a universal model for the AGN phenomenon

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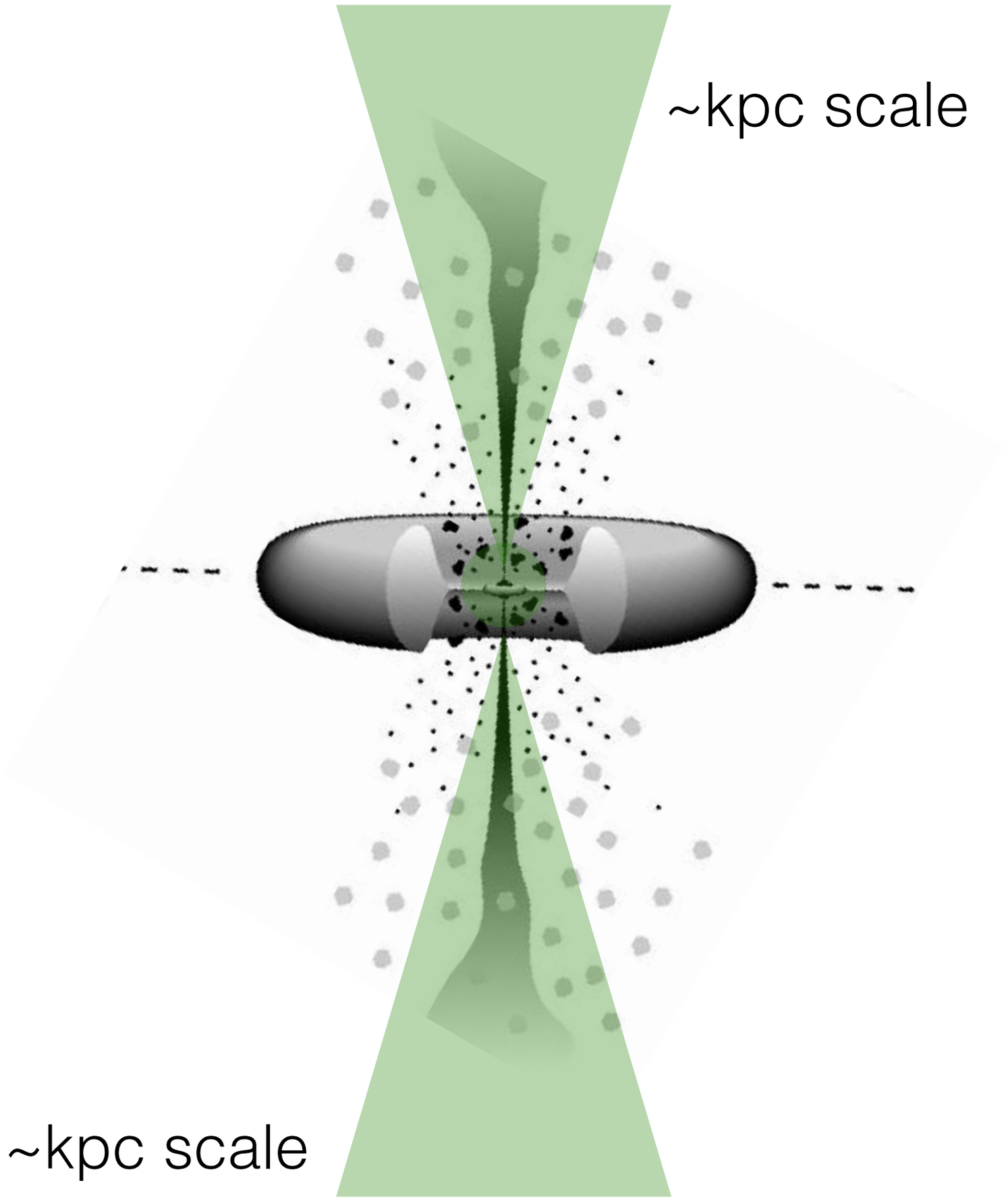
just how simple can we make the AGN phenomenon

can all the phenomenology arise from underlying simplicity via selection effects?


~kpc scale
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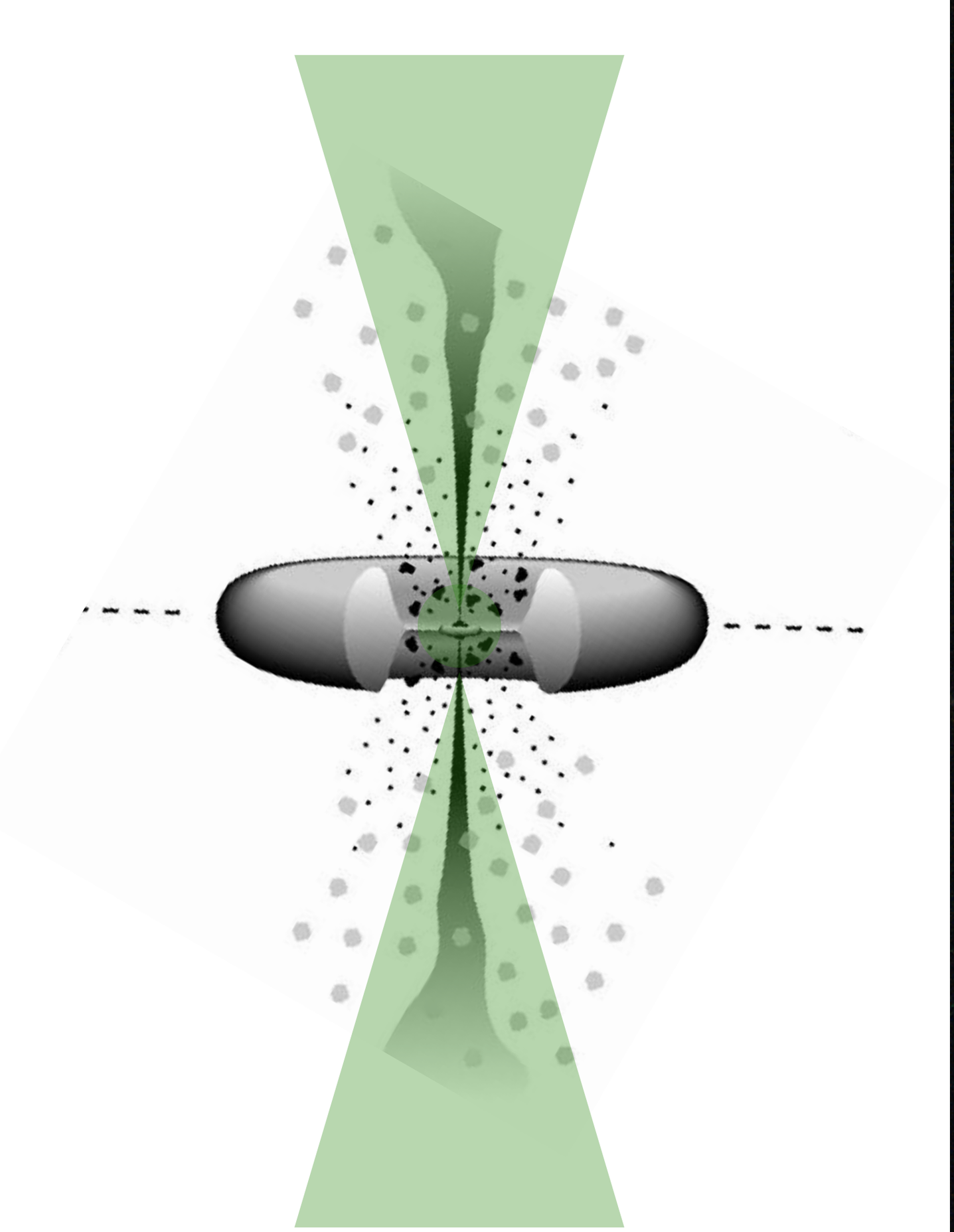
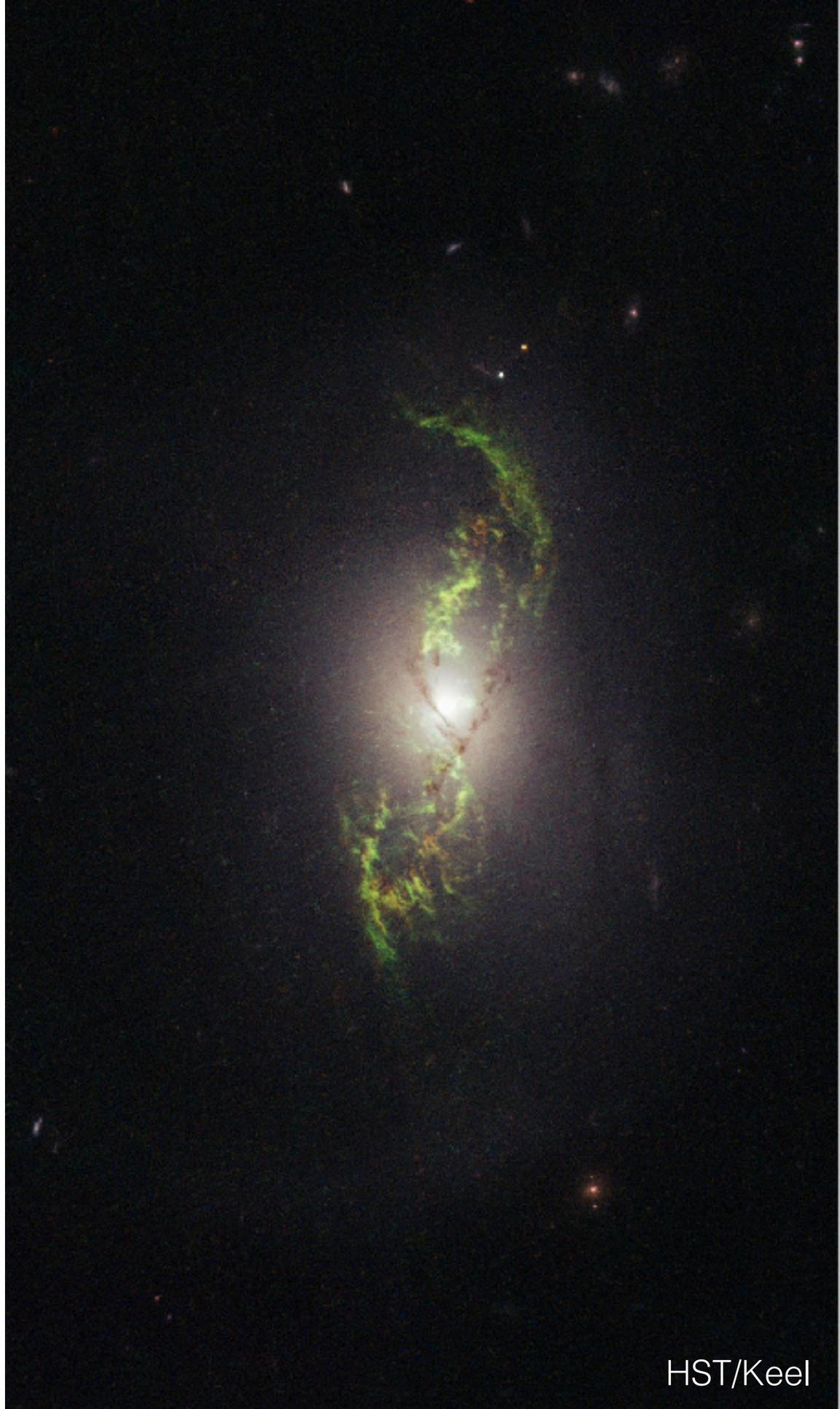
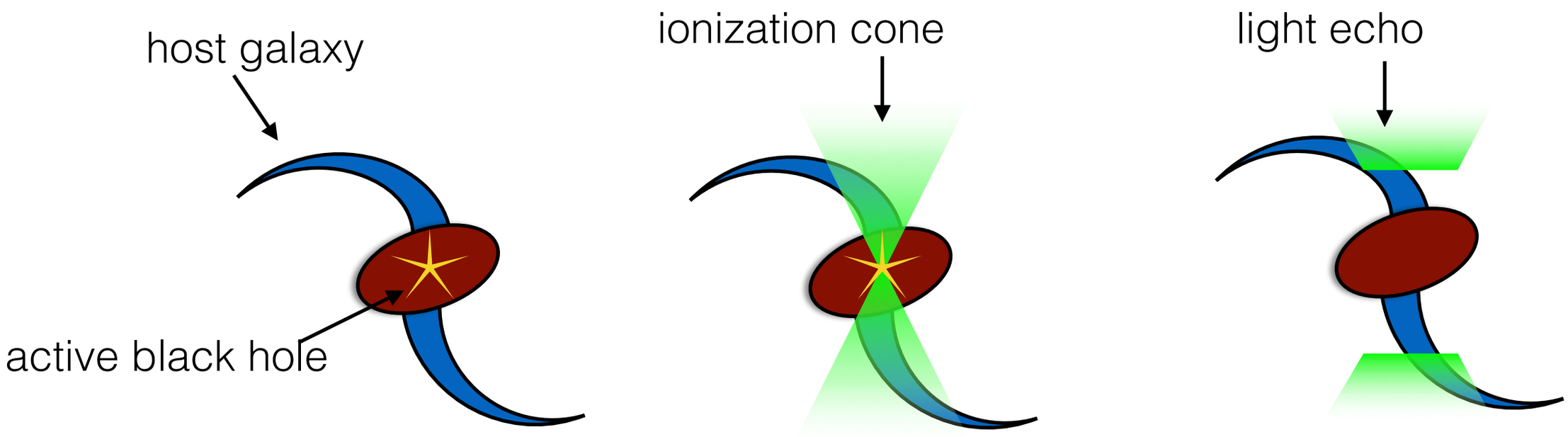


