Star formation and Eddington accretion rate in MIGHTEE galaxies

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1. Observational Data and Sample

We investigate the connection between star formation and active galactic nuclei (AGN) activity in radio-detected sources. We use the MeerKAT International GHz Tiered Extragalactic Exploration (MIGHTEE; Jarvis et al. 2016) Early Science catalogue of the radio sources in the COSMOS field, observed at 1.28 GHz. This catalogue comprises 5223 radio sources with optical and near-infrared counterparts, spanning redshifts up to z ~ 6.

2. Radio observations

Area covered	Thermal noise	rms	Spatial resolution
1.6 deg^2	1.7 μJy/beam	2 μJy/beam	8.6 arcsec

3. Multiwavelength data

- Optical data - HSC and CFHT surveys (Tanaka et al. 2017, Furusawa et al. 2016)
- NIR data - UltraVISTA (McCracken et al. 2012) and SPLASH (Steinhardt et al. 2014)
- The mid-infrared (MIR) - *Spitzer*/MIPS (Rieke et al. 2004)
- FIR data - *Herschel*/PACS (Poglitsch et al. 2010) and Herschel/SPIRE (Griffin et al. 2010)

4. Constraining galaxy properties

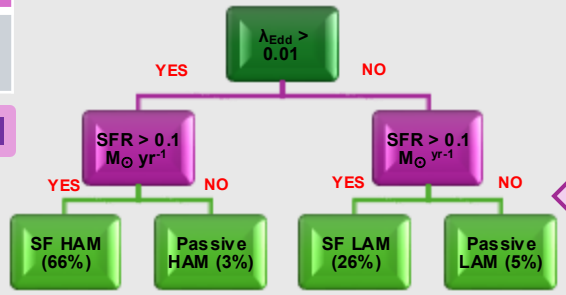
We constrained the **stellar masses (M$_*$), star formation rates (SFRs), infrared luminosity (L$_{IR}$), and AGN luminosity (L$_{AGN}$)** of the radio selected galaxies using **CIGALE** spectral energy distribution (SED) fitting code (Boquien et al. 2019) . To ensure the accuracy of our results, we compare the SED-derived M$_*$ and SFRs with those obtained from Whittam et al. (2022).

5. Classification scheme

We classify the radio sources into high-accretion mode (HAM) and low-accretion mode (LAM) using an Eddington-scaled accretion rate threshold of λ_{Edd} = 0.01 (Best et al. 2012). The Eddington-scaled accretion rates are calculated using the following relation:

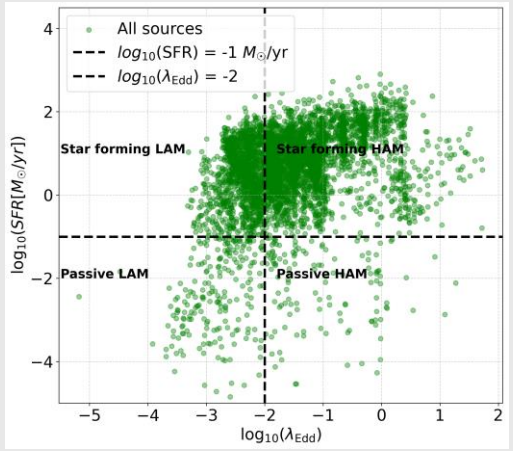
$$\lambda_{\rm Edd} = \frac{L_{\rm AGN} + L_{\rm mech}}{L_{\rm Edd}},$$

- L_{AGN} is the CIGALE-derive intrinsic bolometric luminosity of the AGN.
- L_{mech} is the mechanical luminosity of the radio jet ; $L_{mech} = 7.3 \times 10^{36}(L_{1.4GHz}/10^{24}\,W\,Hz^{-1})^{0.7}\,W$ (Cavagnolo et al. 2010).
- L_{Edd} is the Eddington luminosity; $L_{Edd} = 1.3 \times 10^{31}\,(M_{BH}/M_{\odot})$ W, where M_{BH} is the black hole mass, given by $M_{BH} \sim 0.0014 M_{\star}$ (Häring & Rix. 2004).

