Megamaser Disk Host Galaxies

Ai-Lei Sun (ASIAA), Anil Seth (Utah), Ronald Laesker (MPIA), Patryk Pjanka (Princeton)

MCP:
Feng Gao, Wei Zhao, Cheng-Yu Kuo (ASIAA), James Braatz, Fred Lo, James Condon (NRAO), Dom Pesce, Remco van den Bosch, Viollette Impellizzeri, Mark Reid, Christian Henkel

Maser Hosts

Scaling relations, **fueling**, and **demographics**

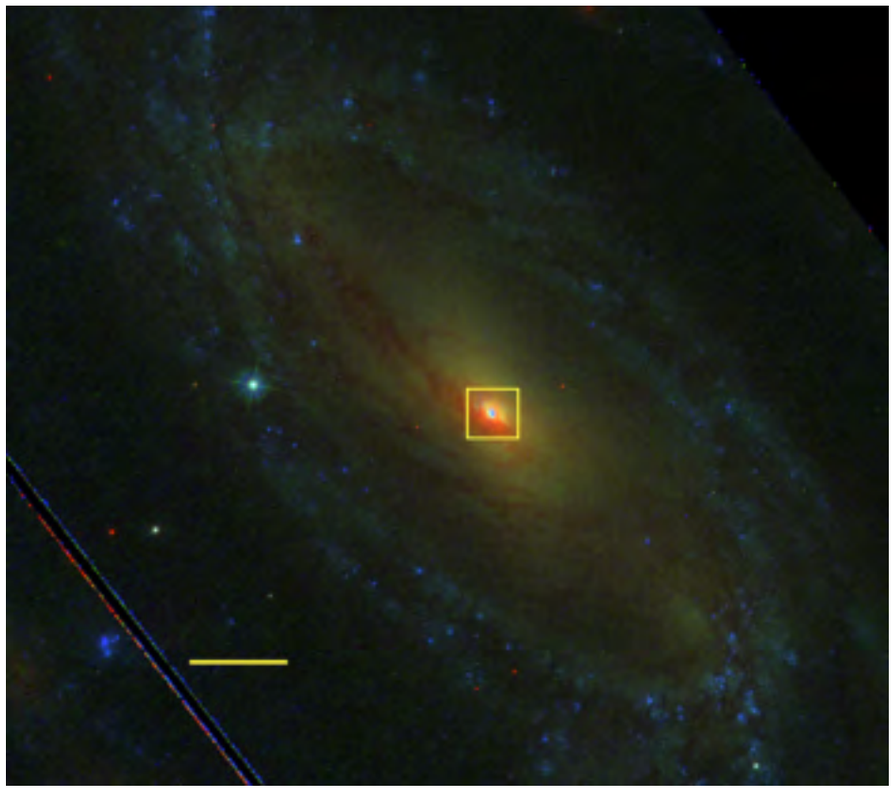
Black hole masses are all ~10^7 $\boldsymbol{M}_\odot$ (with ~10% uncertainties)

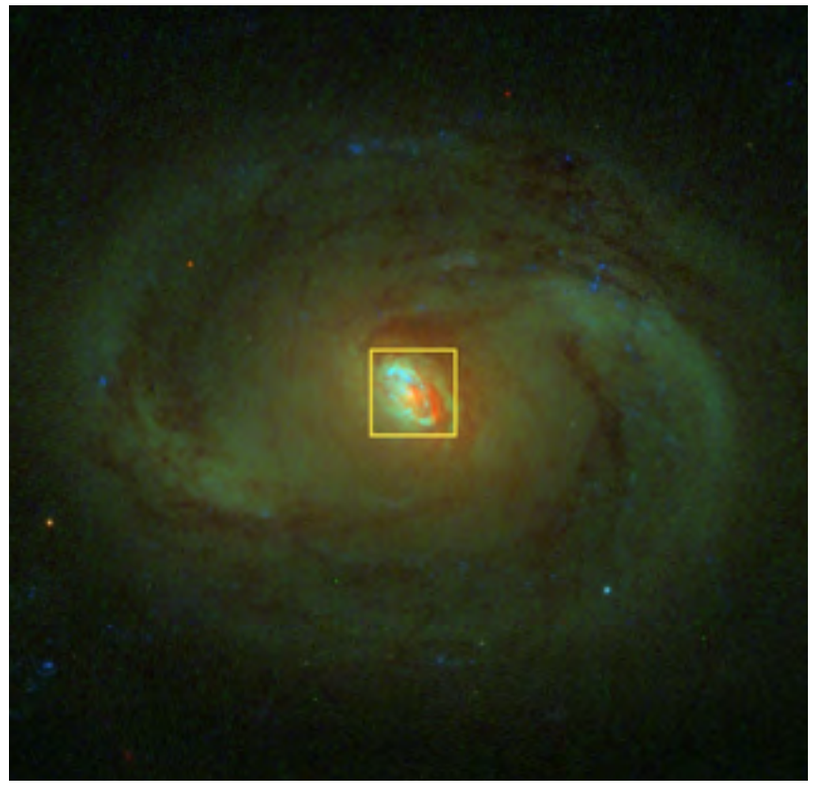
Galaxies are all spirals (S0-Sb), with >60% barred. 15 < D < 150 Mpc.

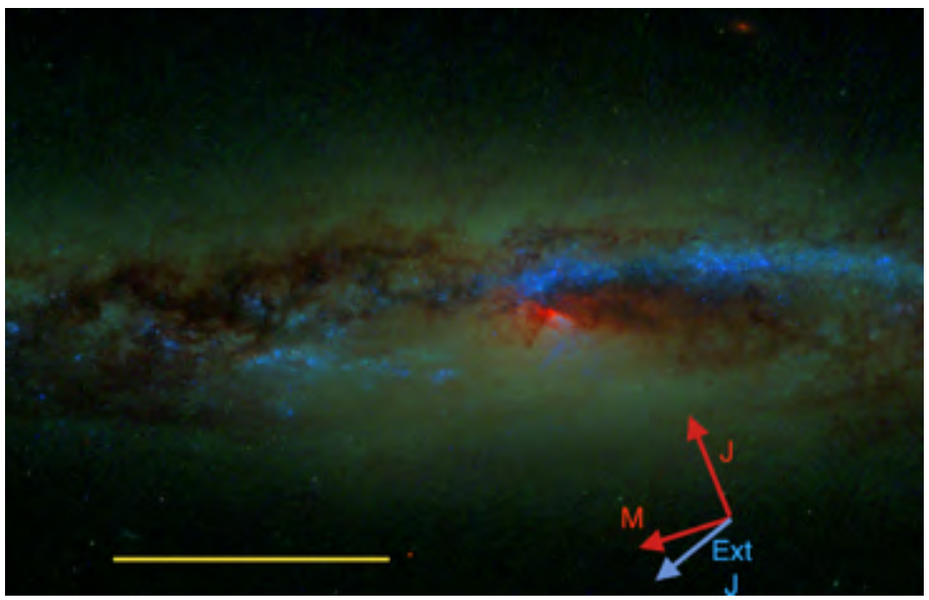
These are obscured active galaxies, many are Compton thick. Eddington ratios are ~10%.

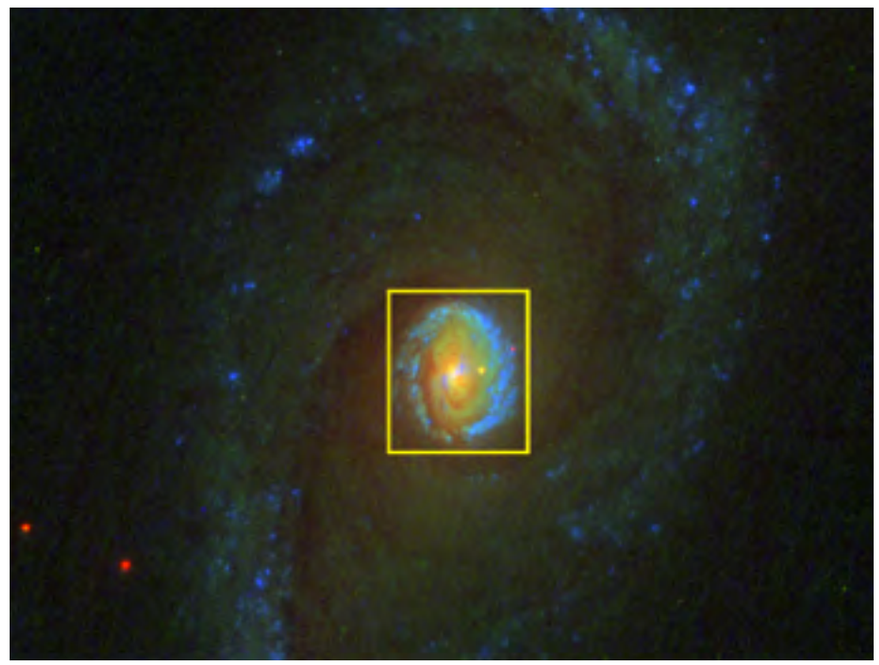
Interestingly, not all edge-on galaxies

Complex Nuclei



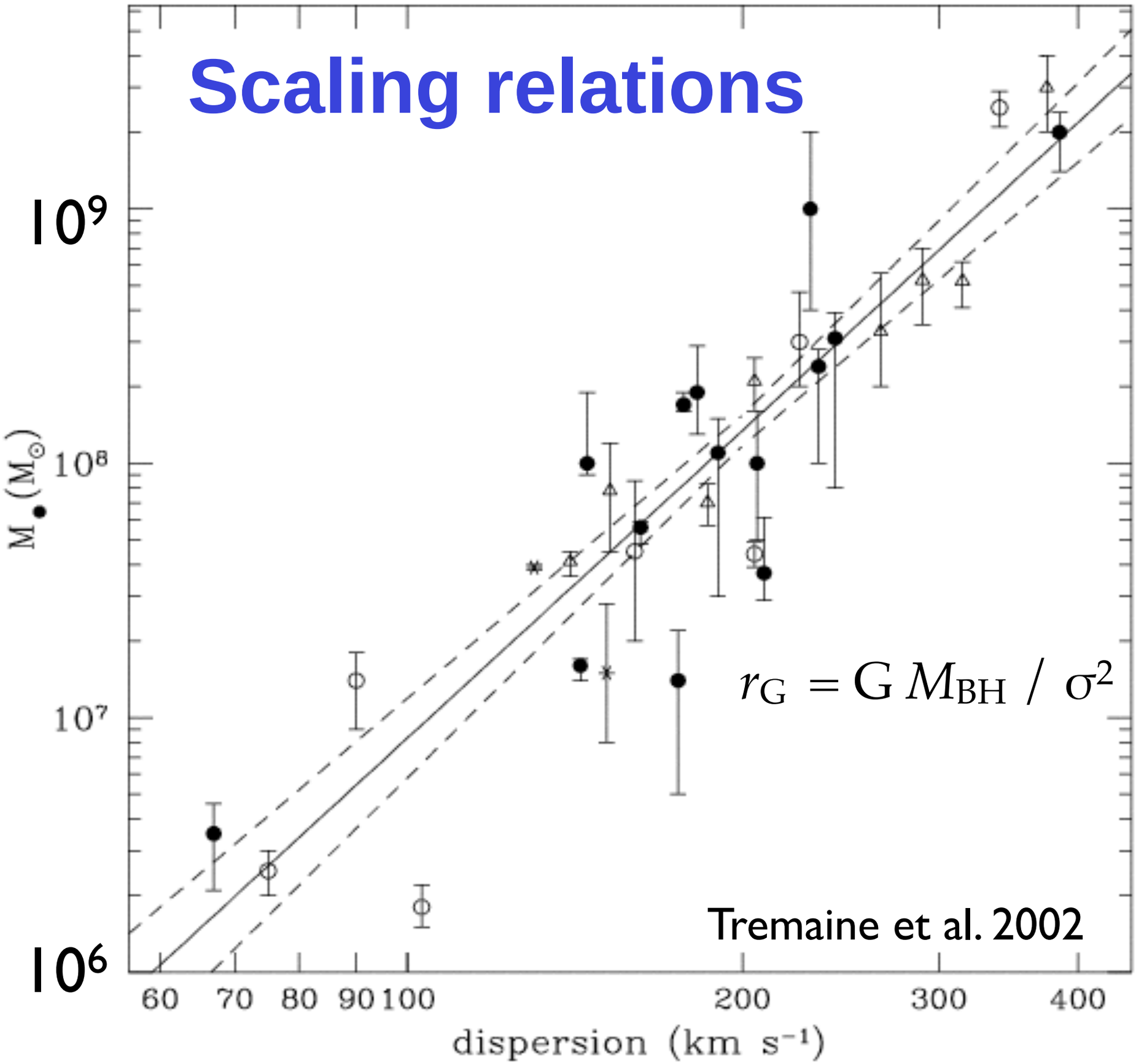






Laesker+2016, Greene+ 2013

Scaling relations



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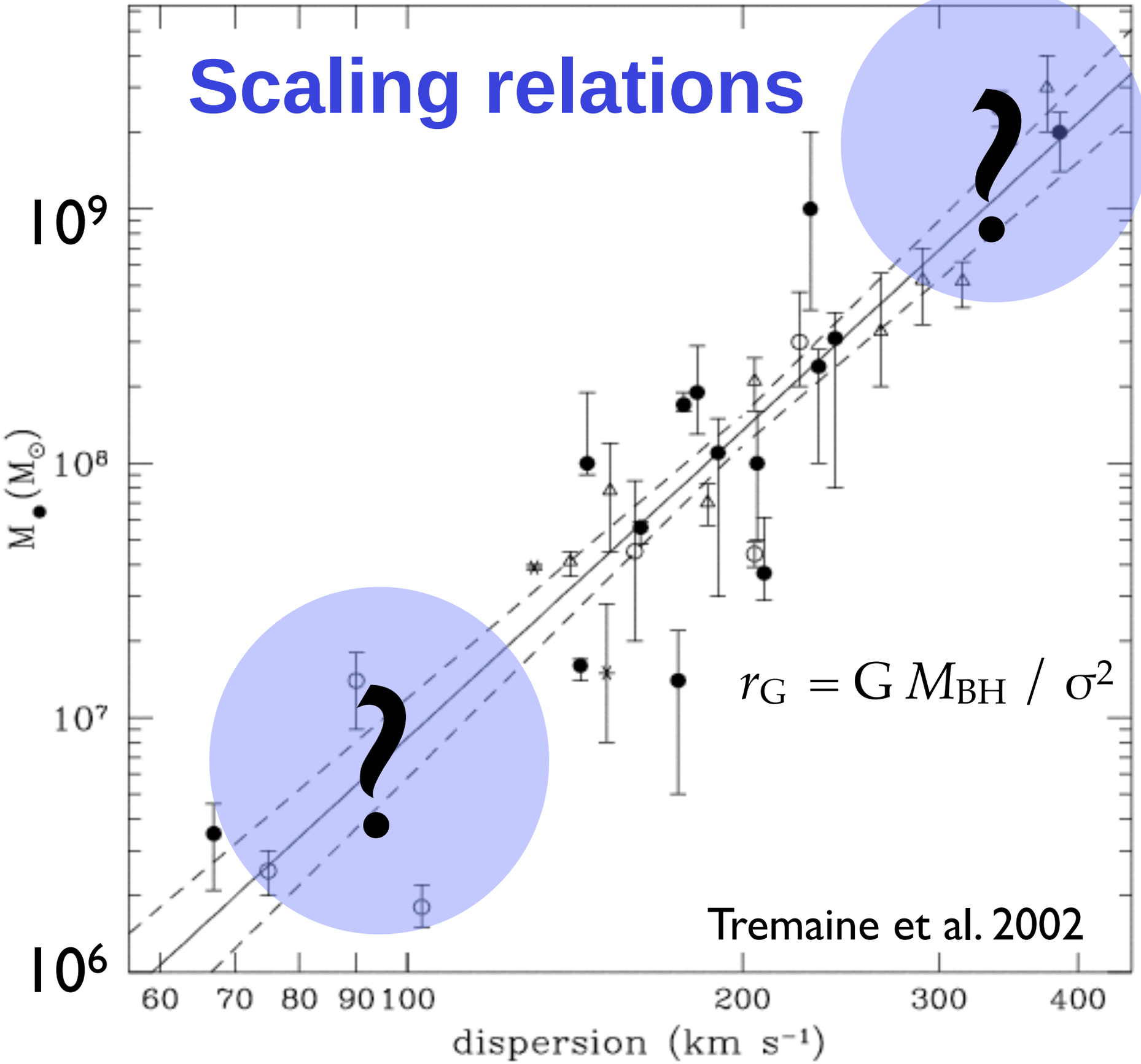
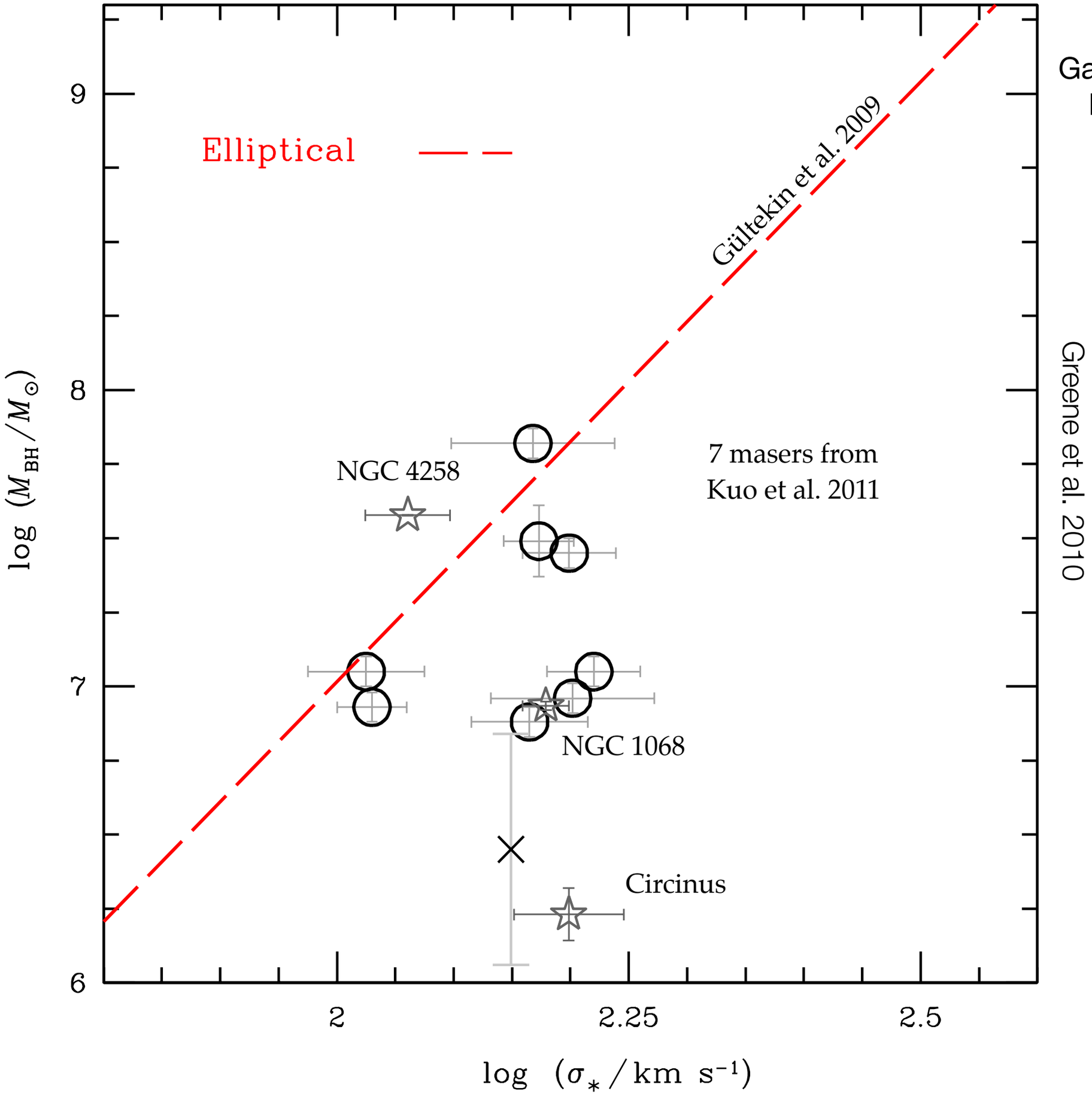