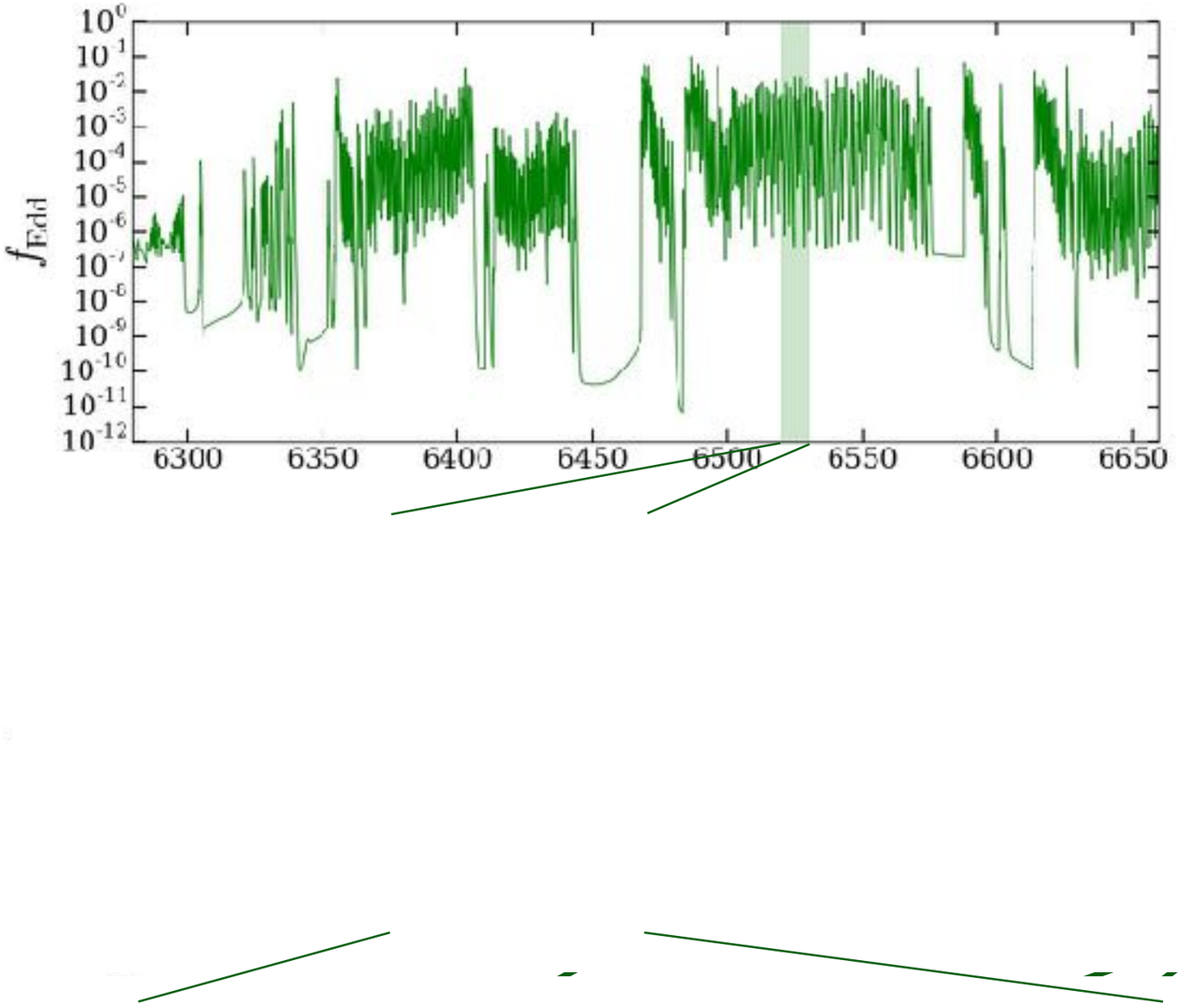

HST/Keel

Schawinski+15

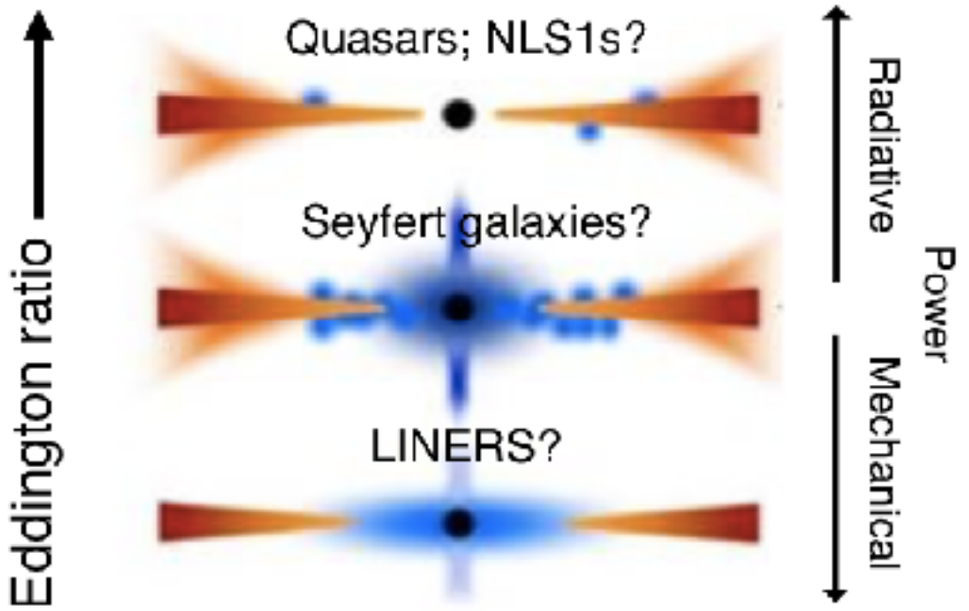
the AGN life cycle



Central emission (X-rays)	**on**	**on**	**off**
Extended emission (photoionized regions)	**not yet generated**	**on**	**still visible**
Classification	**normal galaxy**	**normal AGN**	**light echo/ Voorwerpje**
Duration	**10^4 years**	**10^5 years**	**$10^{4\text{-}5}$ years** **(if screen is present)**



