosity BHs = Self-Similar Jets



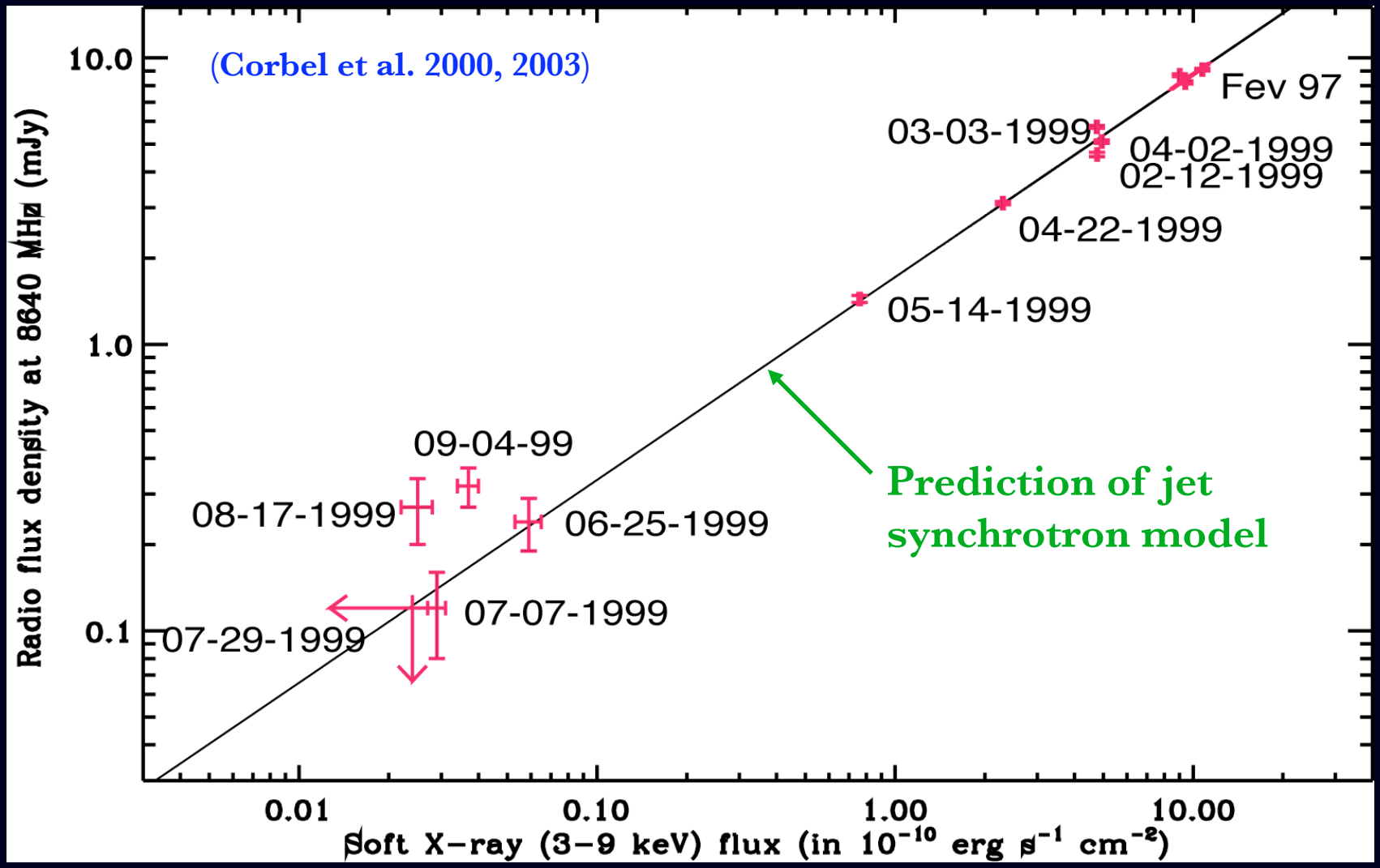
Jet/Disk: Geometry



Historical Hard State SED components



Evidence that the picture is more complex: GX 339-4



(Markoff et al. 2003)

Universal correlation for XRBs

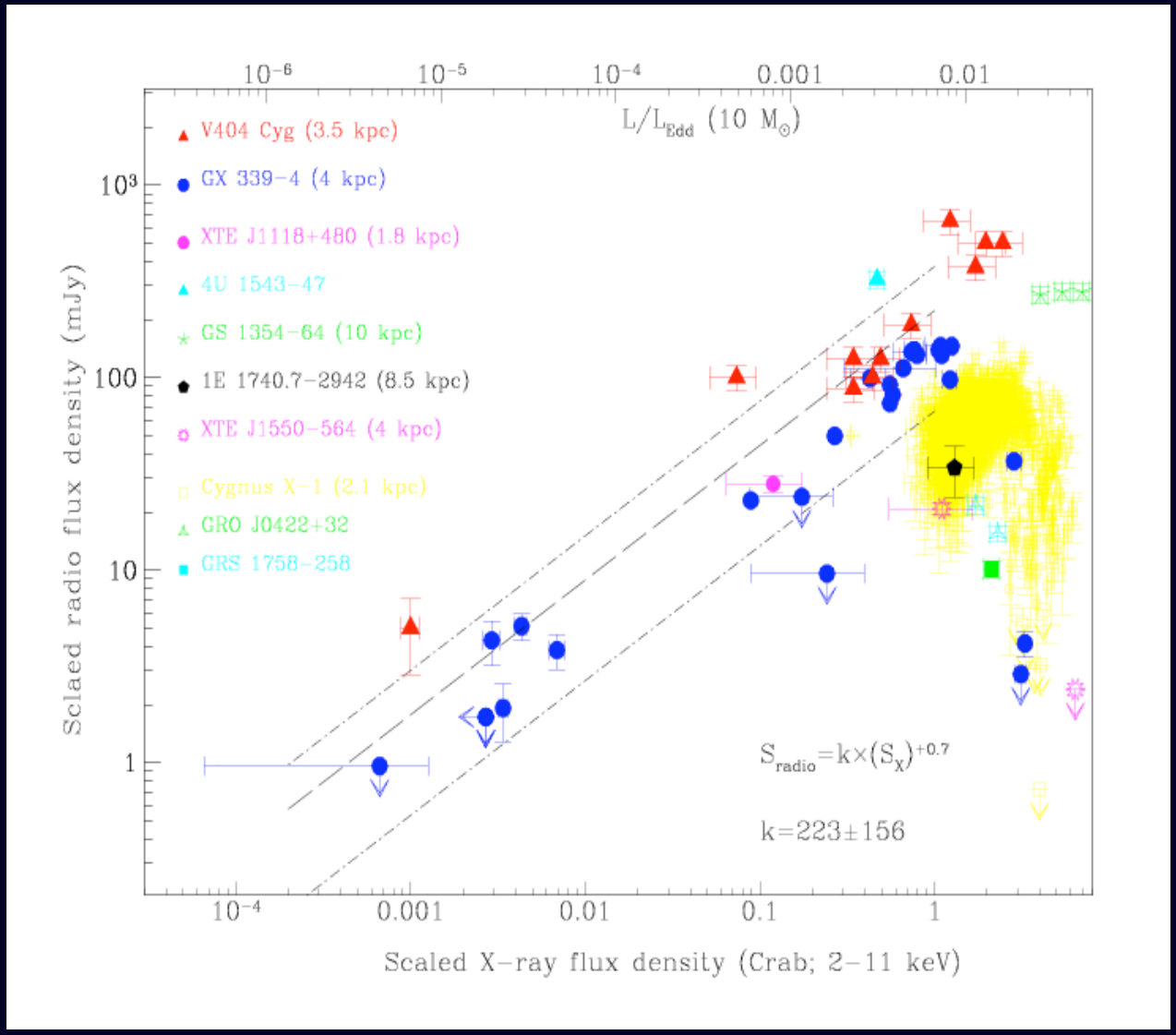
10 Galactic BHCs absorption corrected scaled to 1 kpc

