Identifying AGN in Local Dwarf Galaxies

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Data

Optical

- Sample constructed from MPA-JHU
  - Contains 1,472,581 objects spectroscopically classified as galaxies from the SDSS DR8
- 835, 861 objects with reliable mass estimates

X-ray

- Sample constructed from *XMM-Newton Serendipitous Survey (3XMM)*
- Provides flux data in the 0.2 – 12keV energy range
  - Summed fluxes in the 2 – 4.5 keV & 4.5 – 12 keV and converted to luminosity
  - No rest-frame correction applied

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Matching Optical & X-ray Data

$$M \leq 3\times10^{9} M_{\odot}$$

$$Source\ Extent < 10”$$

$$\frac{Optical\ to\ X-ray\ Separation}{X-ray\ Position\ Error} < 3.5$$

86 possible AGN hosts

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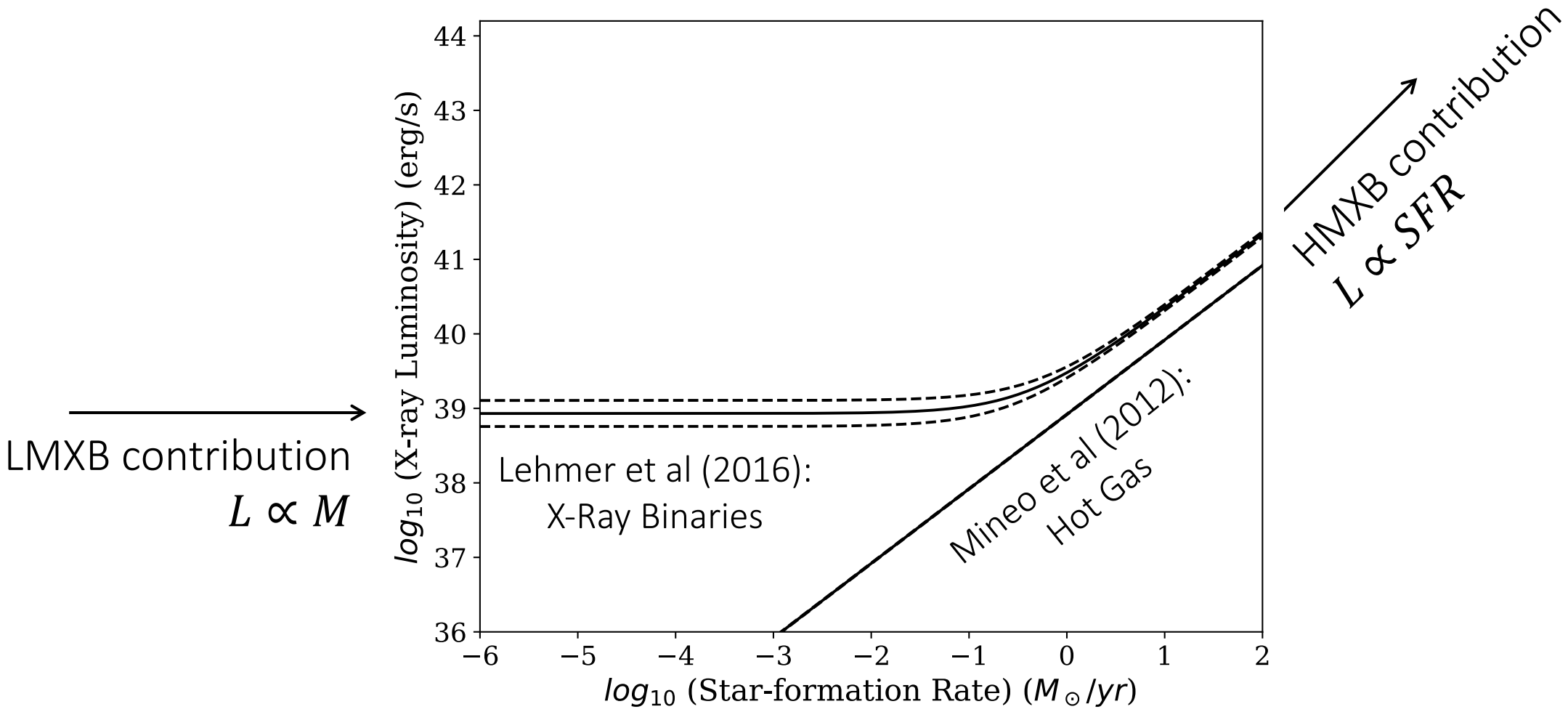
Identifying AGN Emission