See also Hu 2008,
Gadotti & Kauffman 2008,
Kormendy et al. 2011



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Correlation with σ*?

Early Only
All

Ell
S0
S
Maser

M_{BH} $(M_\odot)$

10^{10}
10^{9}
10^{8}
10^{7}
10^{6}

50
100
500

σ_* (km s^{-1})

Greene et al. 2010

See also Hu 2008,
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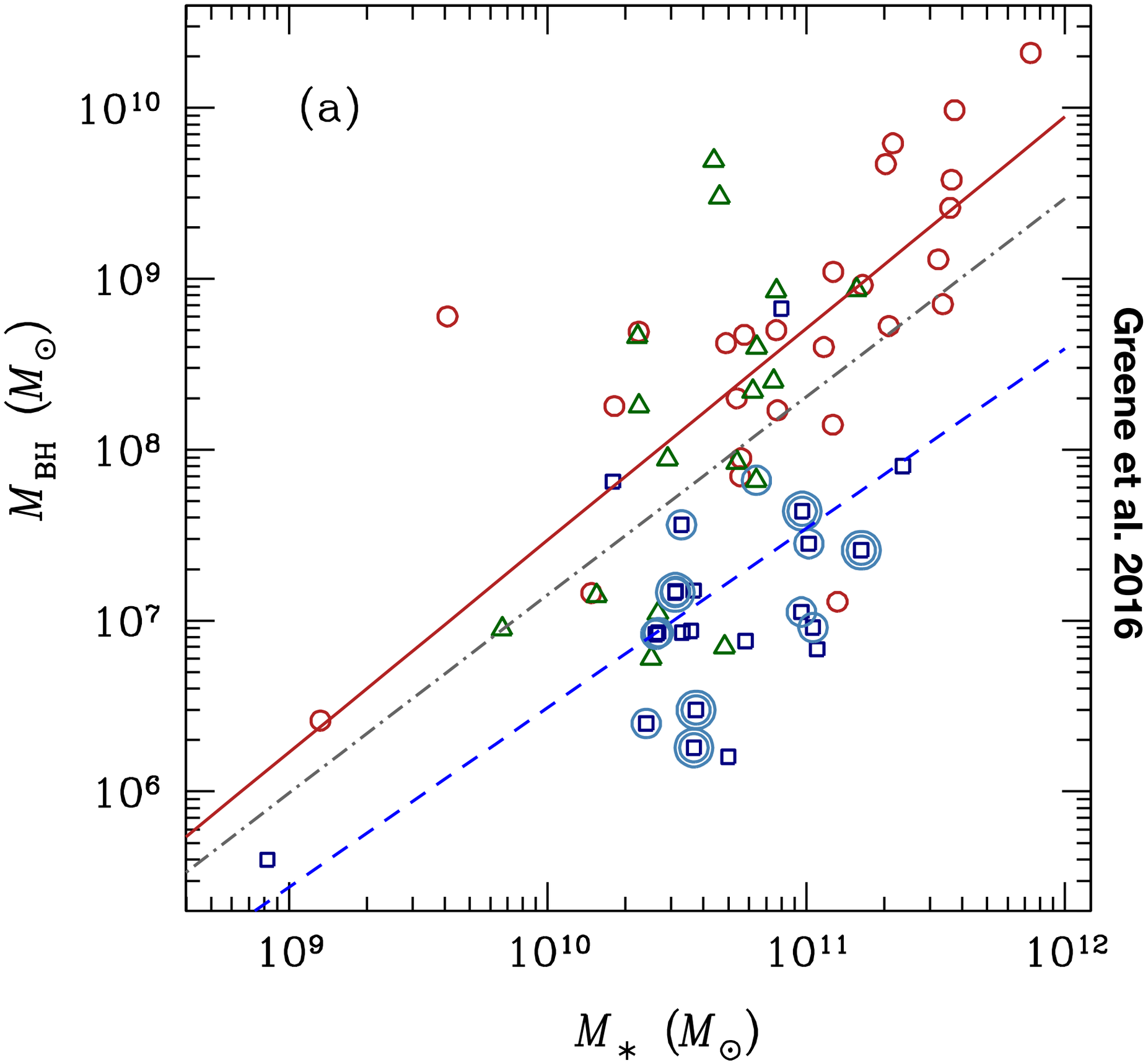
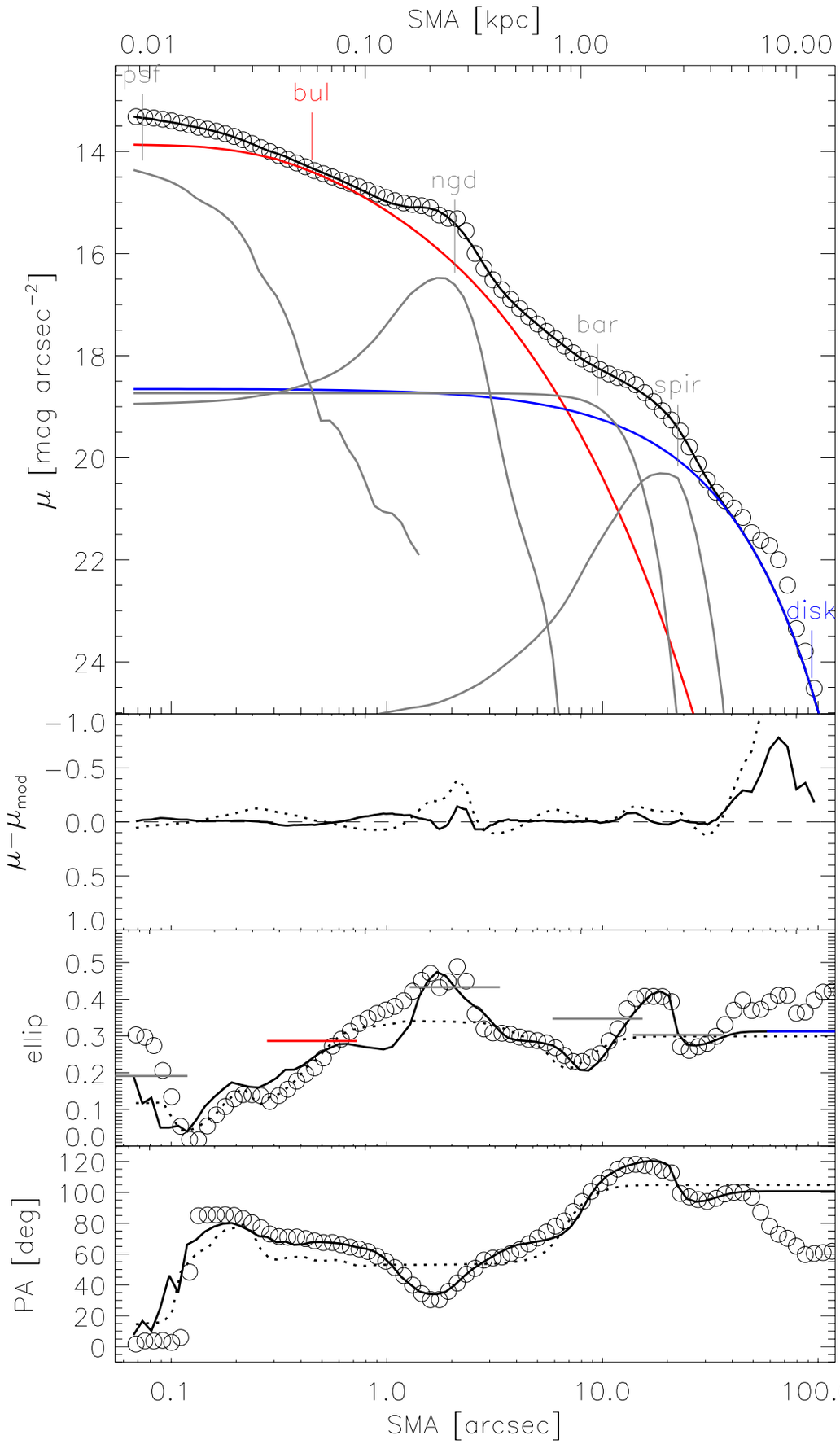
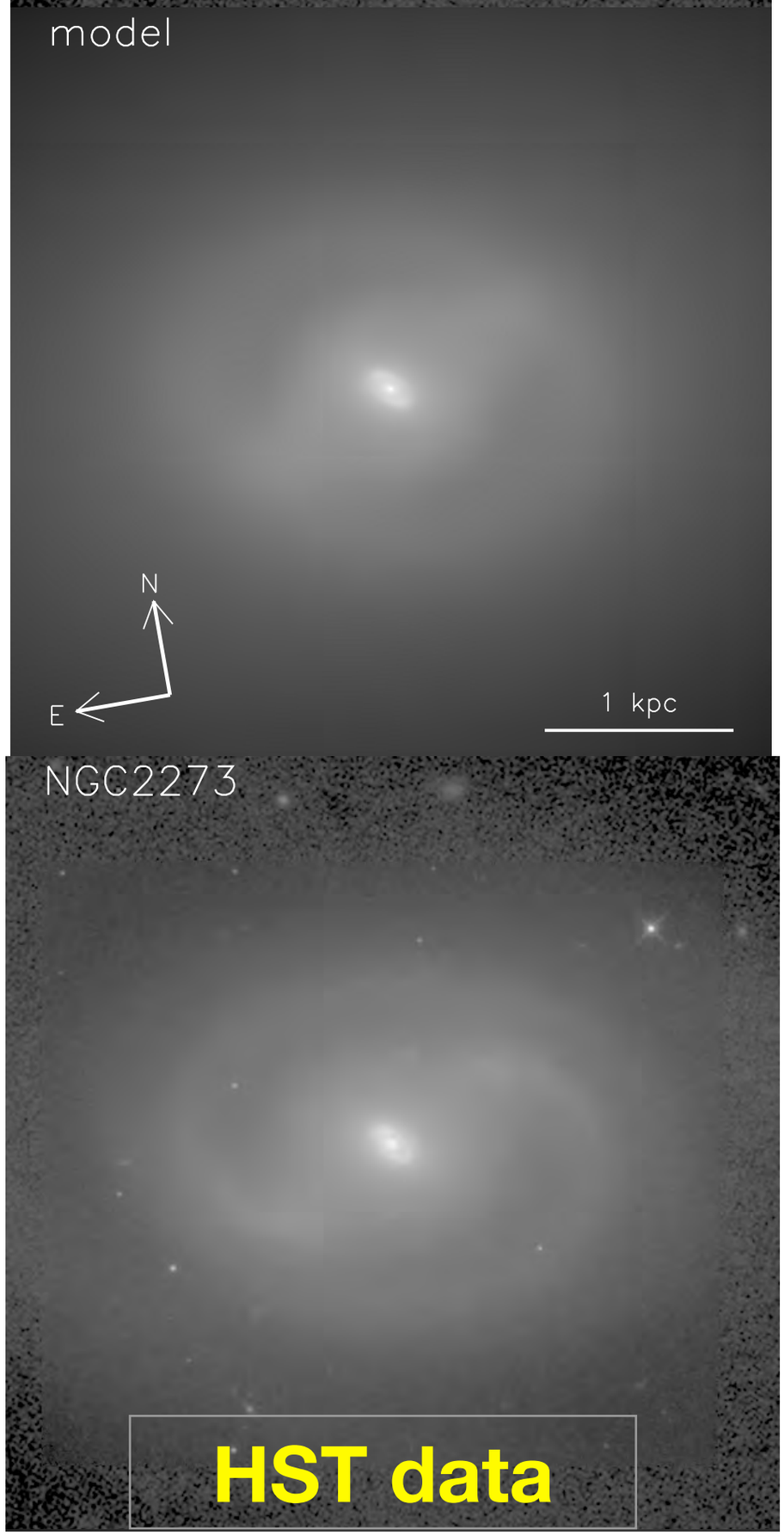


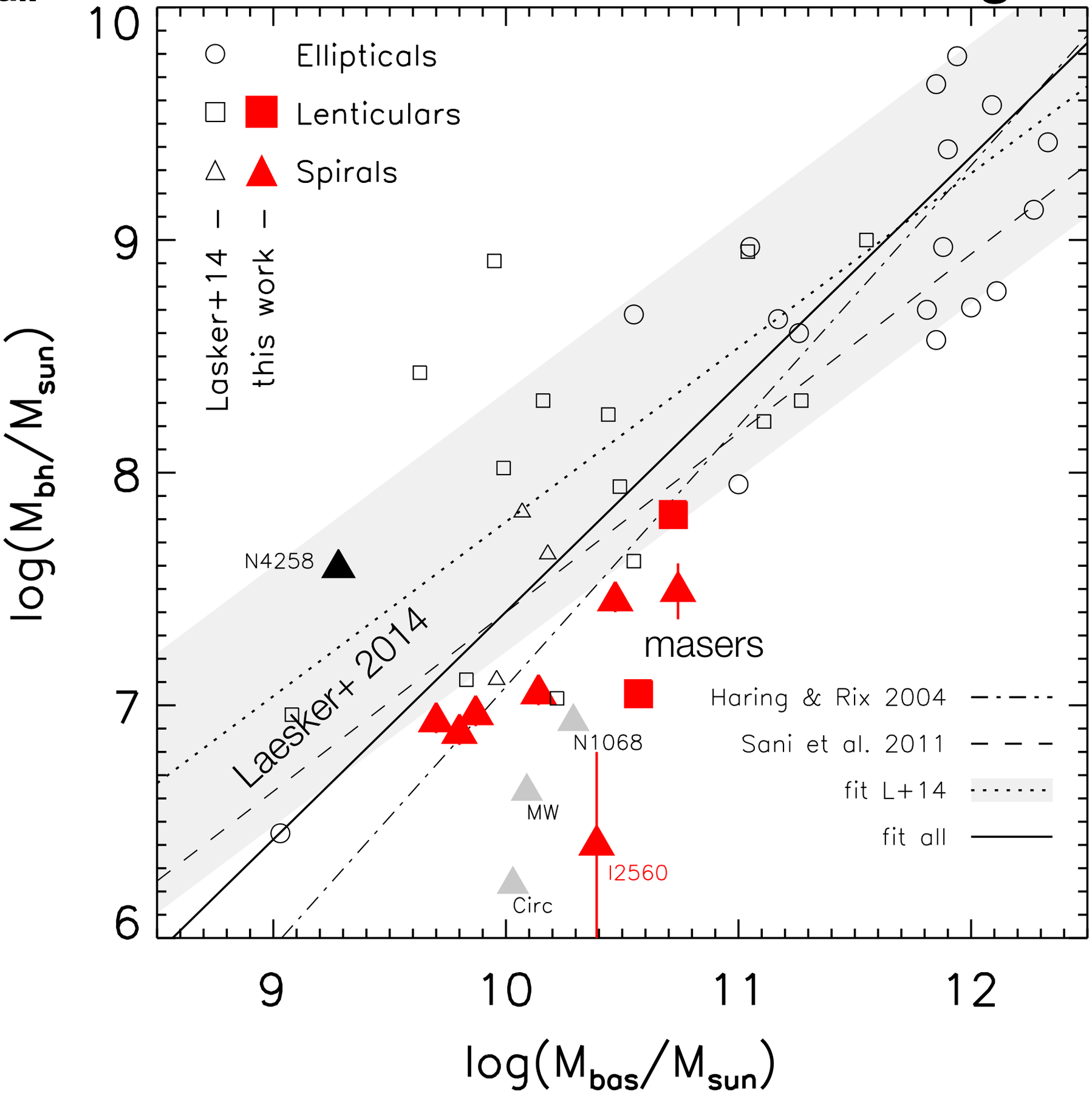
Laesker et al. in 2016





Correlation with Mbulge?