2 sources (V 404 Cyg and GX 339-4) display

$L_{radio} \propto L_X^{+0.7}$

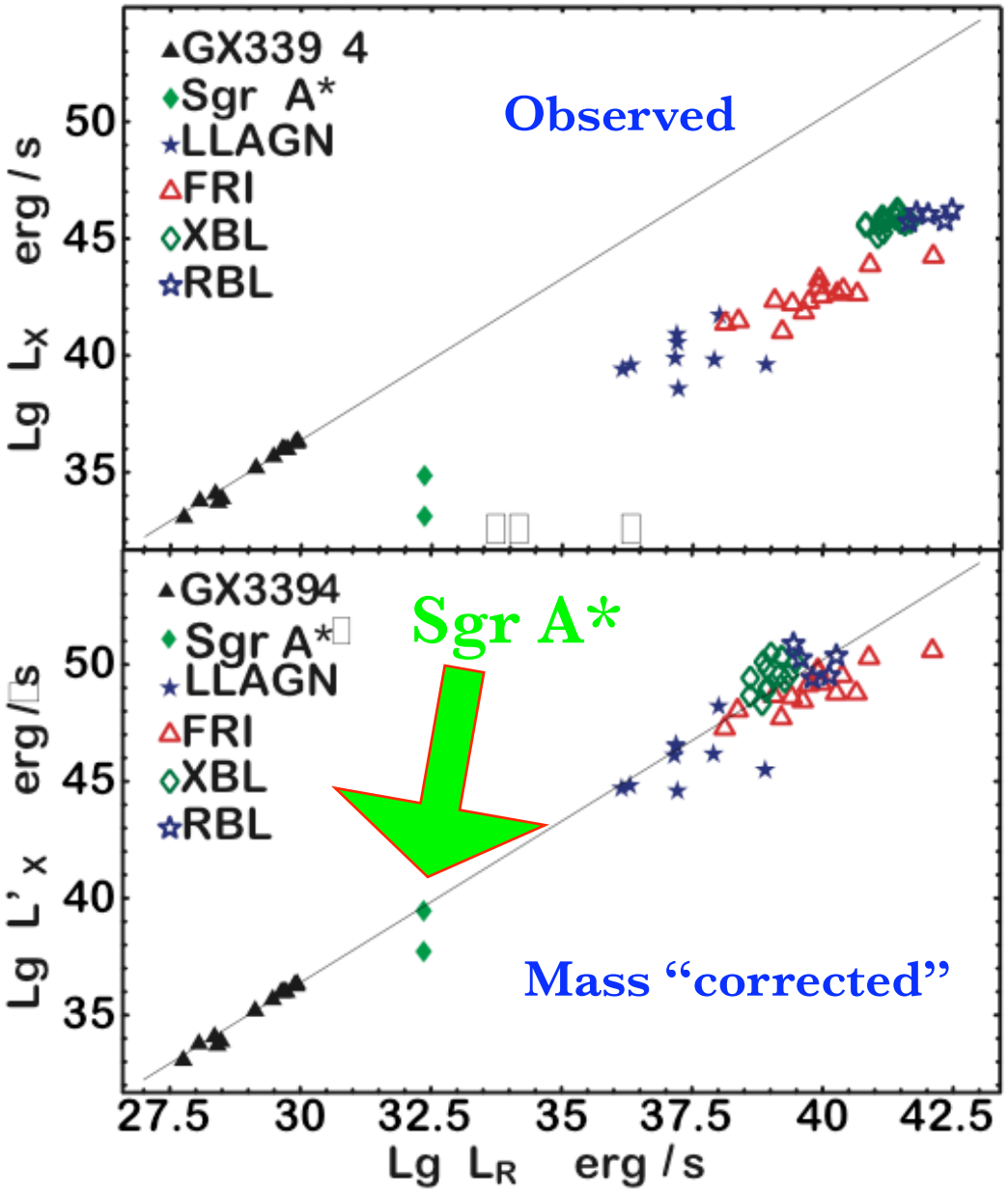
over 3 orders of magnitude!

