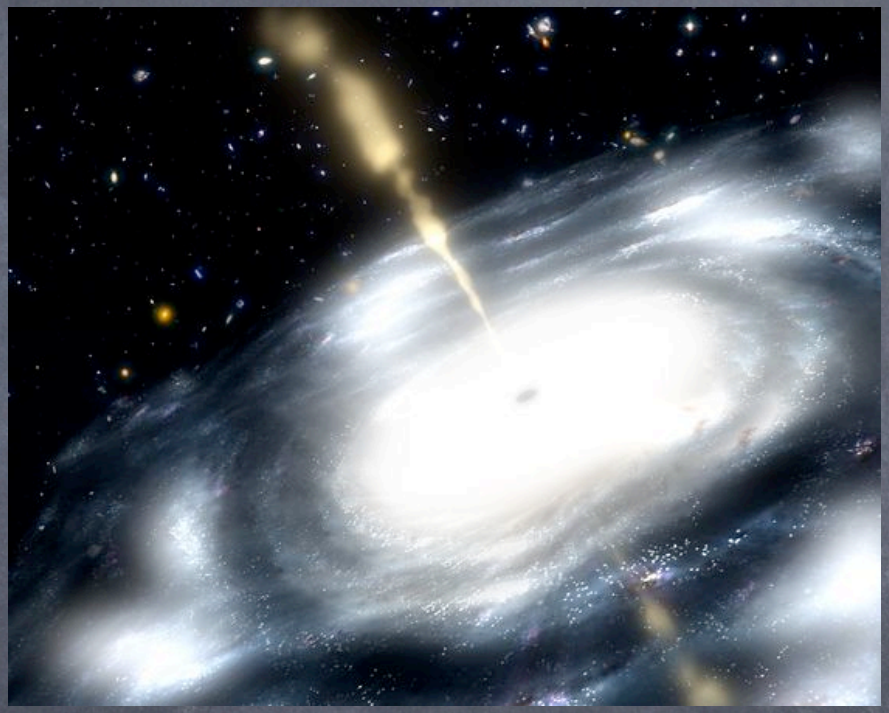
Expanding the Efficacy of the Fundamental Plane of Black Hole Activity



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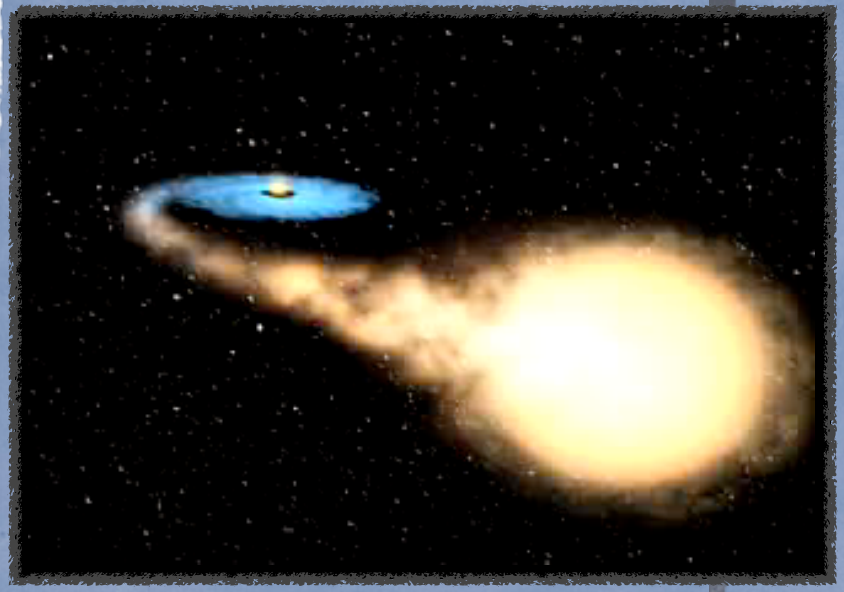
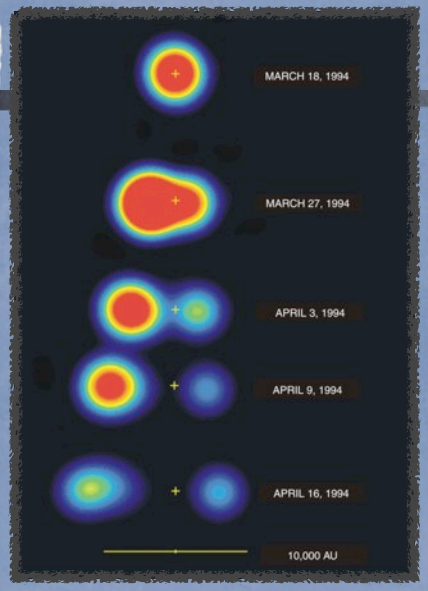
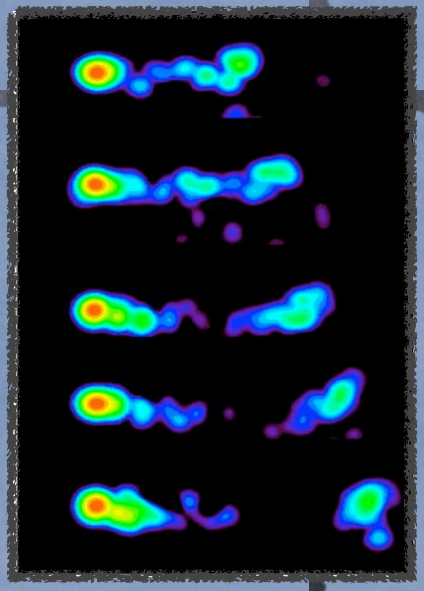