Laesker et al. 2016



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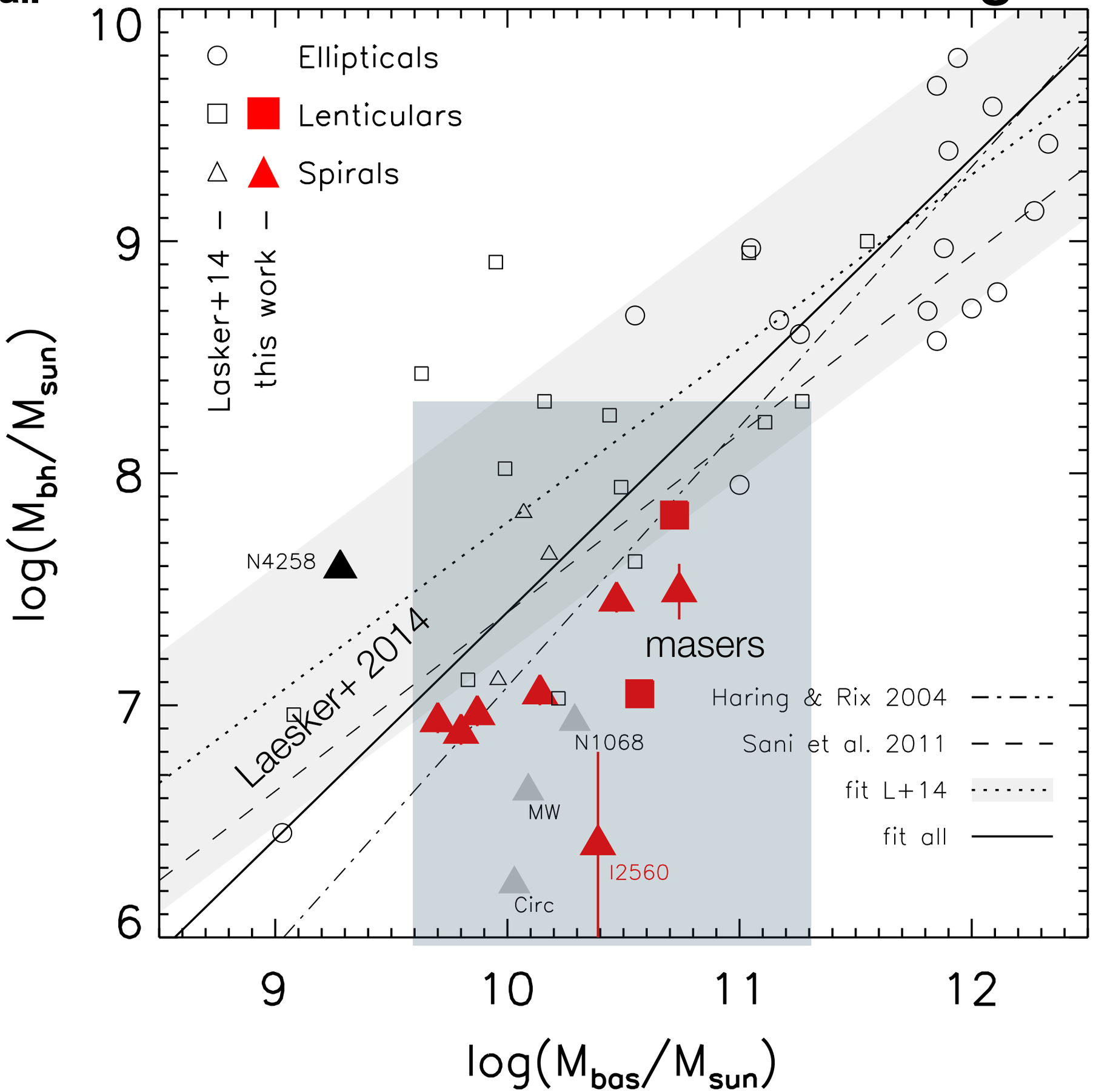
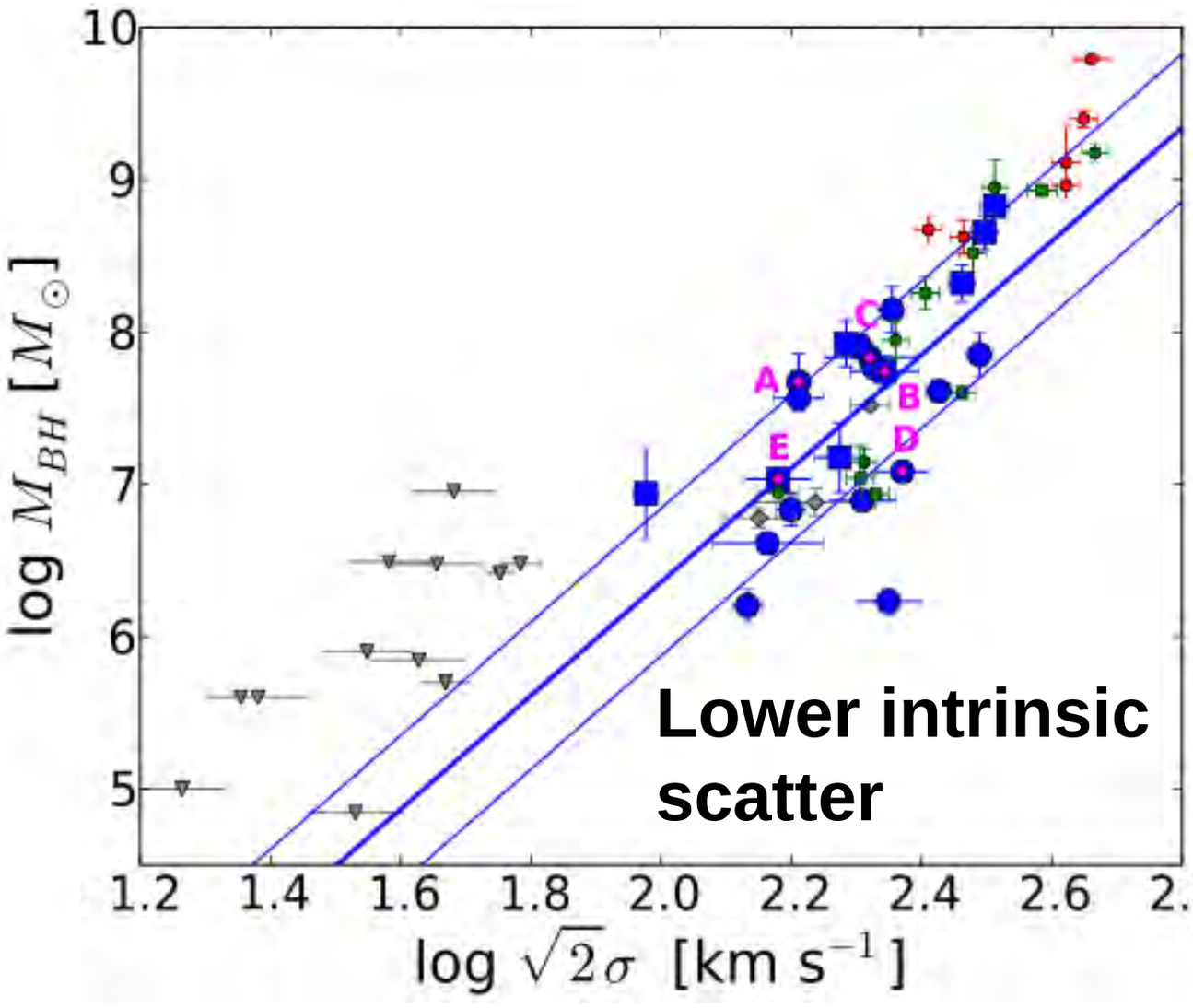
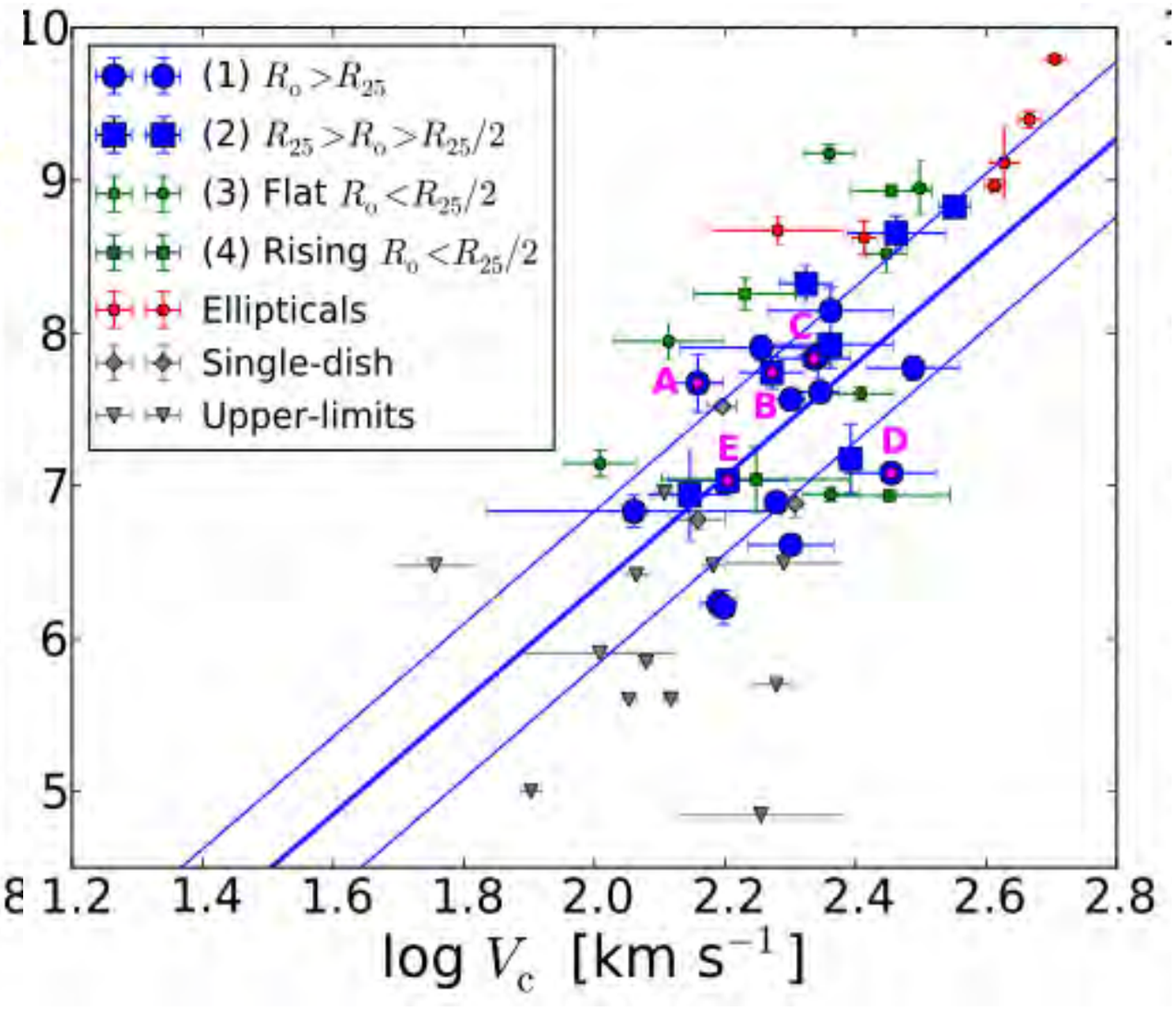


Correlation with halo?