$L_{radio} / L_X \propto L_X^{-0.3}$



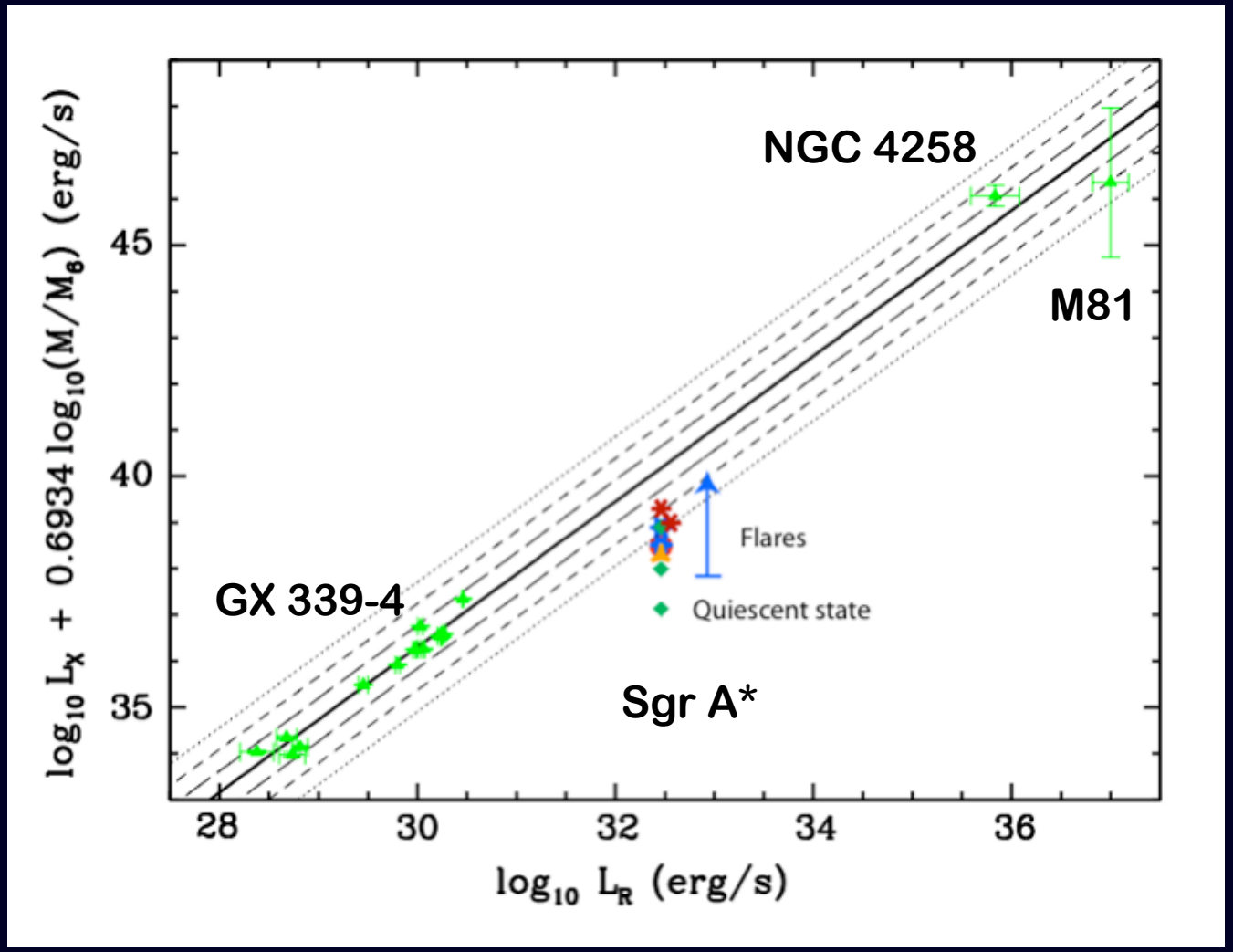
(Corbel et al. `03; Gallo, Fender & Pooley 2003)

Fundamental plane of BH accretion!



(Falcke, Körding & Markoff 2004
Merloni,Heinz & diMatteo 2003)

Sgr A* in the fundamental plane



(Markoff 2005)

Flares ⇒ state transition below $L_x \sim 10^{-9} L_{Edd}$?

1. If Sgr A* remains at its current L_R, no X-ray flare in Sgr A* will exceed the prediction of the correlation for L_X

2. A flare exceeding the correlation prediction will be associated with an accompanying increase in L_R, keeping it on the "track"

➠ Sgr A* monitoring

3. No sources already on correlation (w/higher L_{Edd}) will flare like Sgr A*

4. Black holes at or below $L_x \sim 10^{-9} L_{Edd}$ will fall below the correlation in L_X and show flares

➠ LLAGN, quiescent BH XRBs monitoring

(Markoff 2005)