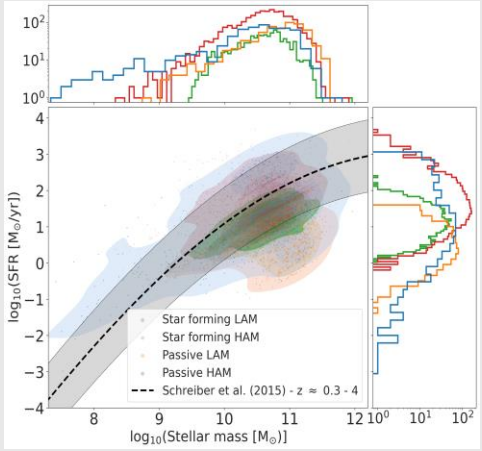


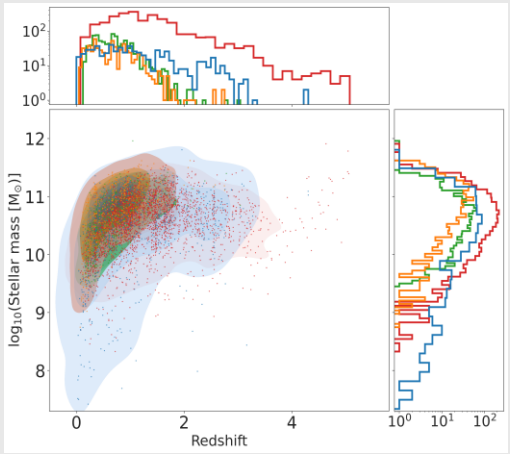
The LAM and HAM populations are further classified into star-forming (SFR > 0.1 $M_{\odot}$ yr^{-1}) and passive (SFR < 0.1 $M_{\odot}$ yr^{-1}) sources.

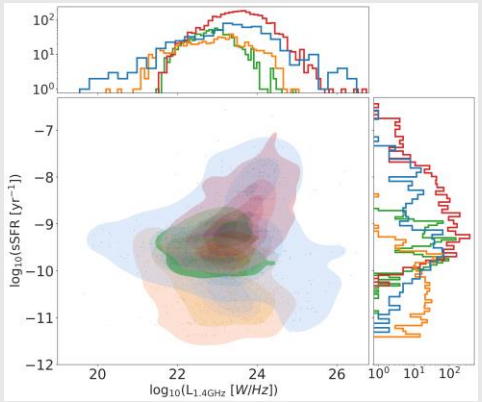
The figure below clearly illustrates this separation.



6. Host galaxy properties vs. accretion rate







SFR–M$_\star$ relation:
- SF sources (HAM & LAM) dominate on/above the main sequence (MS)
- Passive HAM & LAM dominate below the MS
- Star formation activity is independent of accretion mode

M$_*$-redshift relation:
- LAM sources, particularly passive systems, are concentrated at higher stellar masses
- HAM sources span a broader mass range and extend to higher redshifts
- Despite the overlap, a clear shift is observed: LAM → higher mass, HAM → wider distribution

sSFR-L$_{1.4\,GHz}$:
- HAM sources show higher sSFR, indicating more active SF hosts
- LAM sources are shifted to lower sSFR, consistent with passive galaxy populations
- HAM sources extend to higher radio luminosities than LAM sources

7. Conclusions

- Star formation is independent of AGN accretion mode: SF galaxies lie on the MS, passive galaxies below.
- LAM galaxies are more massive and passive; HAM span a broader mass range and higher redshift.
- HAM hosts have higher sSFR and radio luminosity, linking high-accretion AGN to active star formation.
- Trends agree with Whittam et al. (2022) and Mingo et al. (2022), highlighting the mass–star formation–AGN connection.