Stellar Mass Black Hole ($\sim 10 M_{Sun}$)

GRS 1915+105

Super-massive Black Hole ($10^{6-9} M_{Sun}$)



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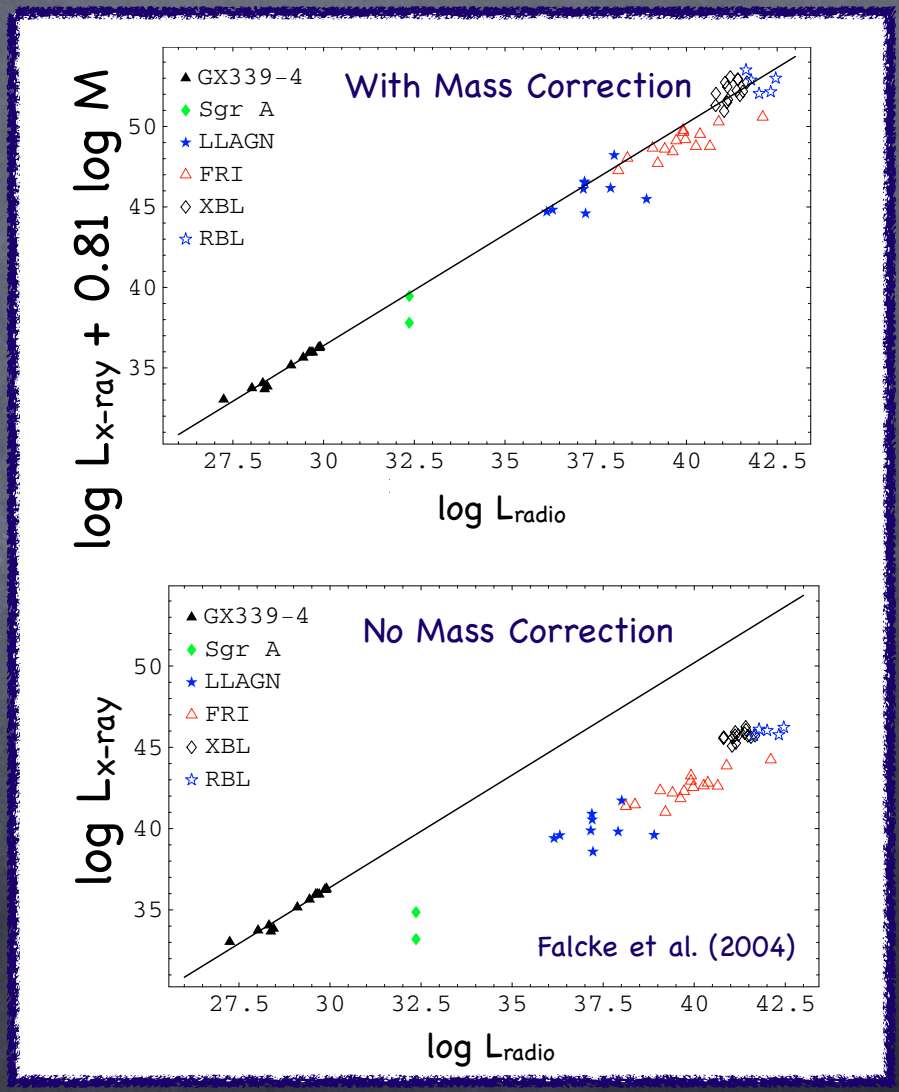
Fundamental Plane of Black Hole Activity