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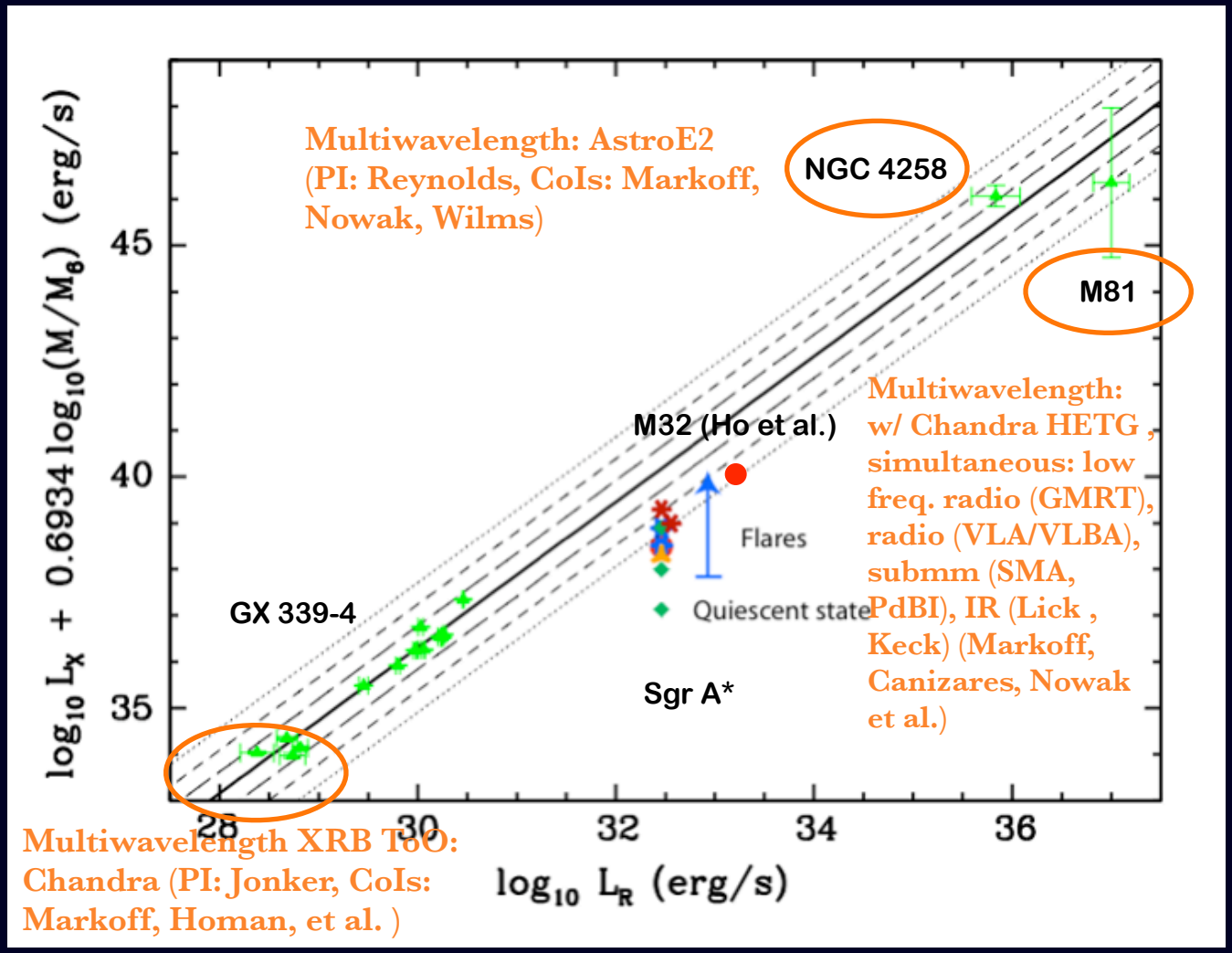

(Markoff 2005)

M81* as bridge source to Sgr A*

- LLAGN ~ 10^{-4} L_{Edd}
- ~20 times bigger central mass, same galaxy type
- Radio properties very similar to Sgr A*; both spectral index and polarization
- Very small, precessing weak jet resolved w/VLBI (can help us understand if jet is really there)

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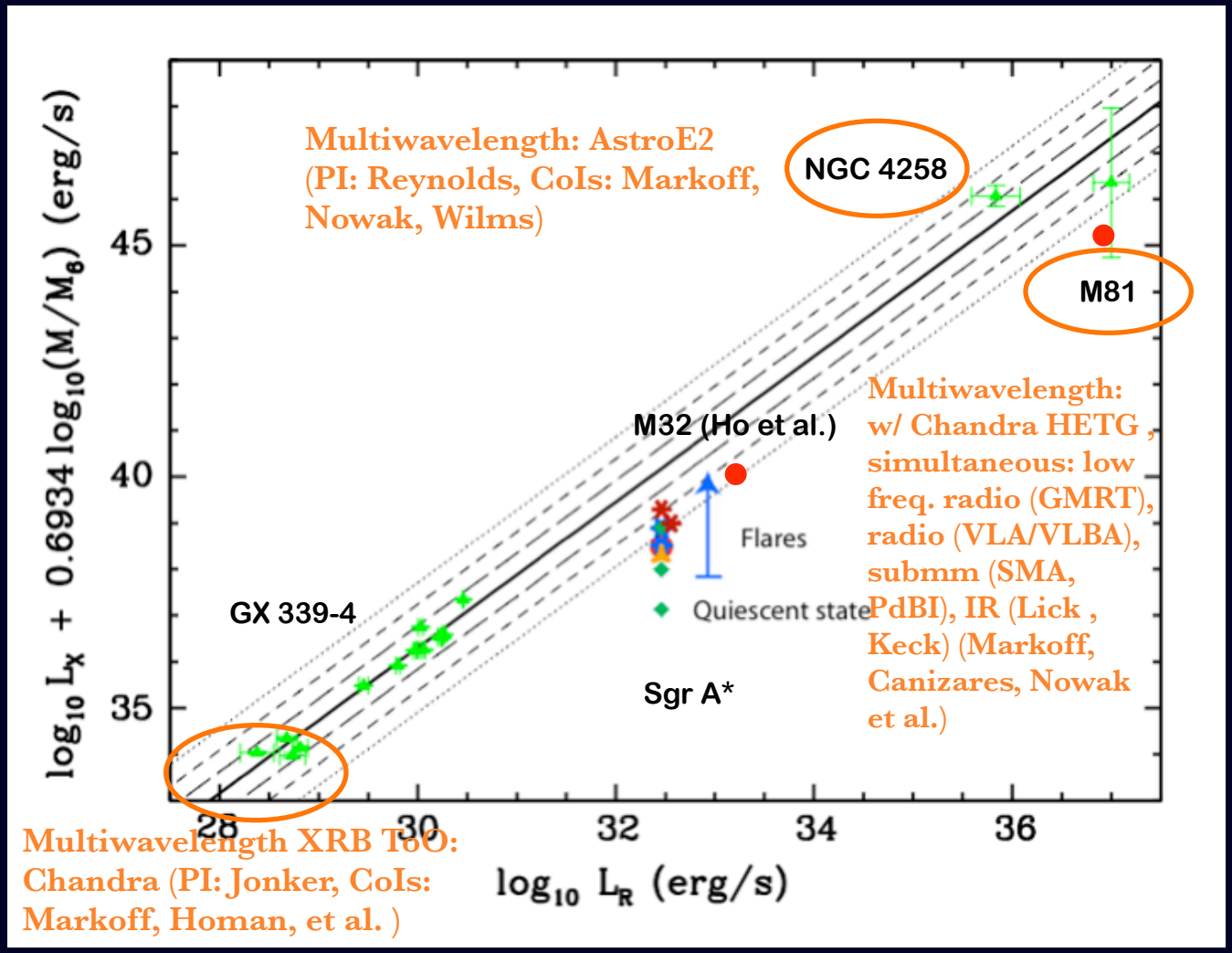