Novak+11; Hickox+14; Schawinski+15

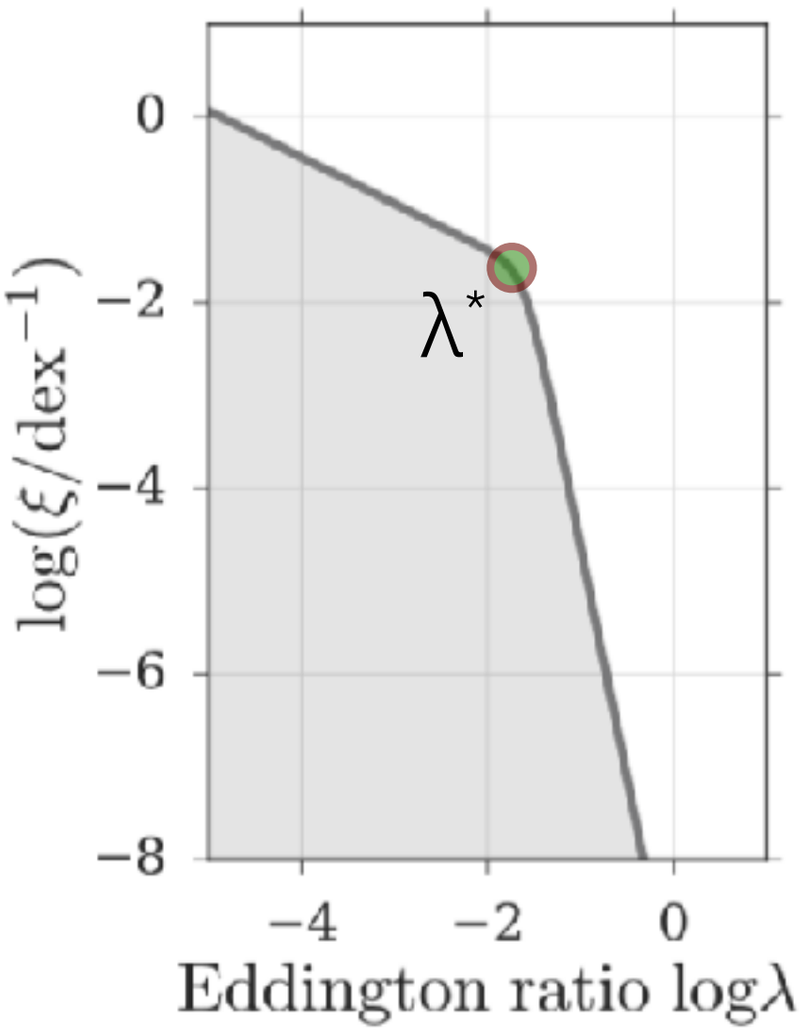


Done, Gierlinski & Kubota 07
Alexander & Hickox 12

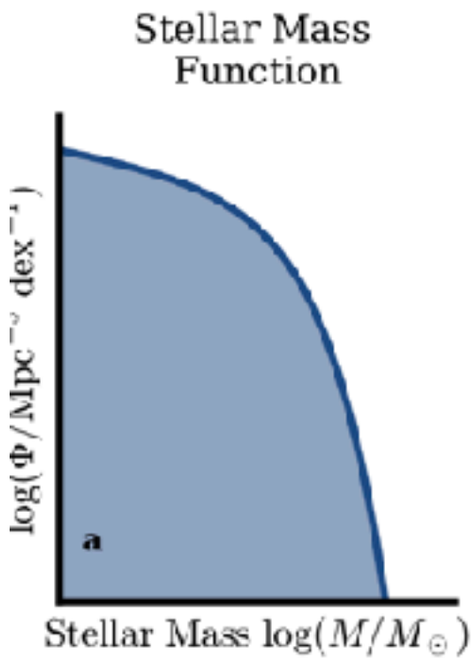
OK, but if AGN “flicker”, can we still capture their role in galaxy evolution?

Anna Weigel
Ph.D Student

Eddington Ratio Distribution Function (ERDF)



the ERDF connects galaxies to the AGN population



$$\log L^*_{AGN} \propto \log M^*_{bh} + \log \lambda^* + \log \rho$$

$$\log \Phi^*_{AGN} \propto \log \Phi^*_{bh} + \log \xi^*$$

Weigel, Schawinski, Caplar, Wong & Treister (submitted)

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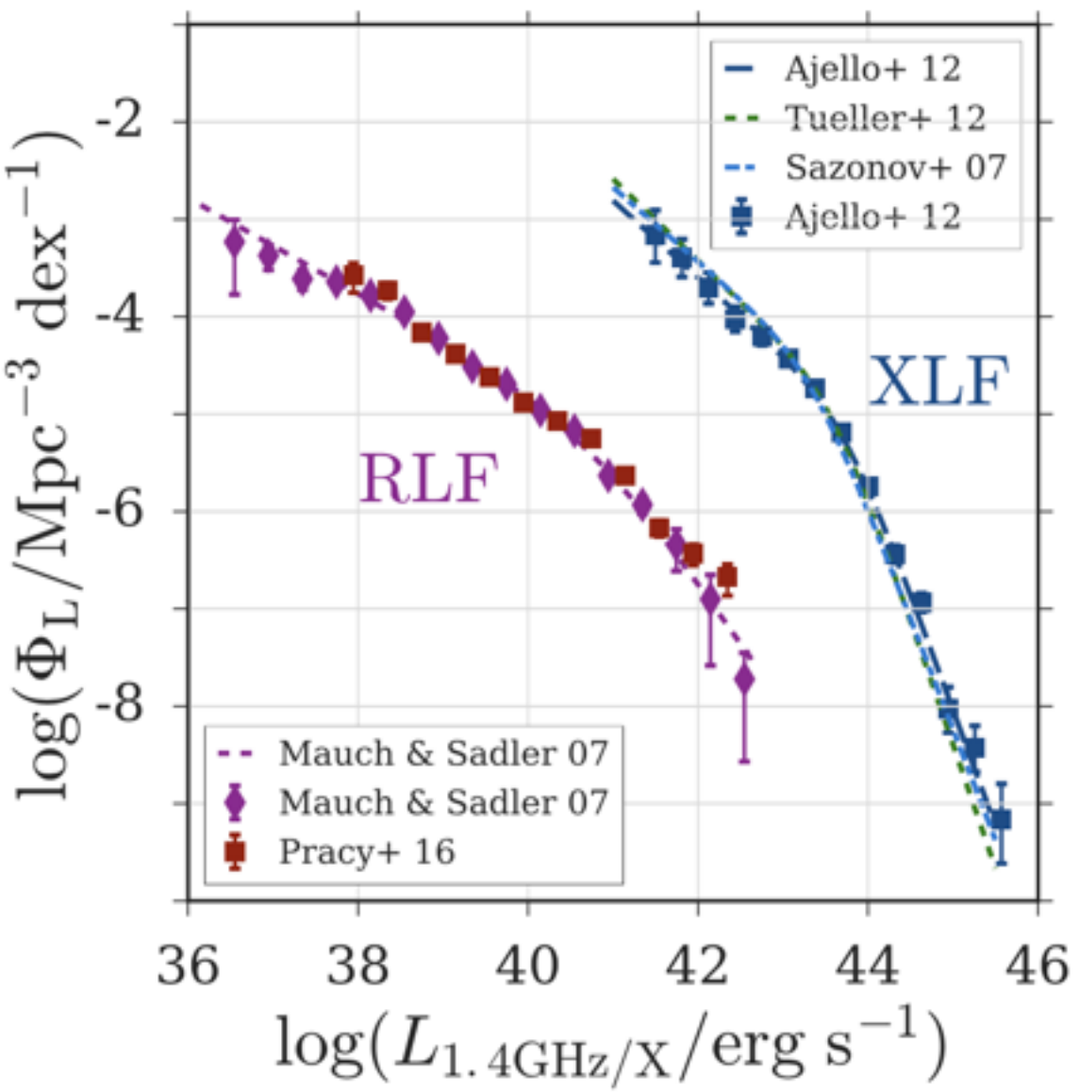
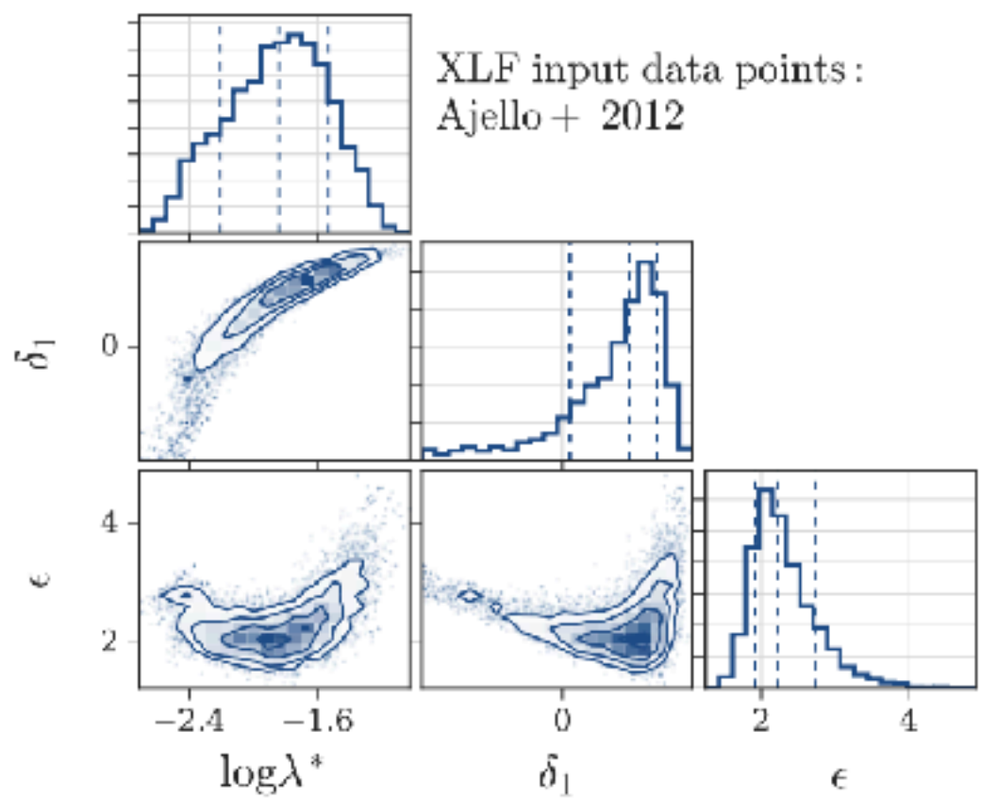
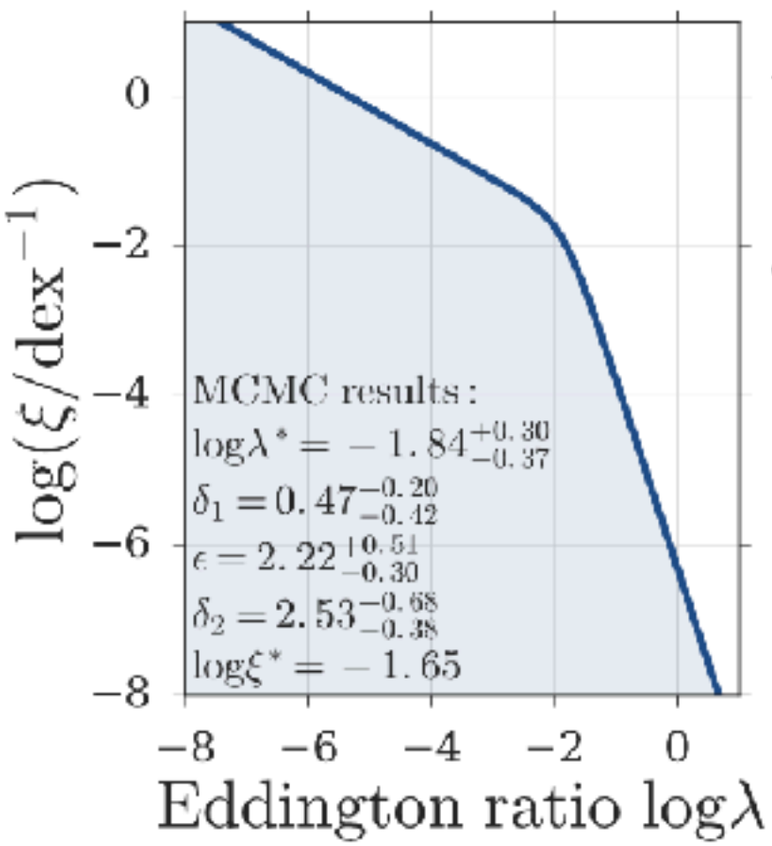
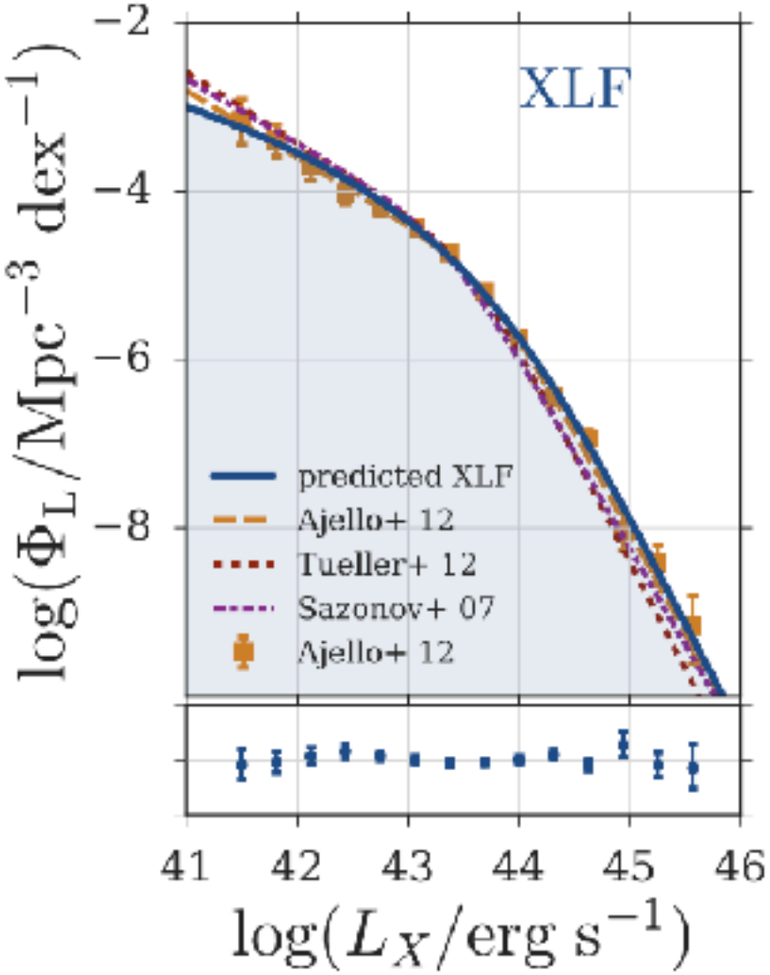


