Evidence for a mass-dependent AGN Eddington ratio distribution via the flat relationship between SFR and AGN luminosity

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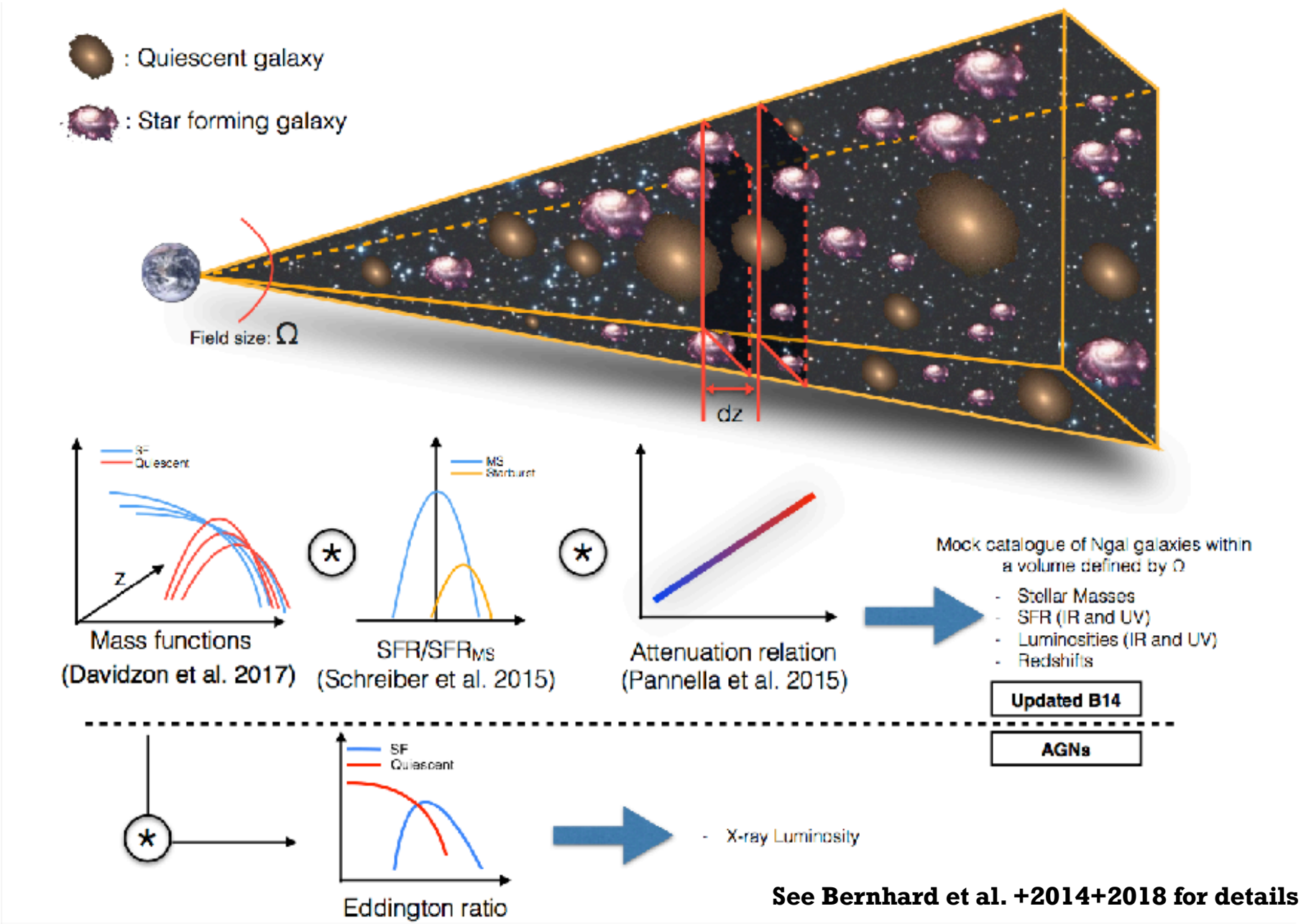
Monday 30th July 2018

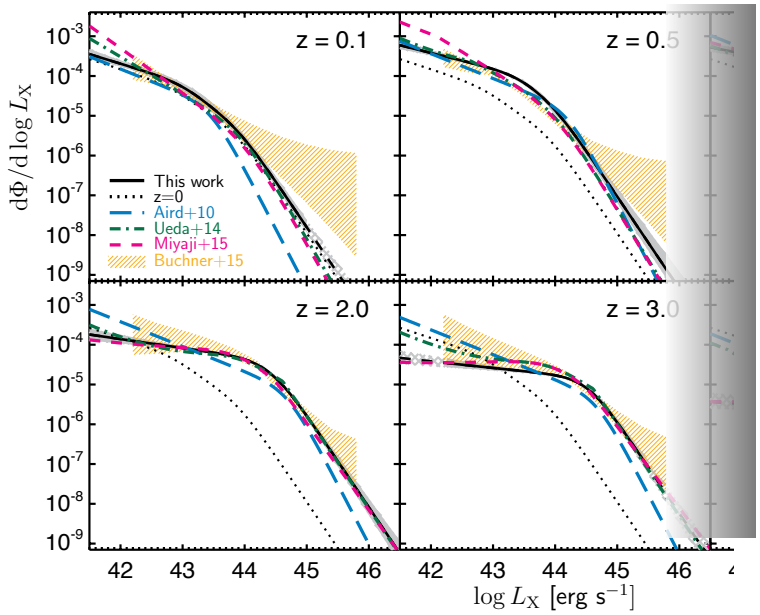
The University Of Sheffield.