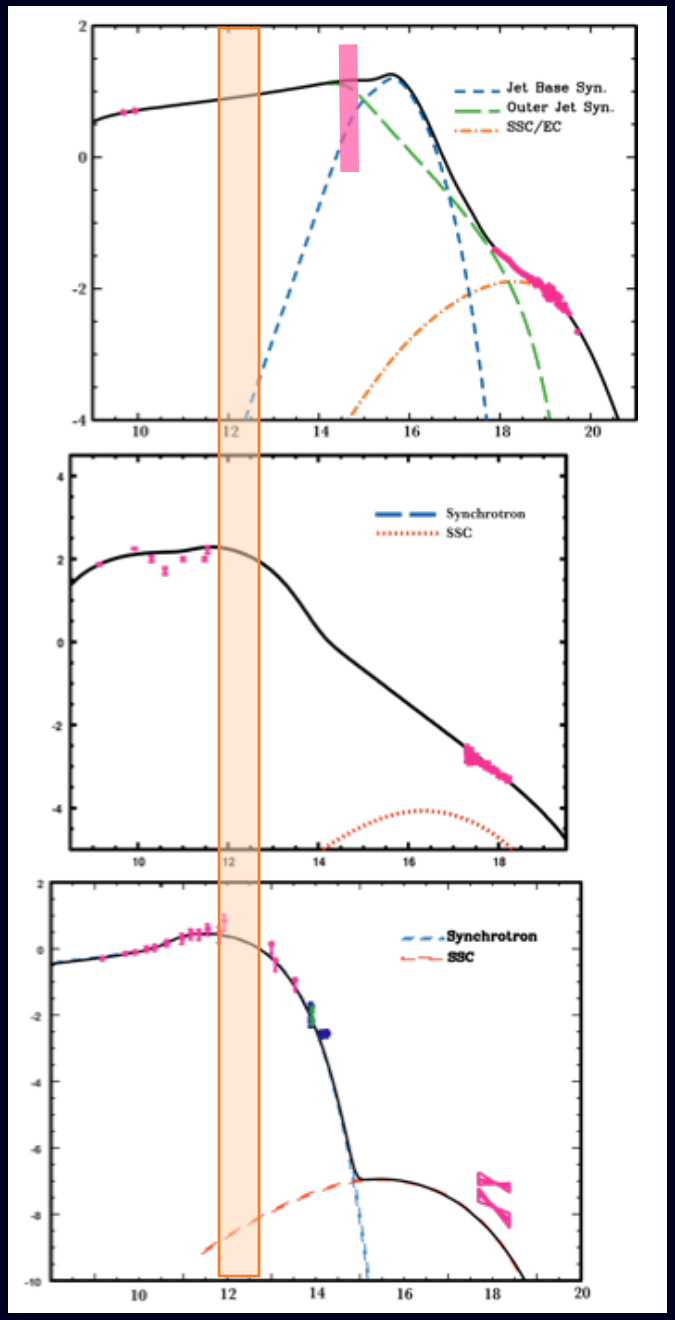
(Markoff 2005)

As above, so below...?

Hard state XRB
(GX 339-4, M=6 $M_\odot$)

Low-lum AGN
(M81*, M=7x10^7 $M_\odot$)

Sgr A*
(M=4x10^6 $M_\odot$)



L_{Edd}

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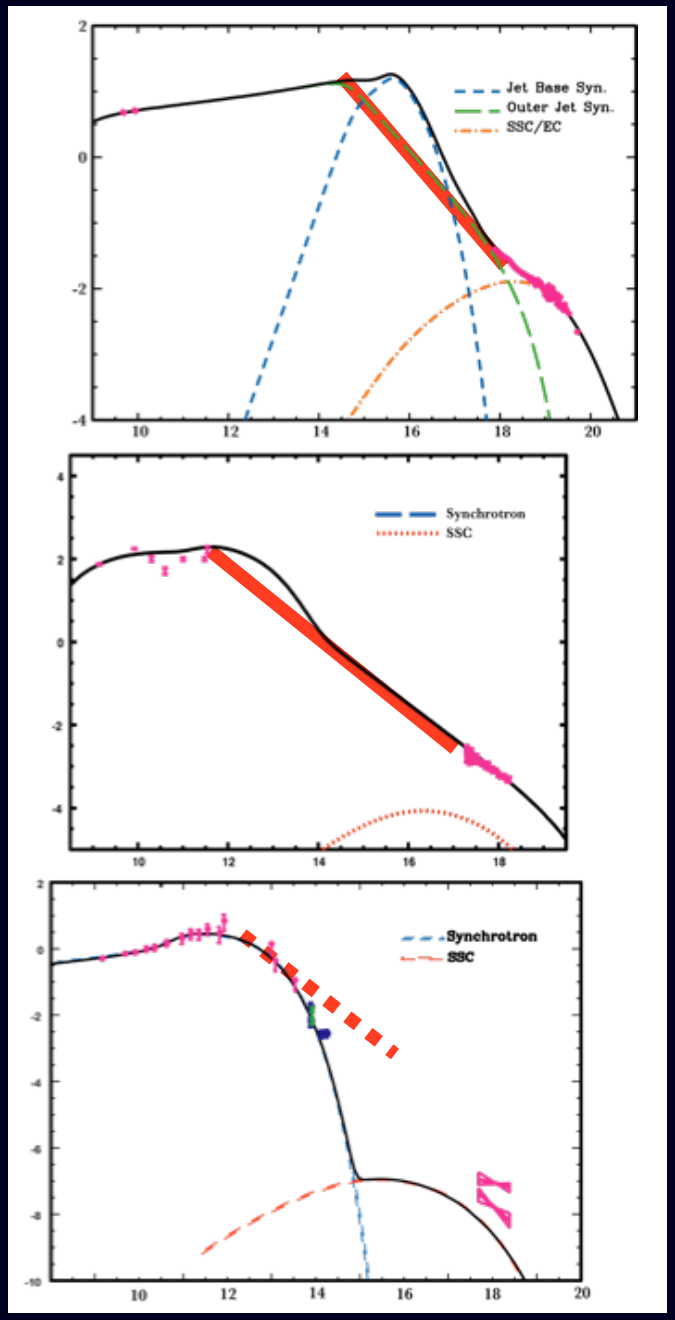