Weigel, Schawinski, Caplar, Wong & Treister (submitted)

two fundamental ERDFs for blue and red galaxies







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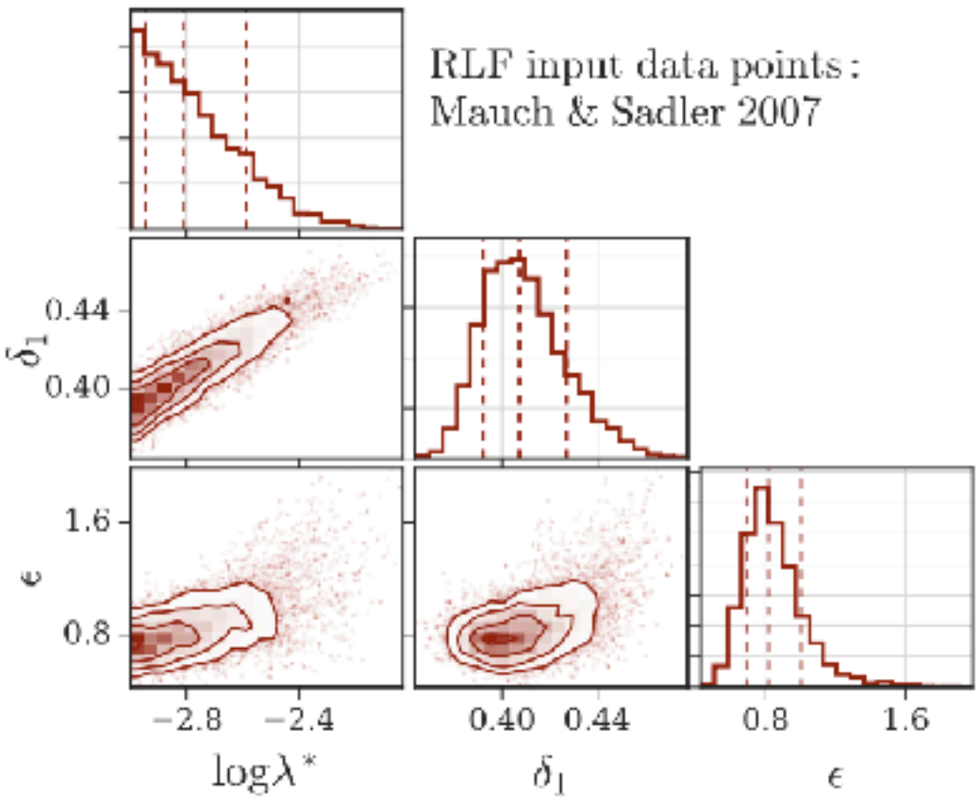