Motivation: Build a coherent AGN-host PSM



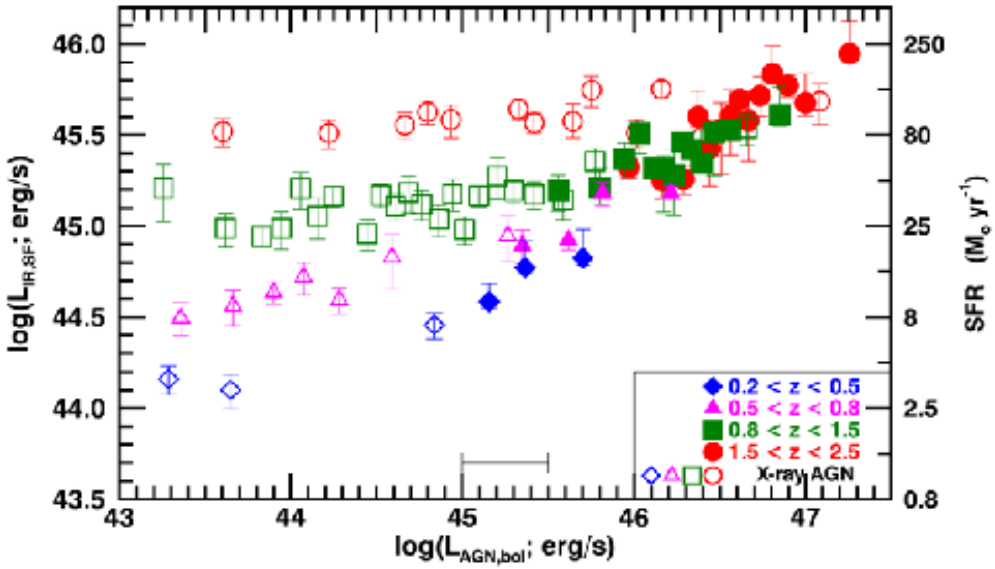
Validation of the PSM

Credits: Aird et al. +15



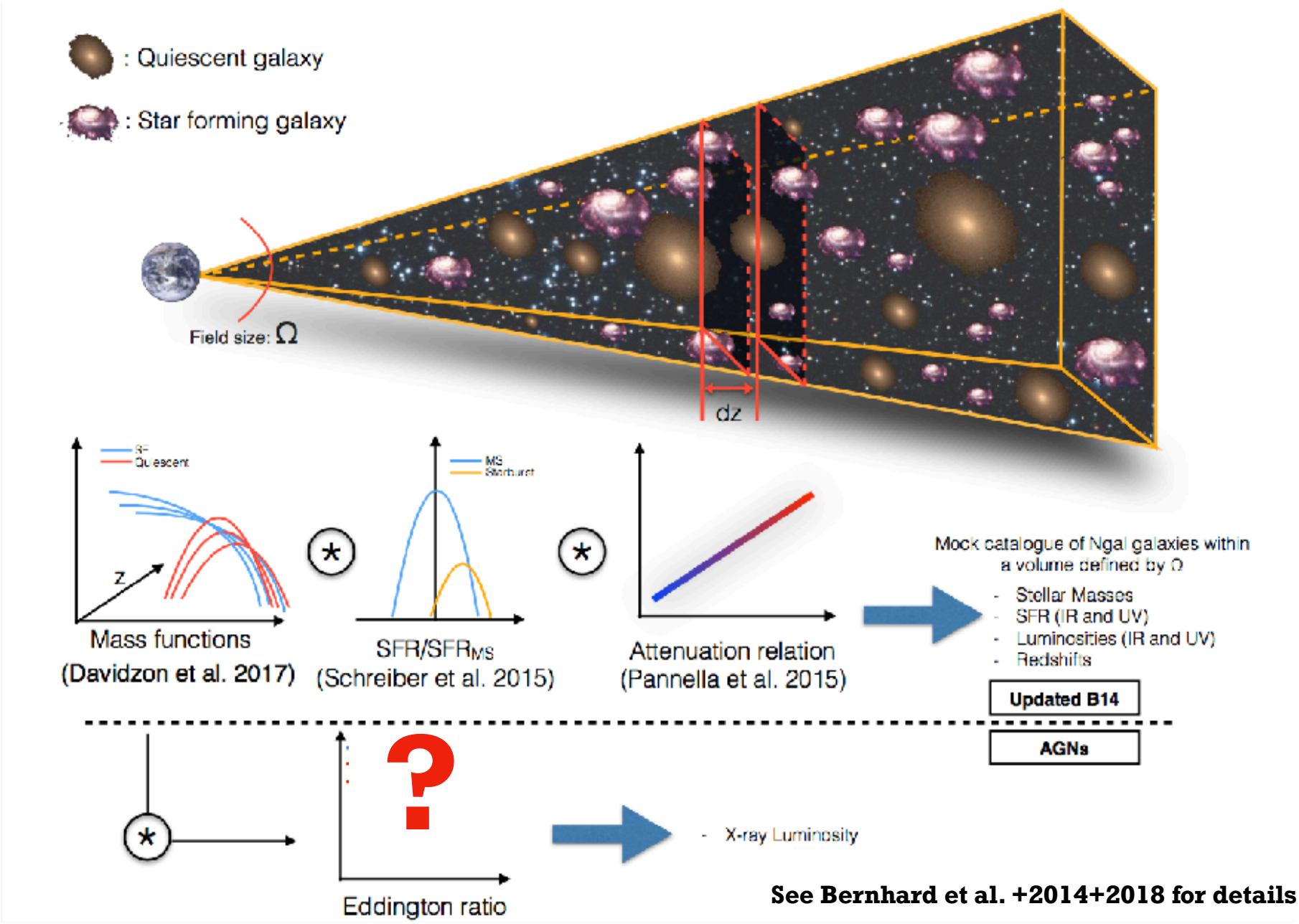
X-RAY LUMINOSITY FUNCTIONS

Credits: Stanley et al. +17



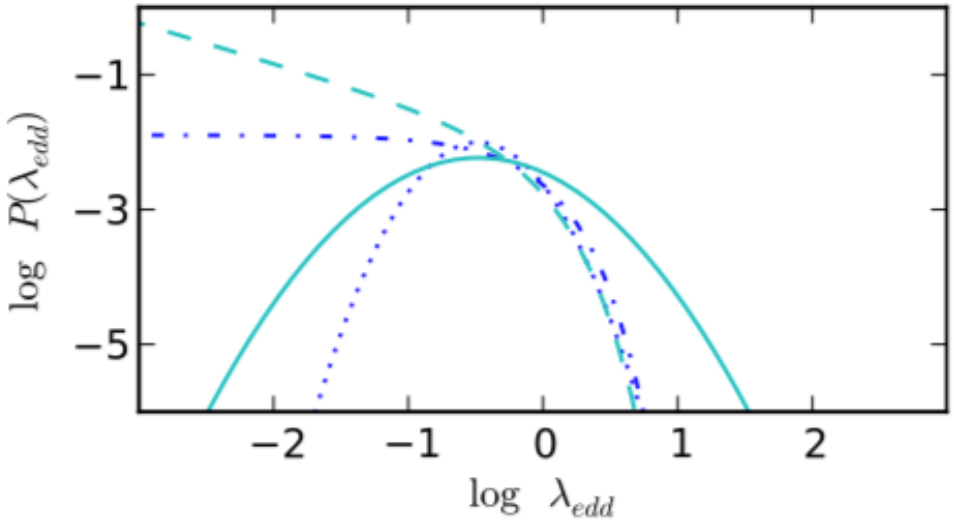
FLAT SFR-LX RELATIONSHIP

Which λ_{Edd} distribution

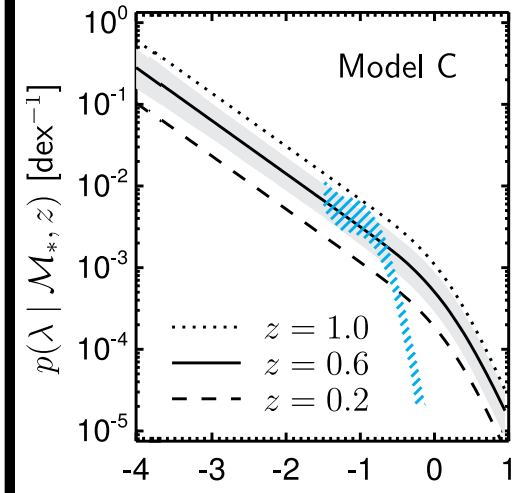


The distribution of λ_{Edd}

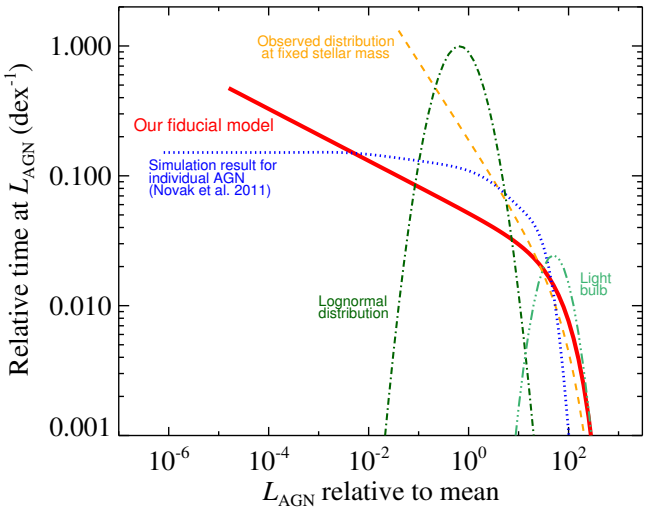
Credits: Veale+14



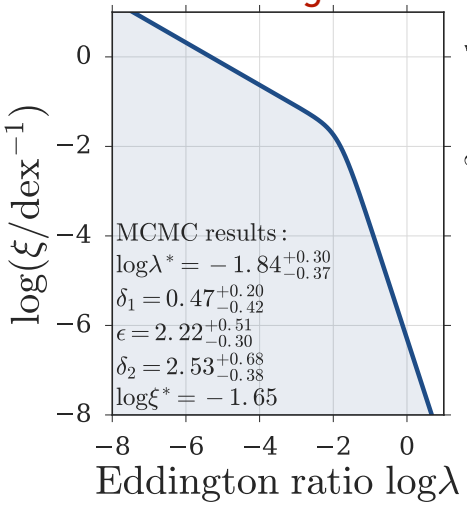
Credits: Aird+13



Credits: Hickox+14



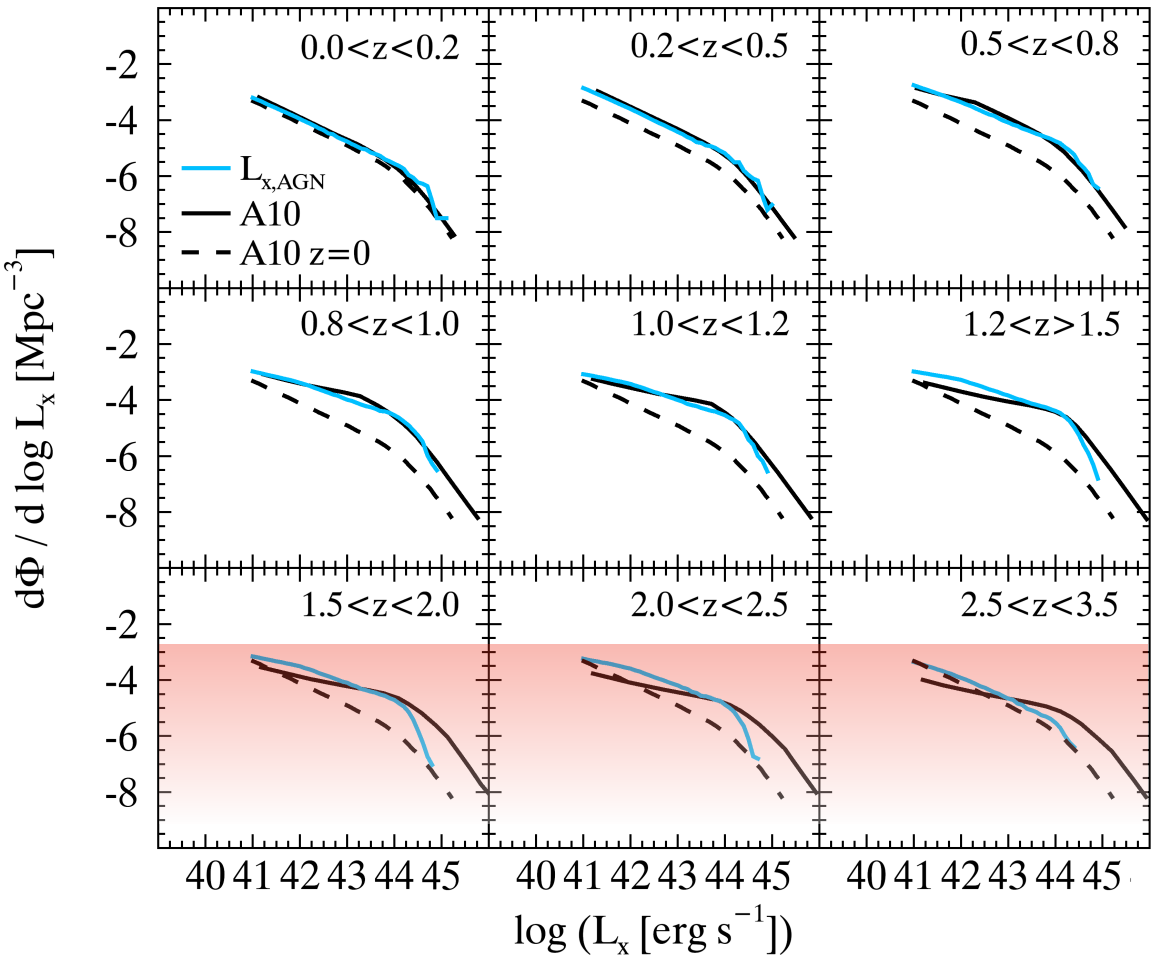
Credits: Weigel+17



Universal Eddington ratio distribution

Need for a new λ_{Edd} distribution

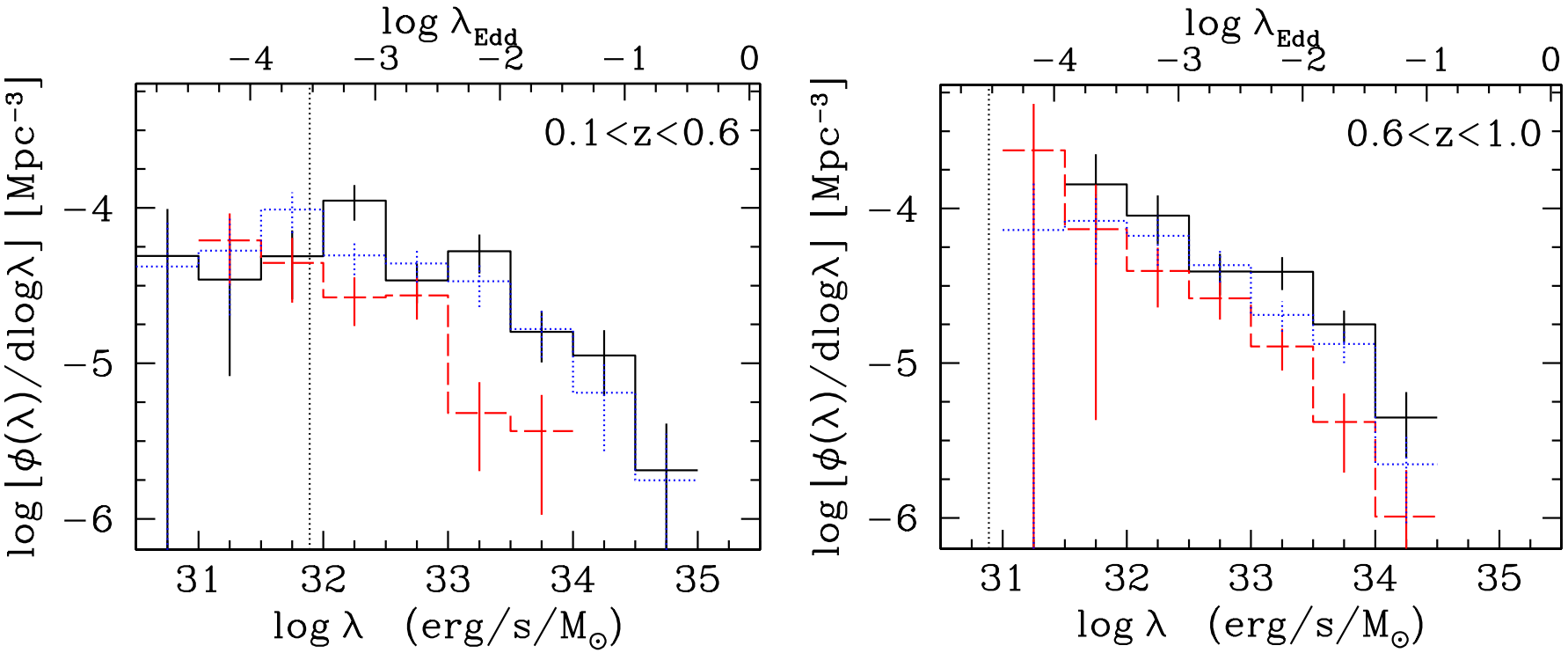
Credits: Jones et al. +17



From Jones+17: "…may be solved by adding additional complexities…"

Universal Eddington ratio distribution?