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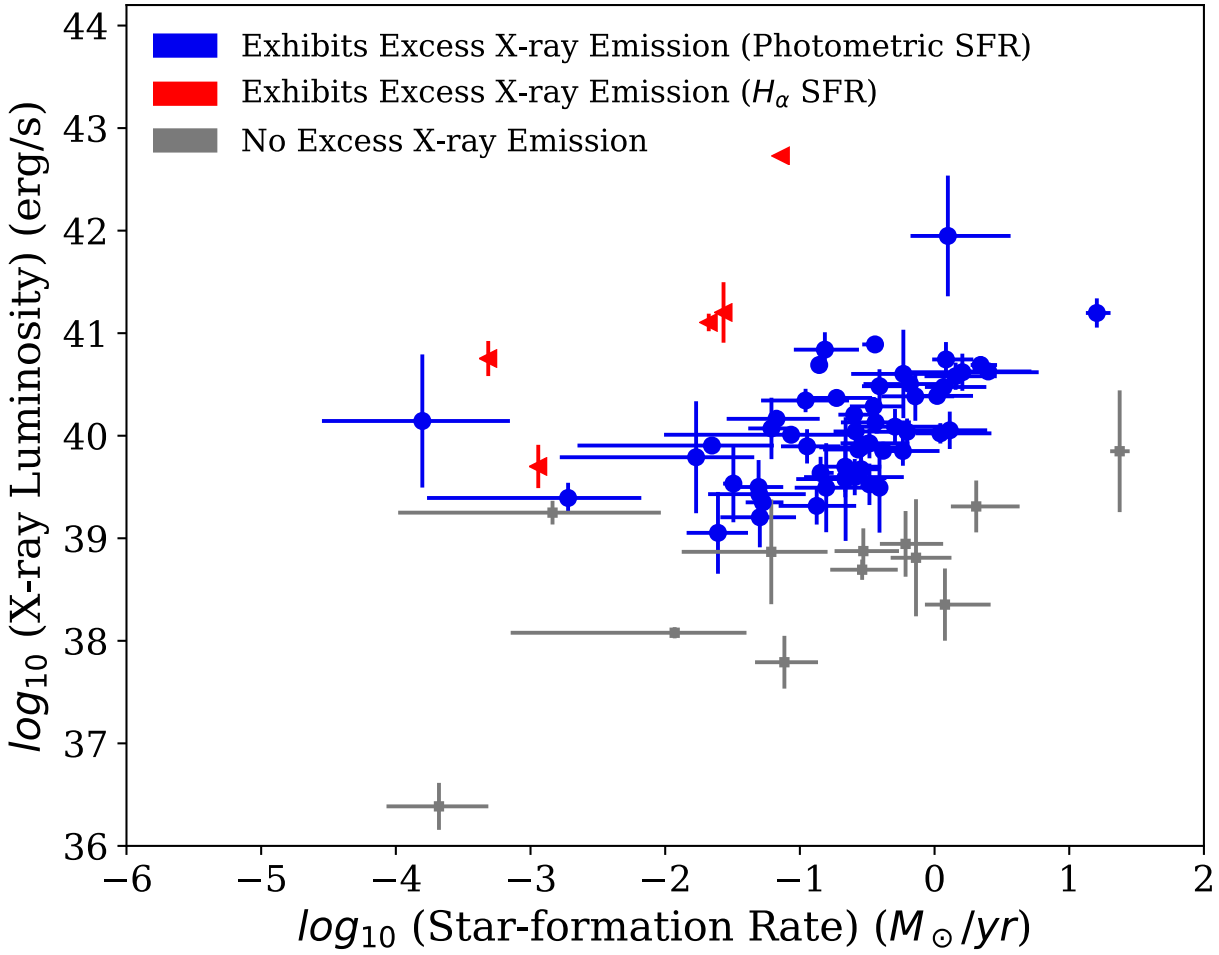
Identifying AGN Emission



X-ray emission from 61 dwarf galaxies exceeds

$$\frac{L_{Observed}}{L_{XRB} + L_{Gas}} \geq 3$$

so are considered AGN

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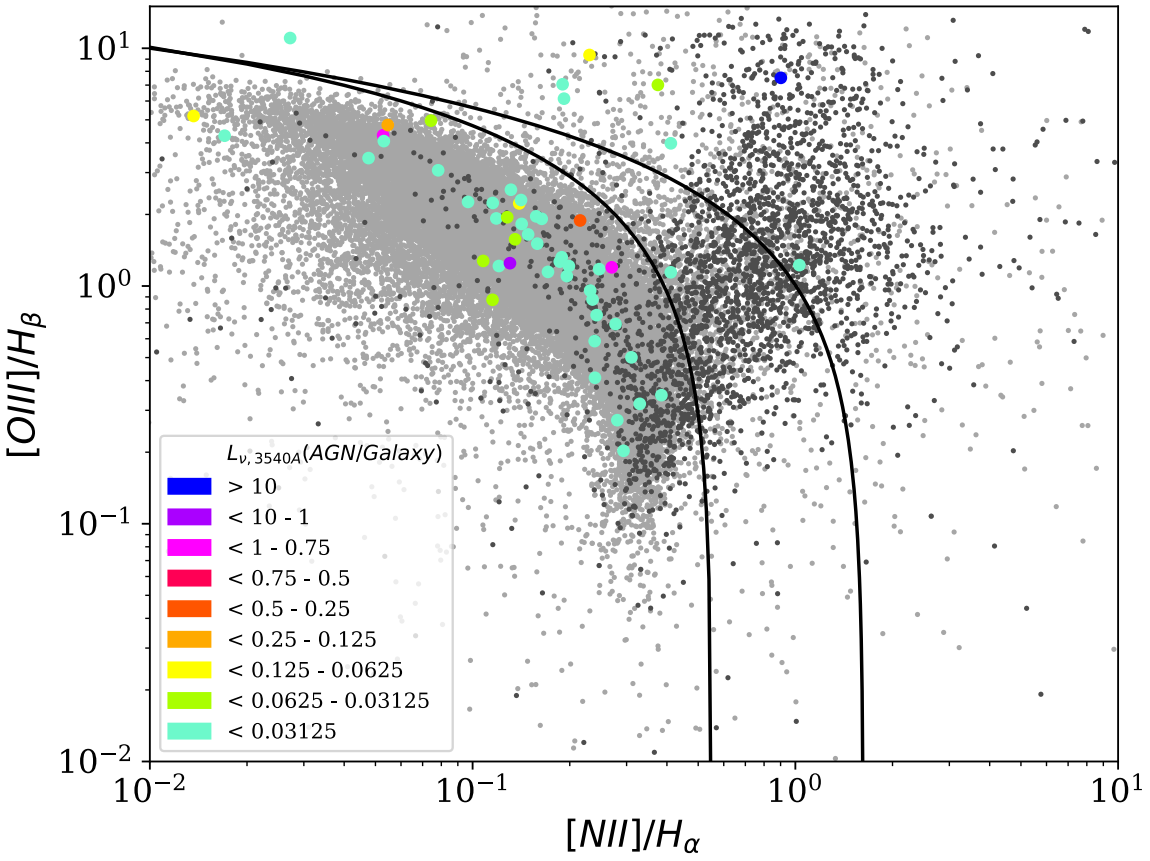
BPT Comparison