M_{BH} - σ

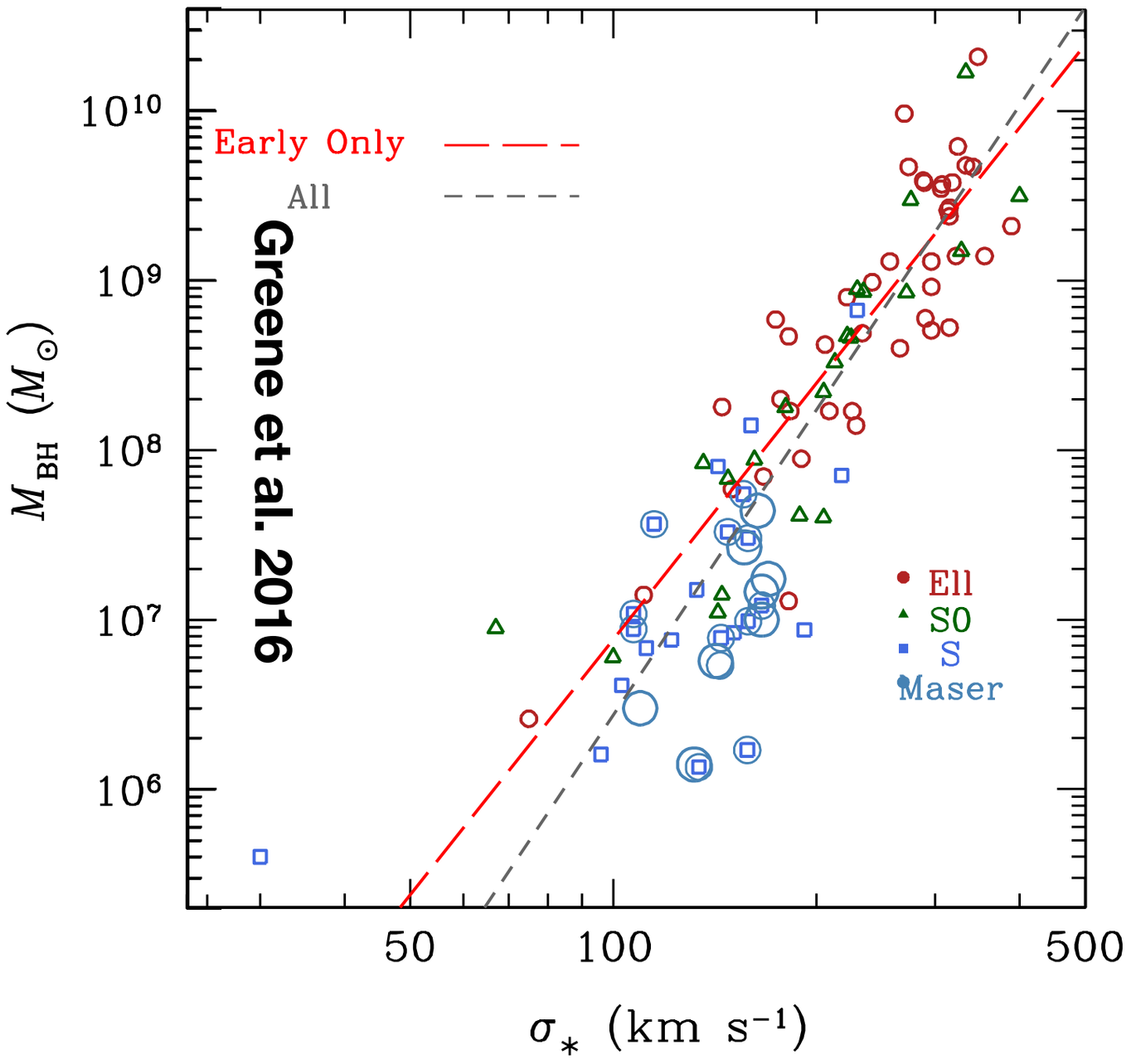
M_{BH} - Vc





Sun, Greene+ 2013

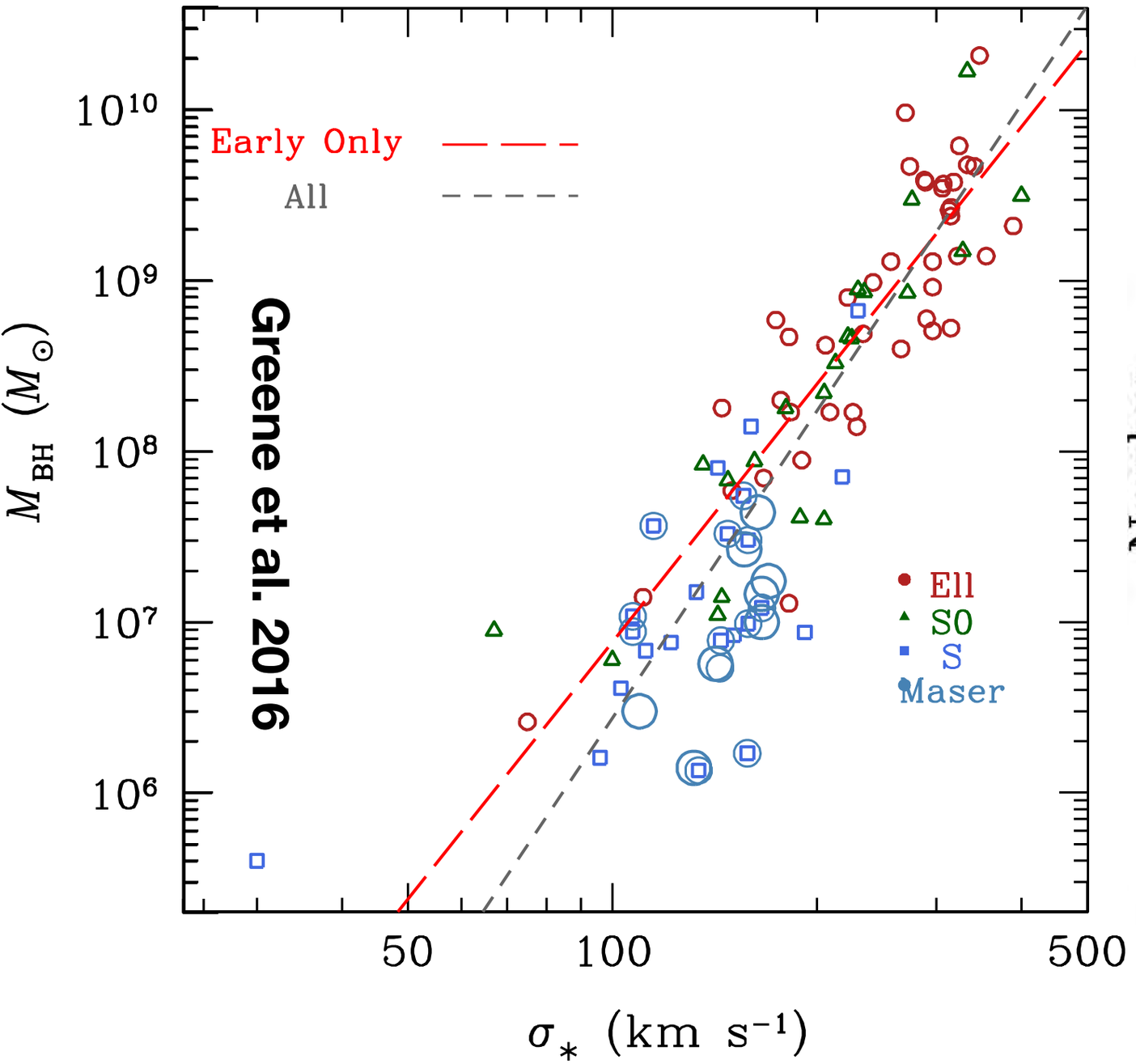
No Correlation with host?

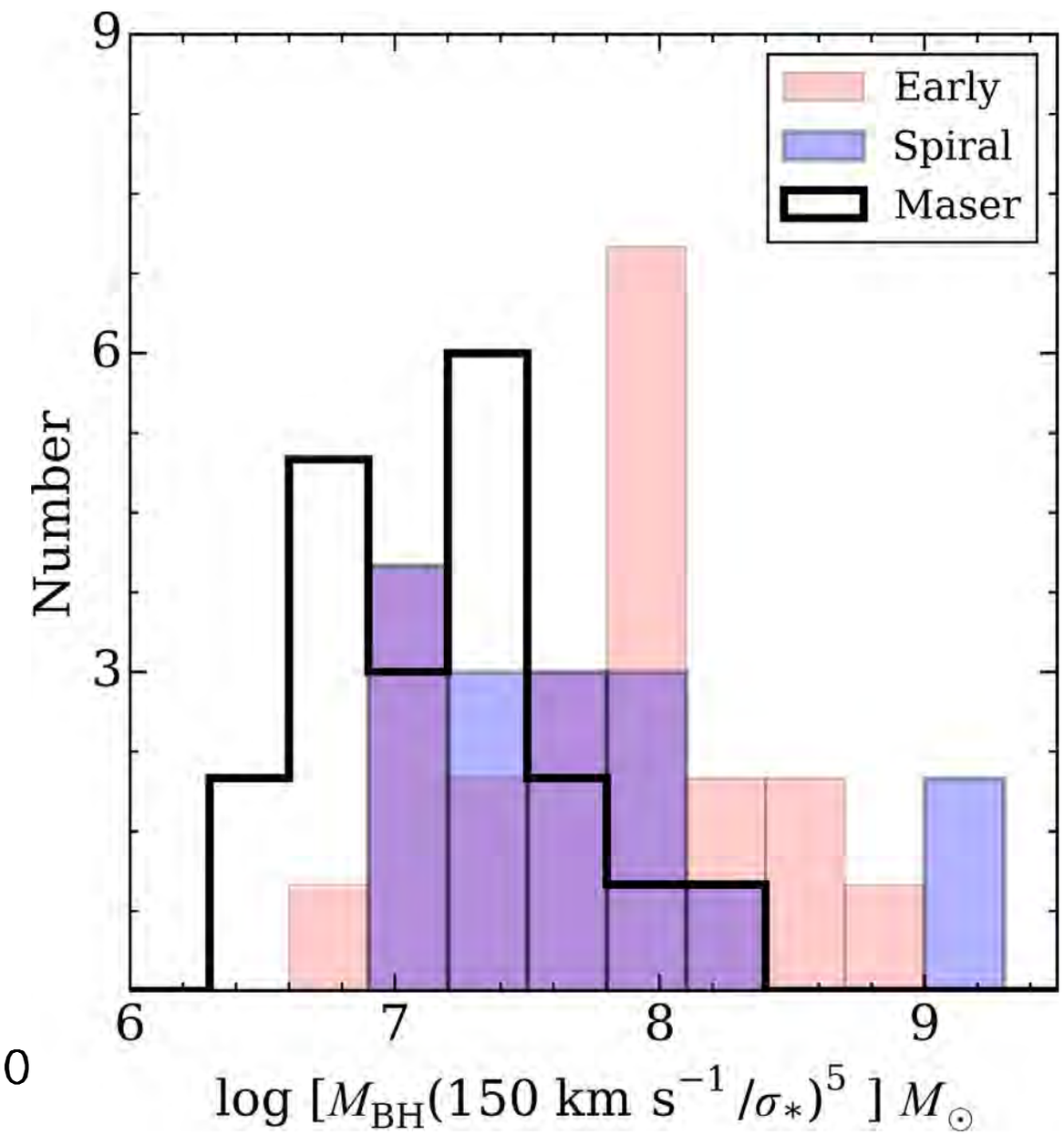


No clear evidence that BH correlates with any galaxy property

Is correlation set when galaxy shuts off? Is it feedback? Or just a side effect of merging?

Maser/non-Maser Spirals different?





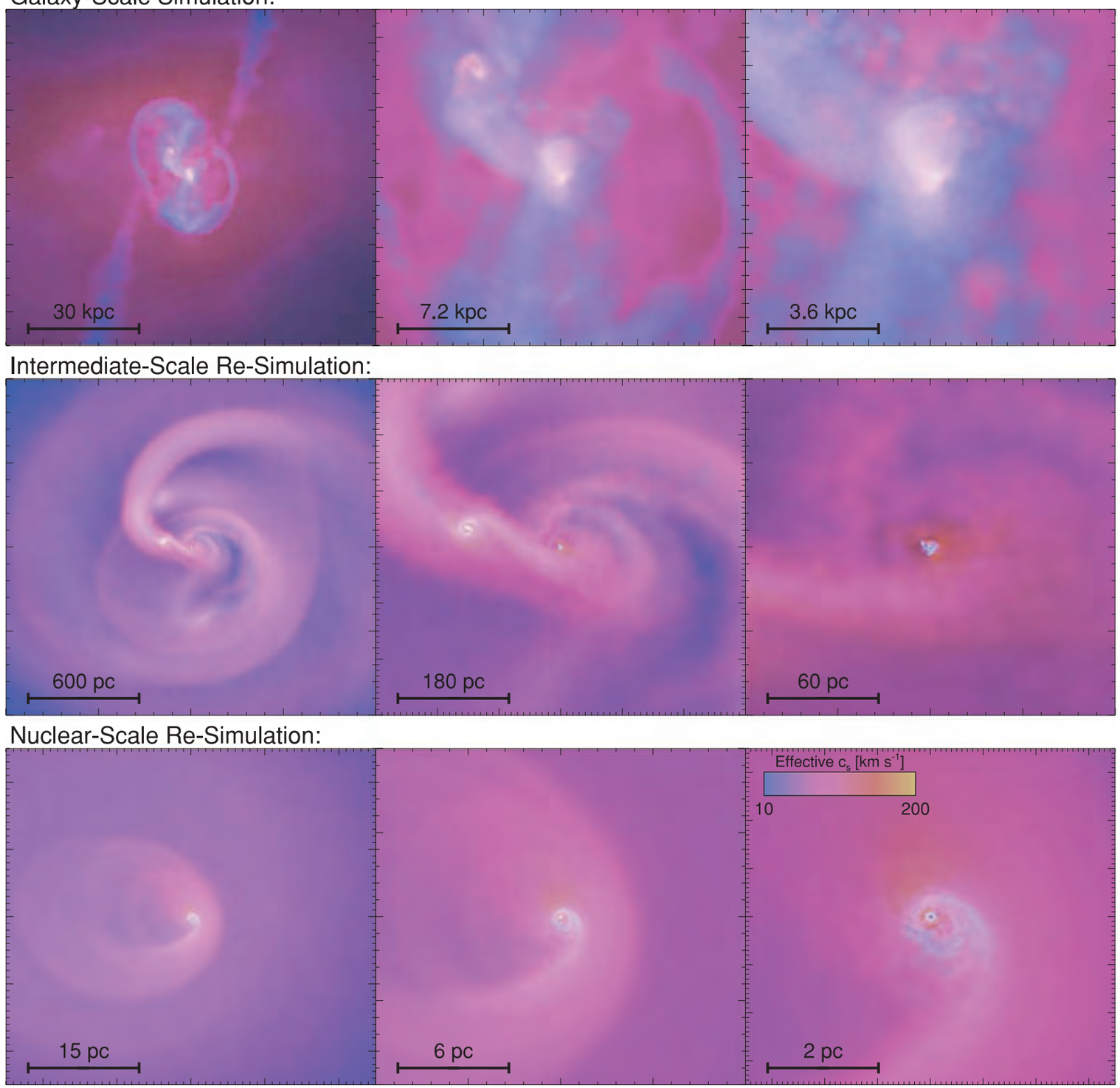
Scaling Relations: Future Work

No obvious correlation between BH mass and galaxy properties for low-mass/spiral galaxies

Is BH growth associated with cessation of star formation (e.g., major mergers+AGN feedback?) *or* does BH grow passively and grow larger in systems that experience more merging?

Need BH masses in more low-mass galaxies! ALMA now, 30m-class telescopes next

Fueling Supermassive Black Holes



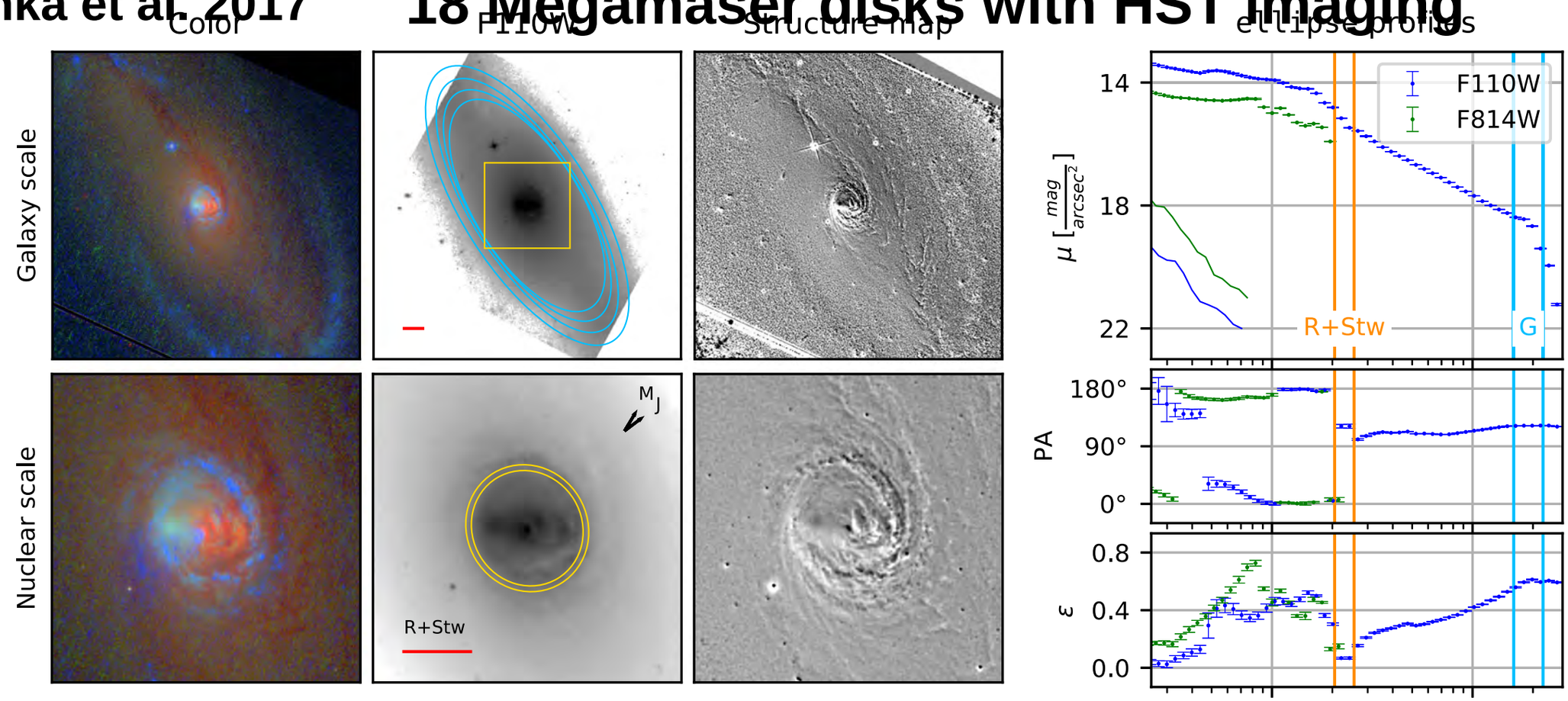
Hopkins & Quataert

Bars within bars (stuff within stuff)

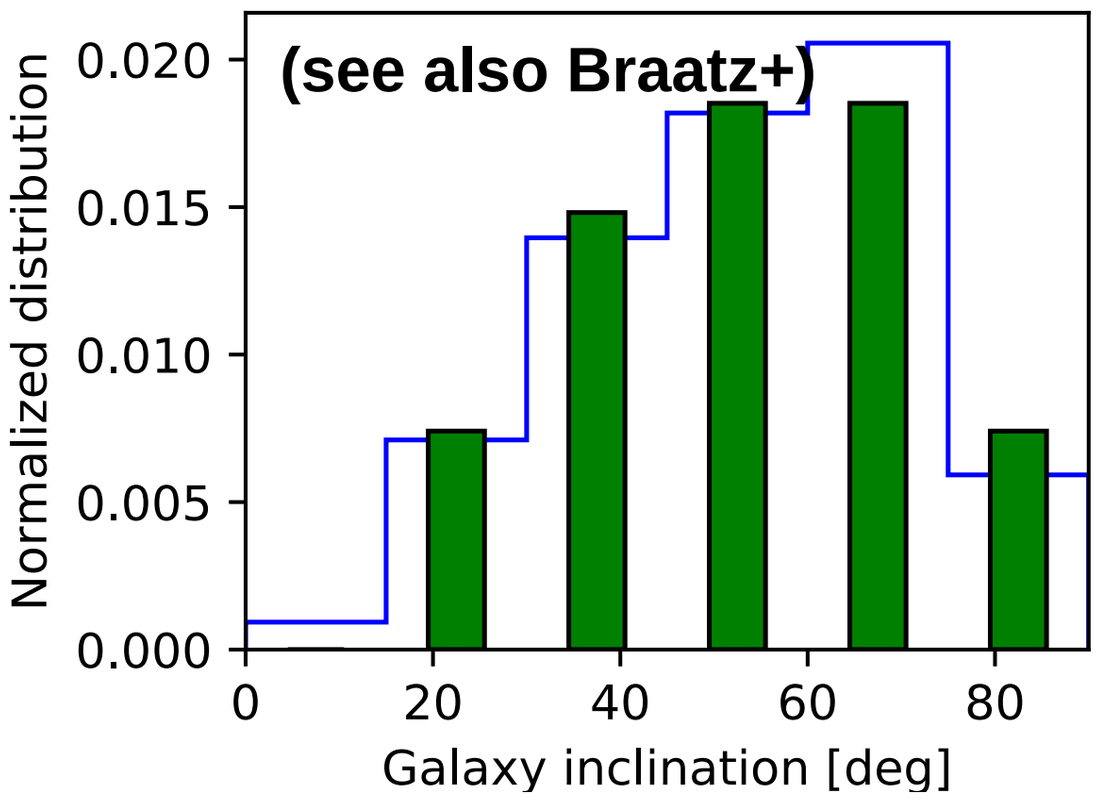
Idea is that because the gas dissipates, there are torques by stellar distribution on gas