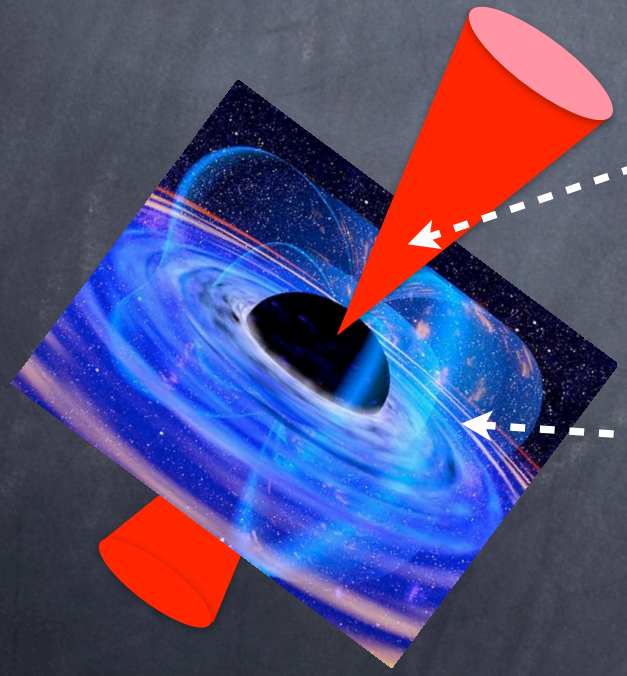
(Merloni et al. 2003, Falcke et al. 2004)

For "hard state" BHs: the conversion of the accretion flow into radiative output is universal across the black hole mass scale

Also a "variability" plane (e.g., McHardy et al. 2006, Körding et al. 2006)



Fundamental Plane as a Tool to Diagnose X-ray Radiative Processes/Geometries



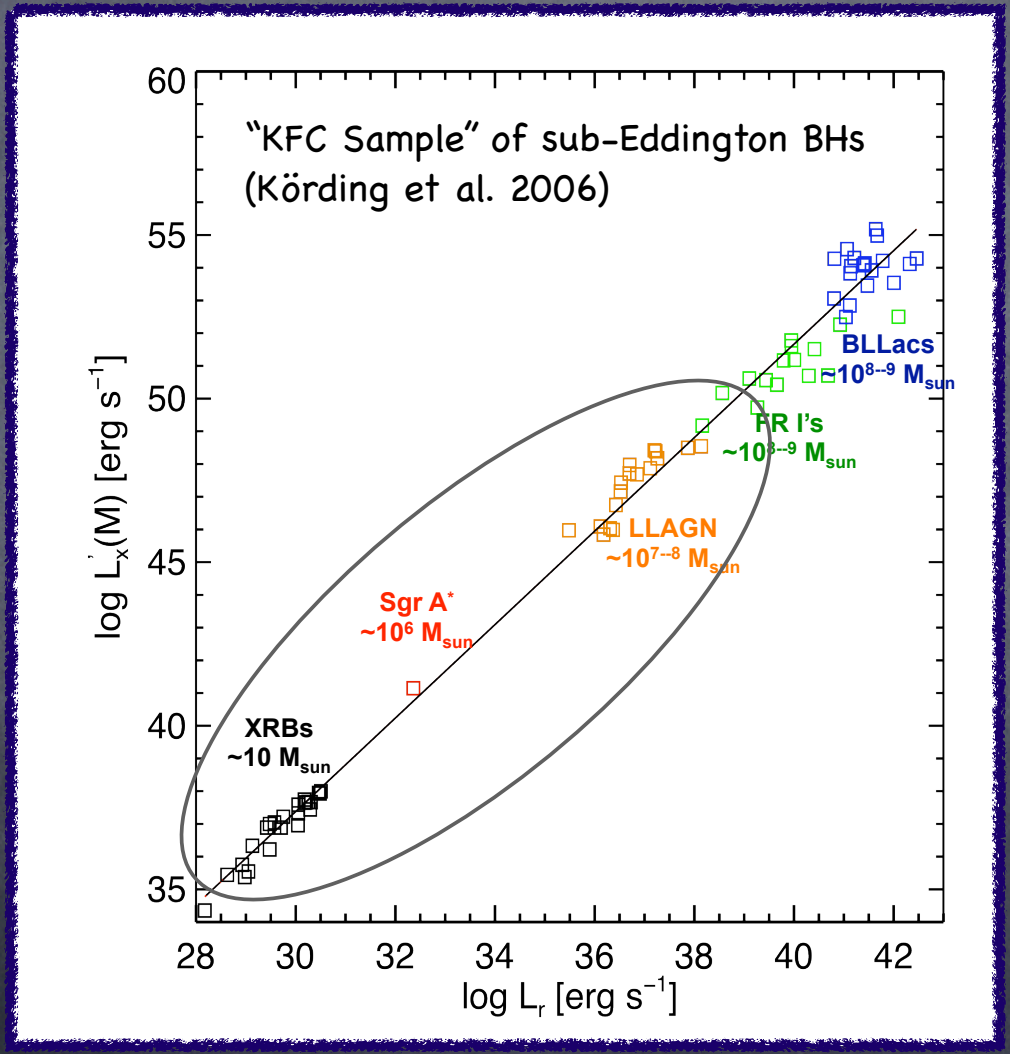
Optically Thin Jet Synchrotron X-rays:

$$L_{x\text{-}ray} \sim (L_{radio})^{1.38}\, M^{-0.81}$$

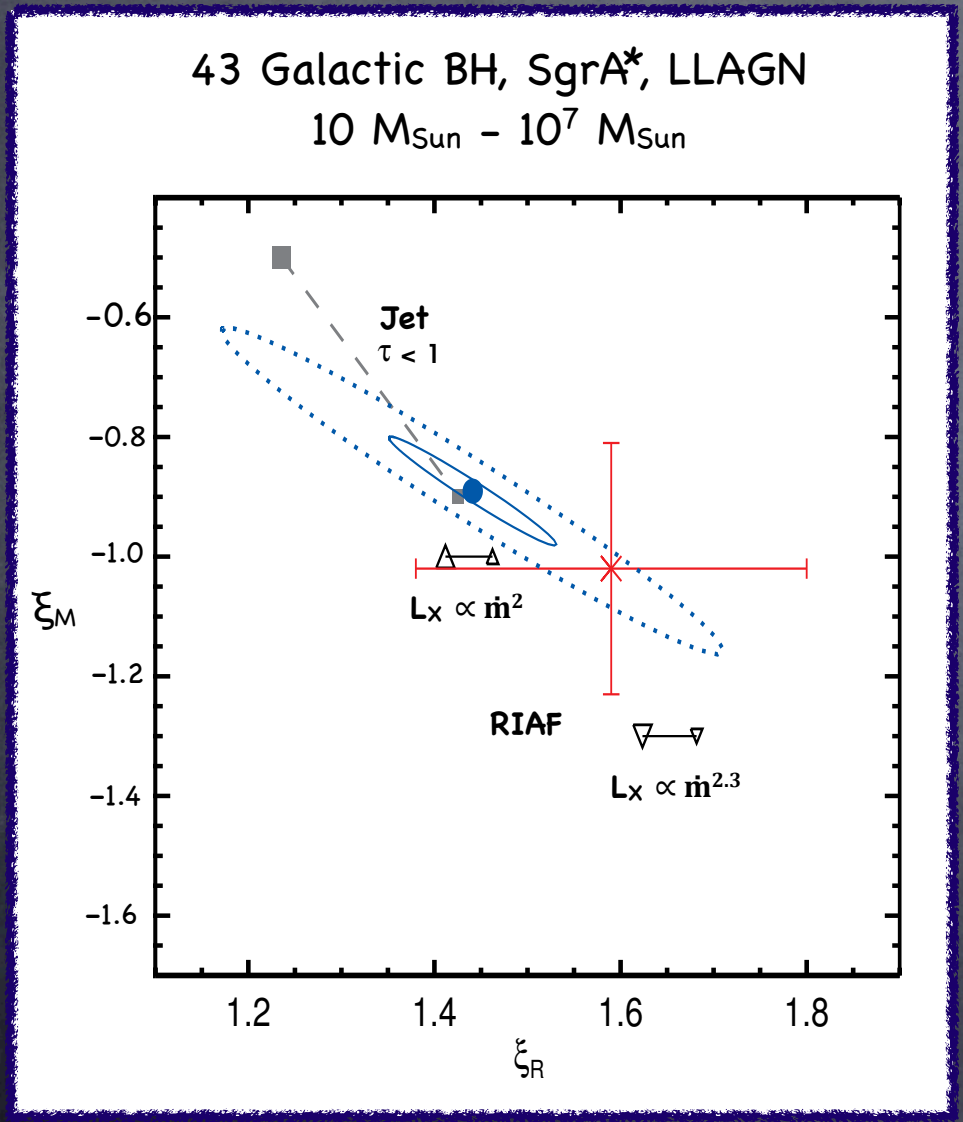
X-rays from Radiatively Inefficient Accretion Flow:

$$L_{x\text{-}ray} \sim (L_{radio})^{1.76}\, M^{-1.56}$$

Finding the best-fit slope is a non-trivial statistical problem



X-rays from the "average" low L/L_{Edd} BHs are Dominated by Optically Thin Jet Synchrotron