- 85% of X-ray selected AGN are missed using BPT selection techniques
- Of these mis-identified AGN, only one host has predicted optical AGN emission greater than that of the galaxy
  - AGN emission being dominated by star formation signatures

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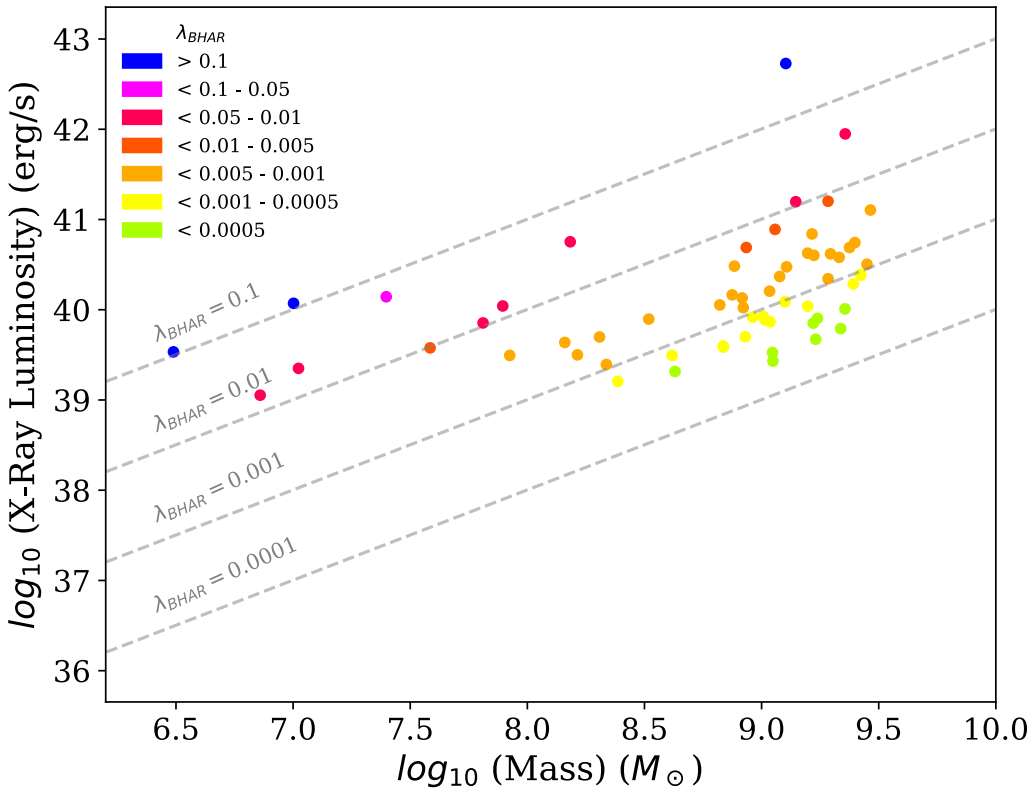
Black Hole Accretion Rate (BHAR)



BHAR gives compares the AGN bolometric luminosity with an approximate Eddington luminosity to give an idea of the activity of the central supermassive black hole:

$$\lambda_{BHAR} = \frac{25\, L_X}{1.26 \times 10^{38} \times 0.002\, M_{bulge}} \approx \frac{L_{Bol}}{L_{Edd}}$$

(Aird et al, 2012)

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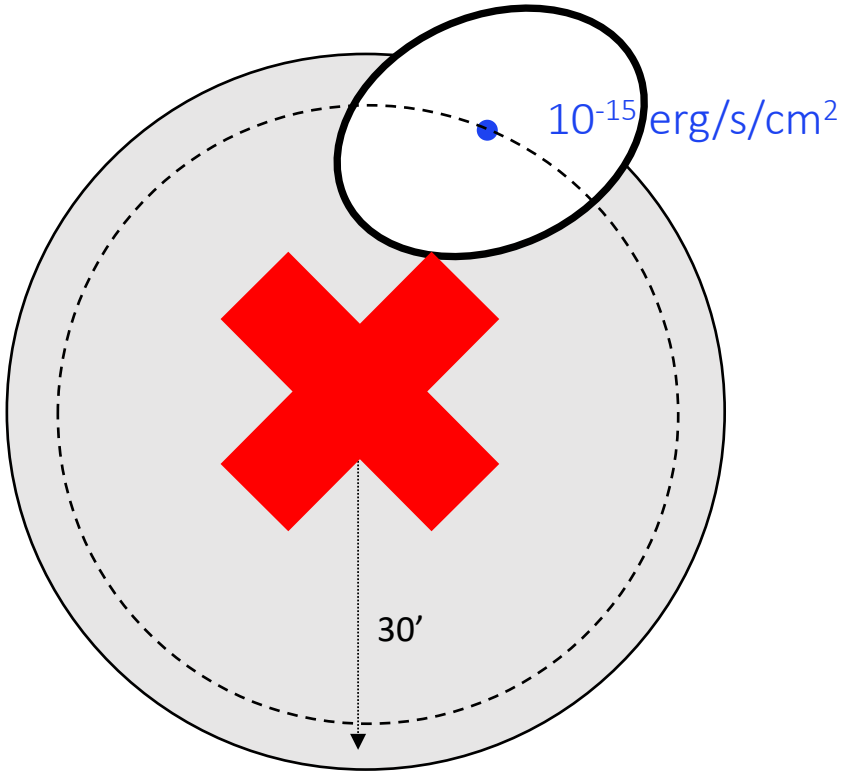
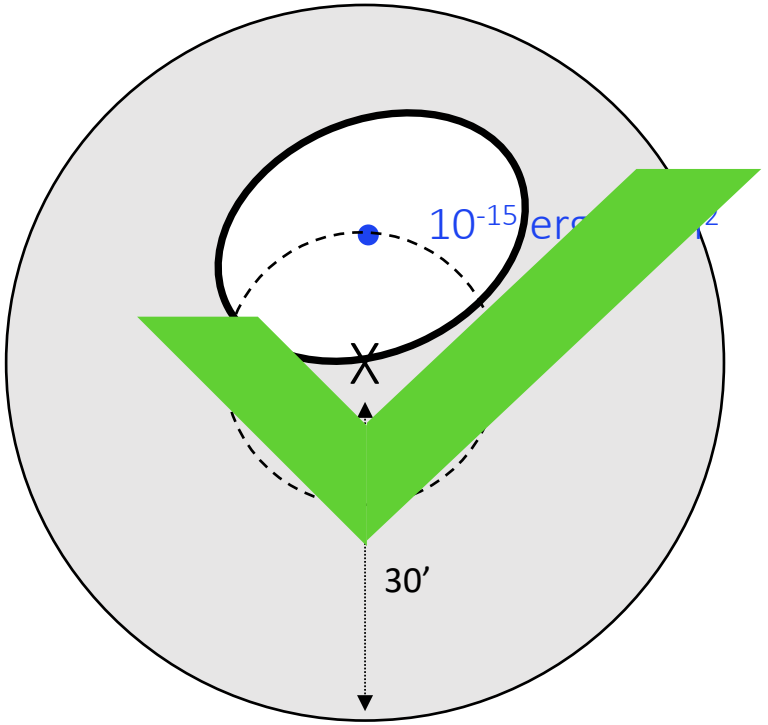
Correcting for Sample Incompleteness