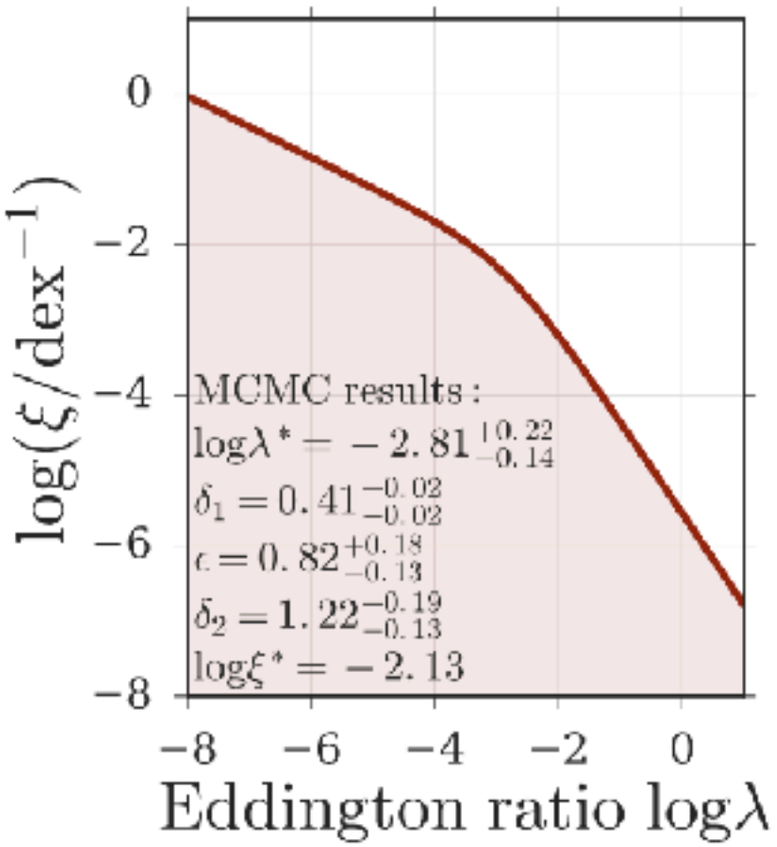

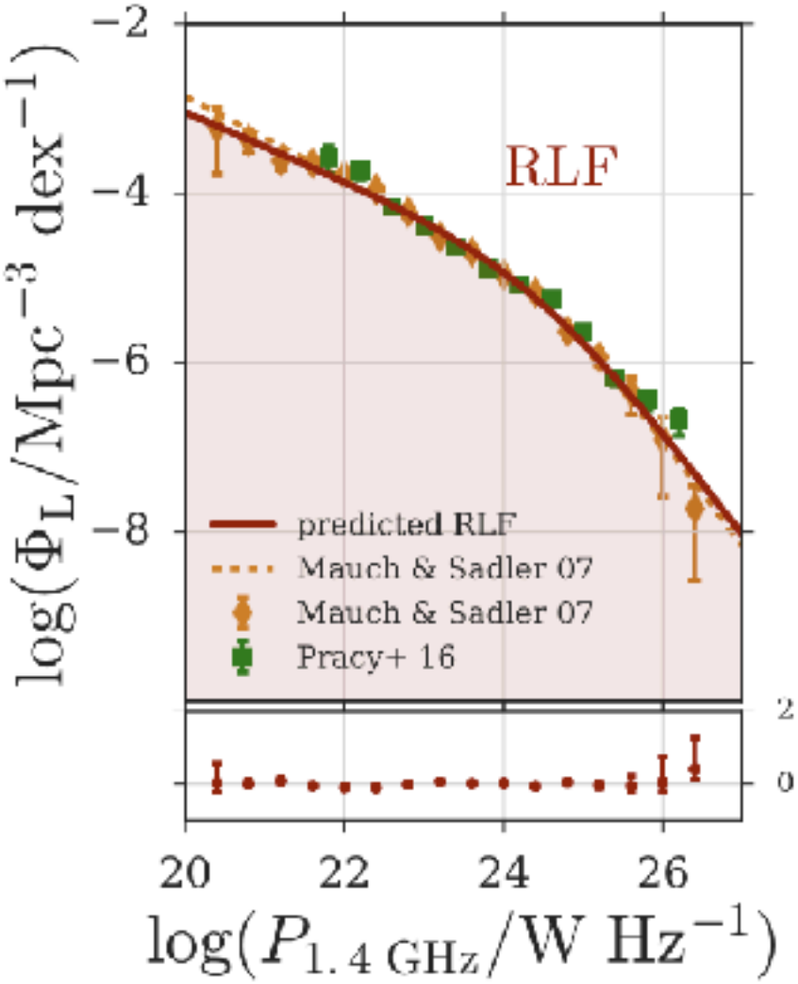

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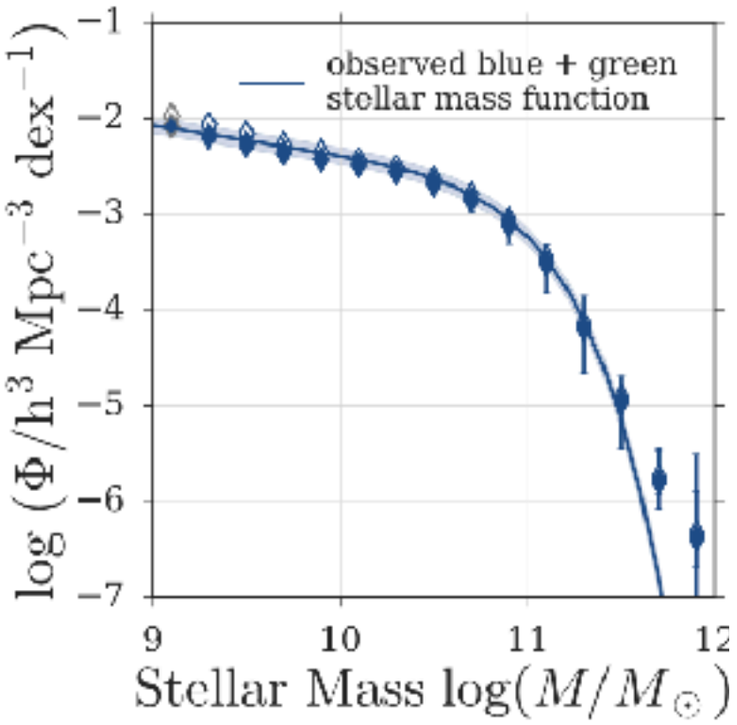
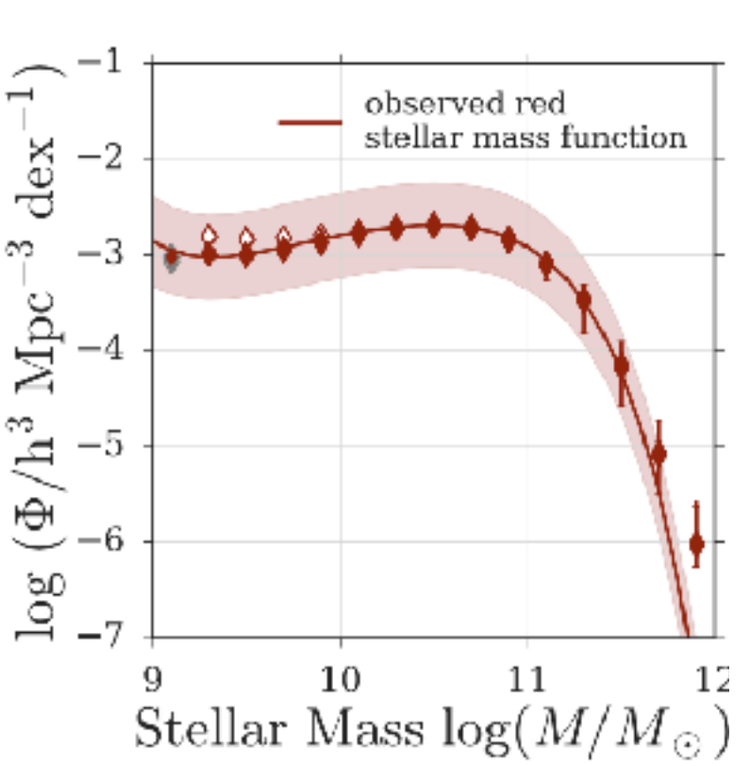
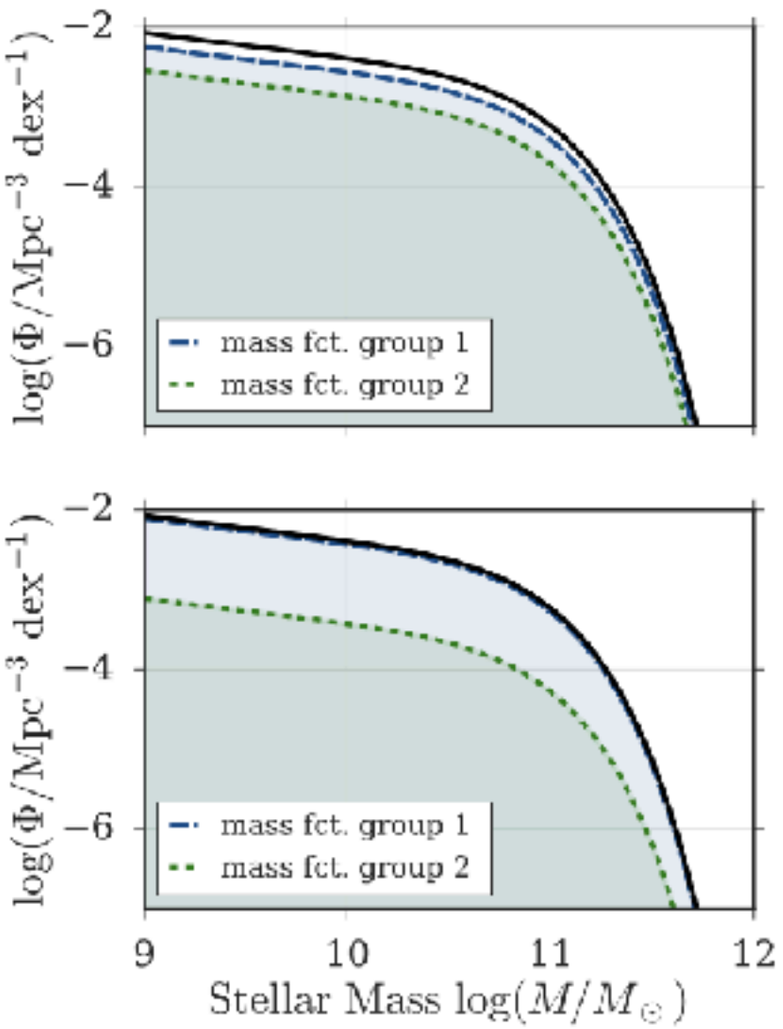
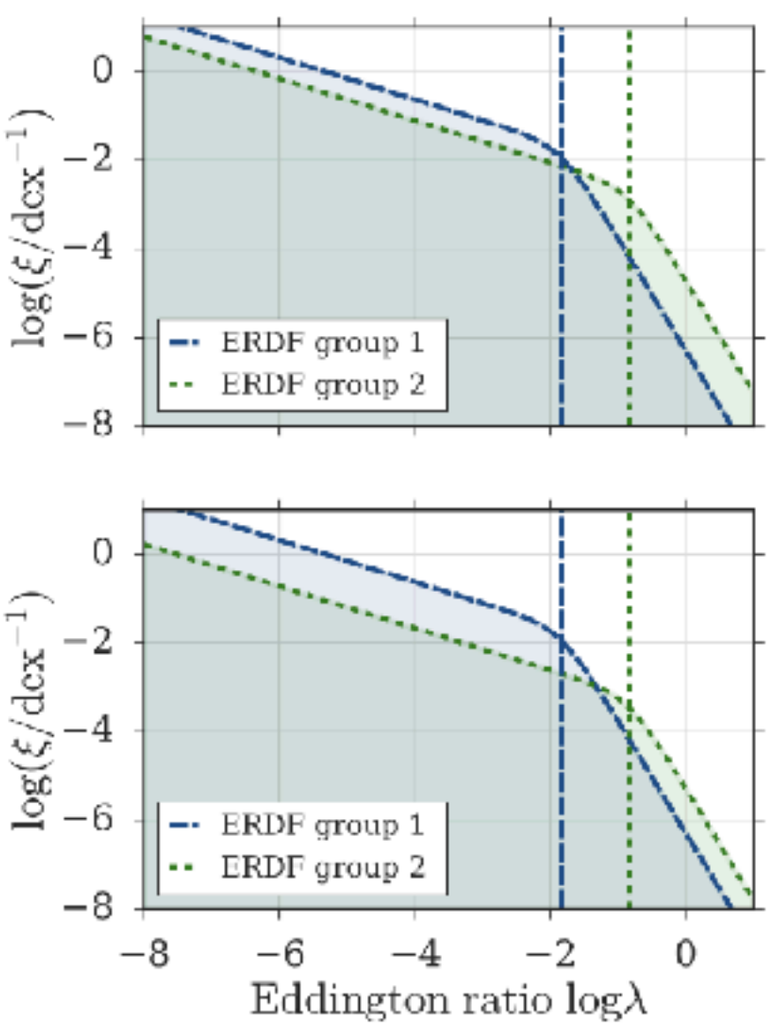