λ_{Edd} distribution with SF dependence

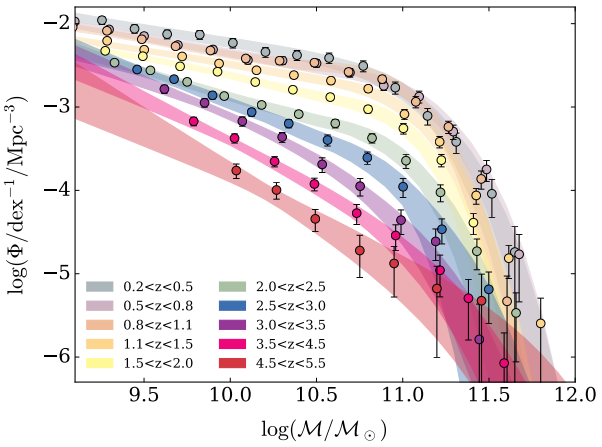


Credits: Georgakakis et al. +14

The λ_{Edd} distribution of SF and Quiescent galaxies seems to differ

Our model

Credits: Davidzon et al. +17



MASS FUNCTIONS

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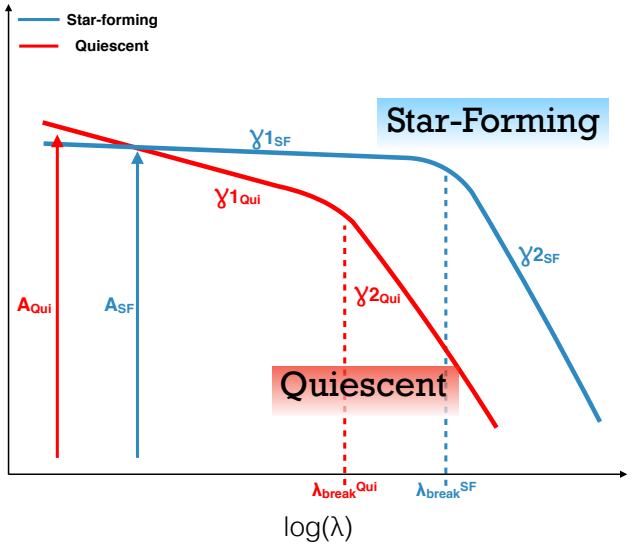

EDDINGTON RATIO DISTRIBUTIONS

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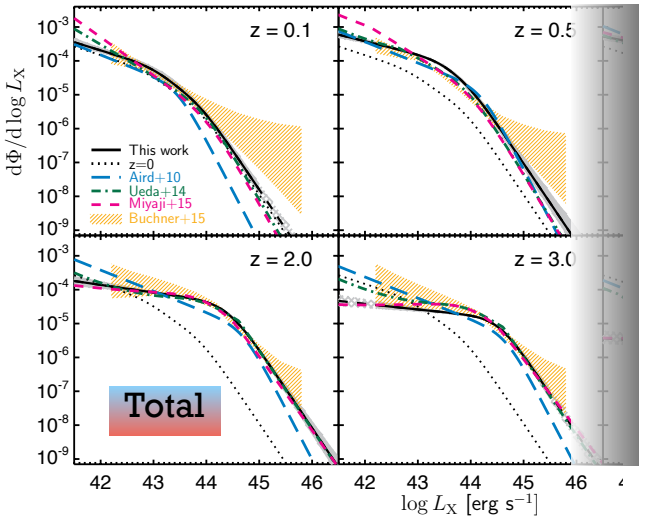
Credits: Aird et al. +15



X-RAY LUMINOSITY FUNCTIONS

Set of free parameters:

- Two normalisations
- Two positions of the break
- Four slopes
- Two assumptions♣ — $A_{SF} > A_{Qui}$; $\lambda_{break}^{SF} > \lambda_{break}^{Qui}$

♣Georgakakis et al.+14, Aird et al. +17, Wang et al. +17

$$M_* \times \lambda_{\mathrm{Edd}} \propto L_X$$

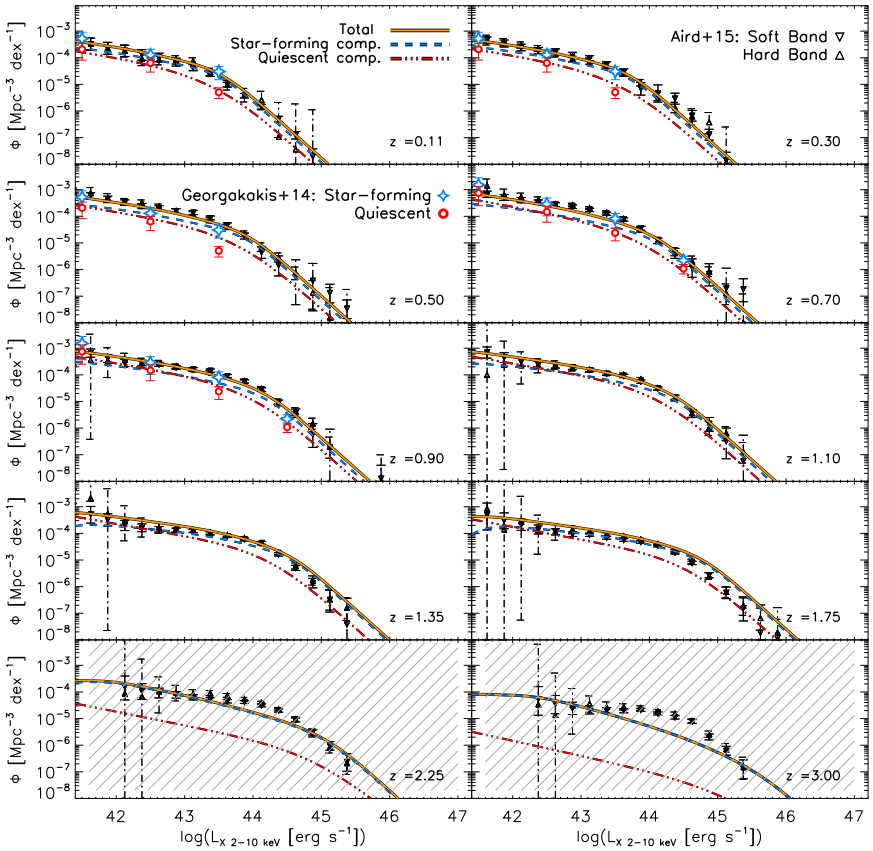
MAXIMUM LIKELIHOOD ESTIMATION

emcee

Foreman-Mackey et al. +13

Results

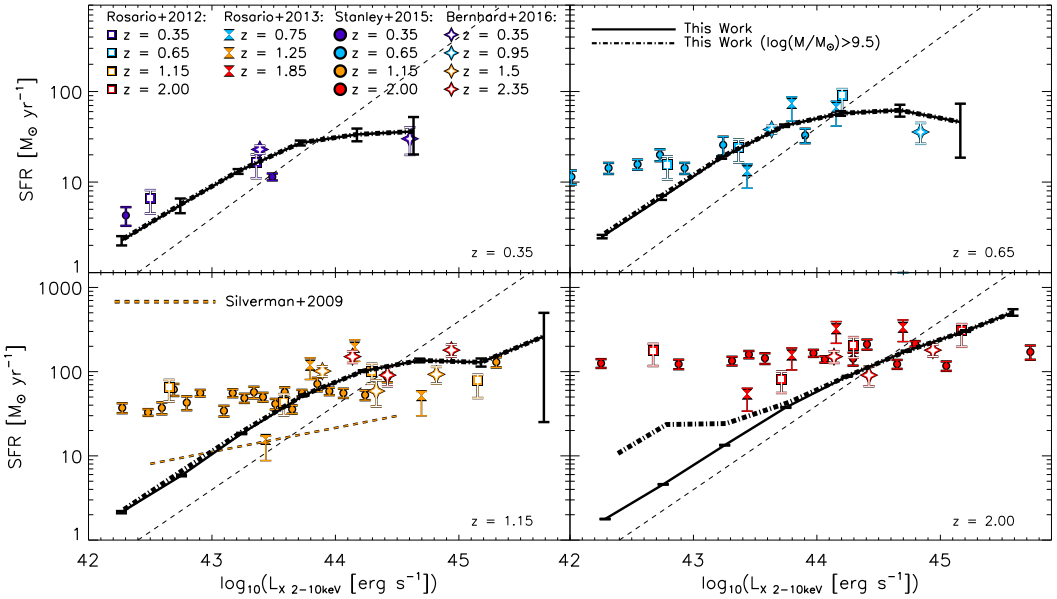
X-ray Luminosity functions



Take Away:

- Good fit out to z~2.
- SF galaxies dominates the XLFs.
- Good agreement with Georgakakis+14 at z<1.

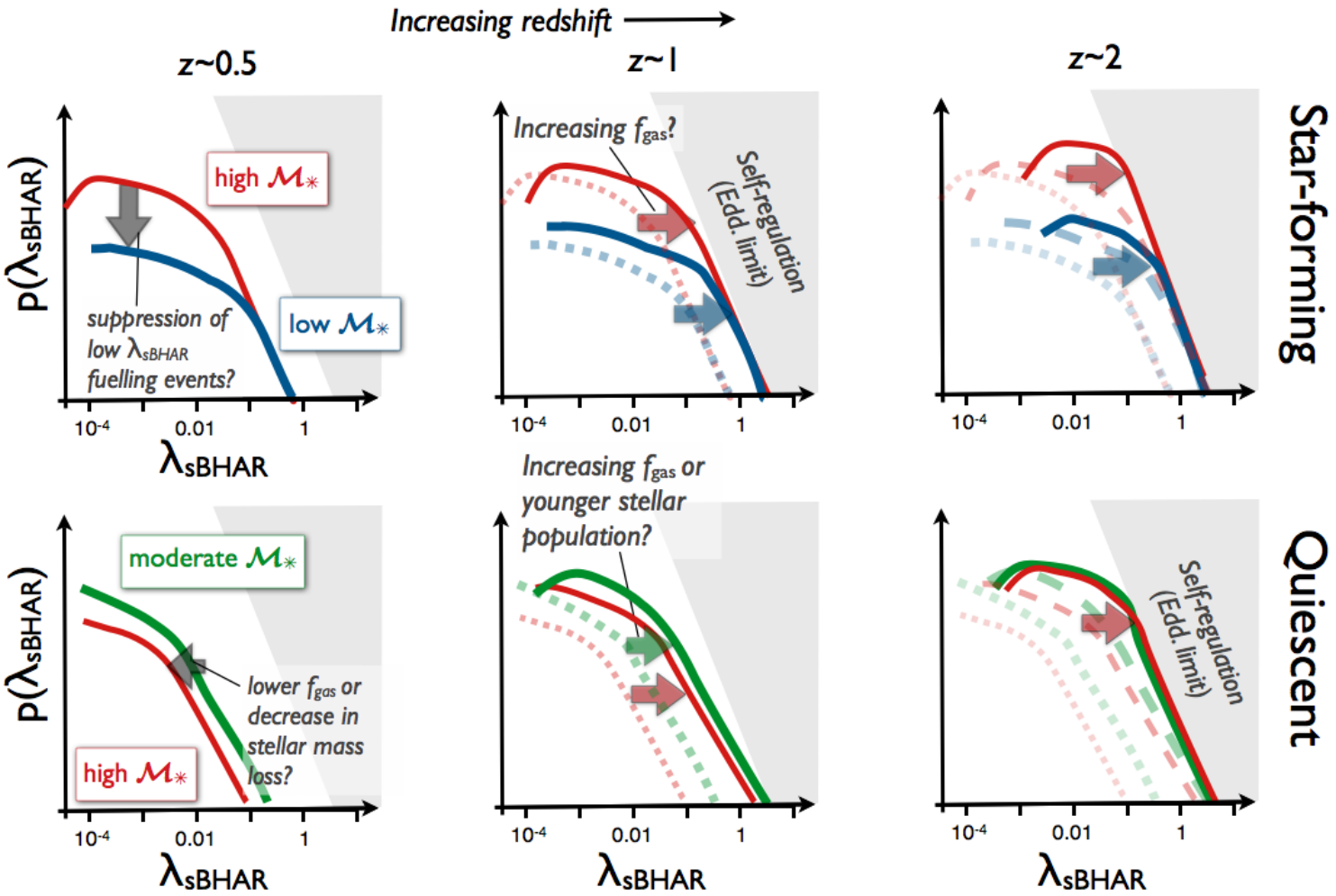
Flat SFR-Lx relationship



Take Away:

- Works at z<0.5.
- Generate a trend in contrasts to observations.
- The flat relationship is not due to mass bias.