----- Flux Limit = 10^{-14} erg/s/cm^2



----- Flux Limit = 10^{-15} erg/s/cm^2

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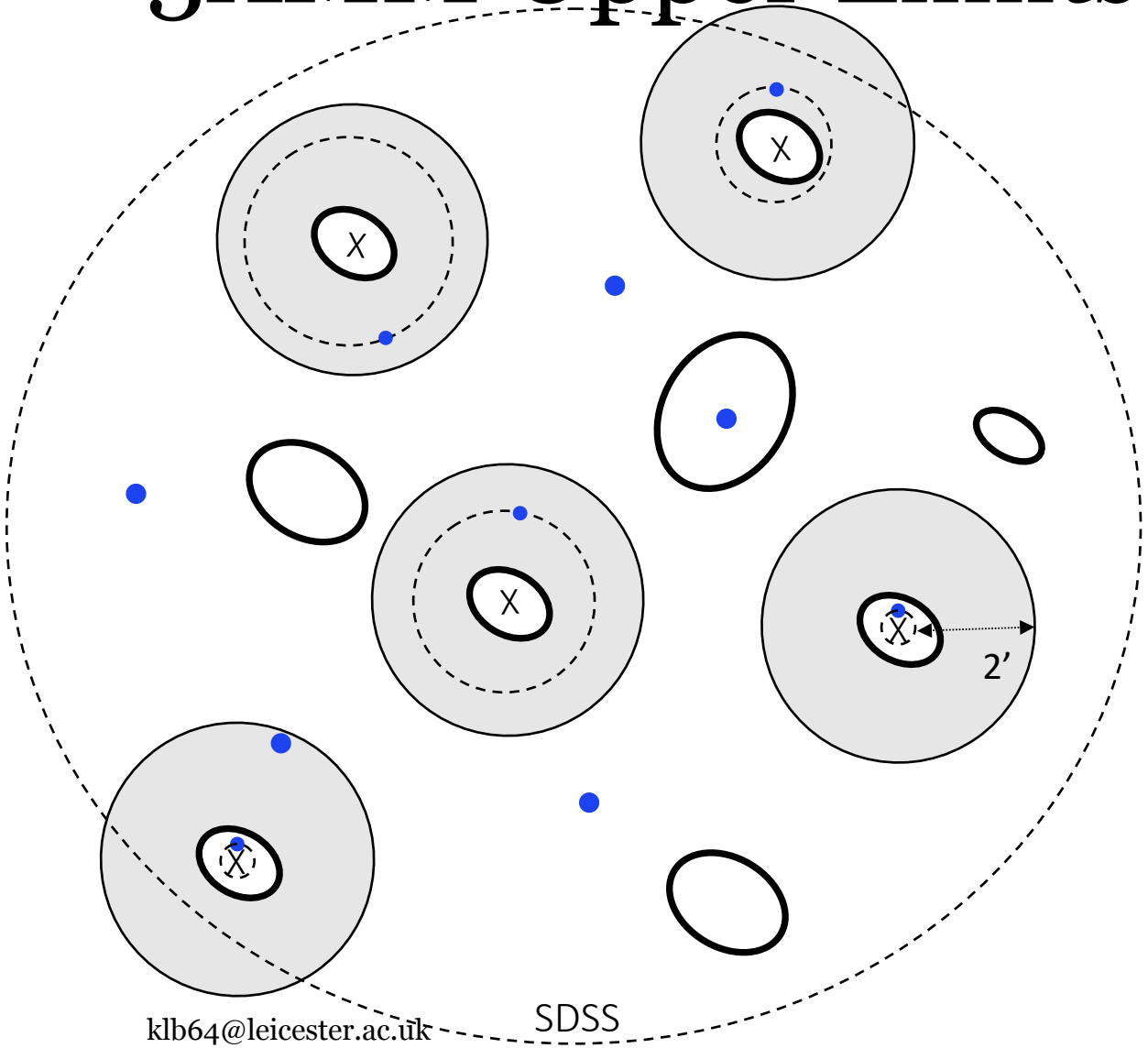
3XMM Upper Limits



