

# Bridging diagnostics: Multi-wavelength consistency and discrepancy in the classification of local AGN

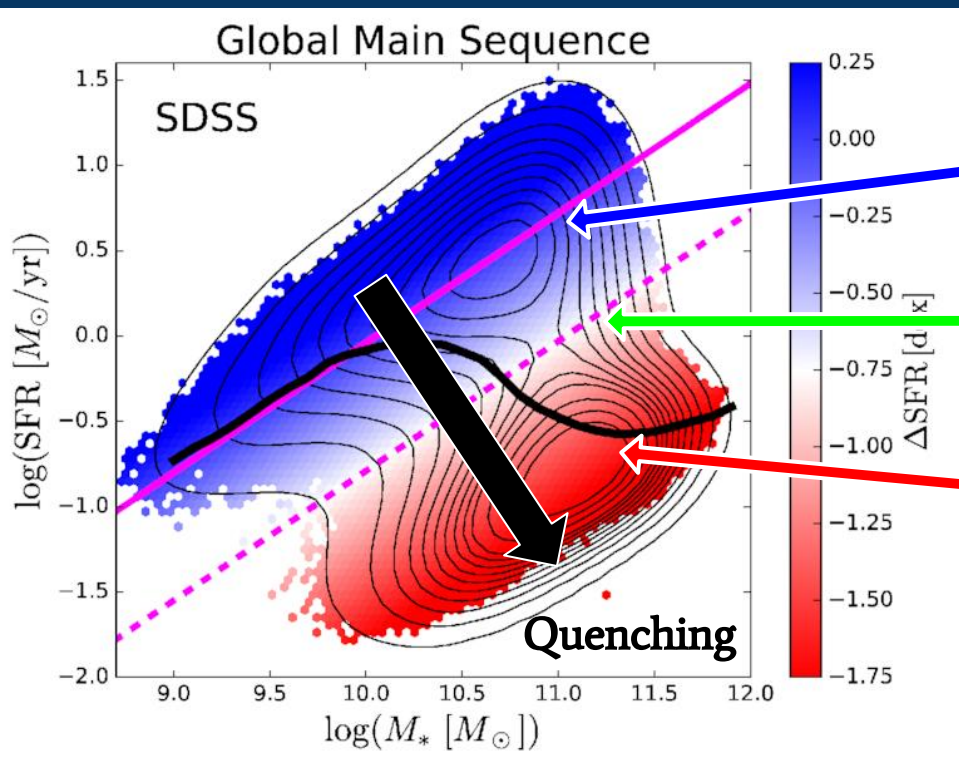


**Helene Kast** , M. Thorp, D. Colombo, F. Bigiel, Z. Bazzi, C. Aydar, A. Bolatto, J. Buchner, R. Herrera-Camus, V. Kalinova, J. Martinez-Lopez, M. Salvato, S. F. Sánchez, Y.-H. Teng, V. Villanueva, T. Wong

Illuminating the Active Universe: Multi-Wavelength and Multi-Messenger Insights into AGN, ESO

September 15, 2026 — Garching near Munich, Germany

# The star formation main sequence



- Bimodality: (e.g., Bell+04; Faber+07; Pozzetti+10; Schawinski+14)