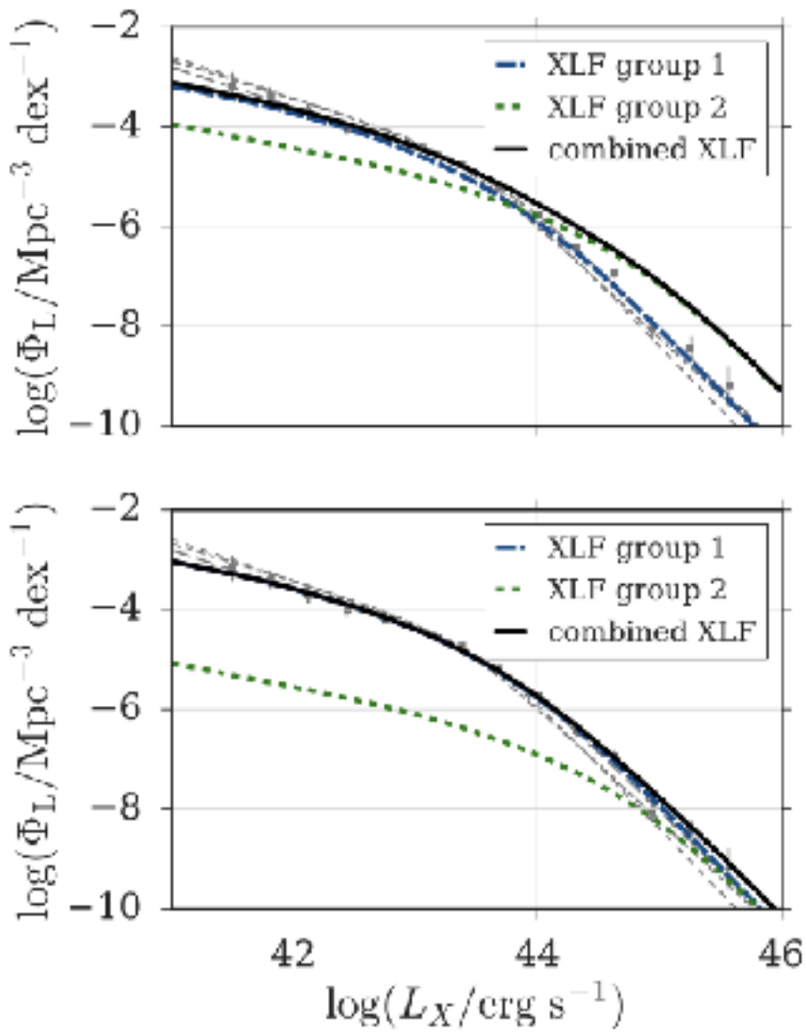


Weigel, Schawinski, Caplar, Wong & Treister (submitted)

the ERDF is (largely) universal

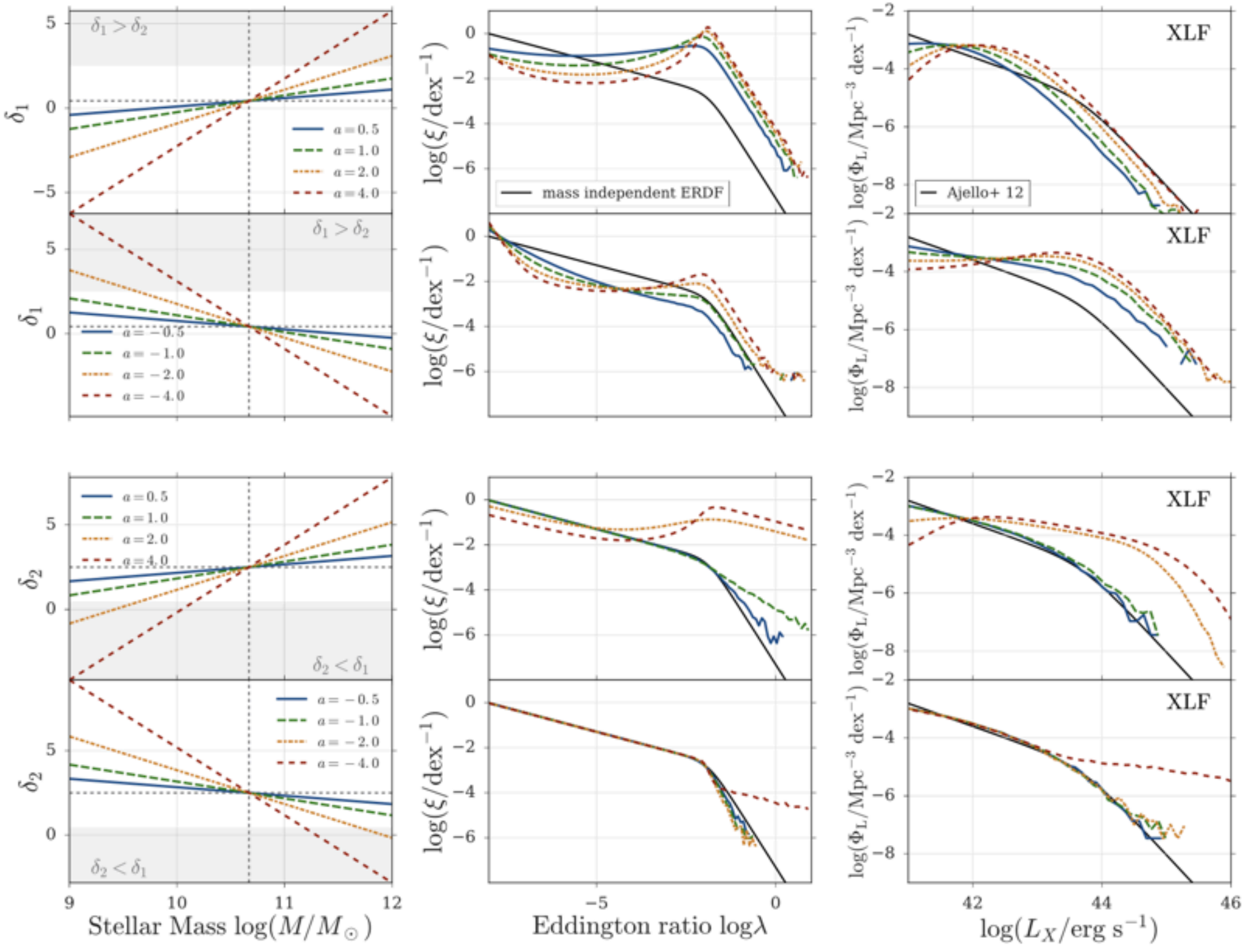






Weigel, Schawinski, Caplar, Wong & Treister (submitted)

the ERDF is (largely) mass-independent



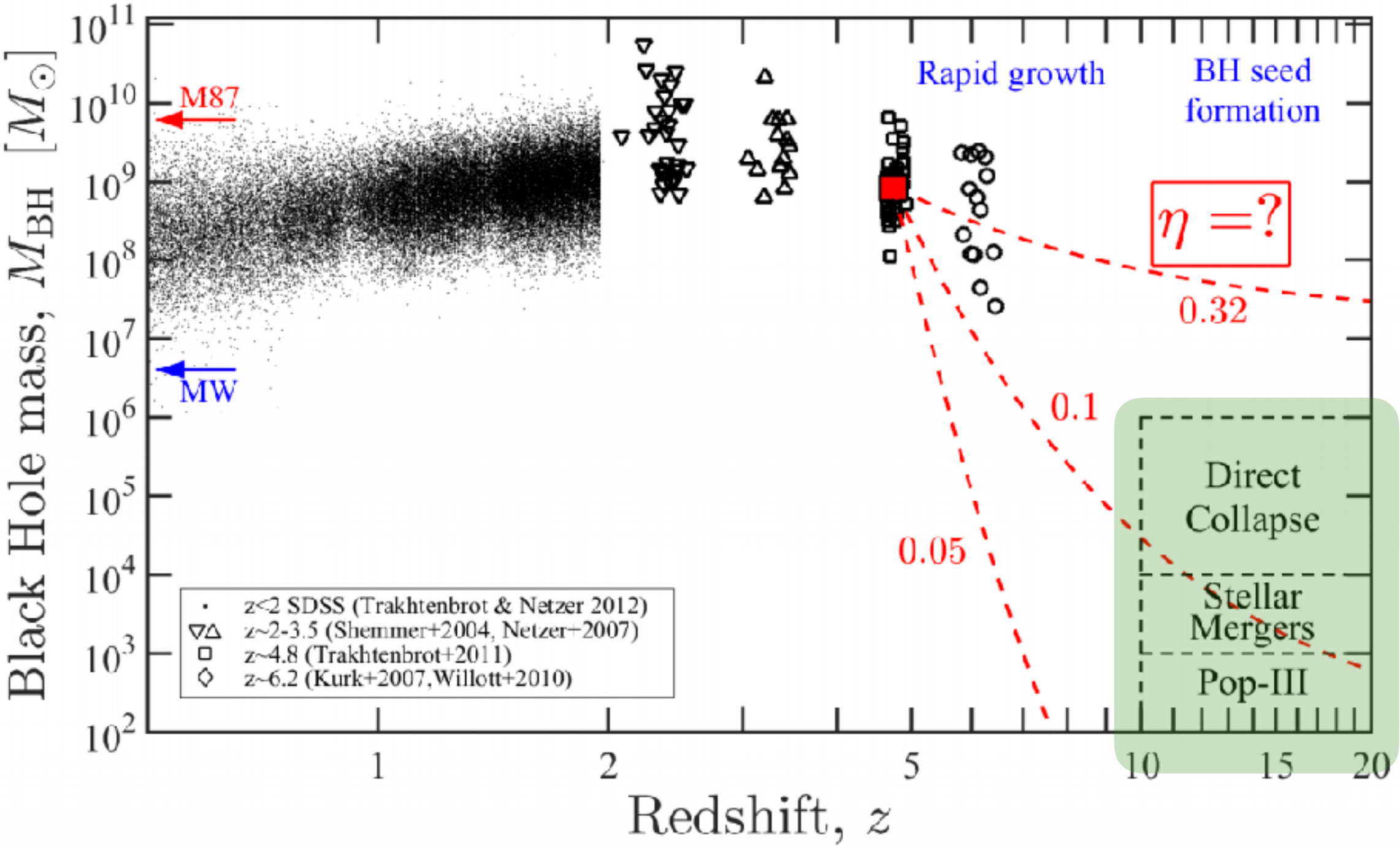
Weigel, Schawinski, Caplar, Wong & Treister (submitted)

the AGN phenomenon can be fully explained with two mass-independent ERDFs:

1. one for X-ray AGN in blue galaxies, and
2. one for radio AGN in red galaxies

Could AGN merely be an epiphenomenon of galaxy formation?

what about high redshift?