- Uploaded co-ordinates for all dwarf galaxies in parent sample to 3XMM upper limits service
- Within 2’ region returned, the flux upper limit of the X-ray detection closest to the dwarf galaxy was recorded
- All upper limits were placed in cumulative distribution and normalised by number of dwarf galaxies
- Correction fractions were taken from the observed AGN luminosity range

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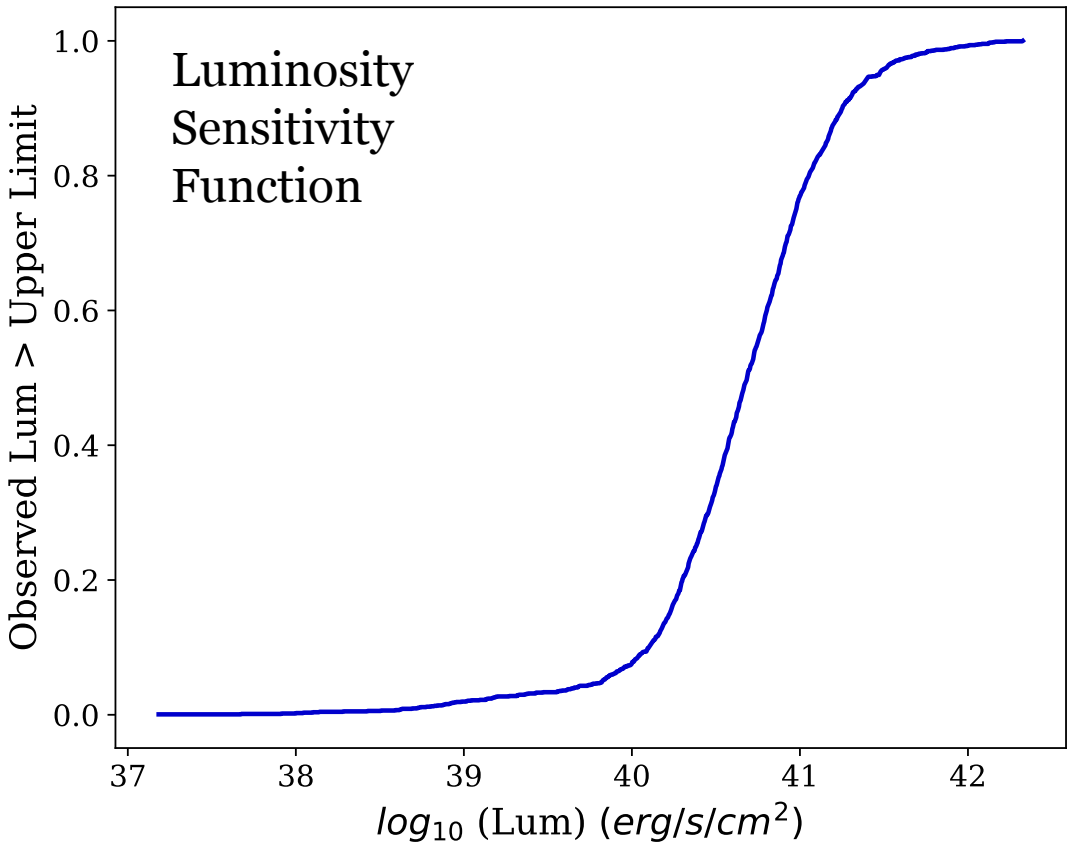

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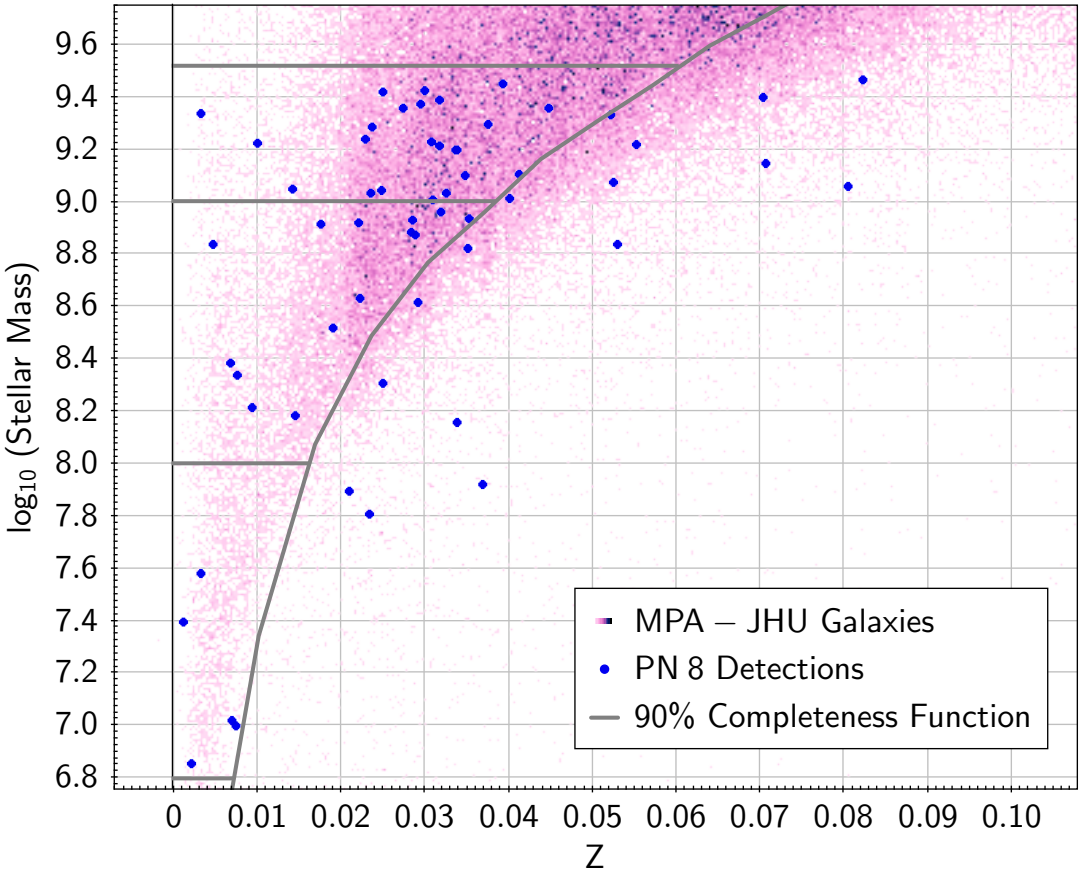
Limiting Observed AGN Sample