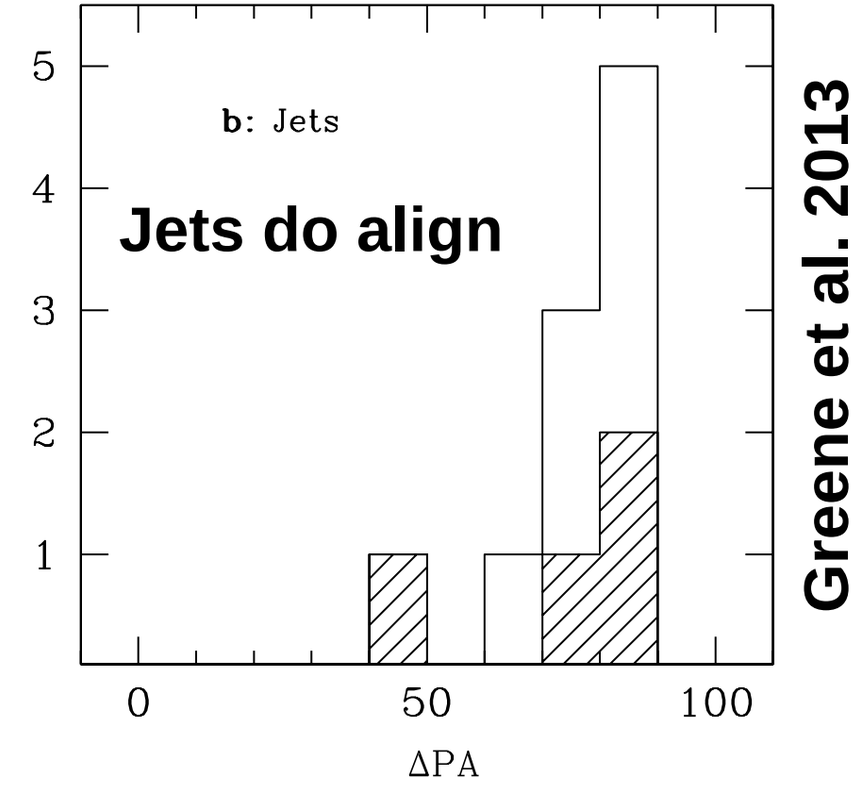
Pjanka et al. 2017

18 Megamaser disks with HST imaging

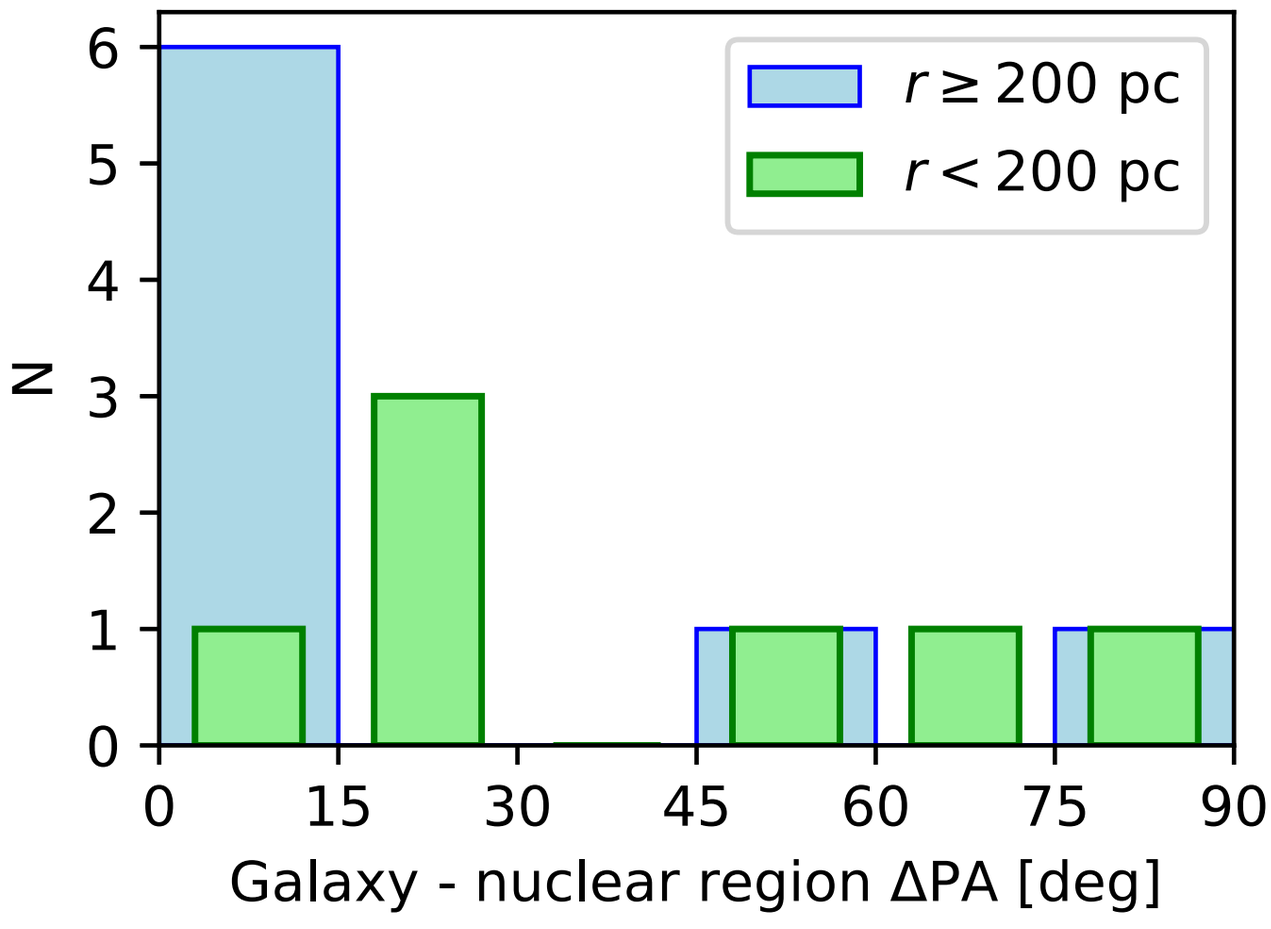


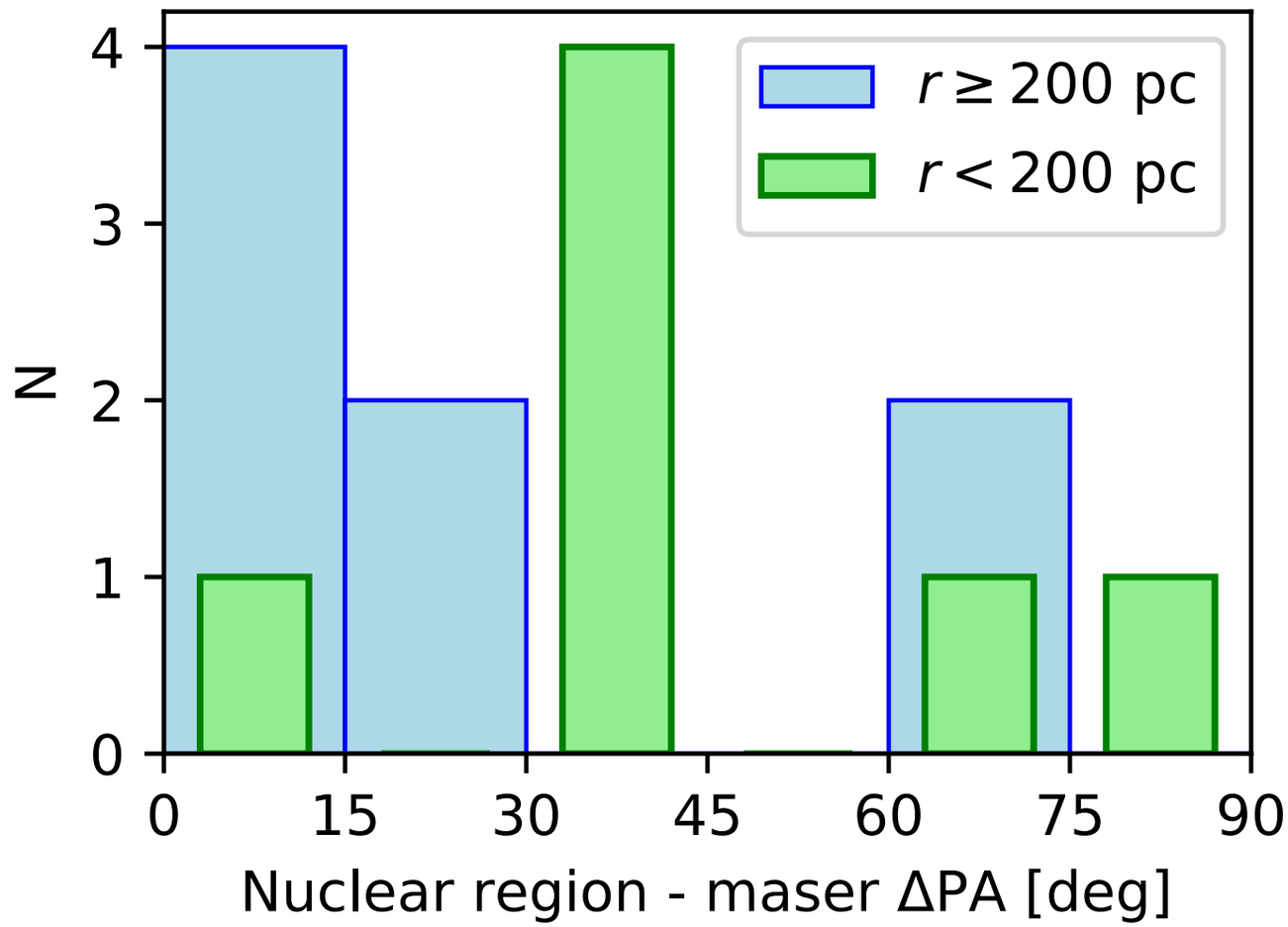
No preference for edge-on galaxies





Pjanka et al. 2017





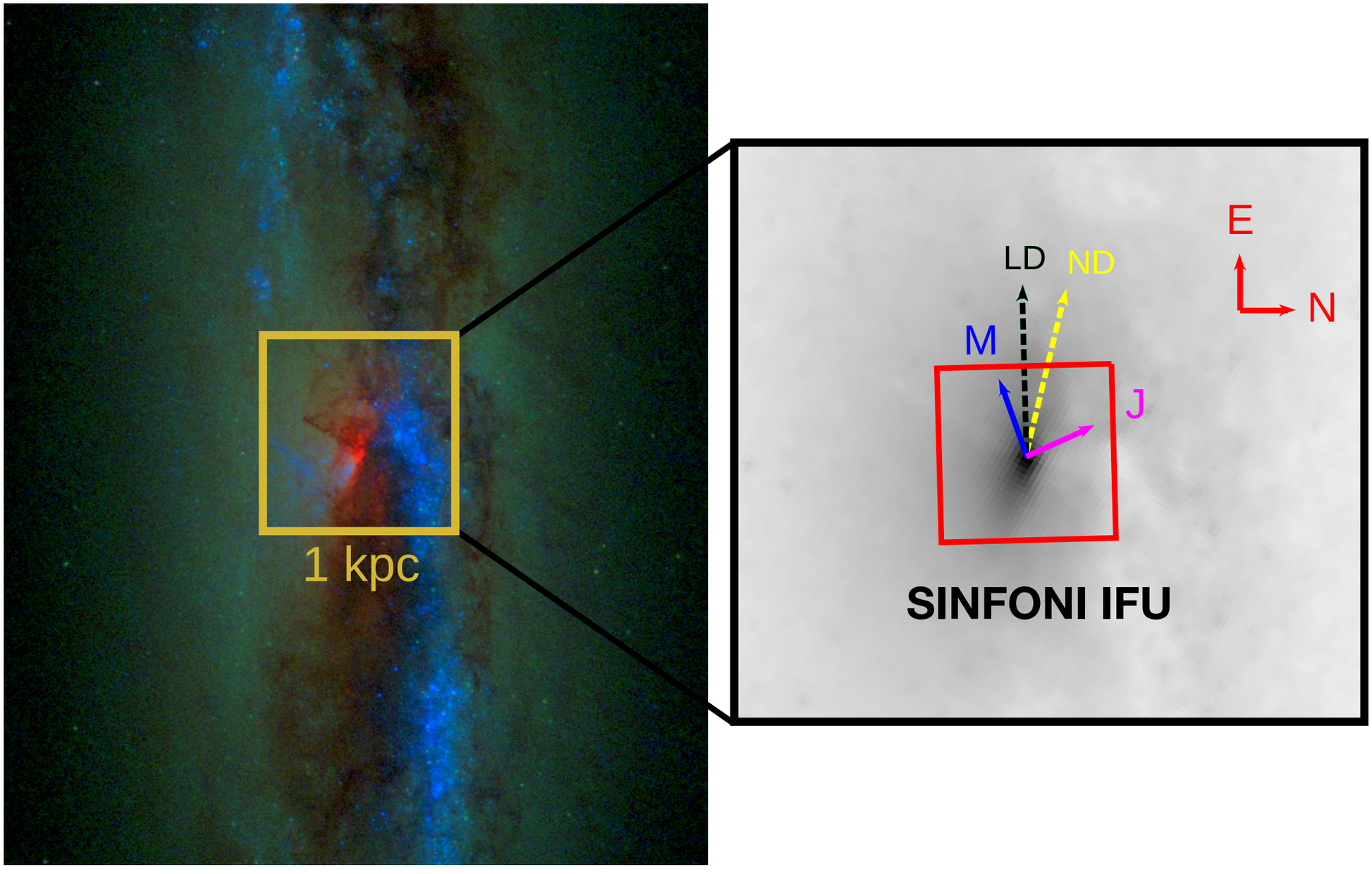
Features <200 pc do not align with large-scale disk, while features >200pc are aligned statistically

Maser disks do not align with disks of any scale. Angular momentum changes required to accrete