Data compilation from: Trakhtenbrot & Netzer

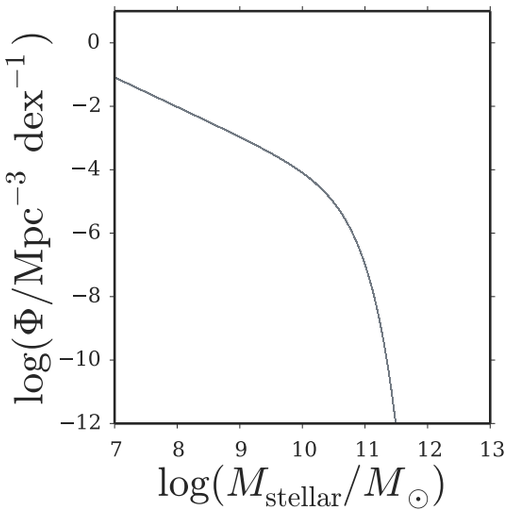
Current **observational** constraints on high-z AGN

I. Wide-area quasar surveys
   - SDSS/deep Jiang+09
   - CFHQS Willott+10
   - SuprimeCam Kashikawa+15

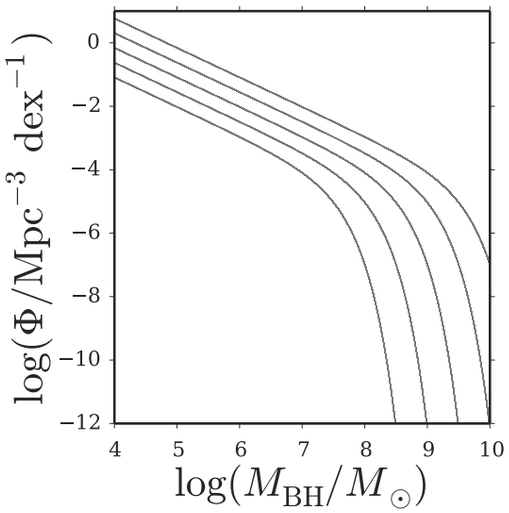
II. Deep fields
   - CDFS stacking Treister+11,13
   - CDFS individual sources Weigel+15

Phenomenological modeling of black hole growth at z~6

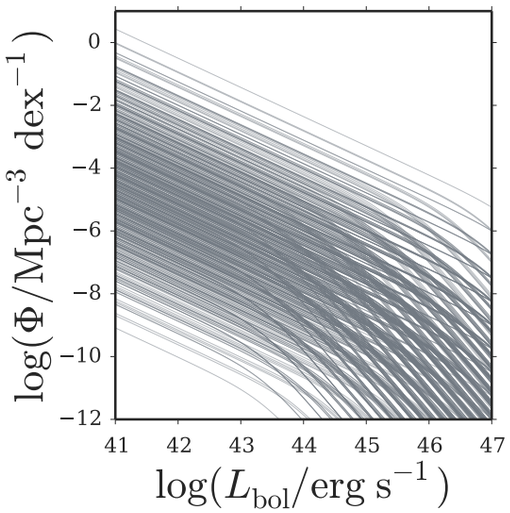
stellar mass function



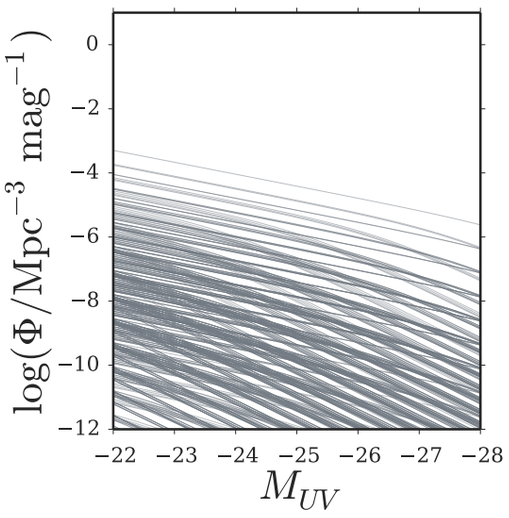
Black Hole mass function



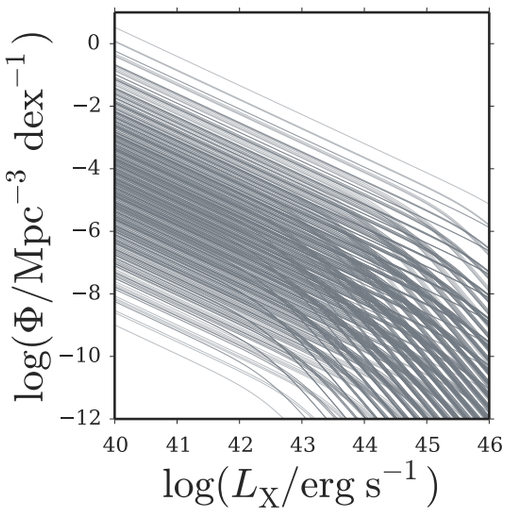
AGN bol. luminosity function



AGN UV luminosity function

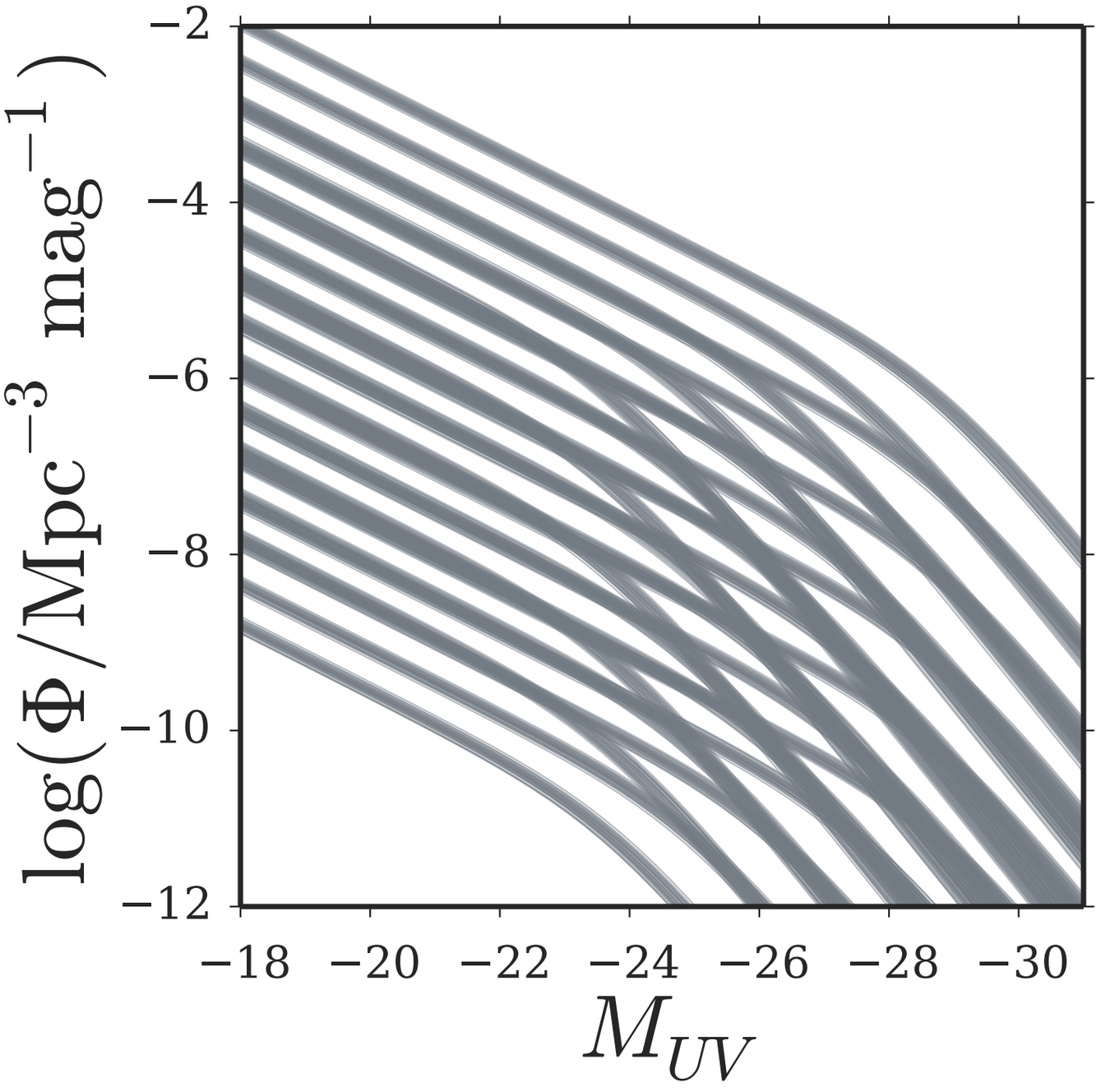


AGN X-ray luminosity function



Schawinski+ (in prep)

Phenomenological modeling of black hole growth at z~6



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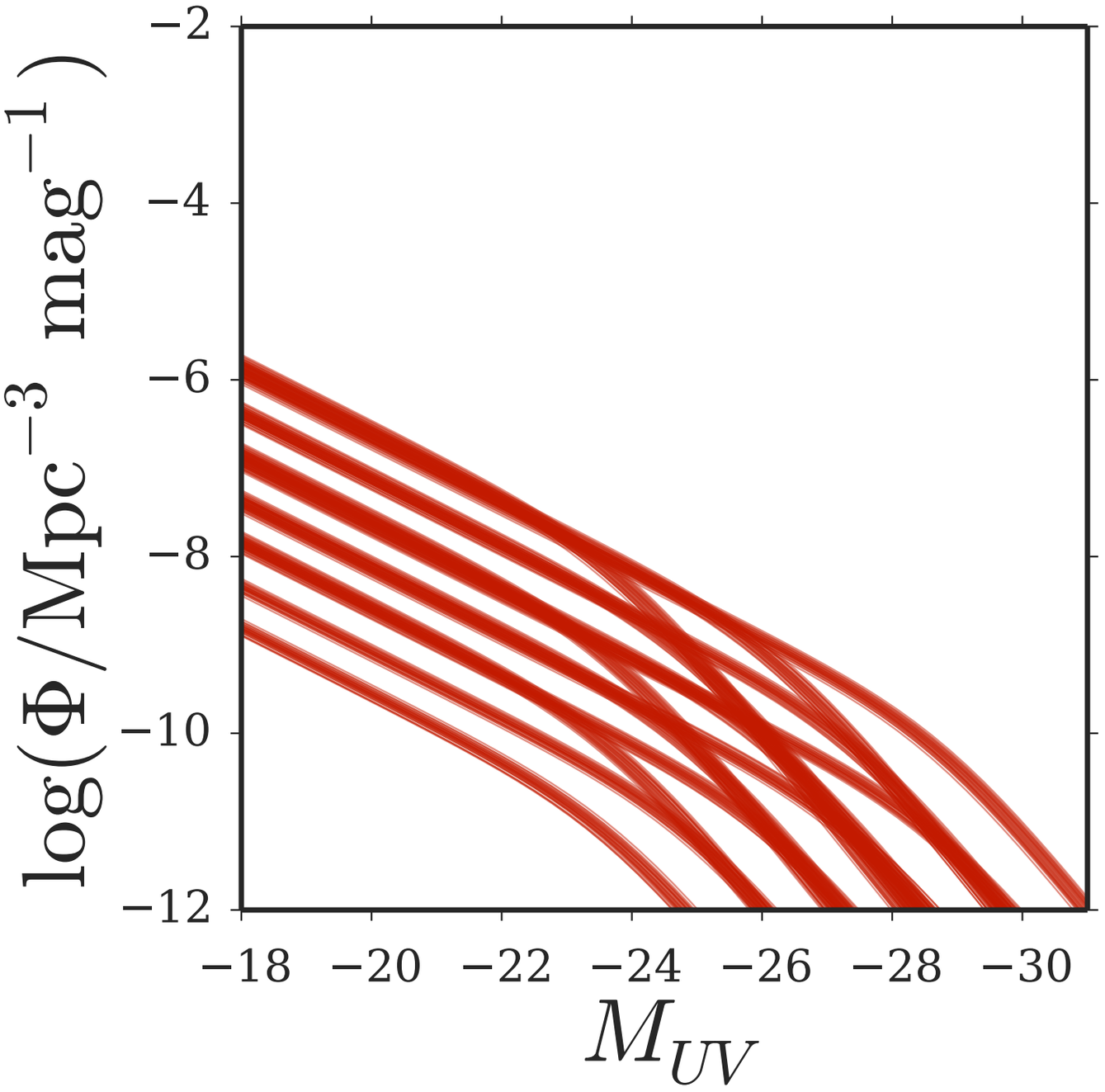
Phenomenological modeling of black hole growth at z~6

