



# Tracing the SFRD and BHARD together: BH accretion and stellar mass buildup in COSMOS galaxies



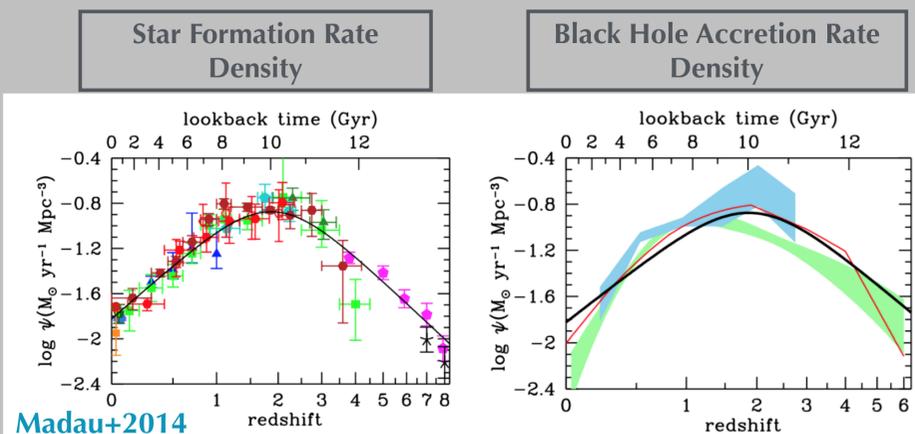
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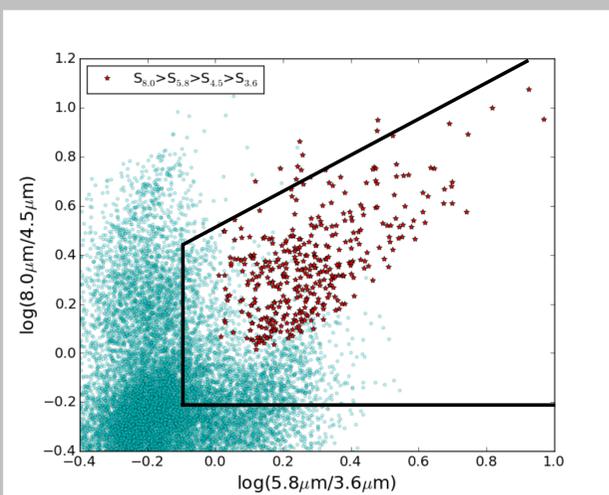
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## Motivation

The possible co-evolution between galaxies and their central supermassive black holes is supported by the similarity in shape between the Star Formation Rate Density (SFRD) and Black Hole Accretion Rate Density (BHARD) out to  $z \sim 3$ . However, this apparent connection between BH growth and star formation is only established globally; while both trends peak at  $z \sim 2$ , the amount of stellar and black hole mass assembly occurring within the same galaxies is unknown. This work begins to shed light on the causal connection between BH growth and stellar mass buildup by computing the BHARD and SFRD for the same sample of galaxies. While these trends have been established independently, we have yet to quantify them both for a common sample of galaxies to address the extent of mass assembly in the universe that is simultaneous.



## AGN Selection Biases

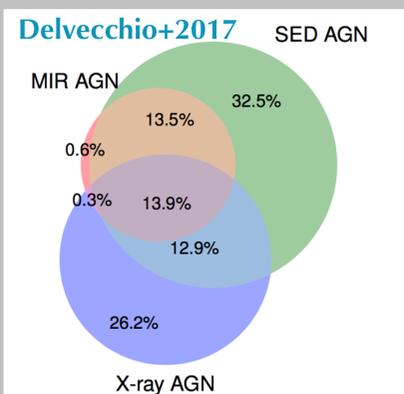


- Working with data from public COSMOS2015 extensive multi-wavelength photometry catalogue (Laigle et. al 2016)
- Mid-IR photometry available from Spitzer/MIPS at 3.6, 4.5, 5.8, and 8.0  $\mu\text{m}$  can show dusty torus emission and set selection criteria

- Figure shows MIR color-color plot of sources at  $z < 3$  to demonstrate AGN MIR selection criteria from Lacey et. al 2007 (black lined region) with red stars showing sources with monotonically rising MIR SEDs, a power-law selection criteria