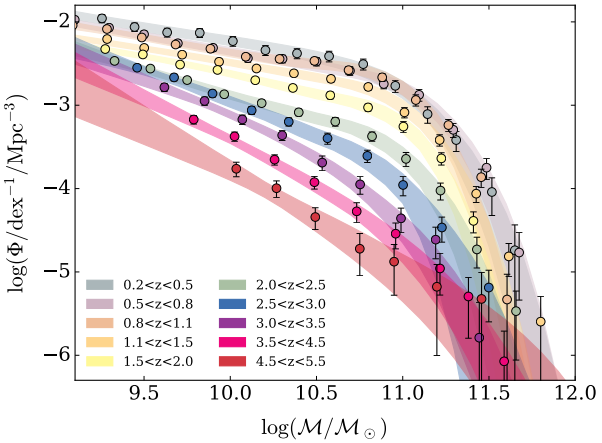
Mass dependency?



Credits: Aird et al. +17

Our model

Credits: Davidzon et al. +17



MASS FUNCTIONS

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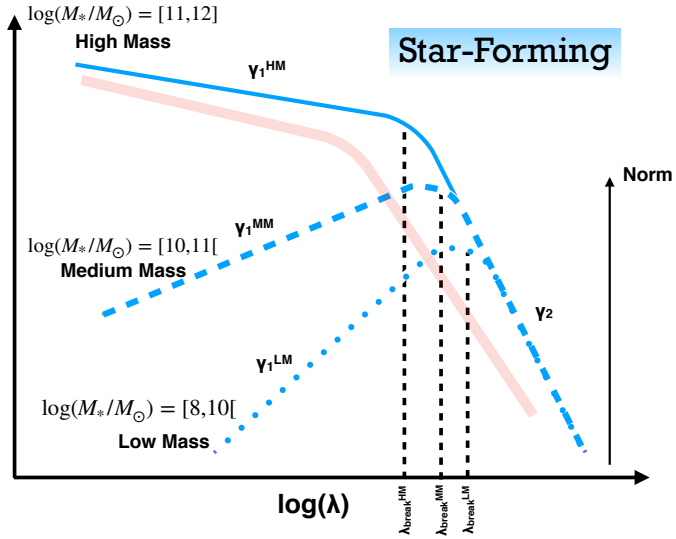

EDDINGTON RATIO DISTRIBUTIONS

Credits: Aird et al. +15

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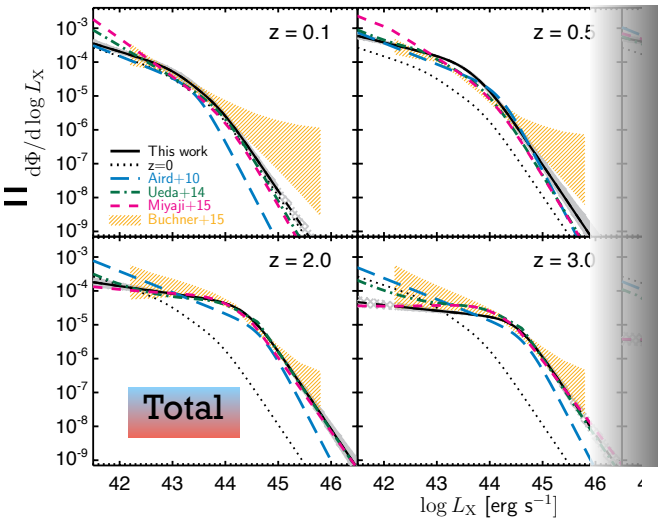


X-RAY LUMINOSITY FUNCTIONS

Set of free parameters:

- One normalisation
- Three positions of the break
- Four slopes
- Two assumptions♣ — $\lambda_{break}^{HM} < \lambda_{break}^{MM} < \lambda_{break}^{LM}$; $\gamma 2^{HM} = \gamma 2^{MM} = \gamma 2^{LM}$;

♣Aird et al. +17

$$M_* \times \lambda_{\mathrm{Edd}} \propto L_X$$

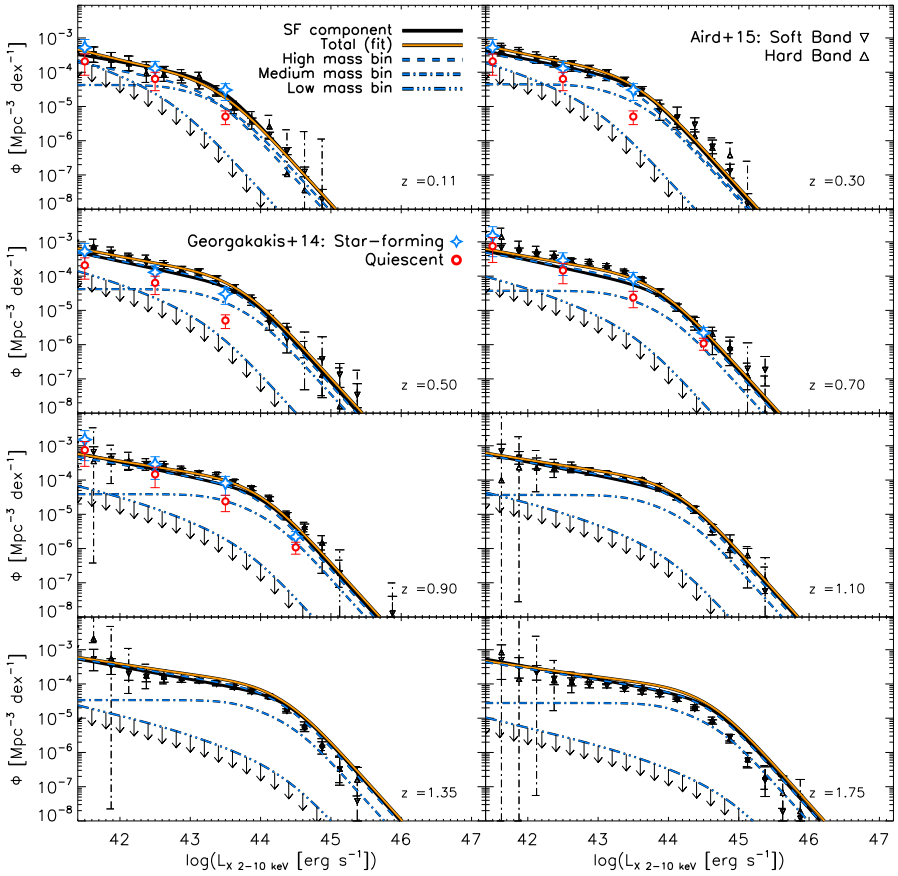
MAXIMUM LIKELIHOOD ESTIMATION

emcee

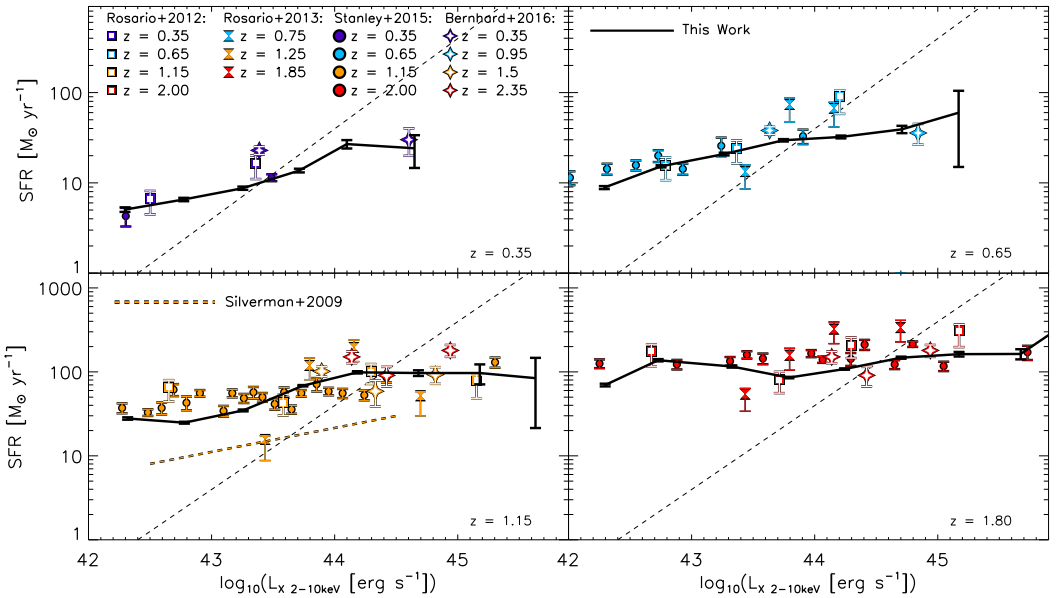
Foreman-Mackey et al. +13

Results

X-ray Luminosity functions



Flat SFR-Lx relationship



Take Away:

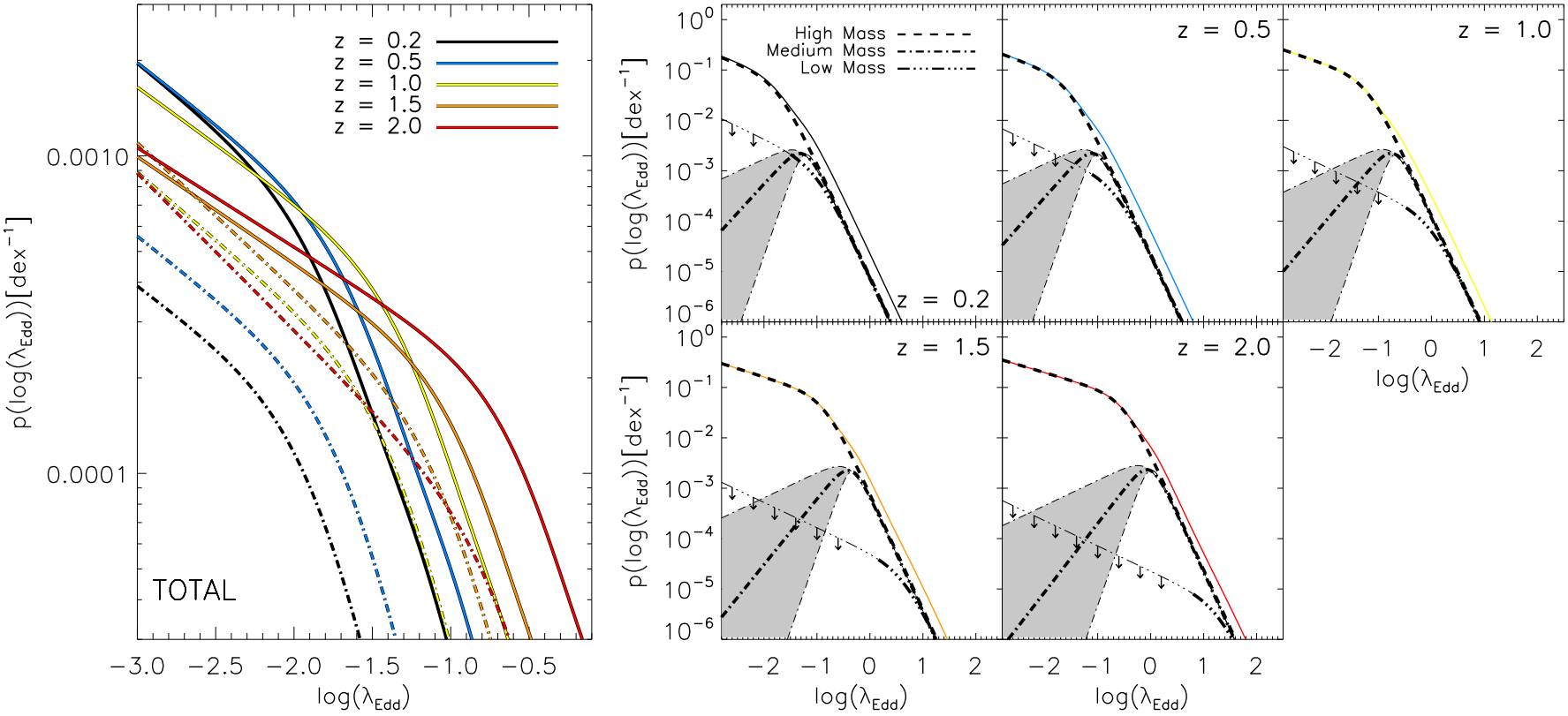
- Good fit out to z~2.
- High Mass dominates the XLFs.
- Low Mass = minimum contribution to the XLFs.