limits from deep fields:
Treister+13
Weigel+15



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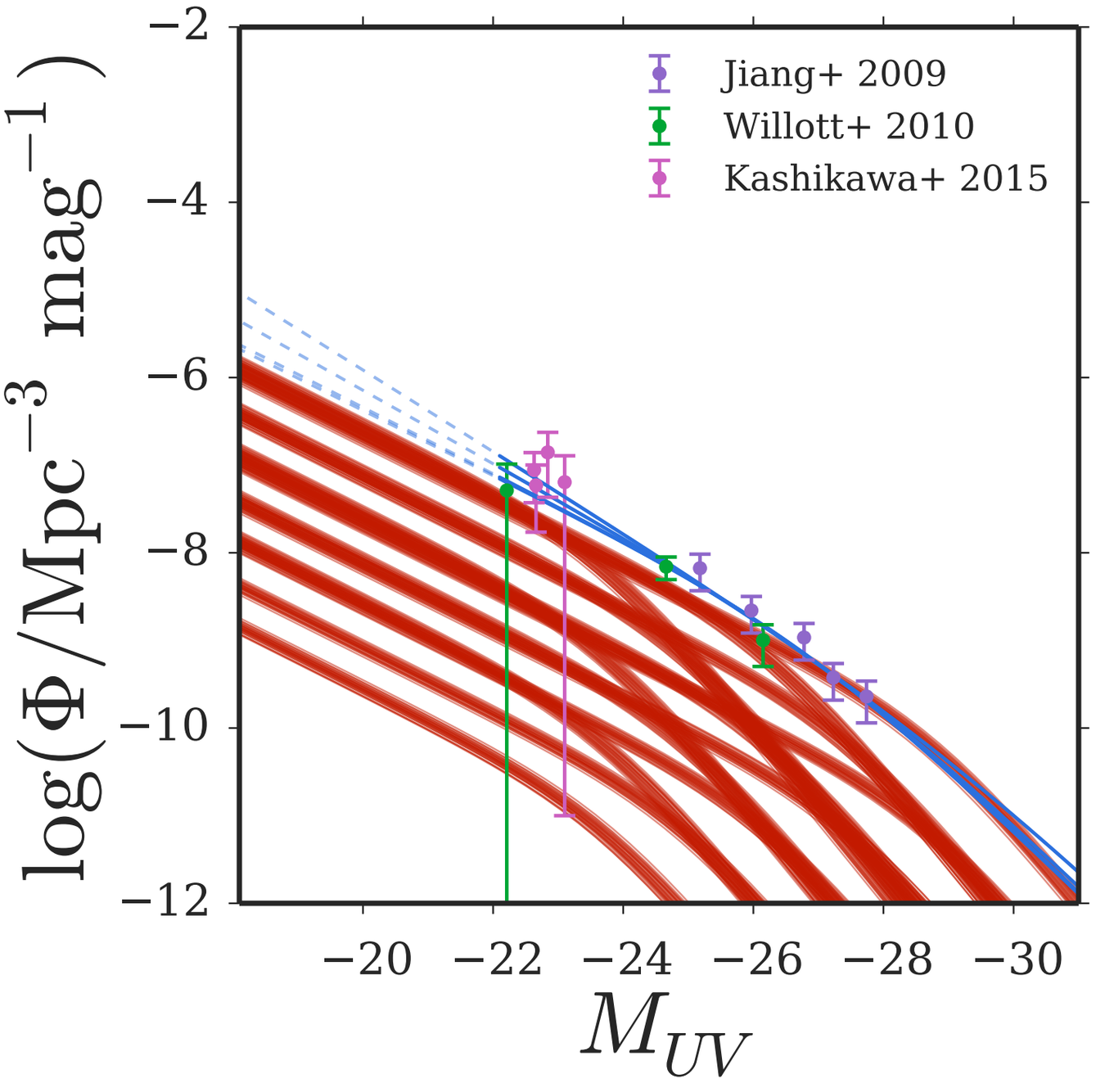
Phenomenological modeling of black hole growth at z~6

limits from deep fields:
Treister+13
Weigel+15

comparison to quasar surveys:
Jiang+09
Willott+10
Kashikawa+15



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Phenomenological modeling of black hole growth at z~6

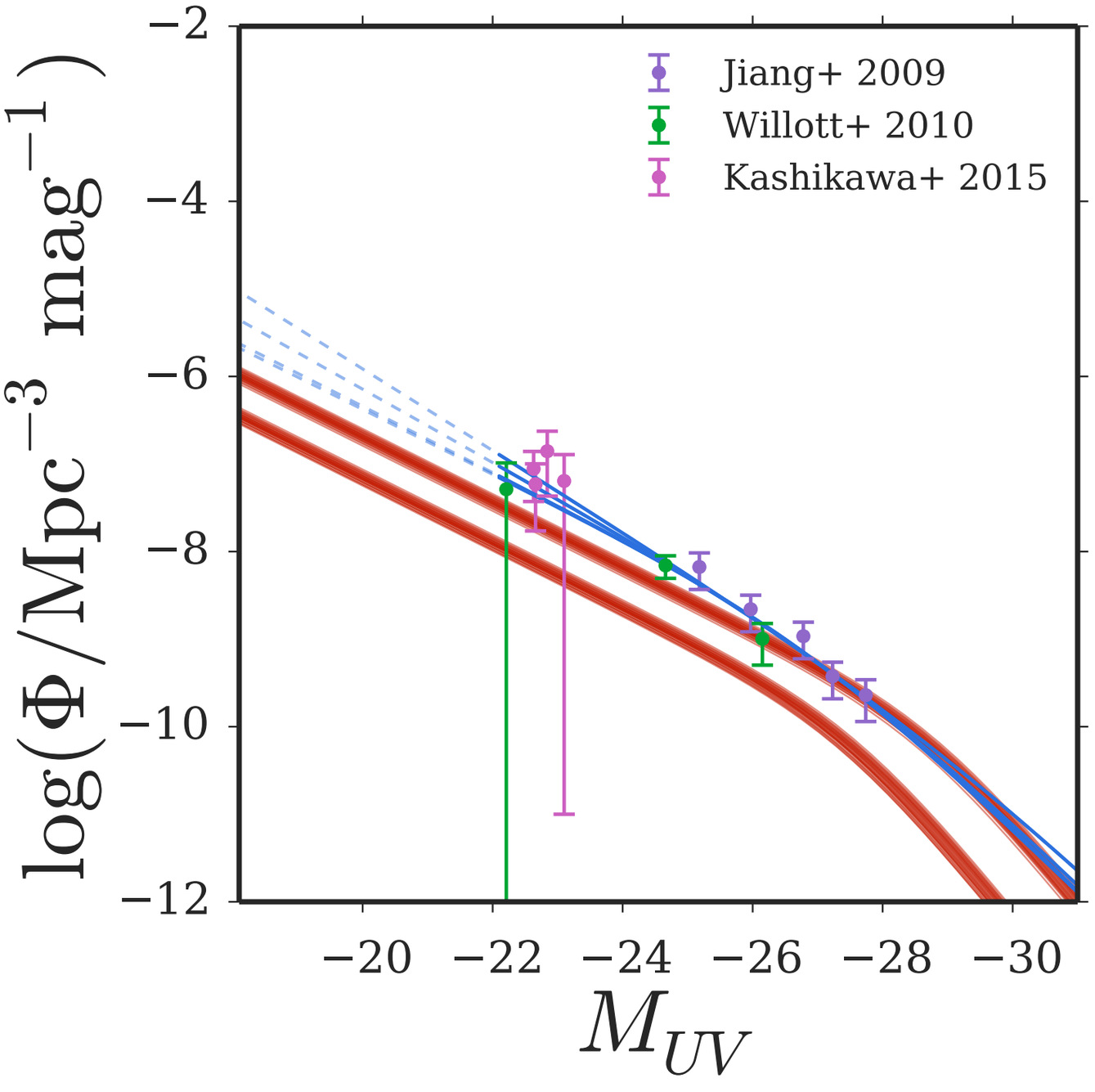
$\log \lambda^* = \log(0.7)$ to $\log(0.9)$

duty cycle = 80% to 100%

occupation fraction = 0.01%

$M_{\rm BH}/M_{\rm stellar} = 0.03$ and 0.1

obscured fraction = 50%



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summary

the AGN phenomenon can be fully explained with two mass-independent ERDFs:

1. one for X-ray AGN in blue galaxies, and
2. one for radio AGN in red galaxies

explanatory power of the universal ERDF framework extends possibly to z~6

lots of work still to be done, incl. forthcoming papers on:

1. mergers
2. HERGs/LERGs
3. redshift evolution

space.ml

from model-driven astrophysics to data-driven astrophysics

GalaxyGAN

More projects coming, stay tuned!

Selected Press Coverage

The Atlantic: Machine Learning Is Bringing the Cosmos Into Focus
WIRED Science: Astronomers Deploy AI to Unravel the Mysteries of the Universe
The Register: From drugs to galaxy hunting, AI is elbowing its way into boffins' labs
Phys.org: Neural networks promise sharpest ever images

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