- Upper limits correspond to detections in a single 3XMM band
- Our observed AGN sample was divided into by host galaxy mass bins with corresponding 90% complete redshifts
  - Bespoke sensitivity functions were made for each bin
- 29 AGN in statistical sample

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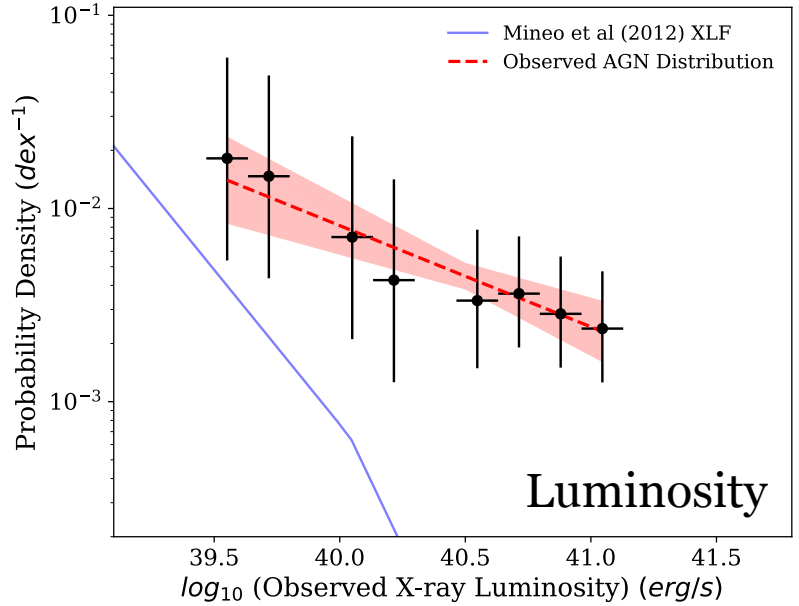
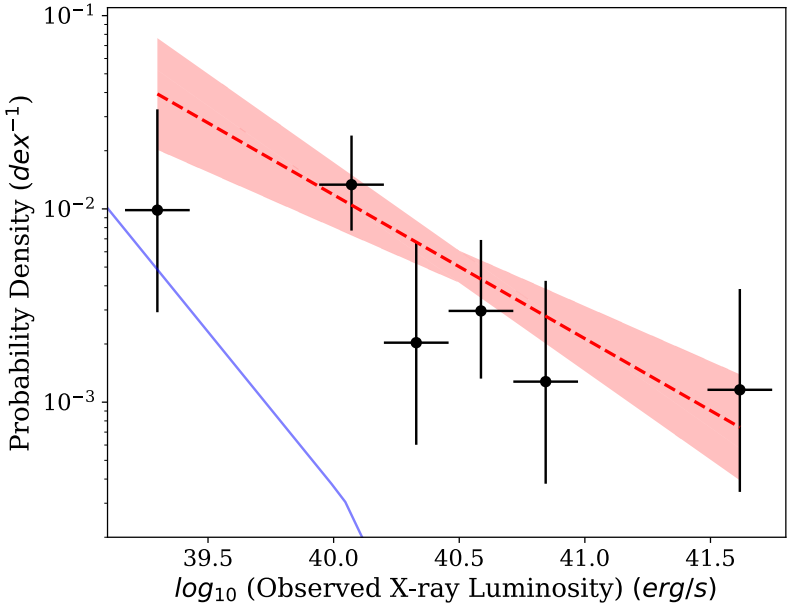
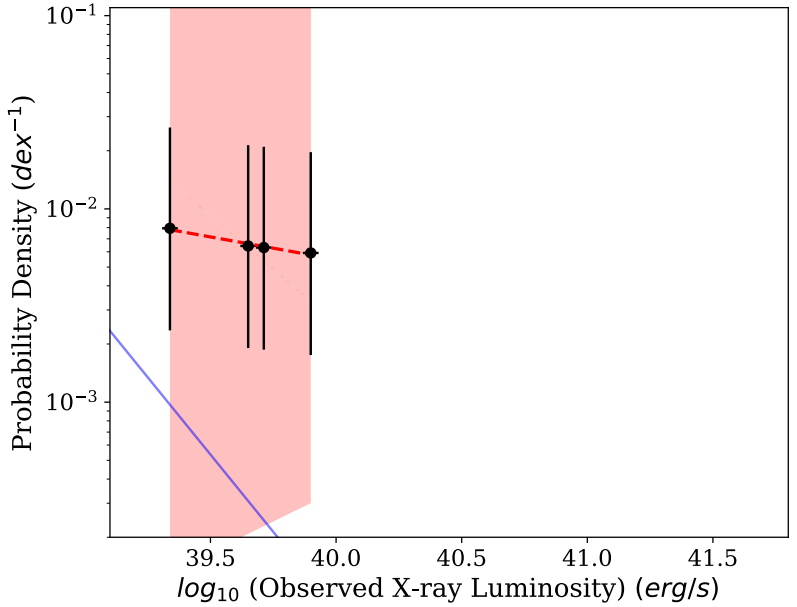
$9 < \log_{10} Mass\ (M_\odot) \leq 9.5$