Take Away:

- In agreement with observations out to z~2.

Results: The Eddington ratio distributions

Mass-dependent



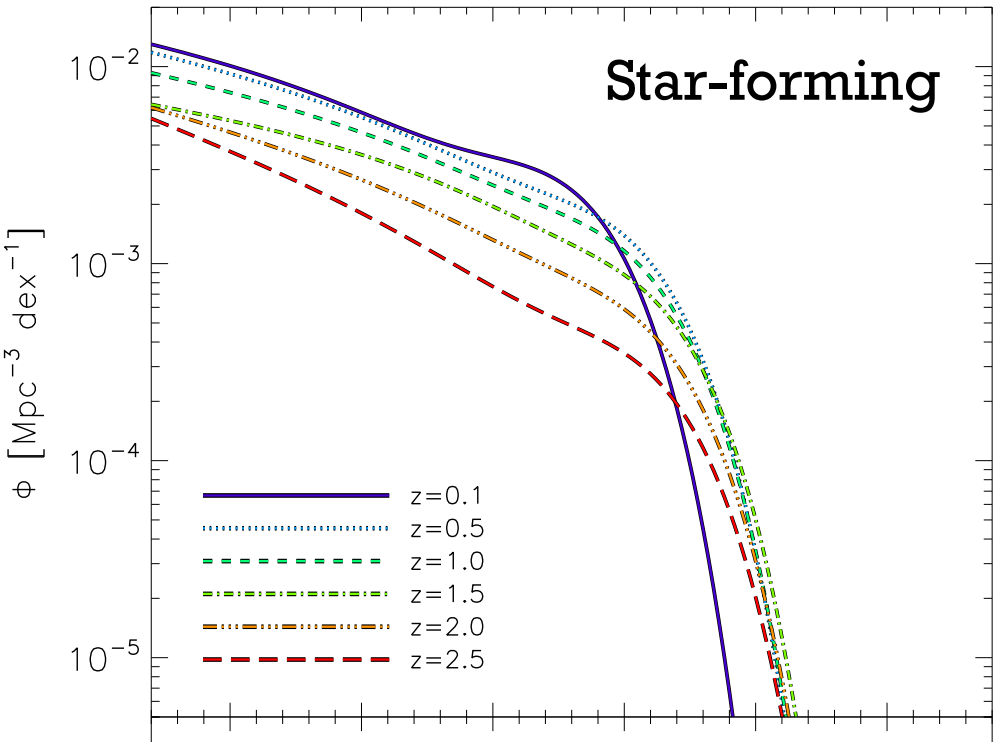
Take Away:

- Suppression of low λ_{Edd} in lower Mass hosts.
- Shift of the knee with z.

Why is our mass-independent model failing at reproducing the flat relationship between SFR and X-ray luminosity?

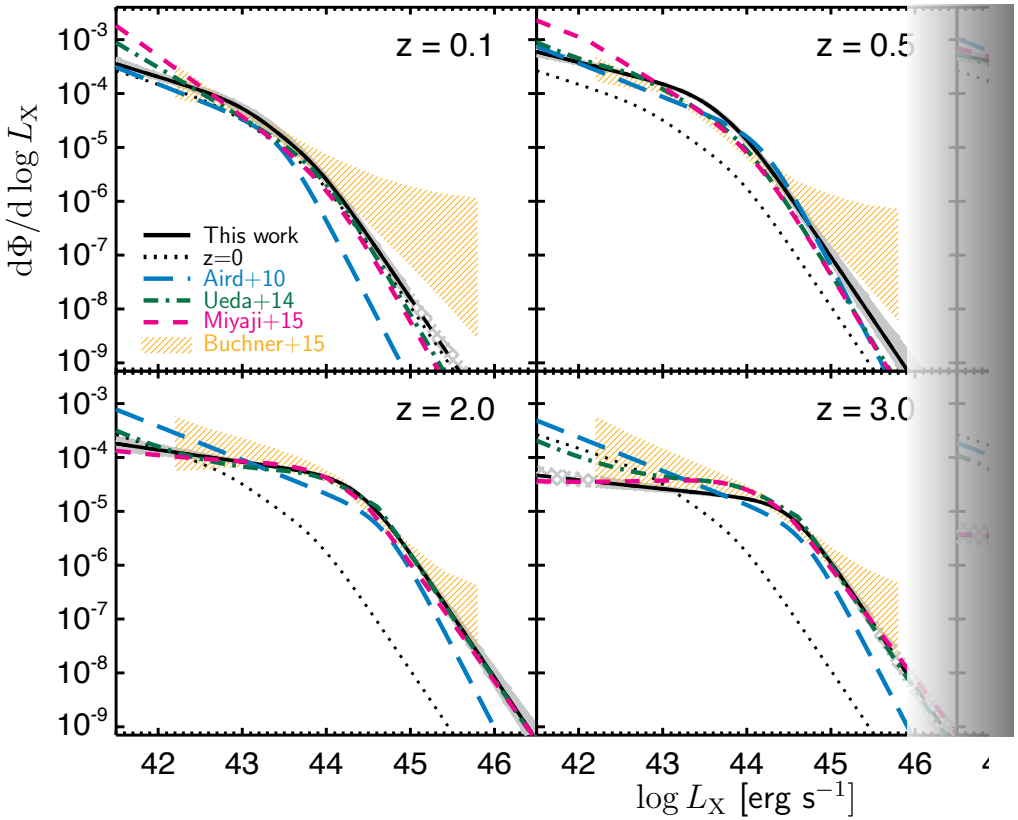
Why is our mass-independent model failing?