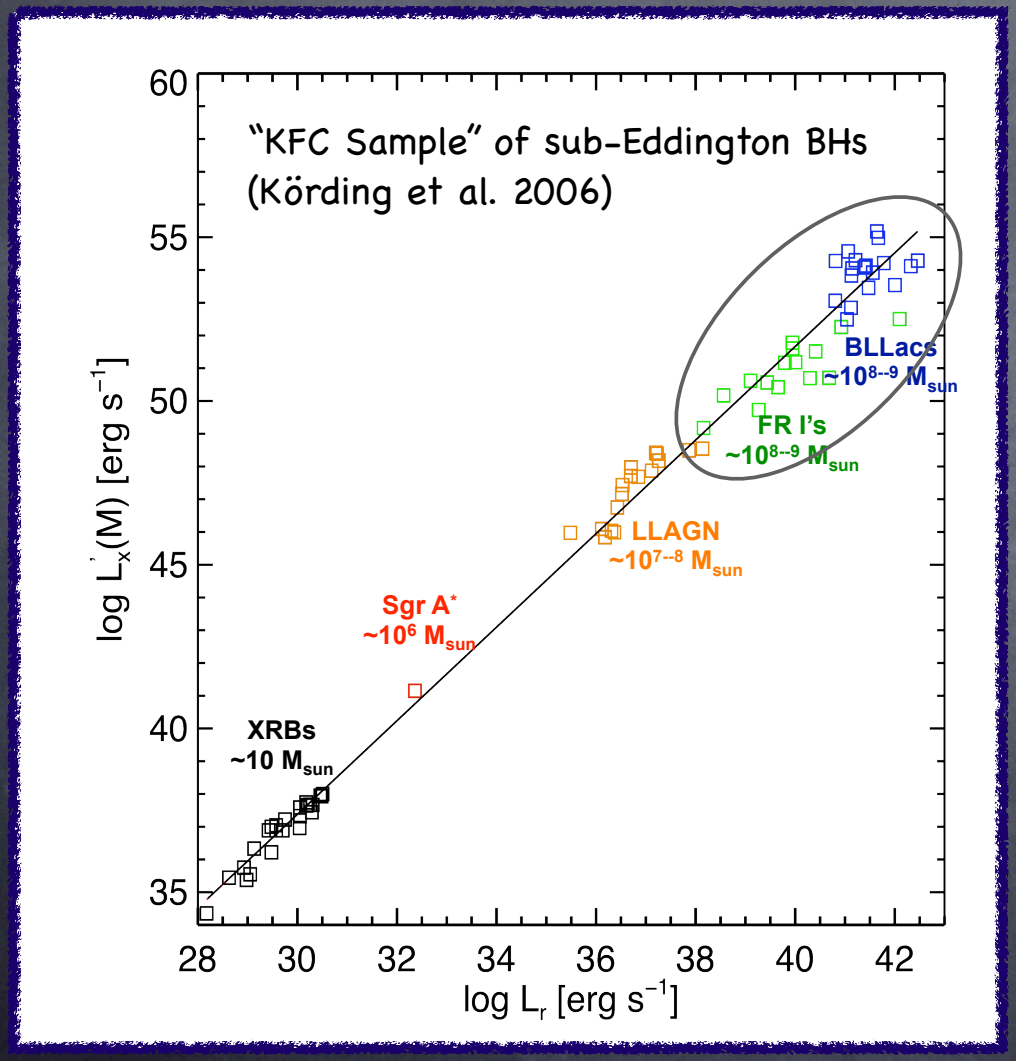
$L_{x\text{-ray}} \sim (L_{radio})^{\xi R}\ M^{\xi M}$