## Main sequence

- $M_*$  and SFR strongly correlated

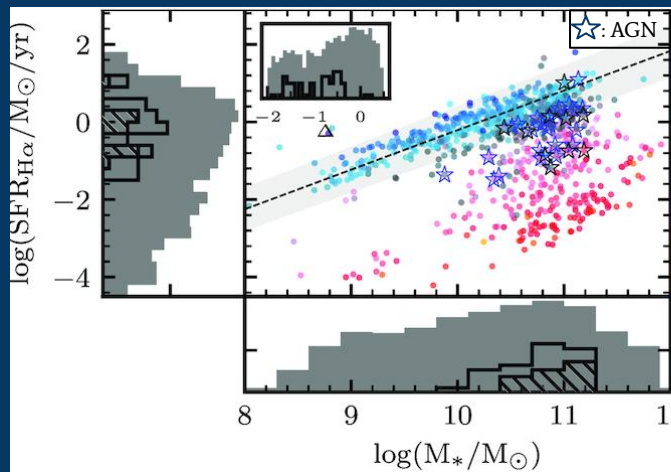
## Green valley

- In between, less populated

## Red cloud

- significant less star production than main sequence

# AGN influence on star formation quenching



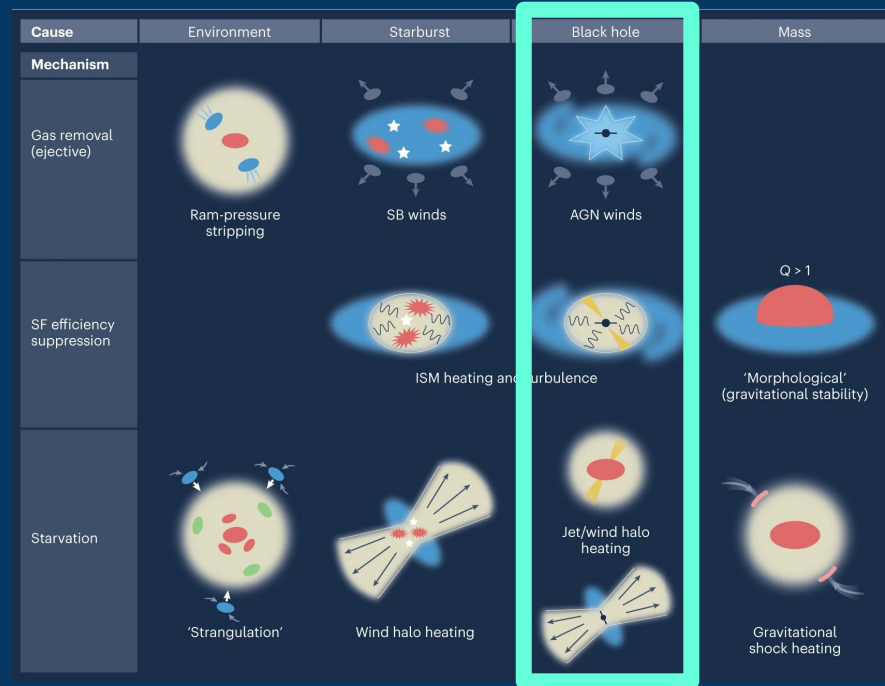
(Lacerda+20)

- AGN-hosts mostly in **green valley**

(Kauffmann+03; Martin+07; Salim+07; Sánchez+18;  
Lacerda+20; Bazzi+25)

- Star formation quenching linked to AGN?

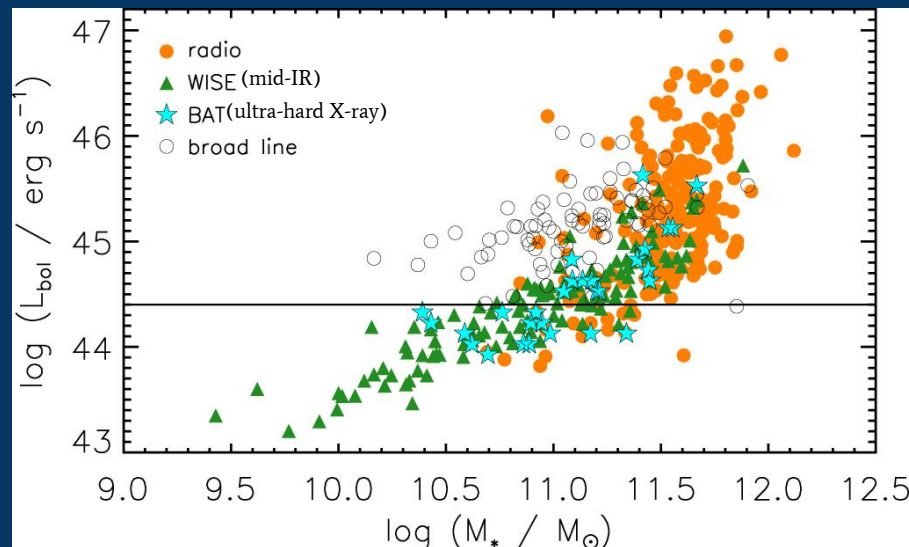
(Silk & Rees 1998; Silk 2005; Harrison 2017; Saintonge+17;  
Ellison+21; Bluck+23)



(Curtis-Lake+23; R. Maiolino)

# AGN influence on star formation quenching

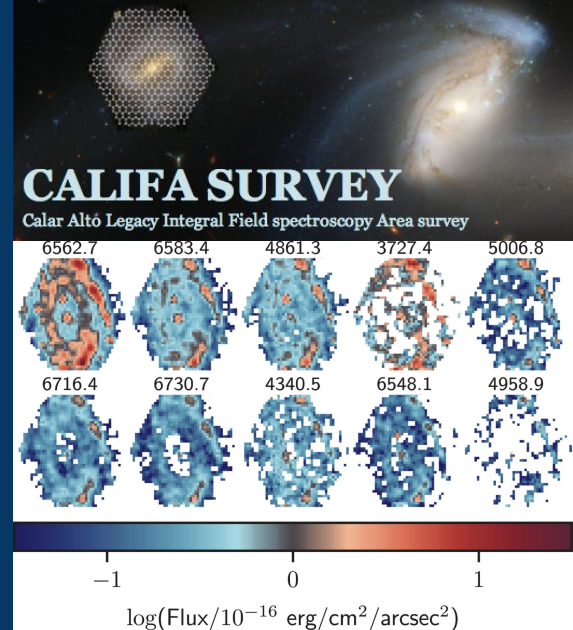
- Accuracy of AGN identification limits understanding
- AGN population properties different depending on  $\lambda$  and classification used  
(e.g., Hickox & Alexander 2018; Agostino & Salim 2019; Osorio-Clavijo+25)
- How does AGN identification compare?
- How does multi-wavelength perspective influence discussion of quenching?