MASS FUNCTIONS



Steepening of the Mass function with redshift

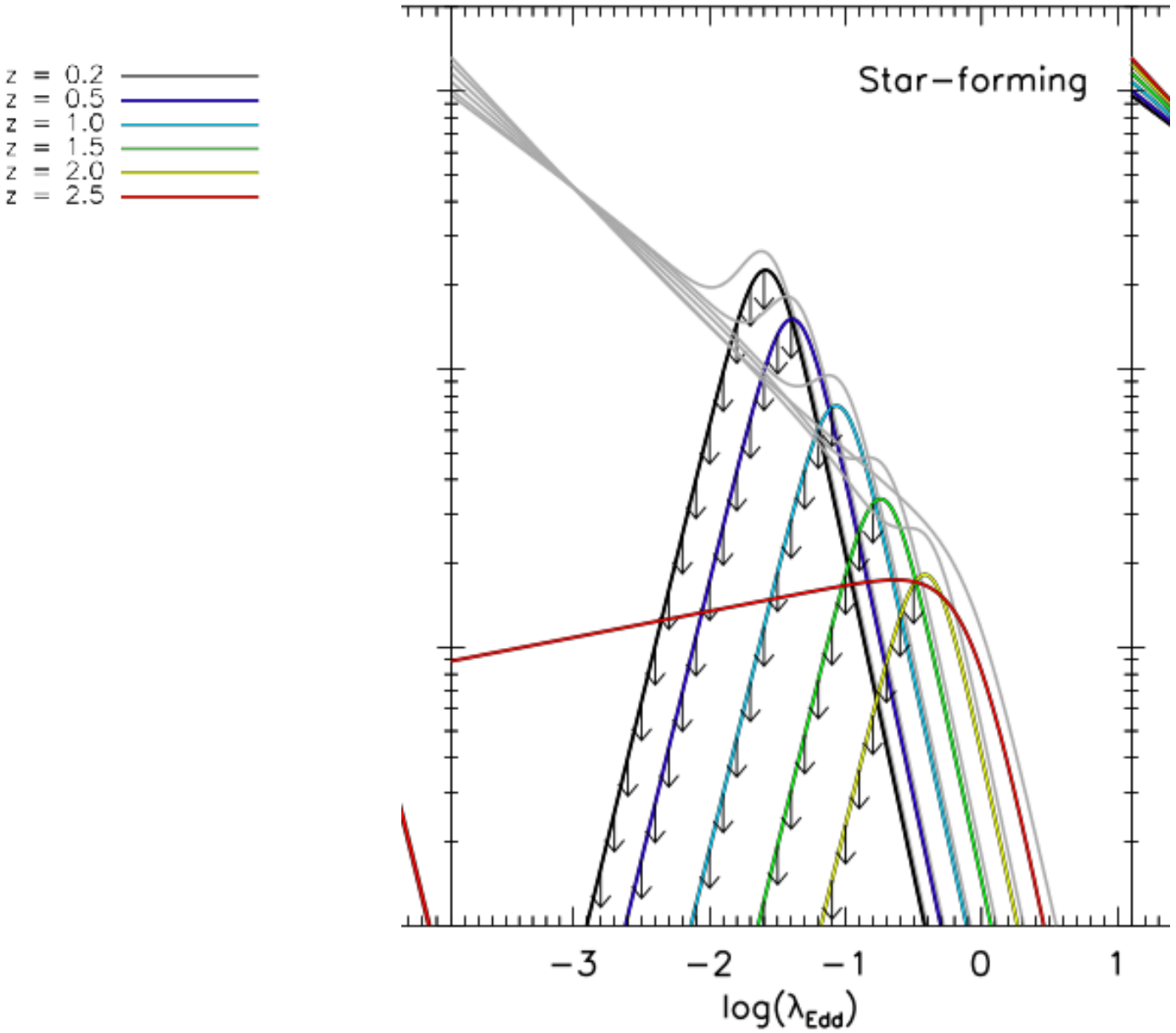
XRAY LUMINOSITY FUNCTIONS



Flattening of the X-ray luminosity functions with redshift

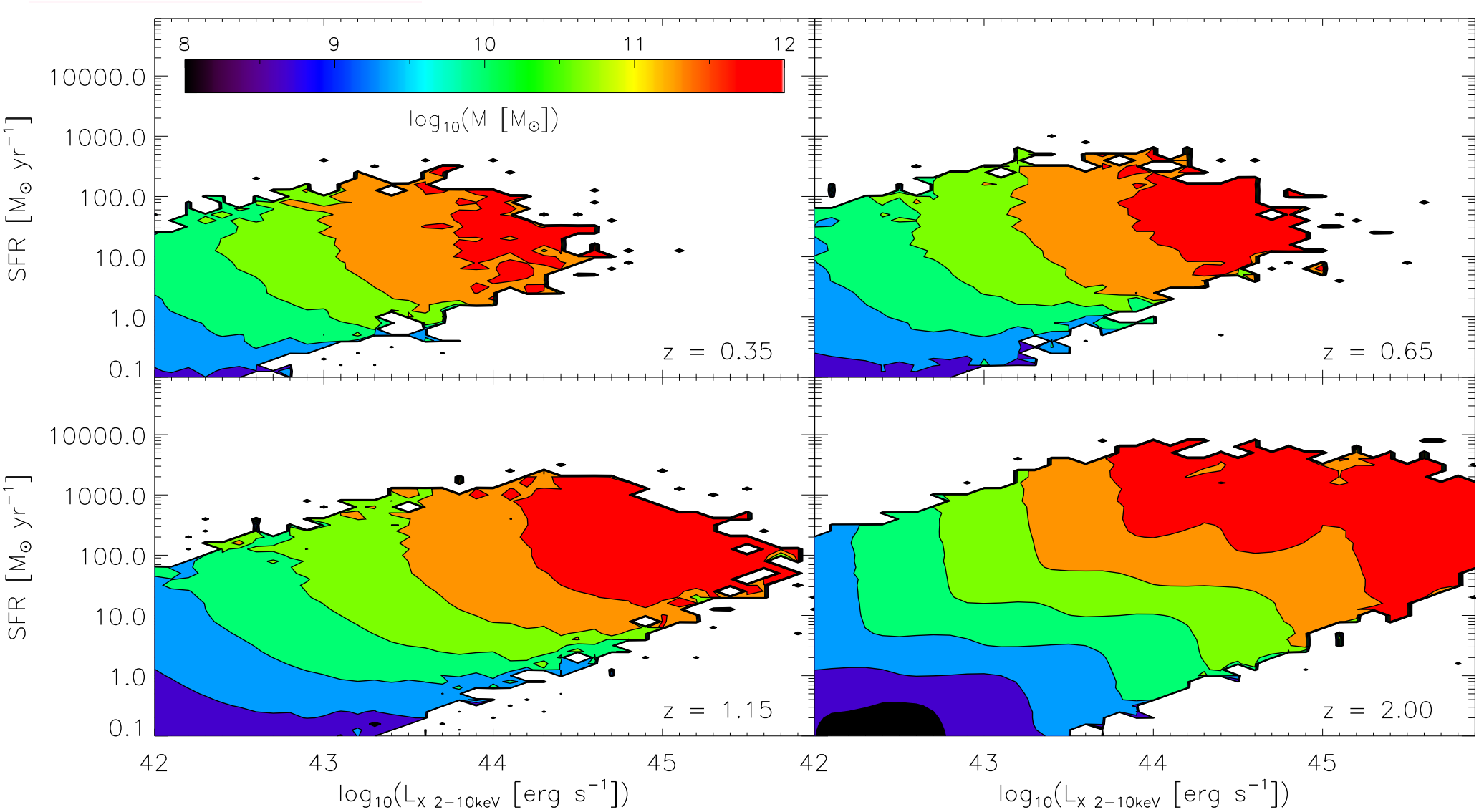
See also: Caplar+15, Weigel+17

Why is our mass-independent model failing?



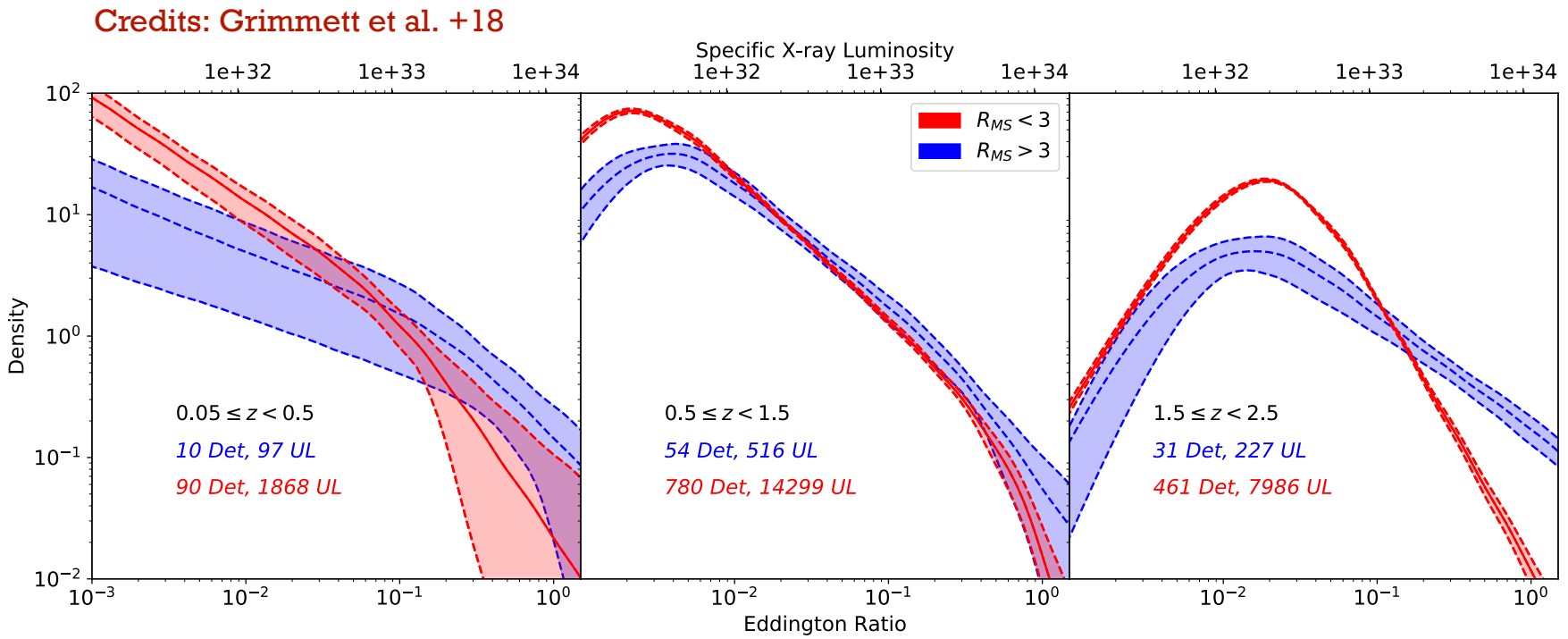
The λ_{Edd} distribution of SF galaxies is very narrow

Why is our mass-independent model failing?



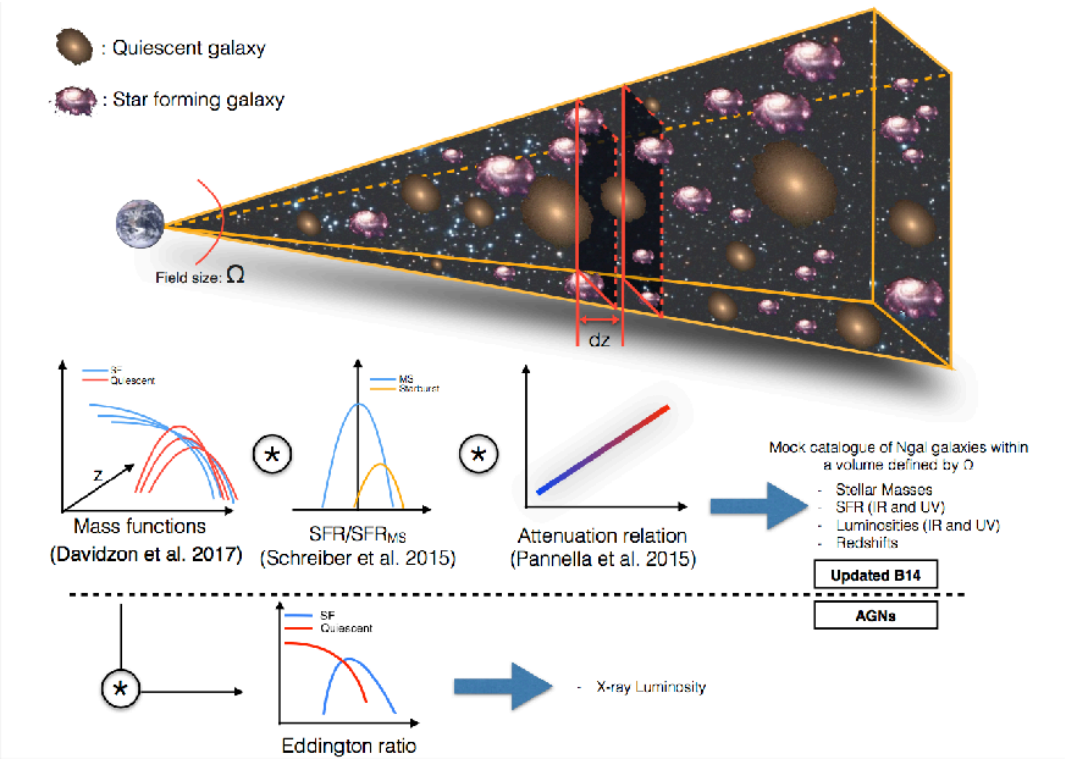
Somehow generate a strict relationship between Lx and stellar mass

Why is our mass-independent model failing?



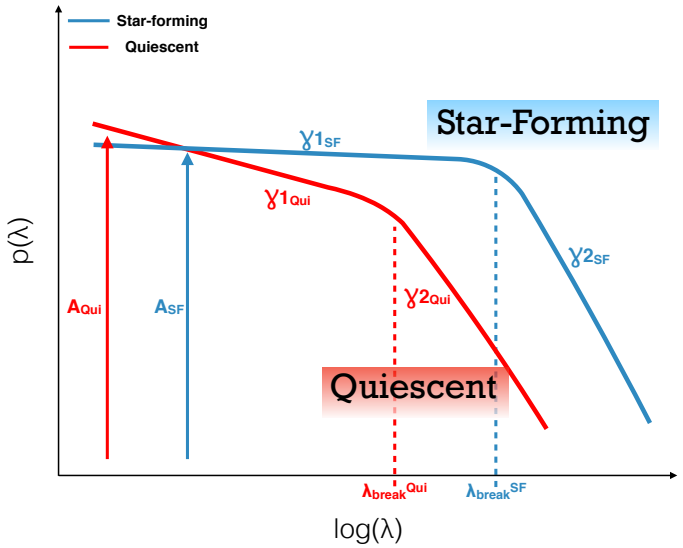
The Eddington ratio distribution for star-bursting galaxies is different from that of lower SFR hosts