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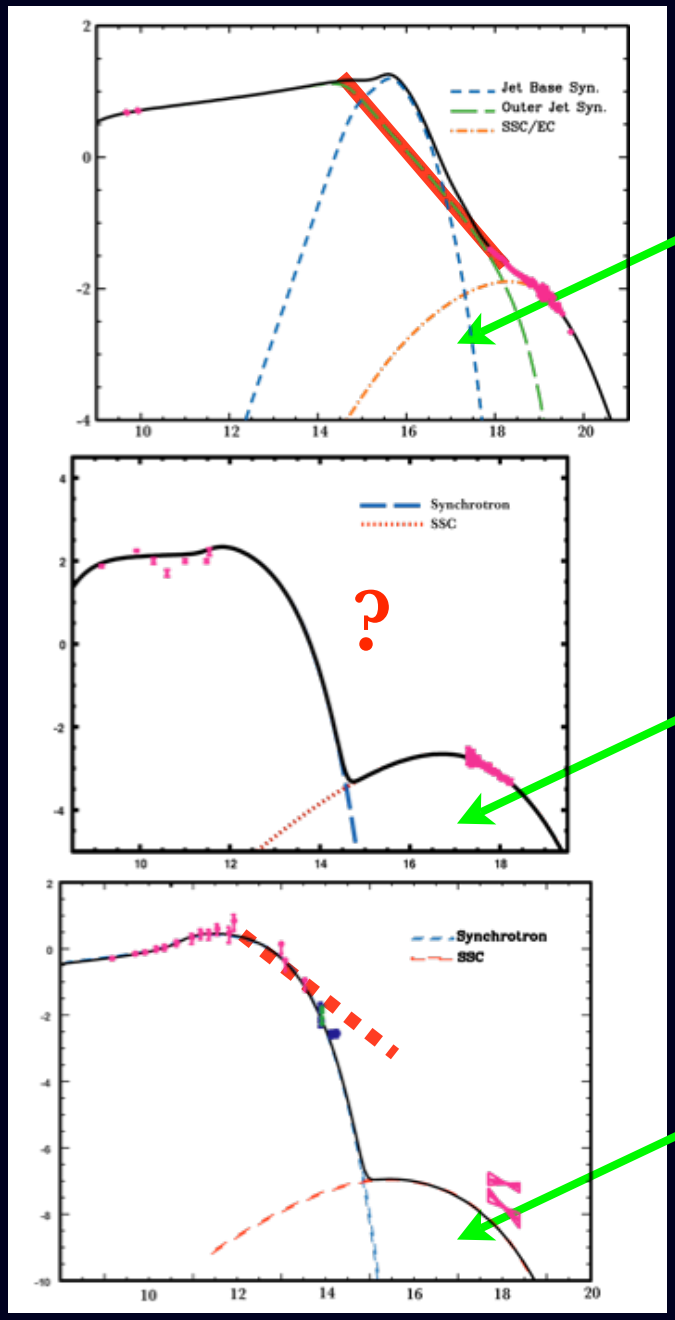
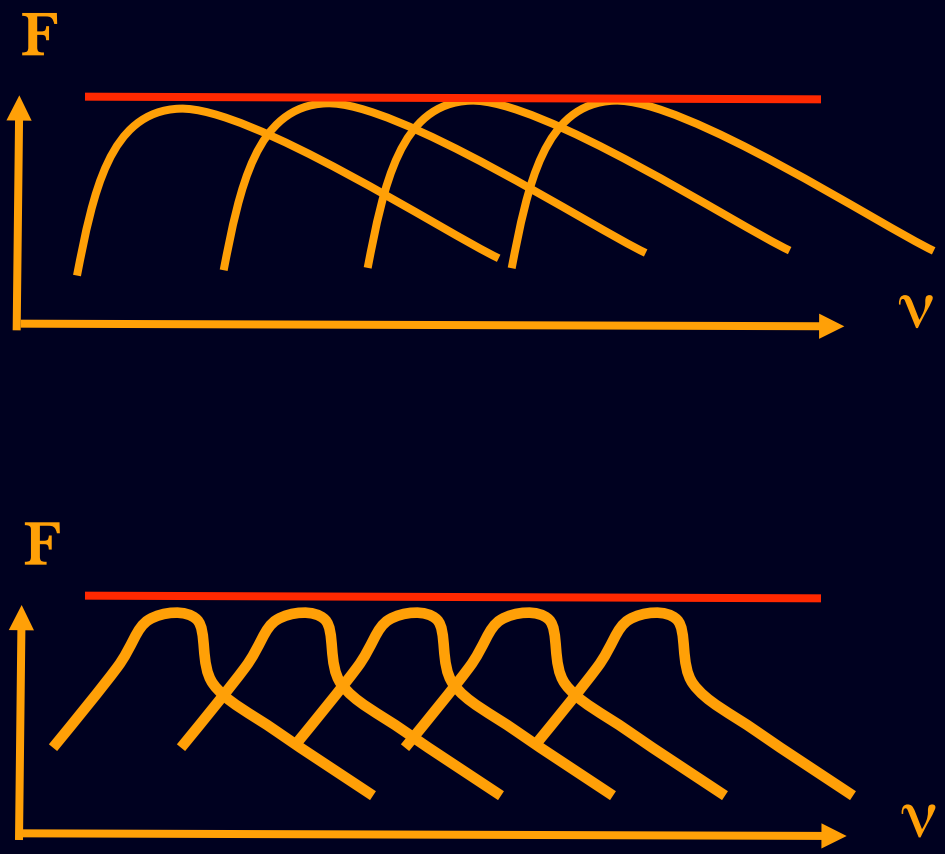
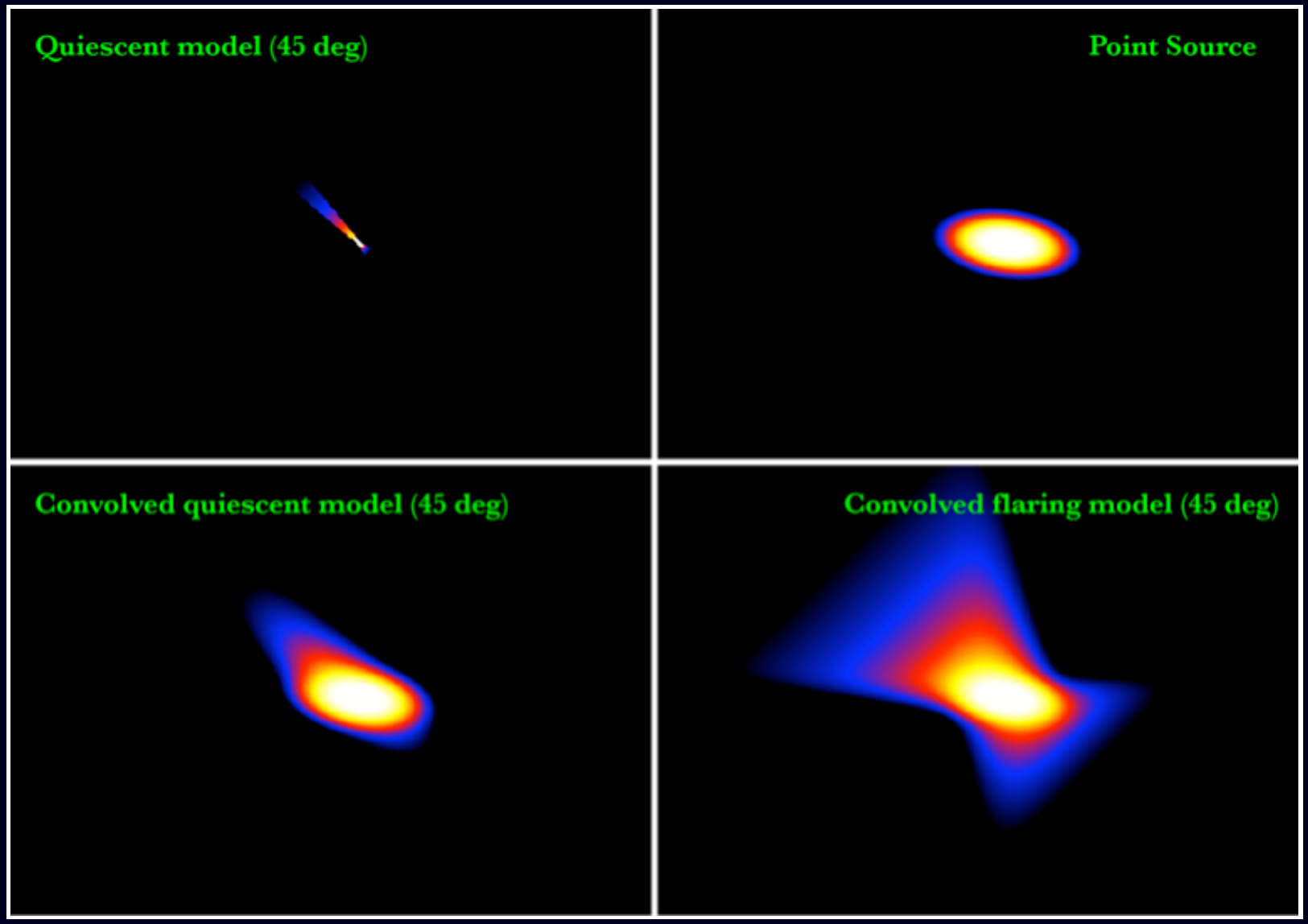