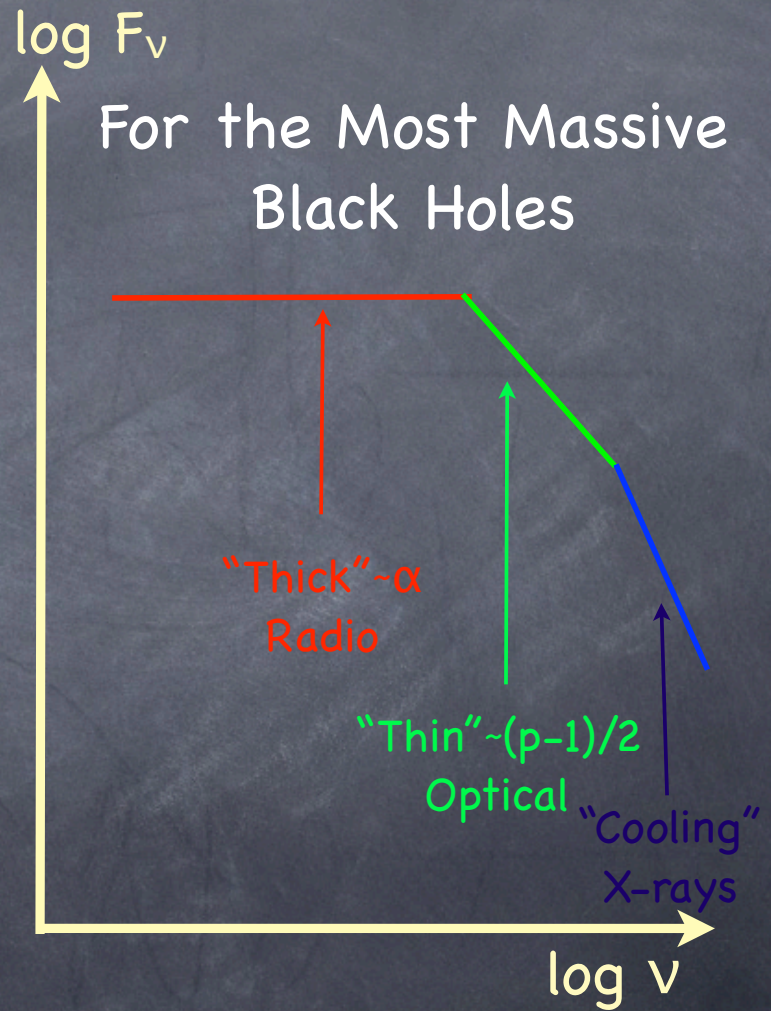
Bayesian Regression

Merit Function

- Merit Function is a χ^2 estimator (from Körding et al. 2006)
- Bayesian Linear Regression (application of Kelly 2007 technique)

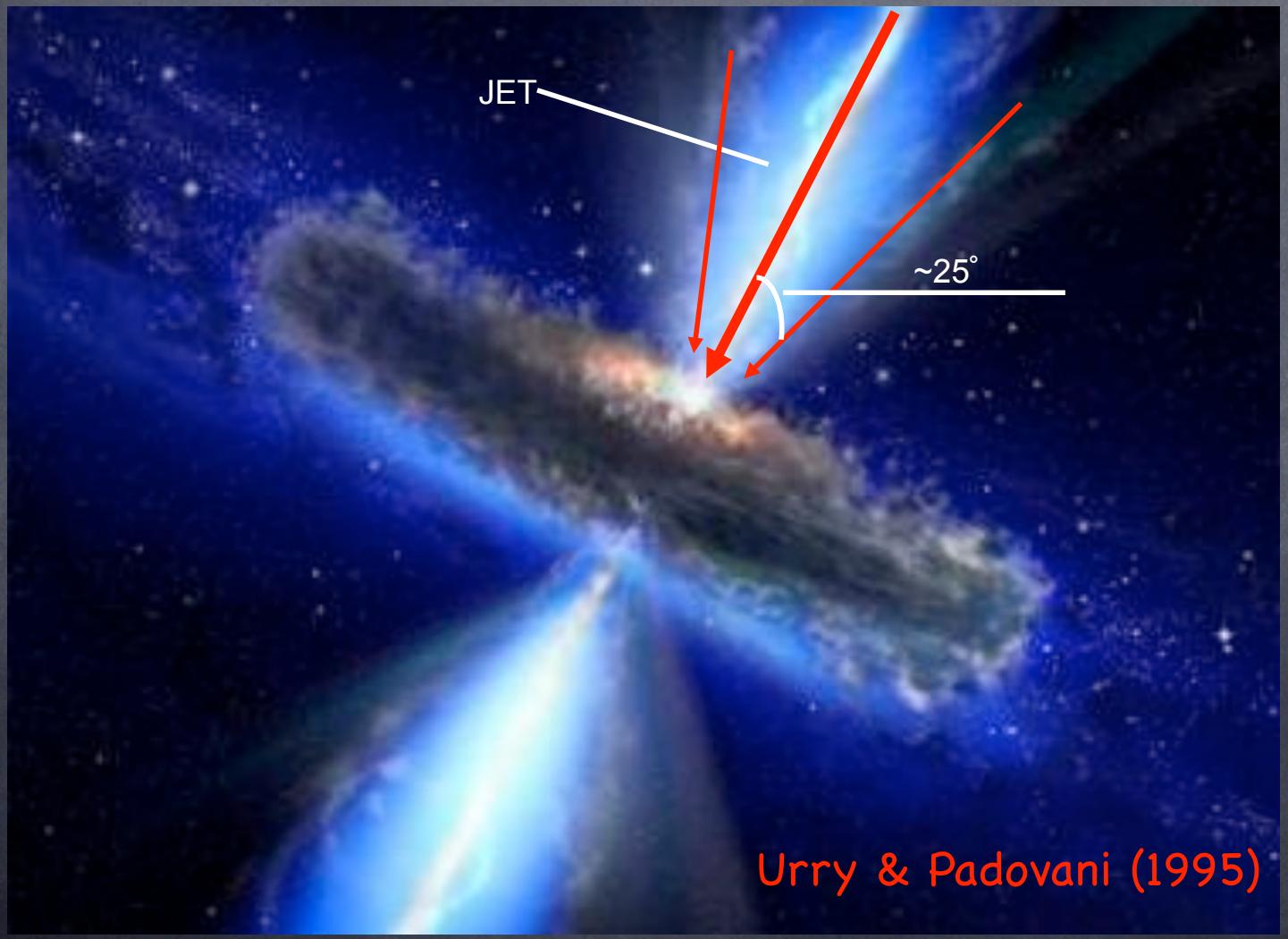
The Massive End Poses a Challenge: Synchrotron Cooling (Heinz 2004*)