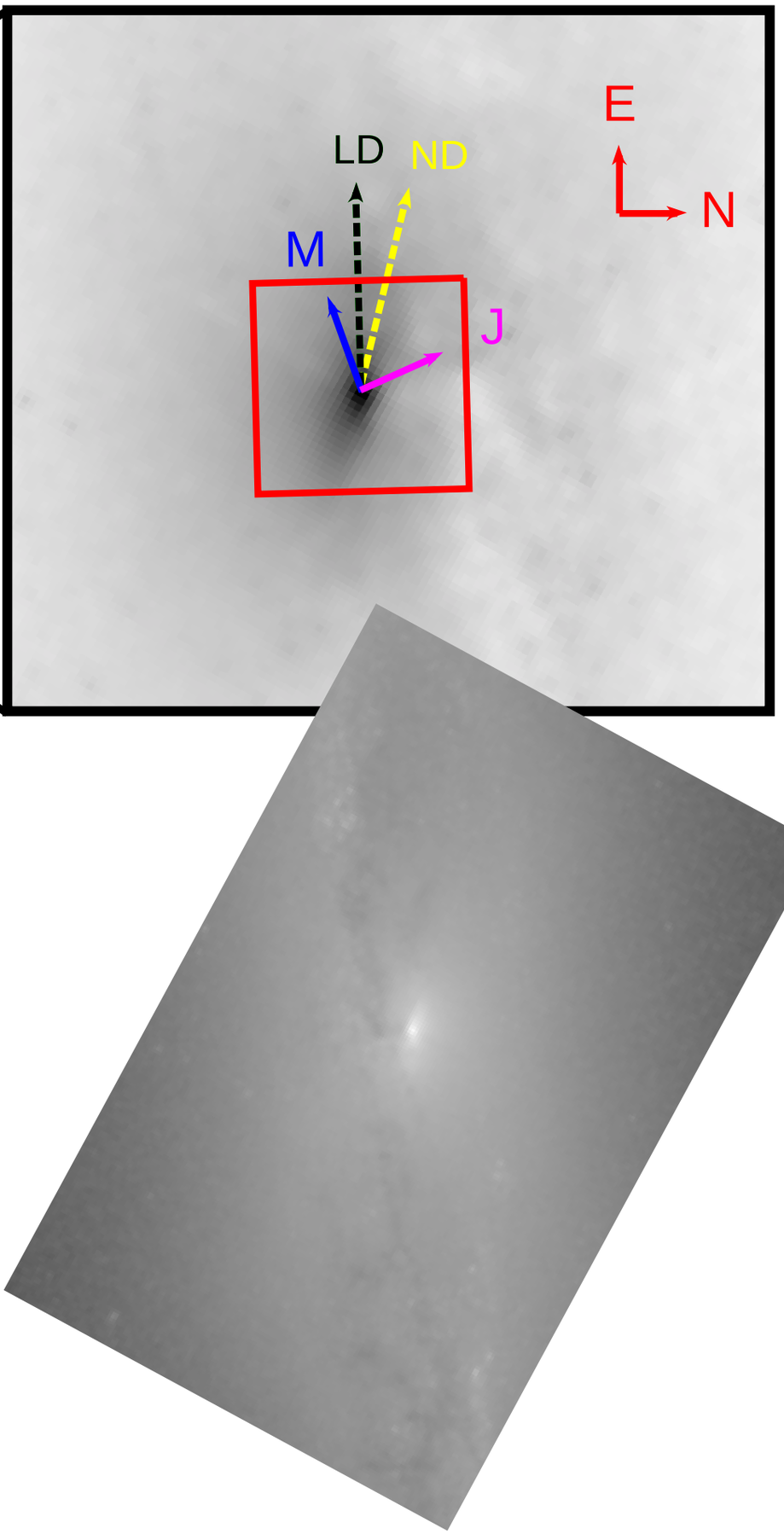
Greene et al. 2014

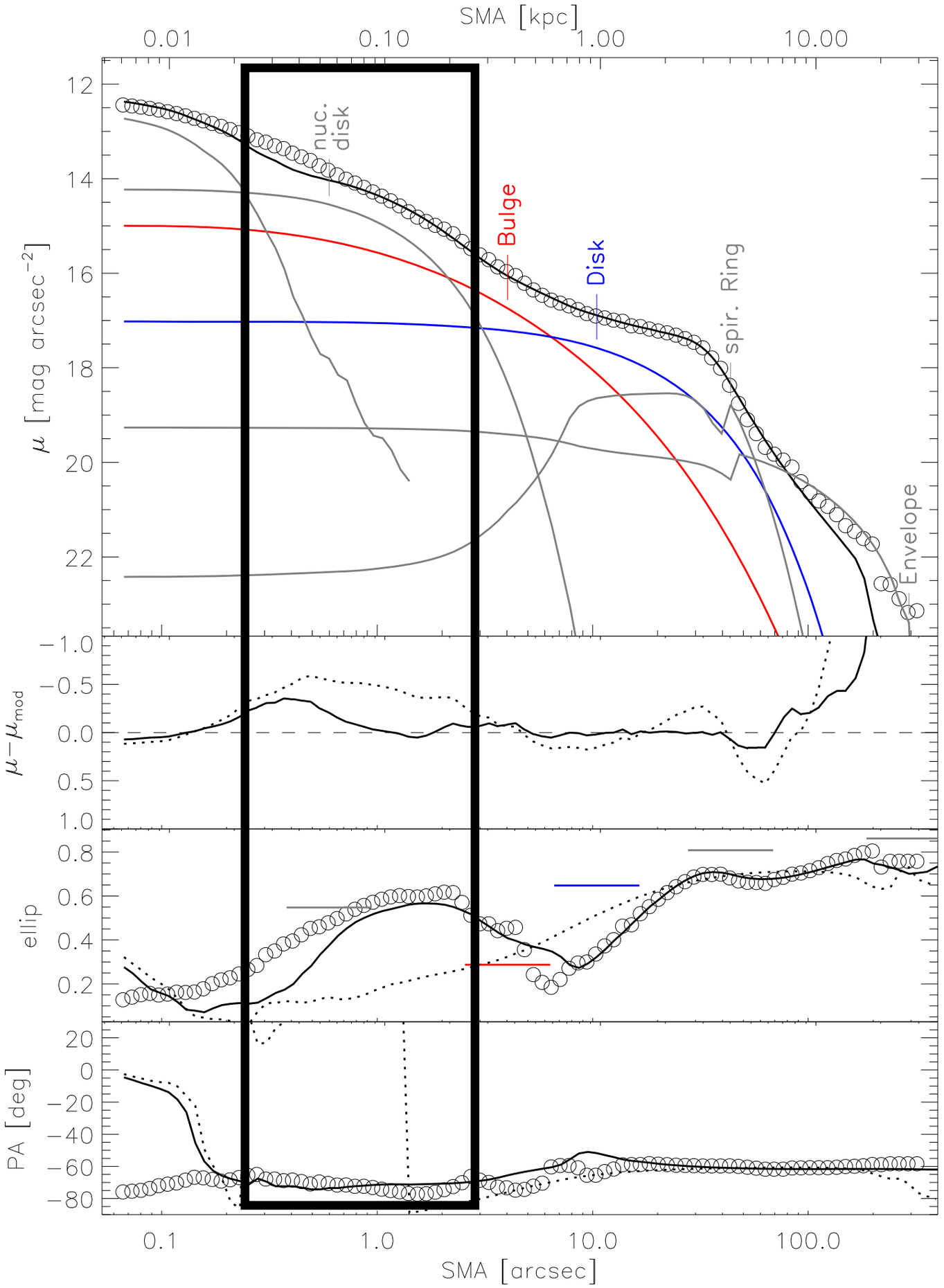
NGC 4388

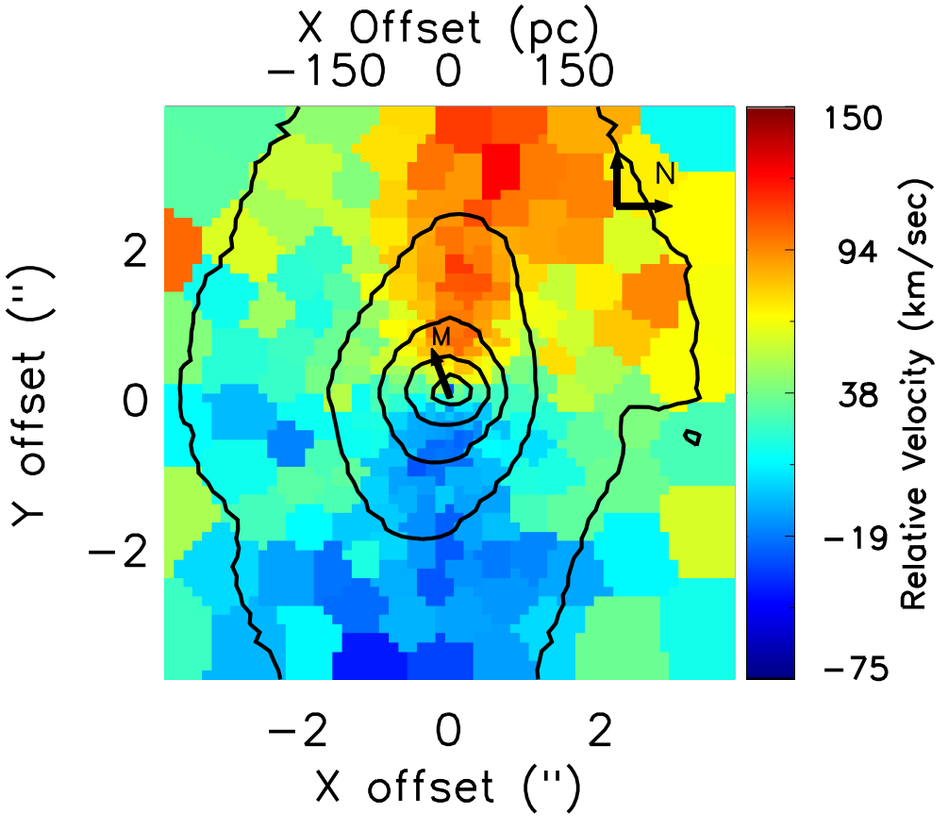
(Virgo)