L_{Edd}

Self-absorption → model degeneracy



VLBI predictions at 43 GHz



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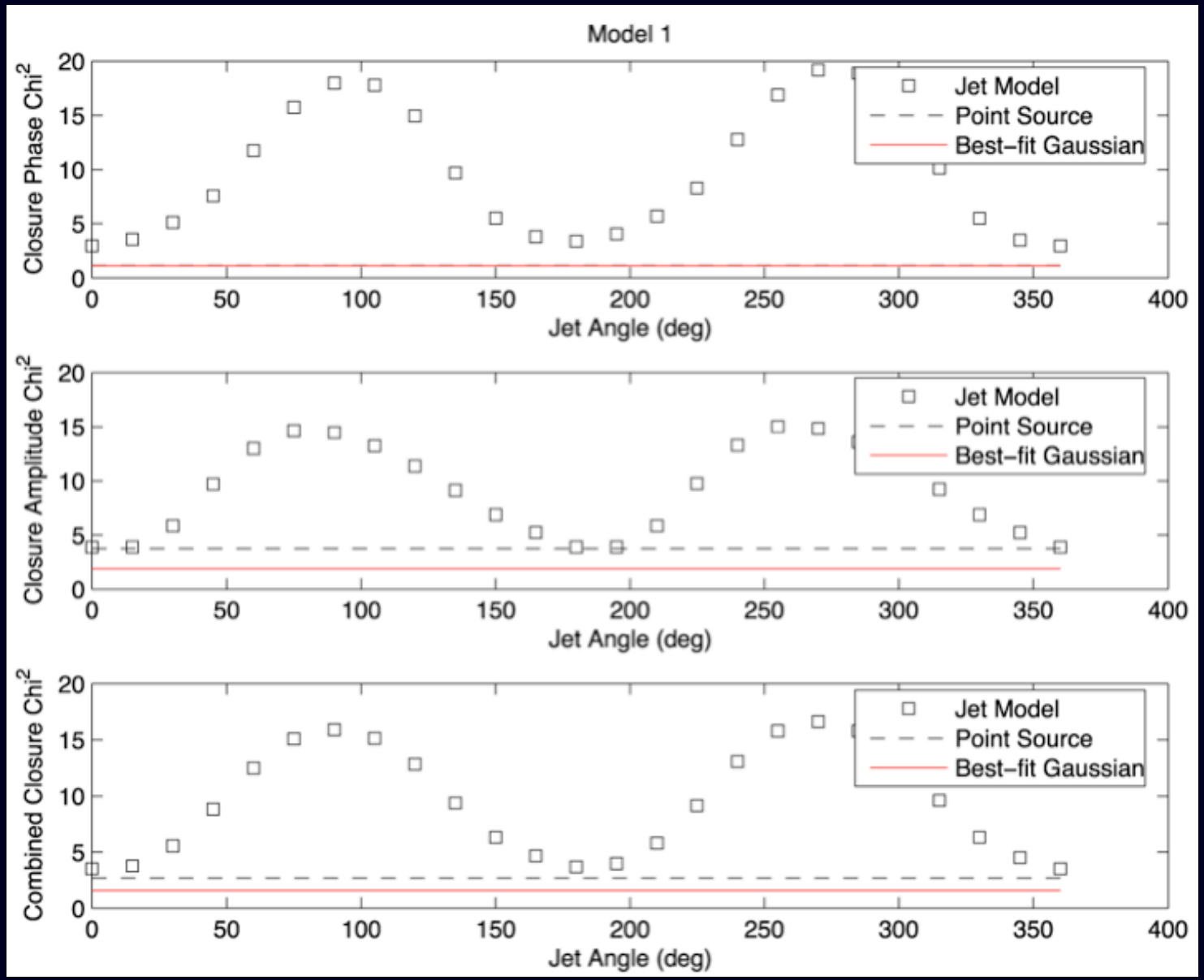