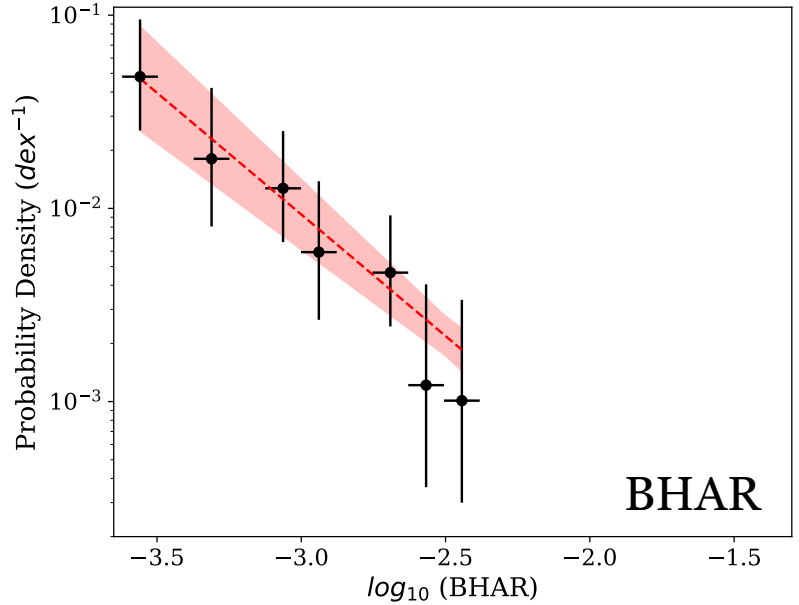
$8 < \log_{10} Mass\ (M_\odot) \leq 9$

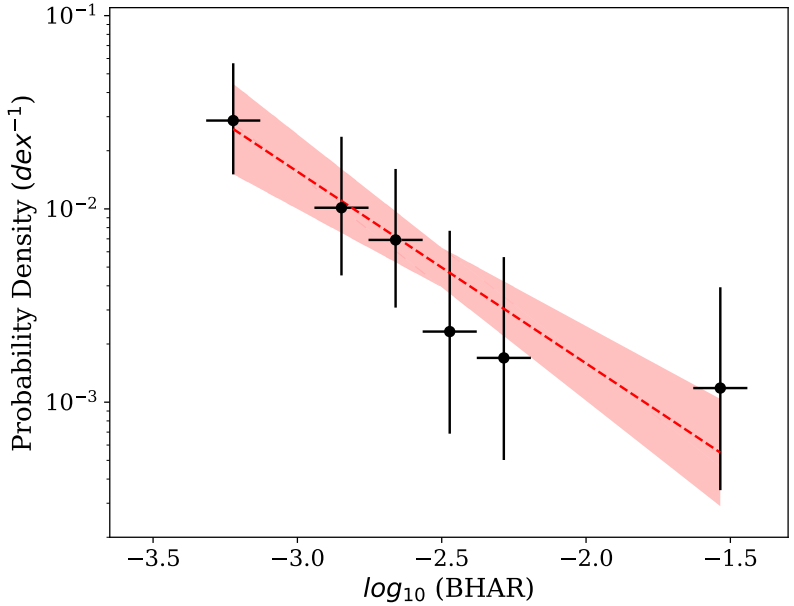
$6.8 < \log_{10} Mass\ (M_\odot) \leq 8$