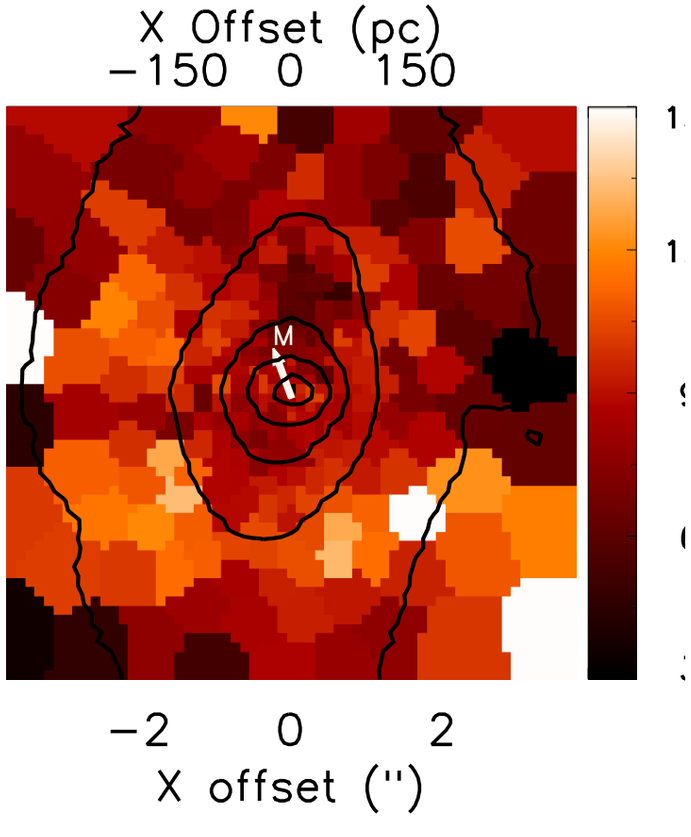


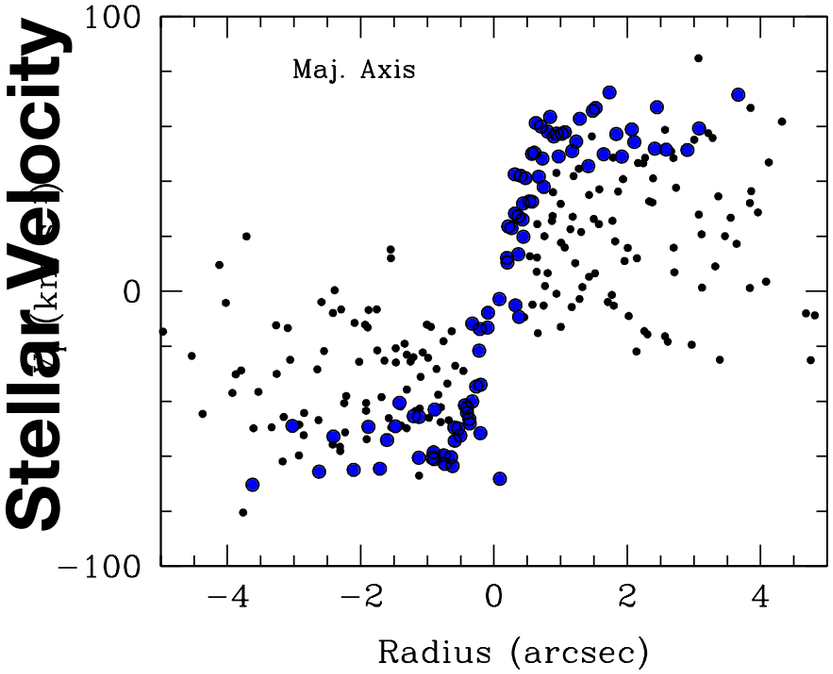
Laesker et al. 2016

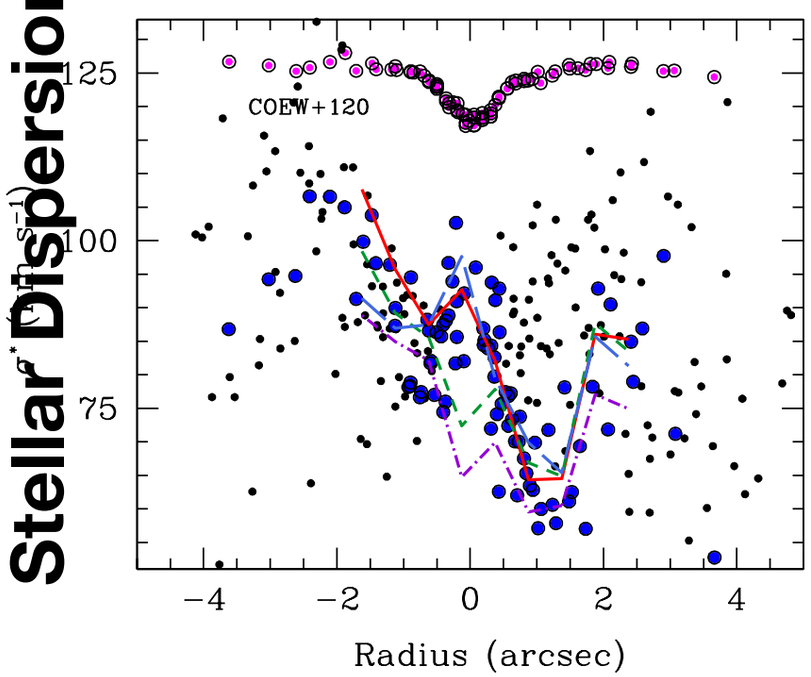






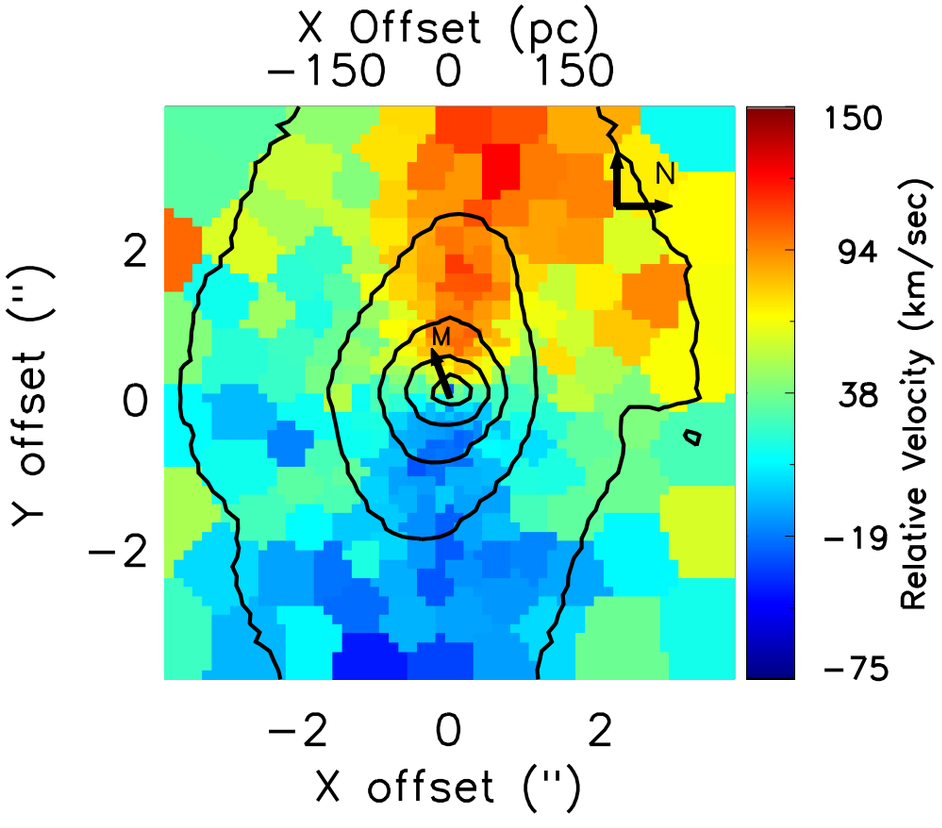


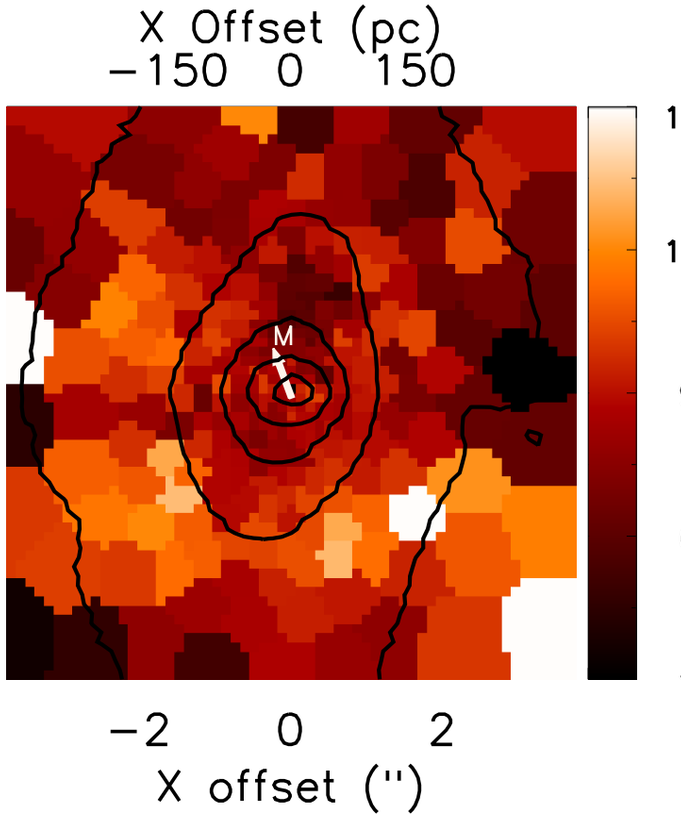




Stellar Kinematic Fields

Greene et al. 2014



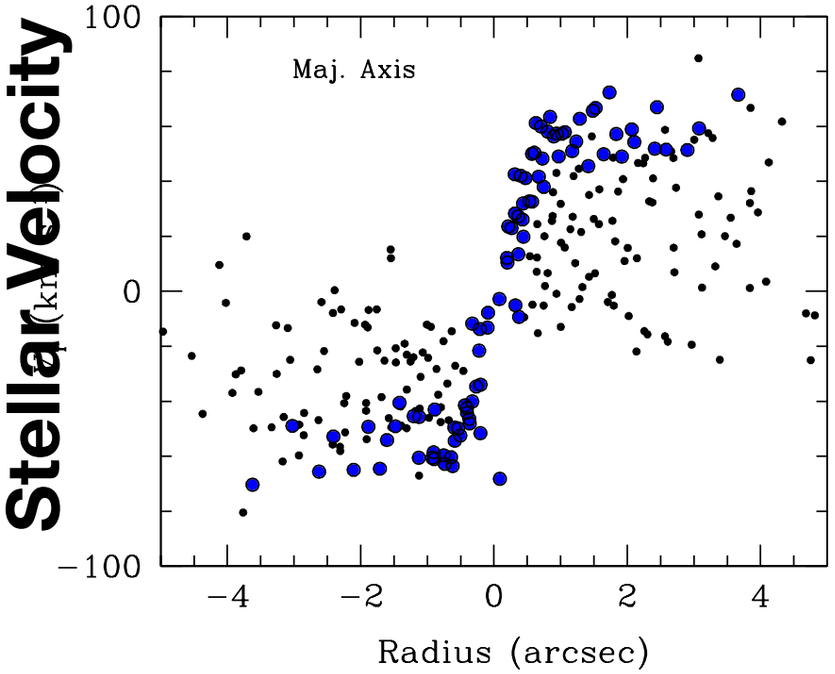


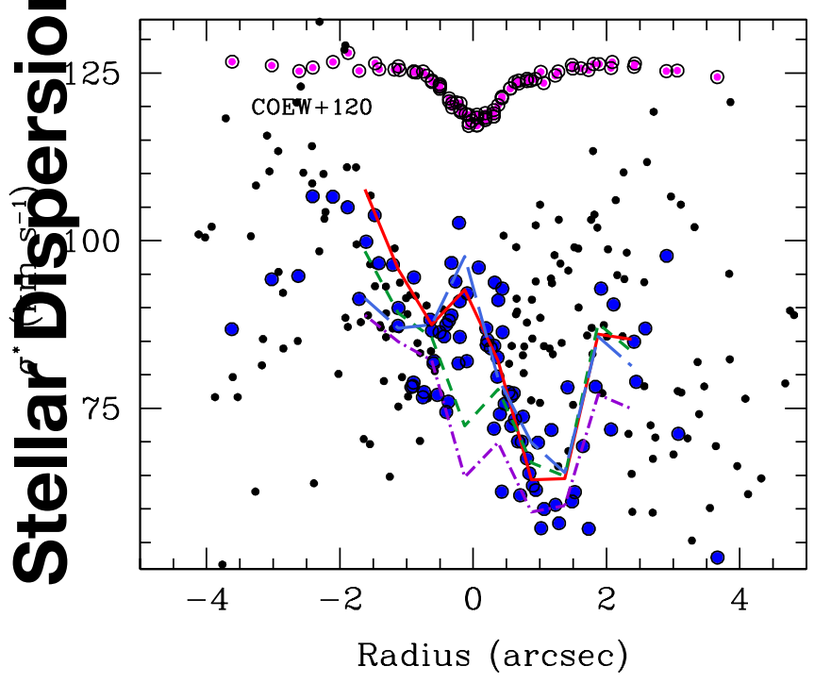
<100 pc disk

— misaligned from large-scale by 15 deg

— misaligned from maser by 35 deg

drop in dispersion clearly seen





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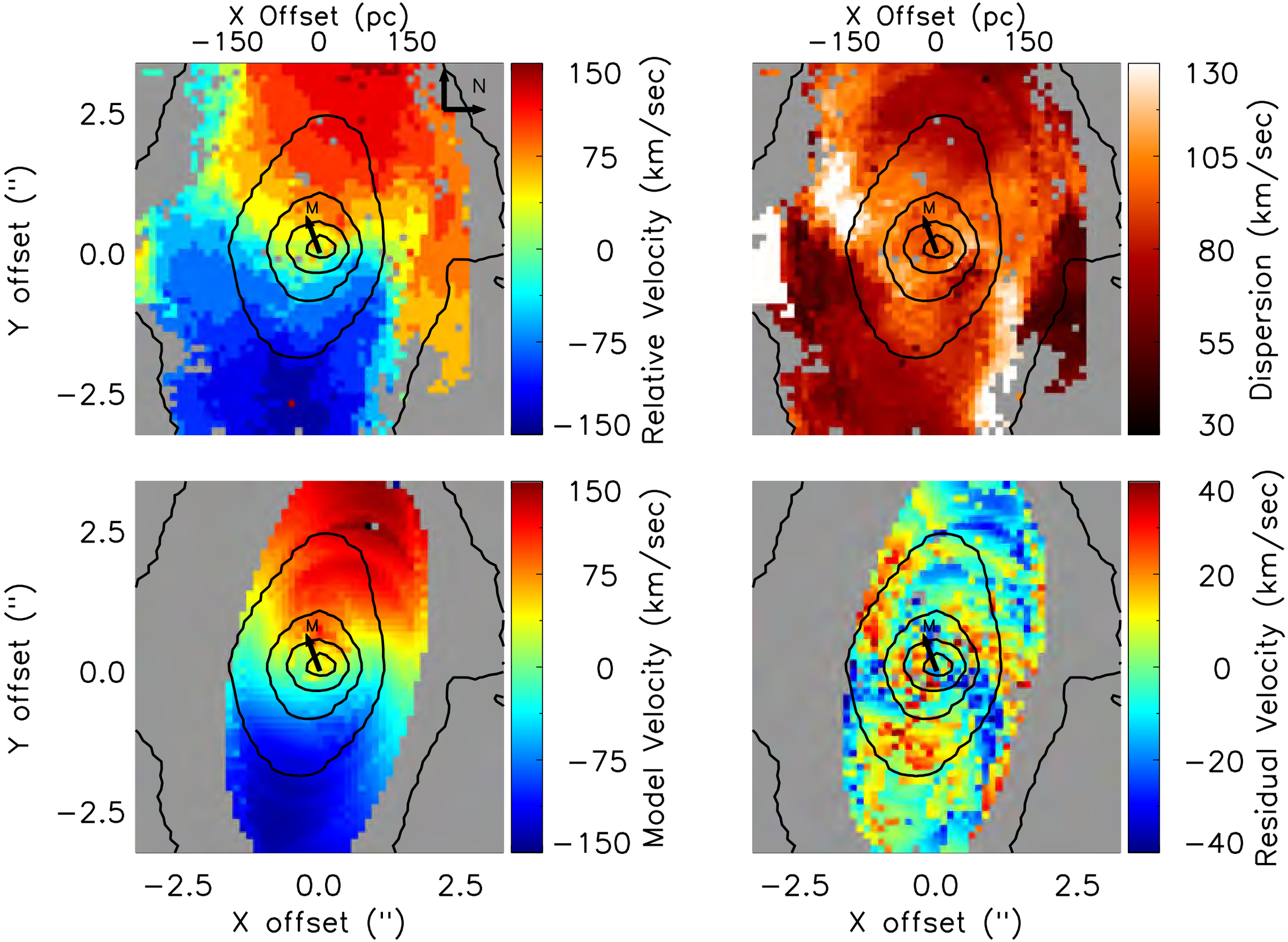
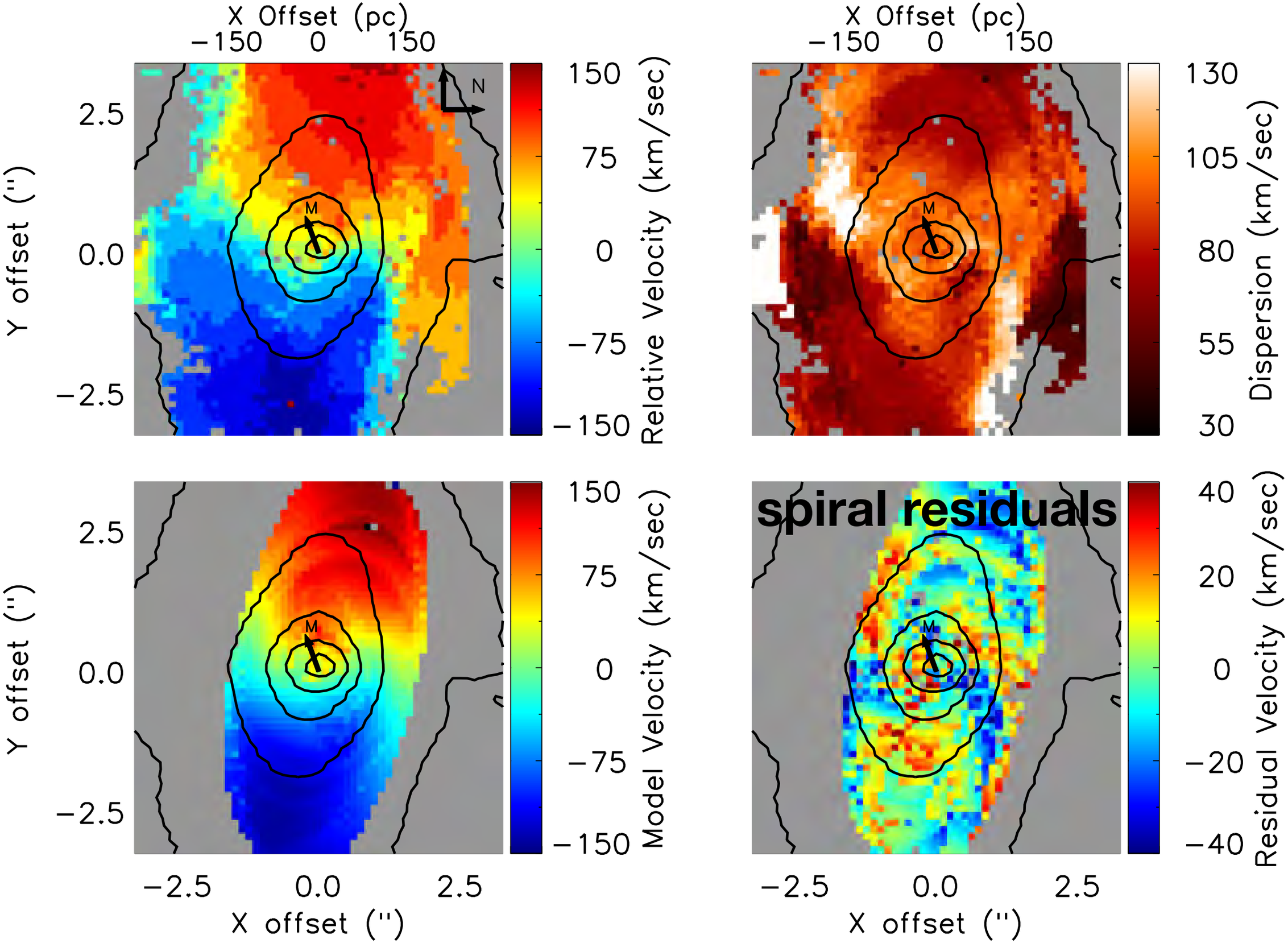


Molecular Hydrogen



Molecular Hydrogen

Fueling: Future Work

Orientation --> mechanics of accretion on small scales.

Have VLT data to examine stars and gas on ~100pc scales

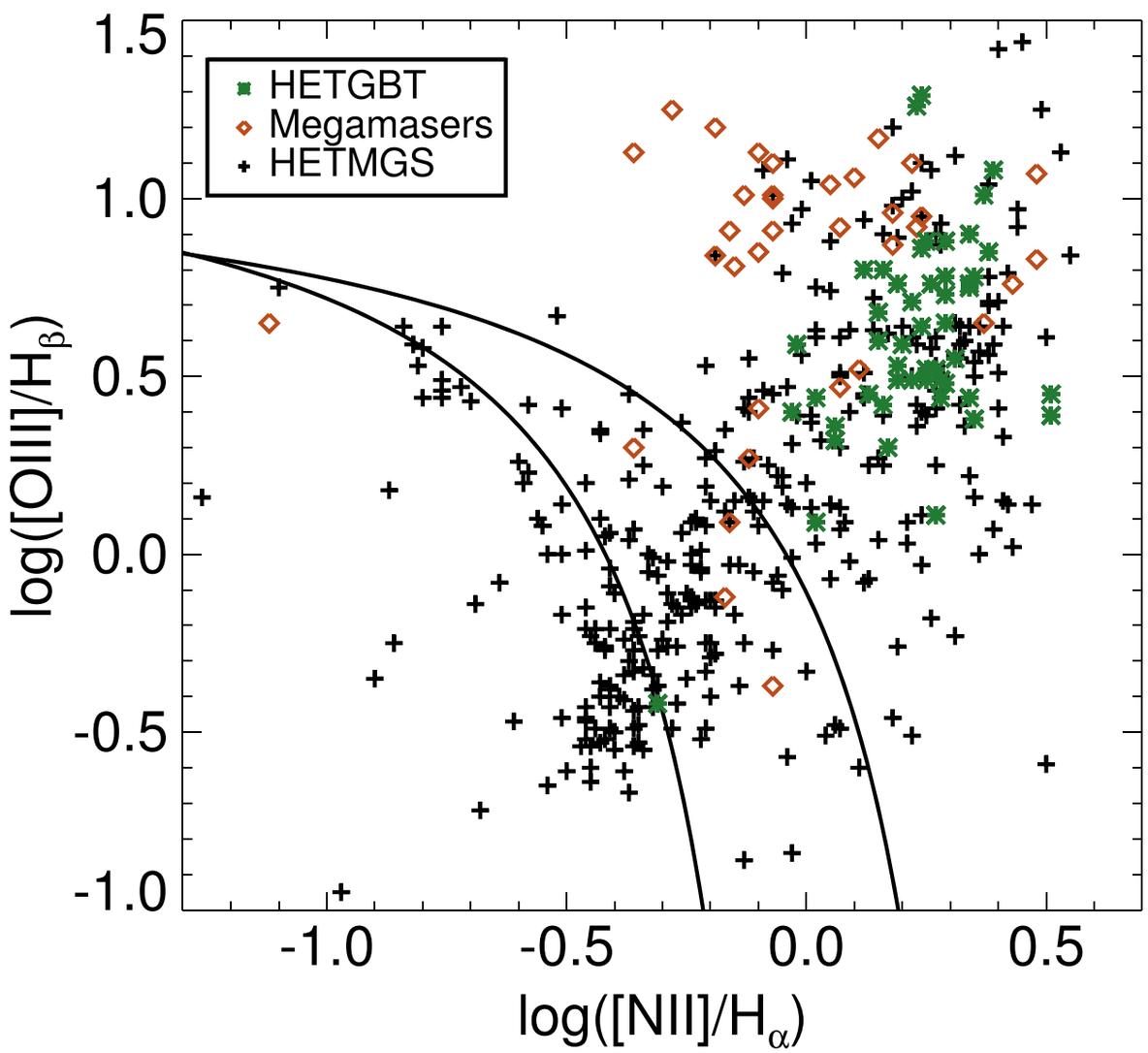
Importance of warping?