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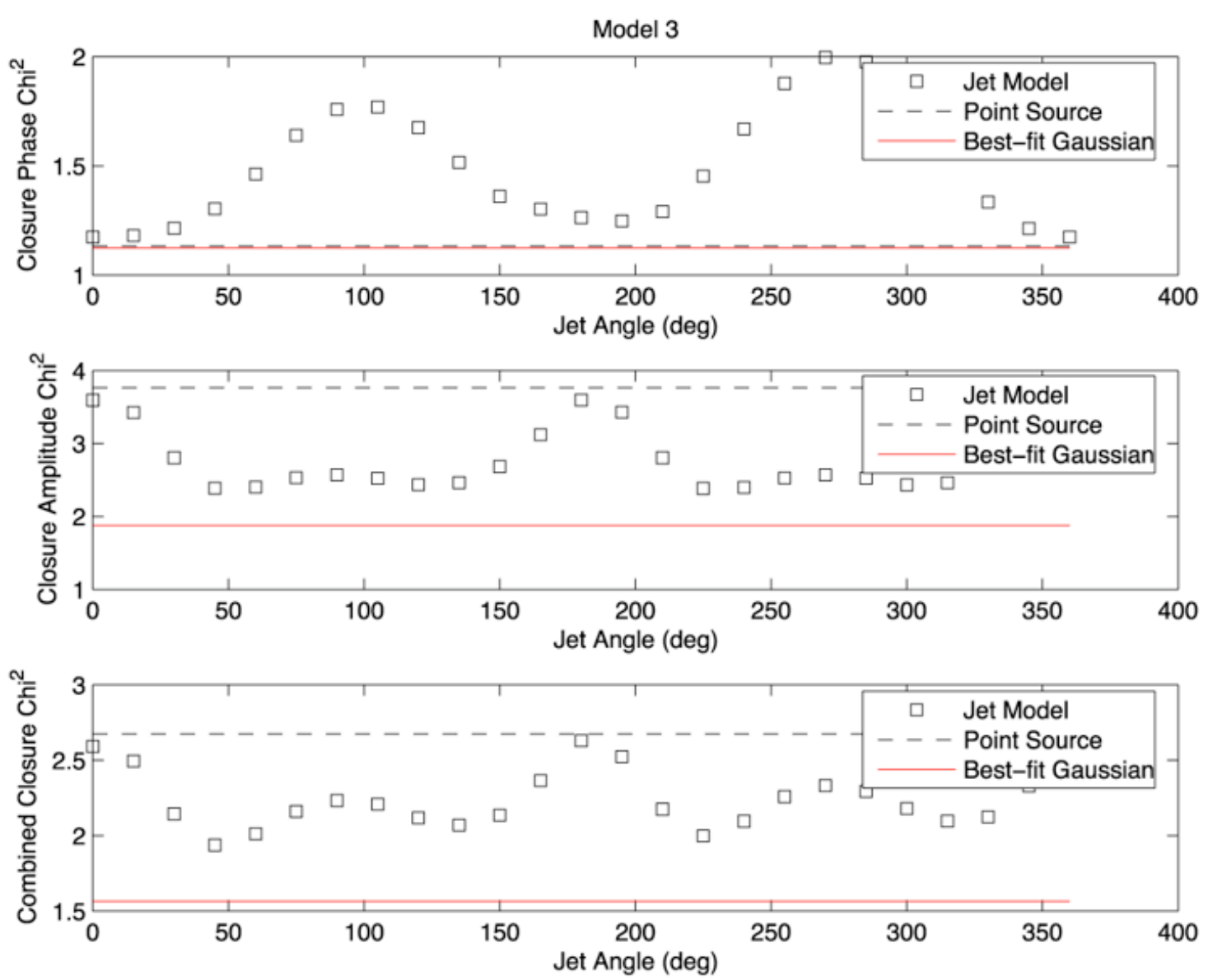

Summary & Outlook

- Sgr A* is an amazing tool for increasing our understanding of the origins of AGN activity
- Theorists agree! ...mostly. Sgr A*'s Radio = jets, Flares = SSC, possibly also synchrotron ⇒ definitely nonthermal
- Sgr A* is **uniquely** weak in X-ray relative to radio: falls below "universal" correlation. Are flares bounded? If yes:
  - ➟ We are potentially witnessing buildup of the correlation
  - ➟ Flare mechanisms related to "correlation" source Xrays
  - ➟ Can monitor many kinds of sources to search for answers
- Flare "ownership" and energization process still unknown: "missing" spectral component may hint to acceleration? Multiwavelength monitoring *with* VLBA during flares key!
- Outlook: modeling multi-λ data from several campaigns in progress for correlation sources to compare to Sgr A*