*Also see Merloni et al. 2003; Falcke et al. 2004; Körding et al. 2006

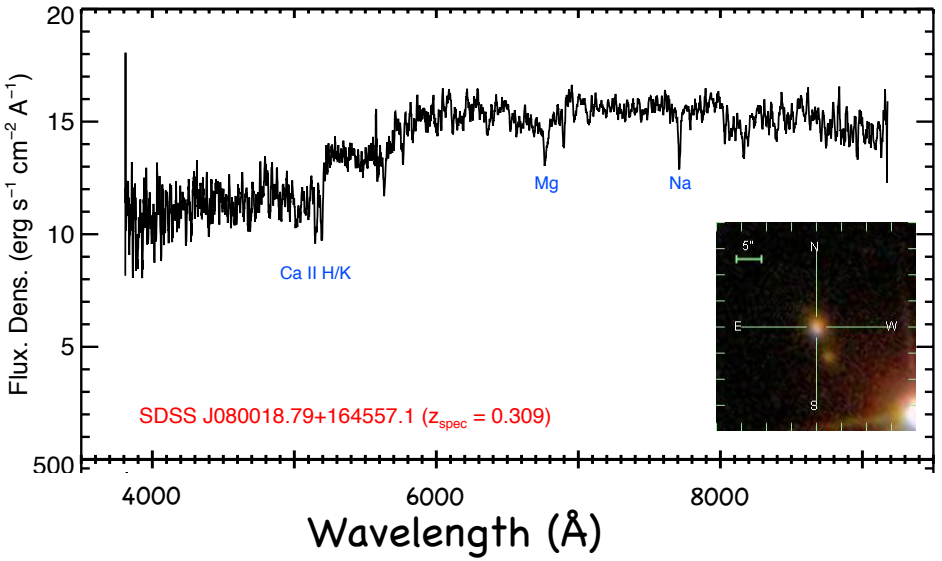
Explore the Massive End with BL Lacs: Uncontroversially Jet Dominated AGN



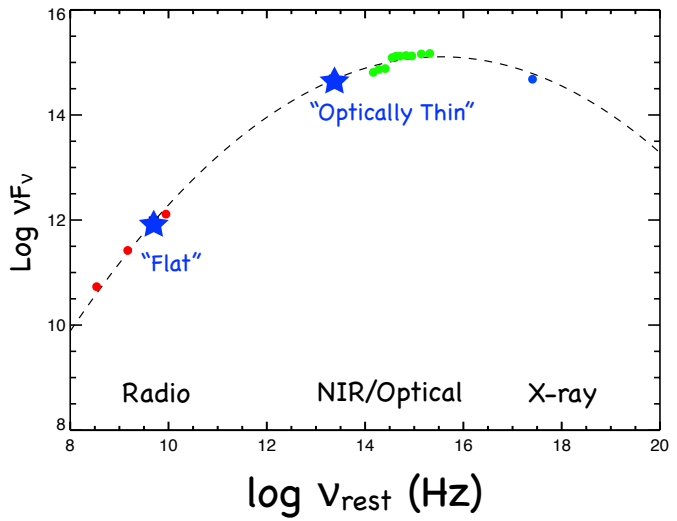
55 BL Lacs from the SDSS with Black Hole Mass Measurements