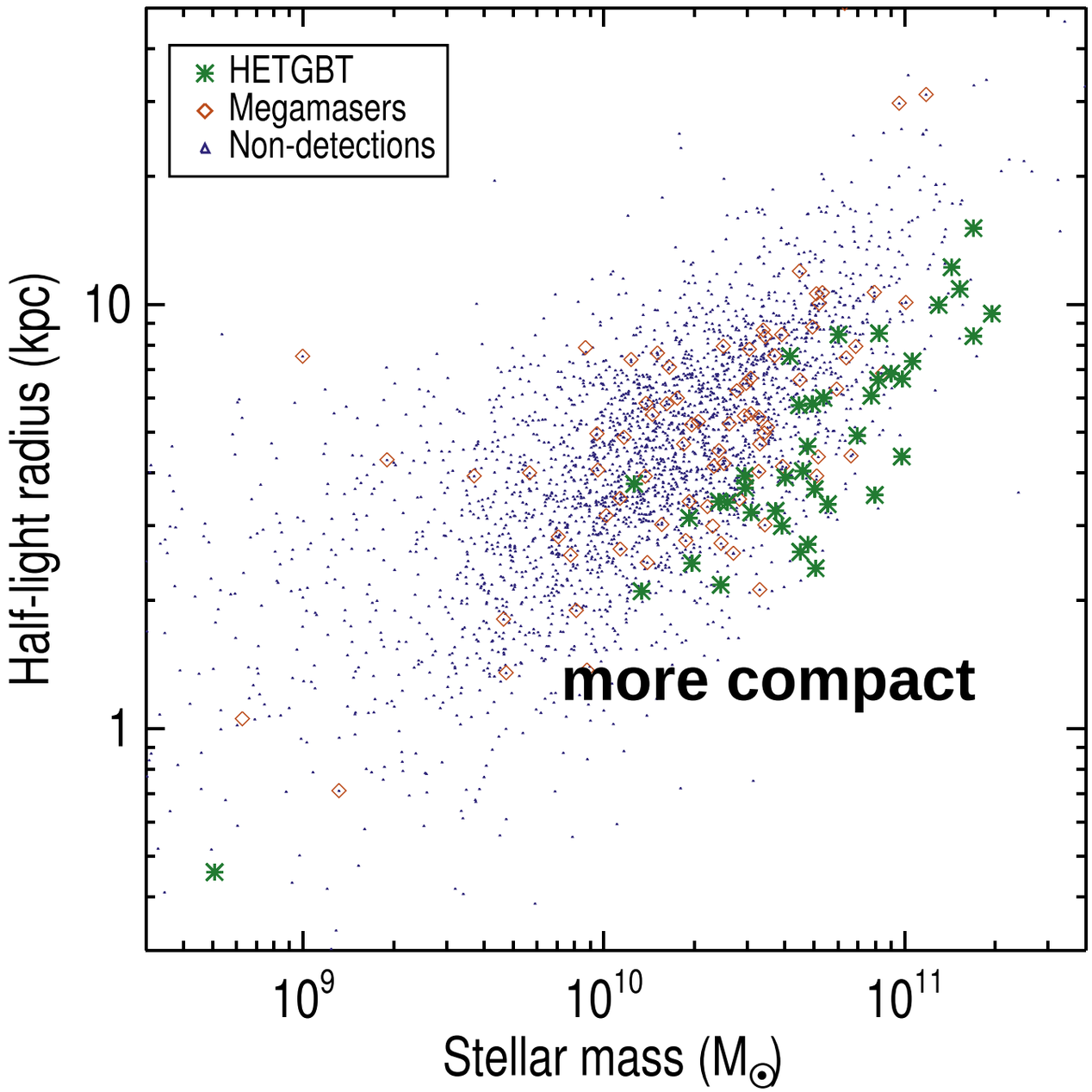
ALMA will be amazing for fueling observations

Understanding Host **Demographics**: Study Ellipticals

van den Bosch et al. 2017

87 line-emitting early-type galaxies





Understanding Host Demographics: High Dispersion

van den Bosch et al. 2017

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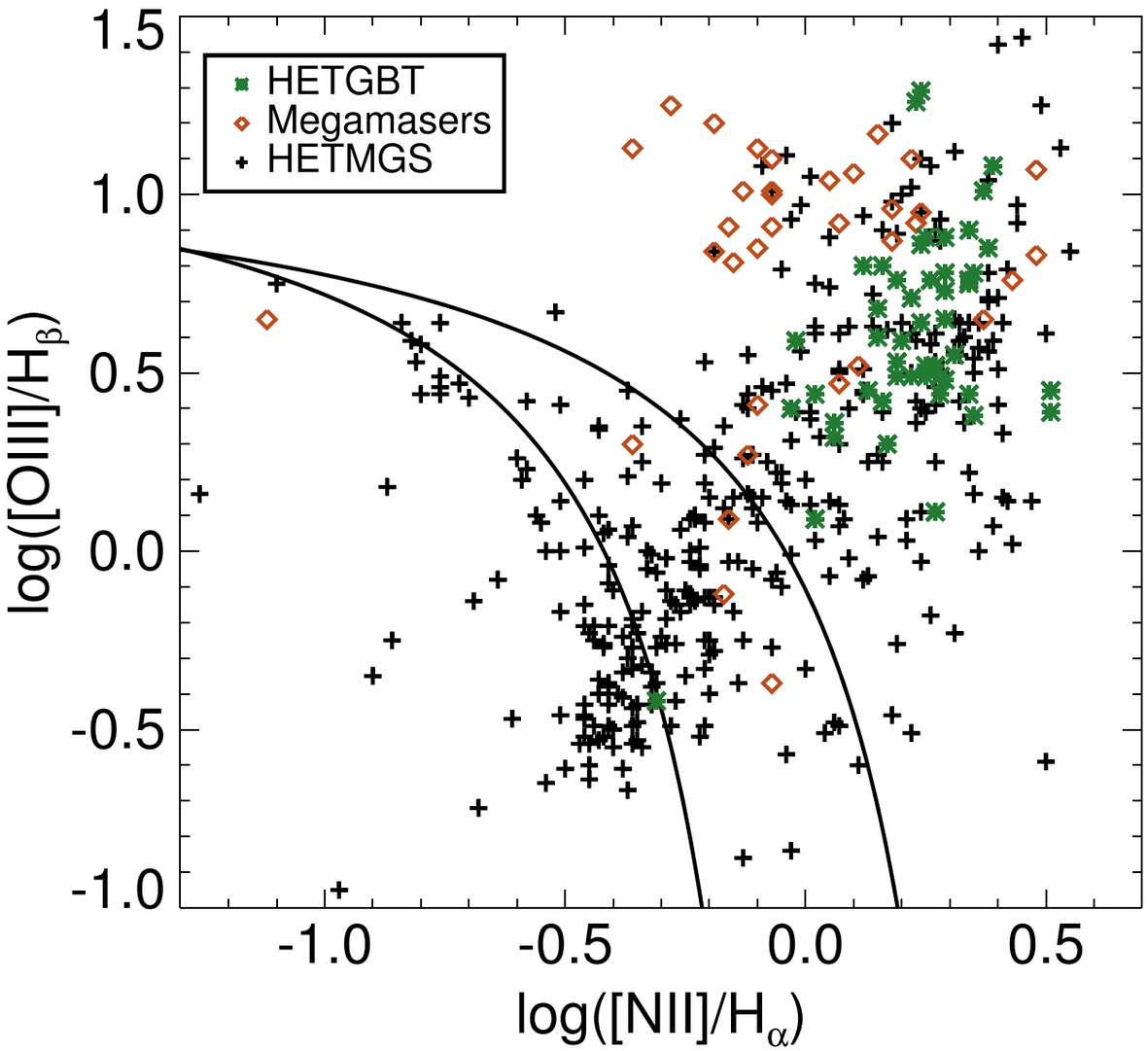
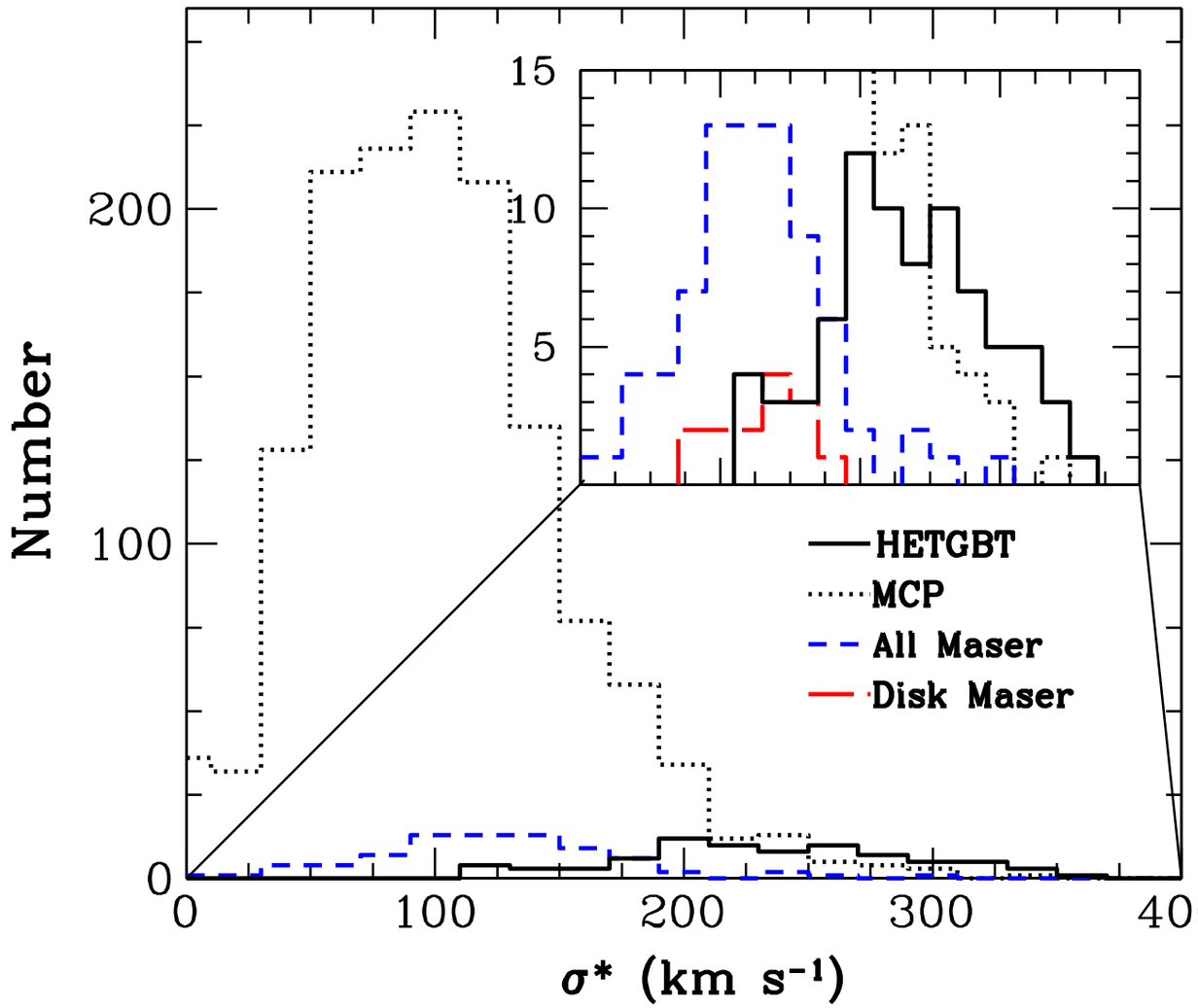
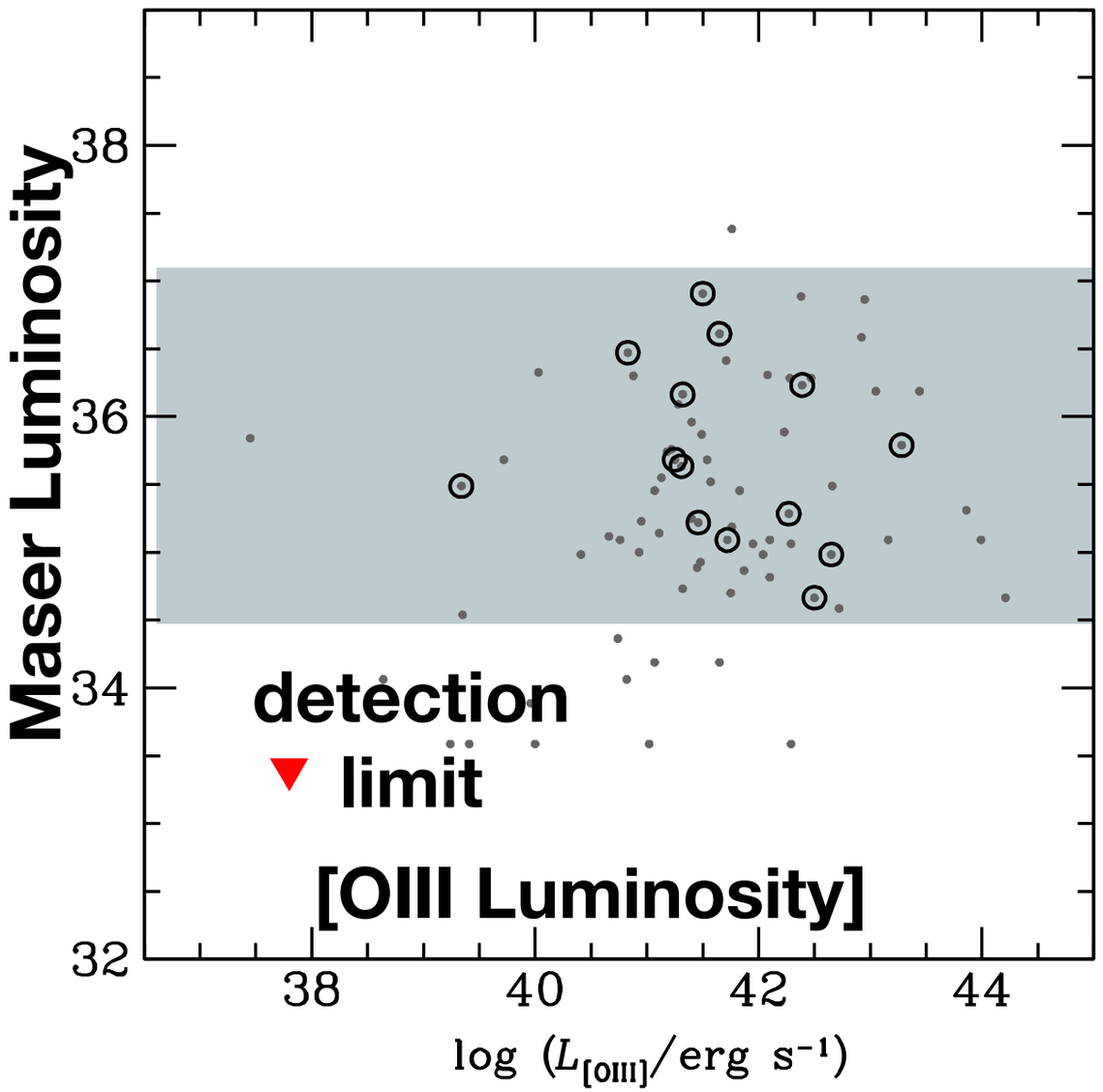
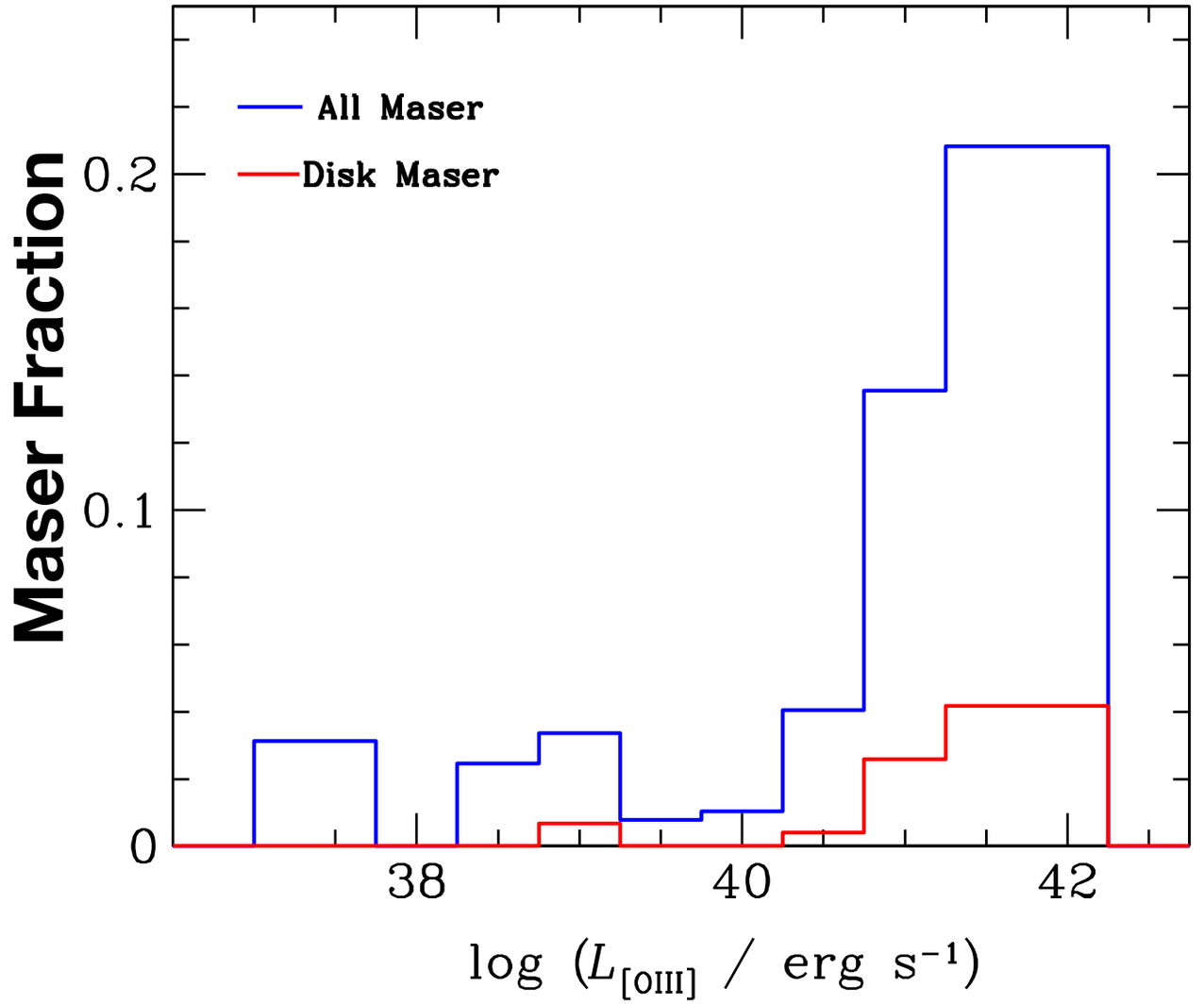




No detections: <1% detection fraction (vs 3% in extragalactic searches overall)





Clear correlation with luminosity (see also Zhang, Panessa talks yesterday on X-ray/radio luminosity)

But no strong correlation between maser luminosity and AGN luminosity.

Lx threshold? Constant surface luminosity density of maser disk, $R_d \propto Lx$

(Kondratko+), then for similar mdot, size of disk scales with Mbh

Masers: Future Work

~20 secure BH masses from megamaser disks: telling us that BH demographics are getting complicated at low mass/in spiral galaxies

Hints of differences between maser and non-maser spirals in scaling relations: track this down?

Blind search of galaxies?

Orientation --> mechanics of accretion on small scales. Importance of warping?

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