Summary



Coherent AGN-host PSM

Summary

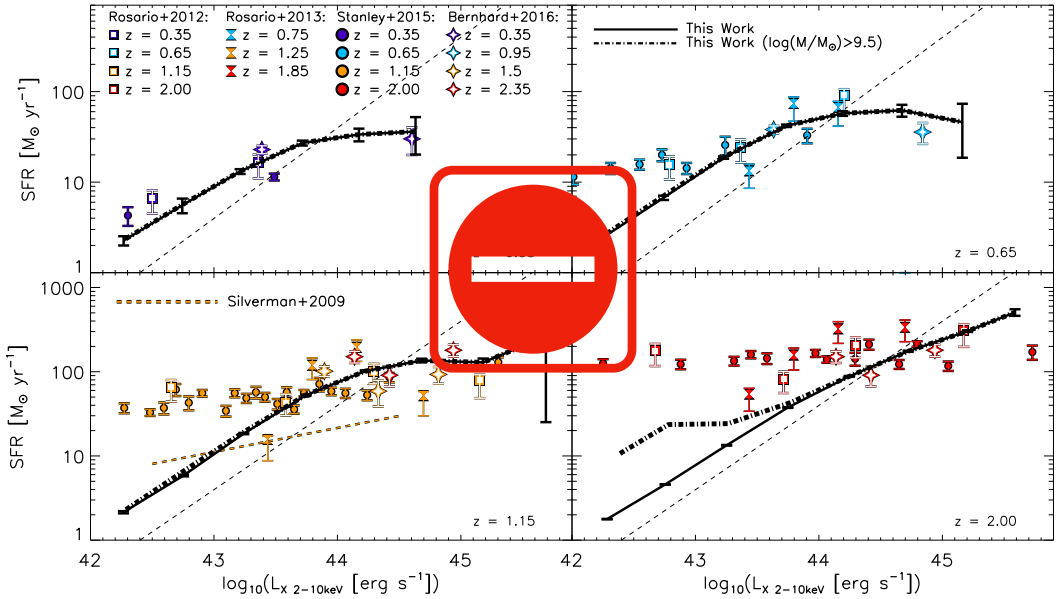


MASS-INDEPENDENT

Need to derive λ_{Edd} distribution split between SF and Quiescent galaxies

Summary

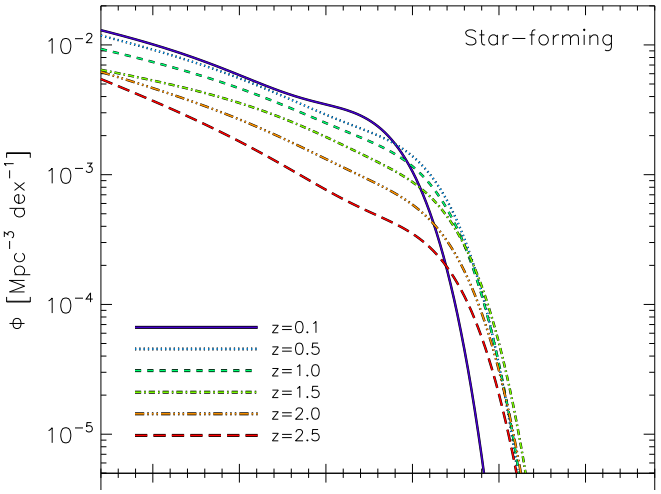
Mass-independent



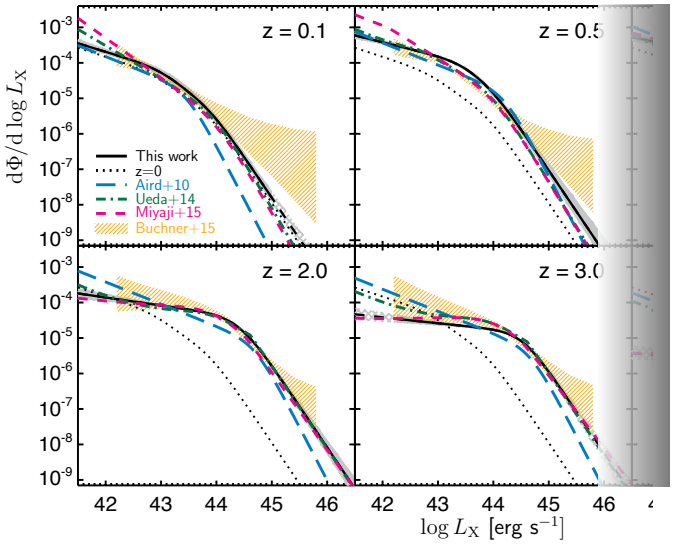
Fail at reproducing the flat SFR-Lx relationship

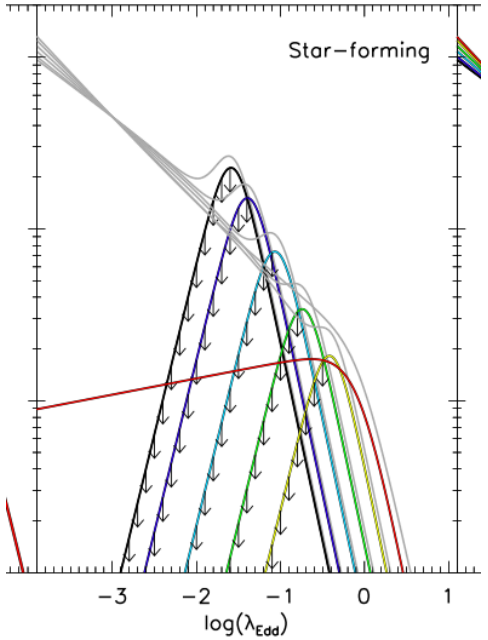
Summary

MASS FUNCTIONS



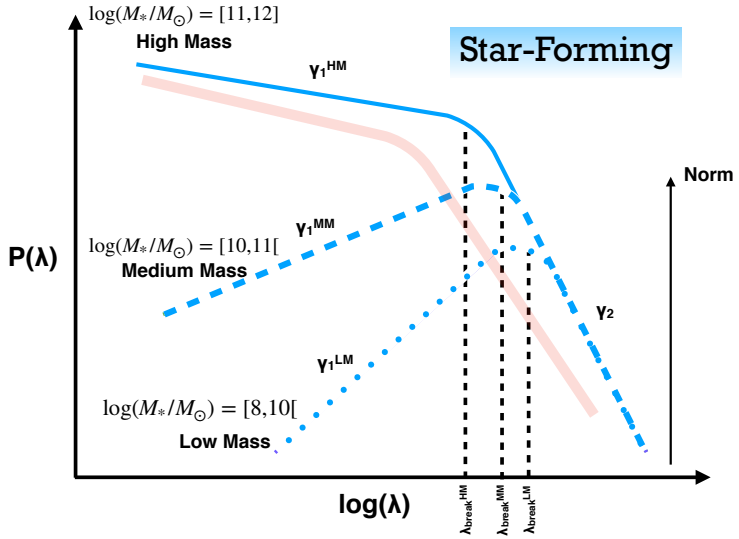
XLF





Related to the intrinsic shape of the Mass functions and the XLF

Summary

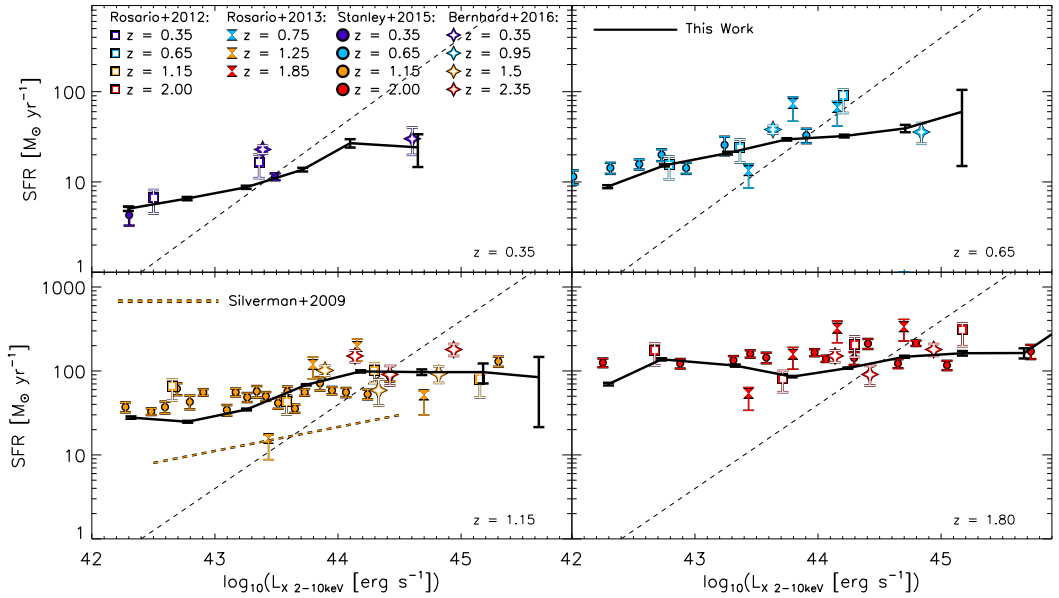


MASS-DEPENDENT
(FOR SF GAL)