(Plotkin et al. 2010; 2011)

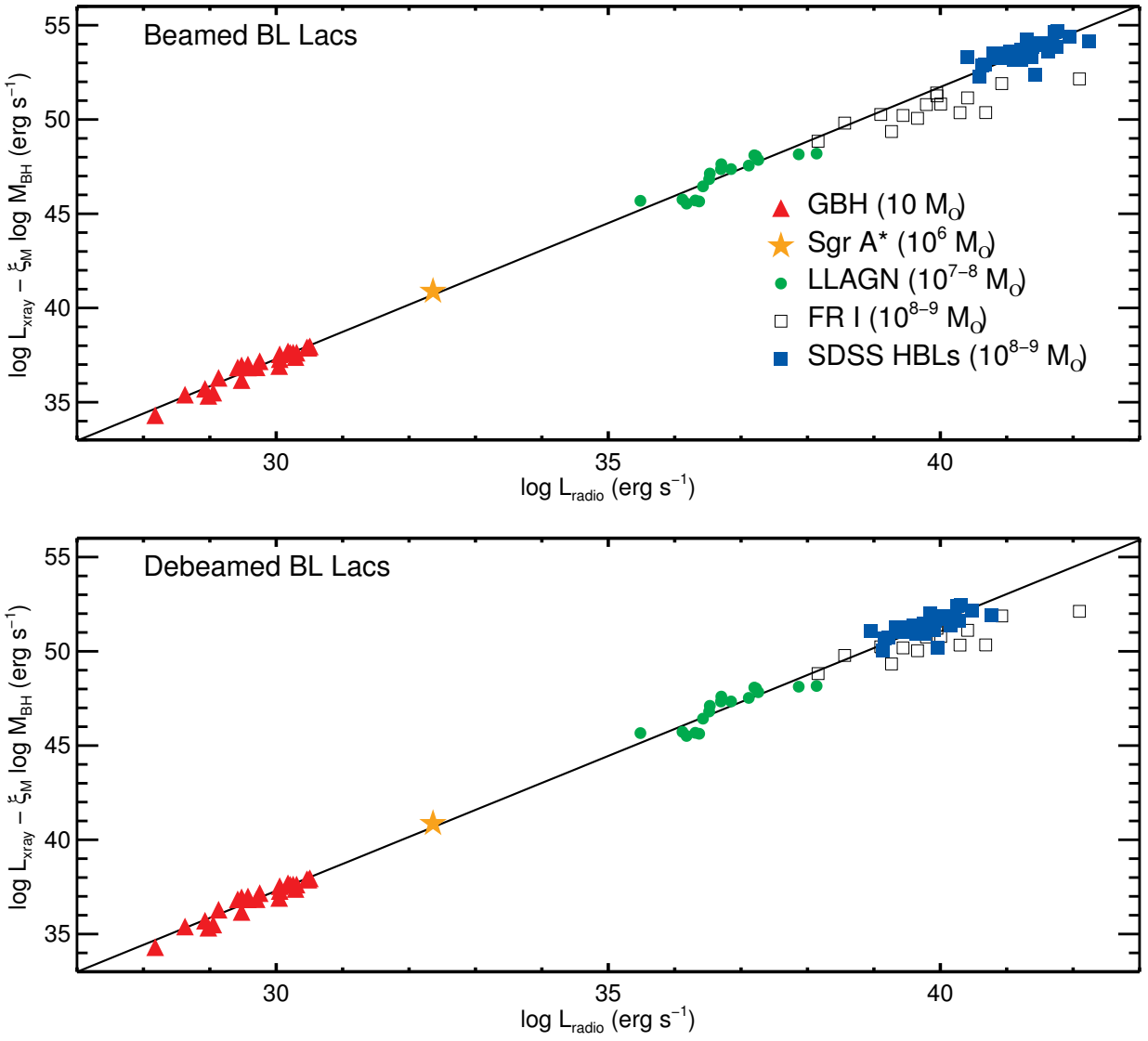
SDSS Spectrum



SED



$$\log L_X = (1.44\pm0.04)\log L_R - (0.88\pm0.06)\log M_{BH} - 6.03\pm1.16$$



Summary

1. Bayesian Regression is Very Promising for Refining the Fundamental Plane
2. X-rays from the "average" low-accretion rate BH are dominated by optically thin jet synchrotron
3. There are Systematic *Observational* Challenges to Including the Most Massive Black Holes
   - Need to account for how SED "shifts" with black hole mass