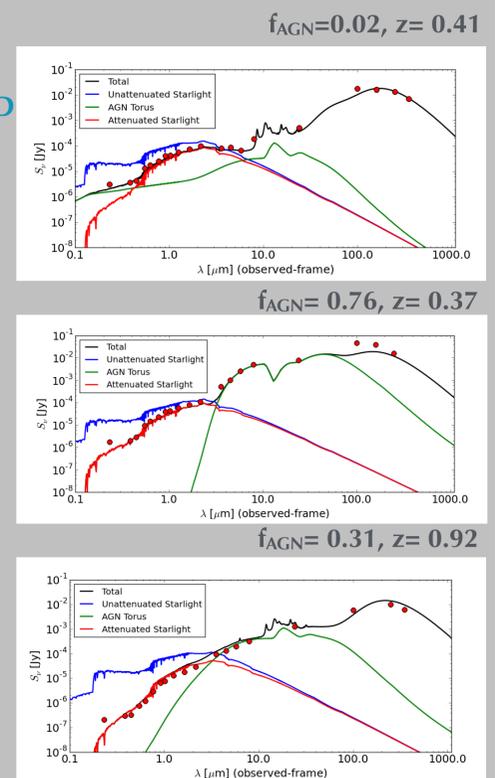
Studies of AGN populations are heavily plagued by selection bias due to multi-wavelength AGN signatures dependent on orientation or phase

- Figure from Delvecchio et. al (2017) on the right demonstrates the overlap for three AGN classification methods for a sample of radio-selected AGN
- Selection techniques bias the conclusions of independent analyses
- This work will attempt to form and analyze an extensive sample of star-forming galaxies and AGN to rectify these biases

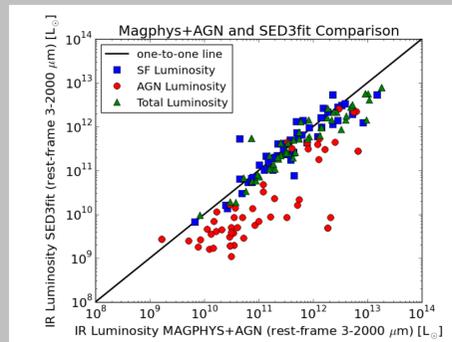


## SED Fitting

- FUV-to-FIR SEDs are fit using *SED3fit* code (Berta et. al 2013)
- SED3fit* is a three-component SED fitting routine to account for contribution from:
  - Stellar emission (Bruzal & Charlot 2003)
  - Dust emission from star formation (Charlot & Fall 2000, da Cunha et. al 2008)
  - Dusty torus/AGN (Fritz et. al 2006, Feltre et. al 2012)
- AGN presence in this wavelength range revealed via additional MIR emission from a heated dusty torus, filling in 3-8  $\mu\text{m}$  dip of a regular SF galaxy
- Three best-fit examples shown to the right with attenuated, unattenuated stellar light and varying AGN torus contribution
- Supercomputing will allow us to run fit on all catalog sources efficiently



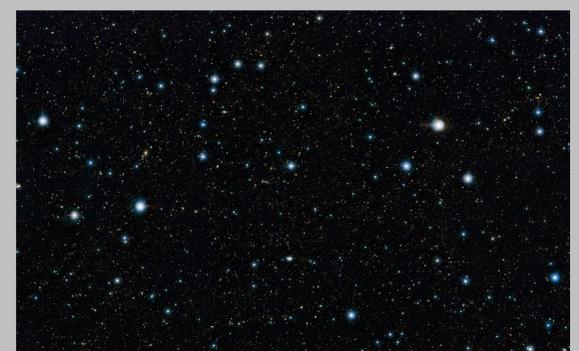
## SED3fit and MAGPHYS+AGN



- Robustness of AGN and SF decomposition will play crucial role in reliability of luminosity functions and SFRD/BHARD trends
- Chang et. al (2017b) performed analysis on IR-selected AGN in COSMOS2015 catalogue fitting all  $\sim 10^6$  sources with MAGPHYS+AGN code
- We perform a comparison between *SED3fit* and these publicly available MAGPHYS+AGN fitting results to analyze how sensitive luminosity outputs are to AGN torus models
- Once comparison is finished and any differences are understood, analysis can proceed with both model outputs to fully test the stability of the final result

## Future Work

- Finalize comprehensive sample within COSMOS2015 to avoid selection bias
- Establish robust  $L(\text{IR})_{\text{AGN}}$  and  $L(\text{IR})_{\text{SF}}$  values & construct (1) SF IR Luminosity functions and (2) AGN Bolometric Luminosity functions (LFs)
- Integration of LFs will produce star formation rate density (SFRD) and black hole accretion rate density (BHARD) trends to be tested for range of AGN fractional contribution
- Can assess: How much BH accretion and SF are occurring together in the same galaxies?



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