Relaxed the mass independence

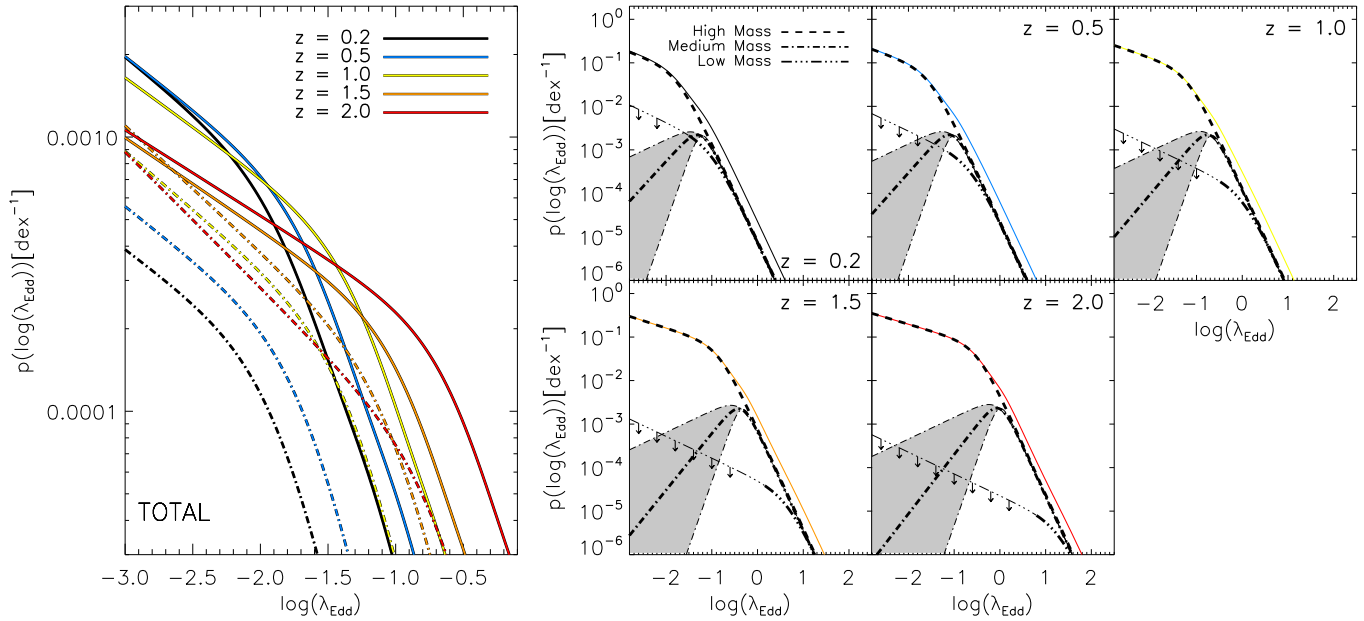
Summary

Mass-dependent



Reproduces the flat SFR-Lx relationship

Summary



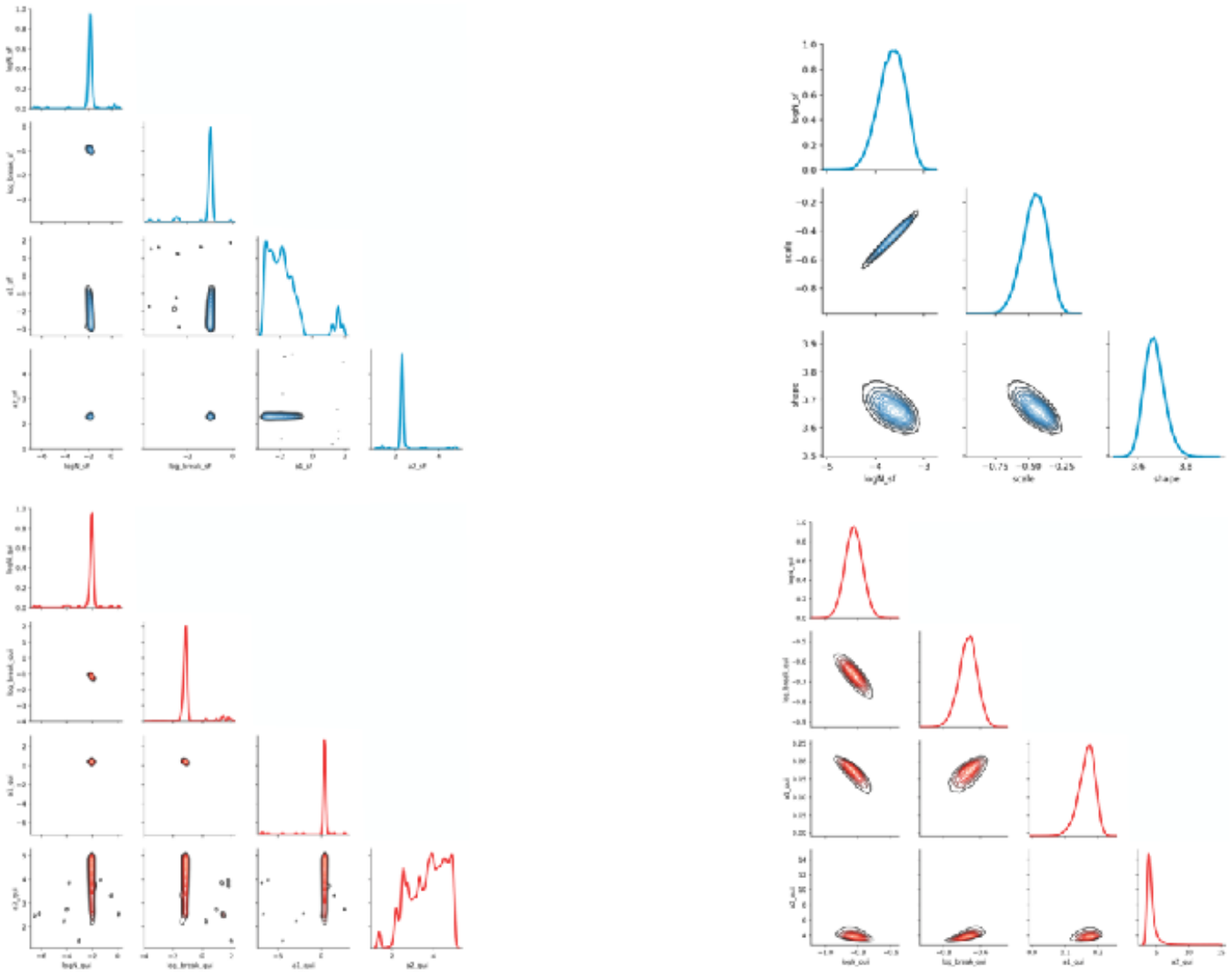
Suppression of lower Eddington ratio in lower mass galaxies

Problem at early time in the Universe?

Summary

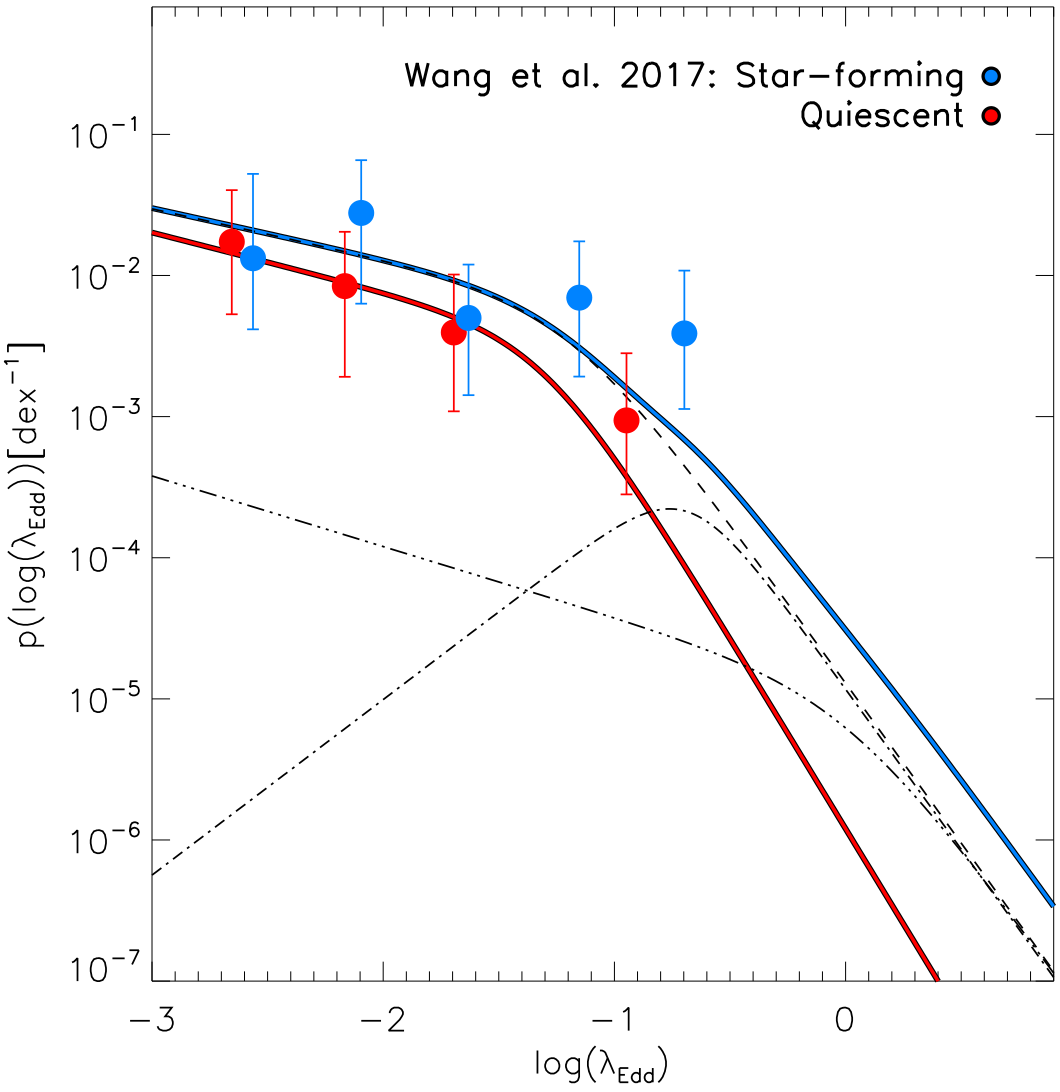
- Developing a coherent Population Synthesis Model for which we have prescriptions on SFR and SMBH accretion rate.
- We use a model where the Eddington ratio distribution is split between SF and Quiescent galaxies.
- We find that it fails at reproducing the flat relationship between SFR and X-ray luminosity, and that it is a consequence of the intrinsic shape of the low mass end of the mass function versus that of the faint end of the X-ray luminosity functions.
- We adopted a model where the Eddington ratio distribution also incorporates the newly discovered mass dependency for SF galaxies.
- We find that we are now able to reproduce both the X-ray luminosity functions and the flat relationship between SFR and X-ray luminosity.
- A consequence is the suppression of lower Eddington ratio in lower mass galaxies, as found by Aird+17.

Appendix



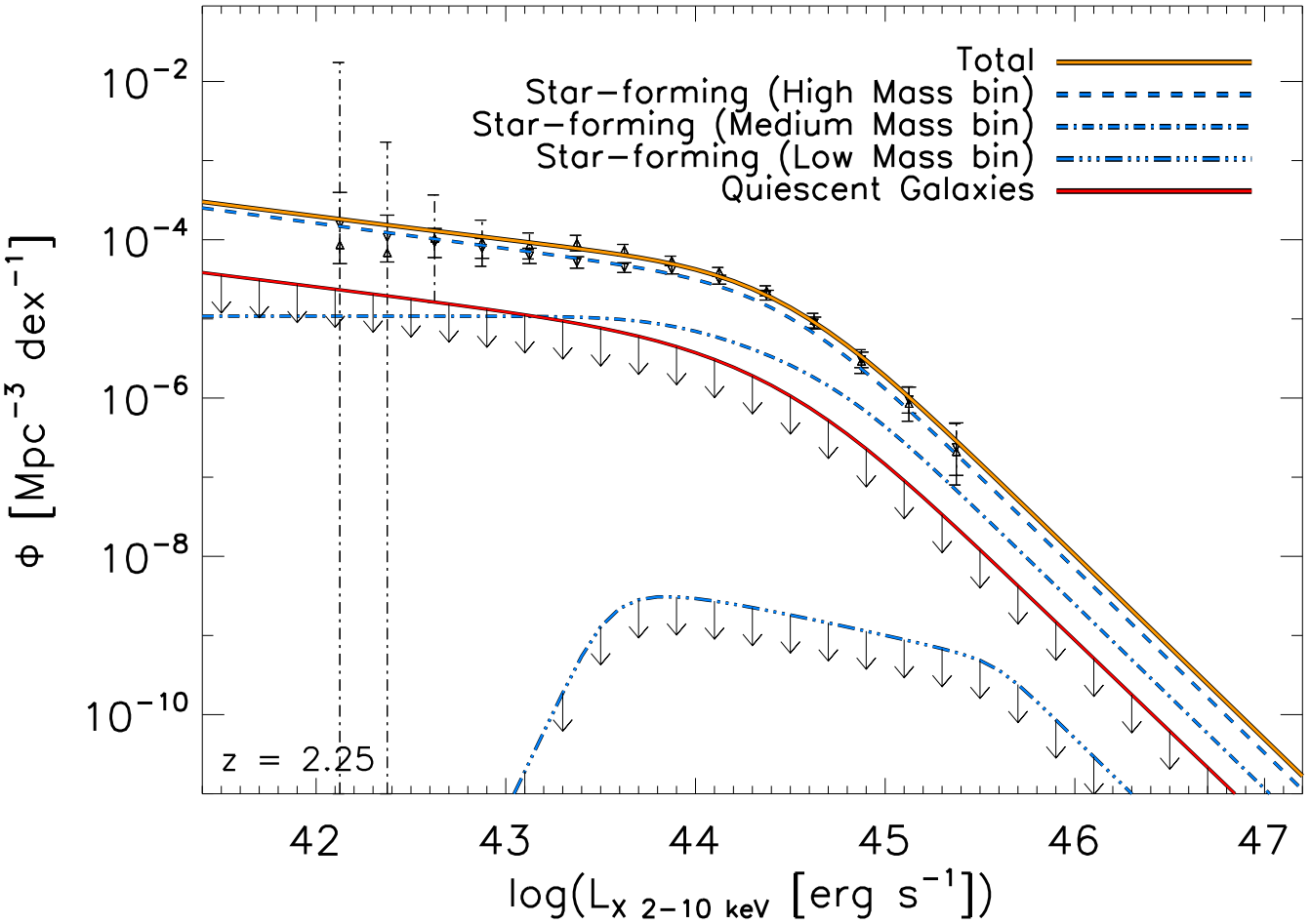
Corner plots for the MCMC

Appendix



COMPARISON TO WANG+17

Appendix



EXPAND BEYOND Z=2