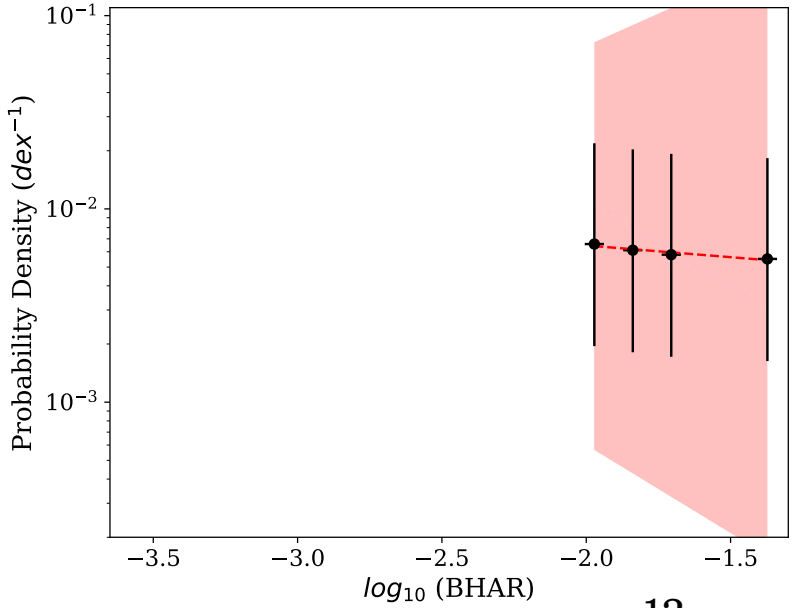












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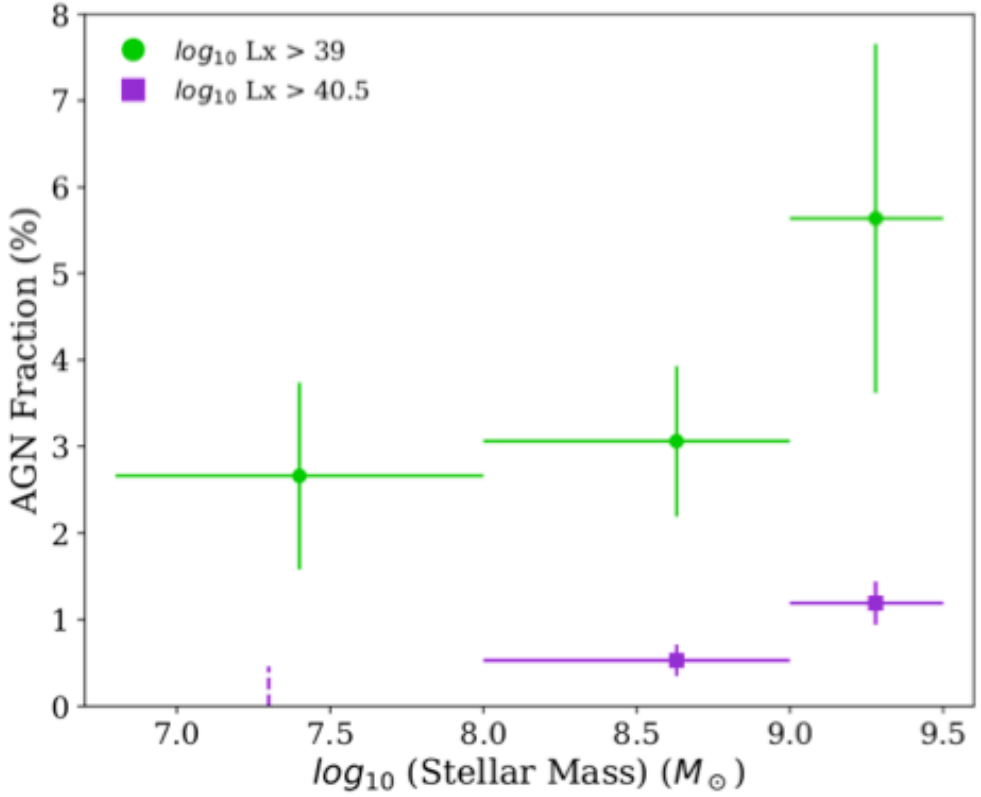
$z \leq 0.06$

$z \leq 0.04$

$z \leq 0.02$

AGN Fraction and Host Galaxy Mass



- Summing data points in each mass bin shows AGN fraction likely increases with host galaxy mass in full luminosity (up to 6%) and high luminosity (up to 1.2%) ranges
- As black holes get larger, lower accretion rates are needed to become detectable

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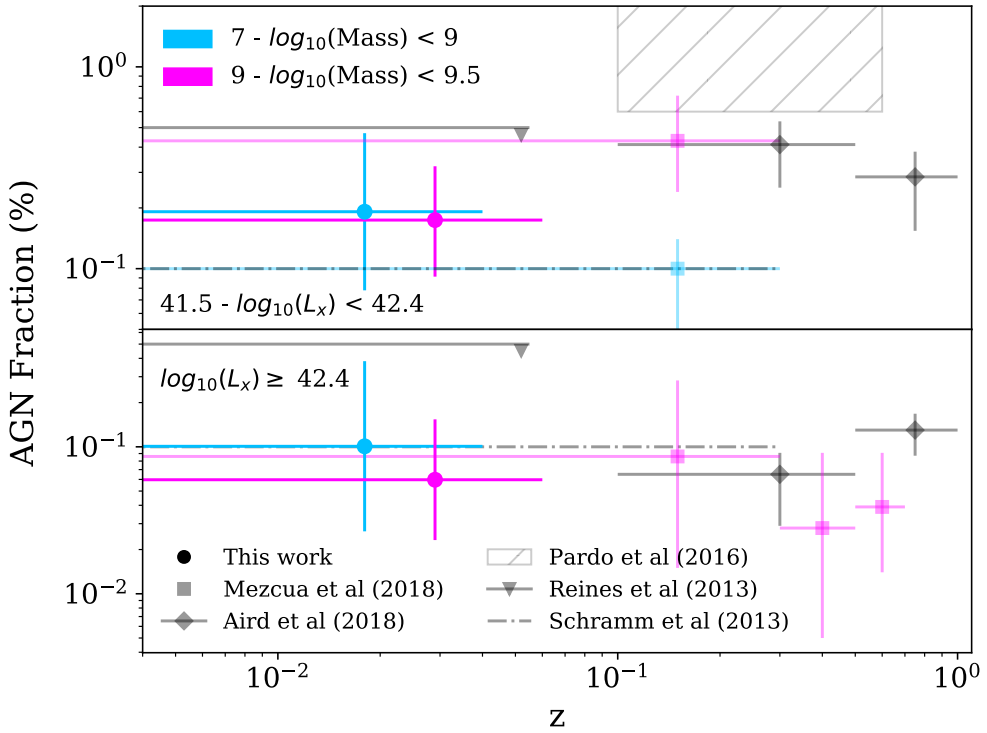
AGN Fraction and Redshift



- Integrating under the power law allows us to predict the AGN fraction beyond our observations
- Adapting a plot from Mezcua et al (2018) we can see our data fits with other work in the field
- AGN fraction appears to be constant for high-mass, high-luminosity AGN out to at least $z \approx 0.7$

Thank You for Listening

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- AGN in dwarf galaxies have a wide range of activity
- AGN fraction generally increases with host galaxy mass
- AGN fraction appears to be constant for high-mass, high-luminosity AGN out to at least $z \approx 0.7$
- BPT diagnostic not suited for identifying AGN in dwarf galaxies
  - Likely dominated by star formation signatures

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