(Comerford et al. 2024)

# Surveys

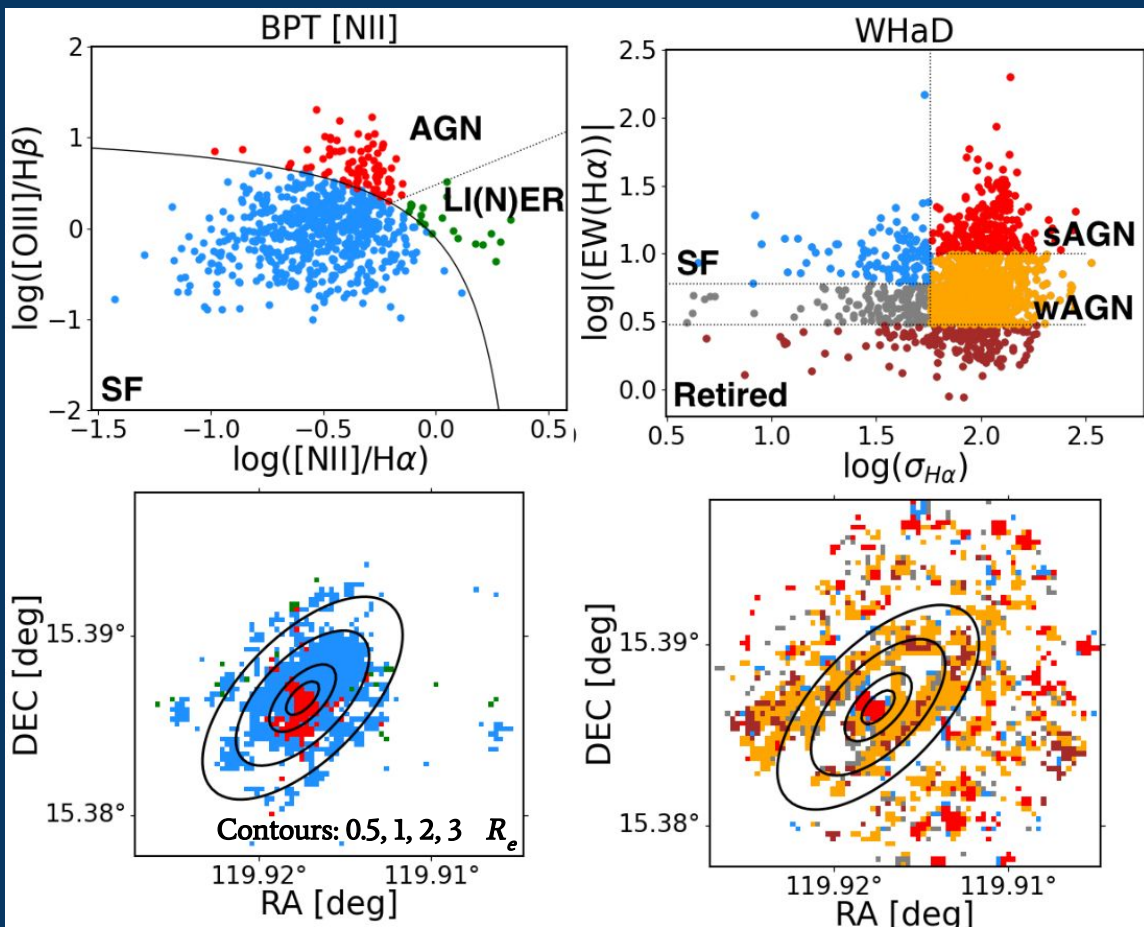
- **CALIFA** (extended Calar Alto Legacy Integral Field Area survey): (Sánchez+12; Walcher+14; Sánchez+16; Lacerda+20)
  - IFU spectroscopic data; resolution: 2.5 arcsec
  - ~ 1000 representative local galaxies ( $0.05 < z < 0.3$ )
  - **iEDGE**: global (CO-)properties database for 643 eCALIFA galaxies (Colombo+25)
- **eROSITA** (extended ROentgen Survey with an Imaging Telescope Array): (Merloni+12; Salvato+18; Merloni+24)
  - completeness & homogeneity in X-ray



# Optical diagnostics

- BPT: 3 flux ratio diagrams
  - e.g.  $[\text{O III}]/\text{H}\beta$  vs.  $[\text{N II}]/\text{H}\alpha$
- WHaD: Single emission line
  - $W_{\text{H}\alpha}$  and  $\sigma_{\text{vel,H}\alpha}$

(Sánchez et al. 2024)

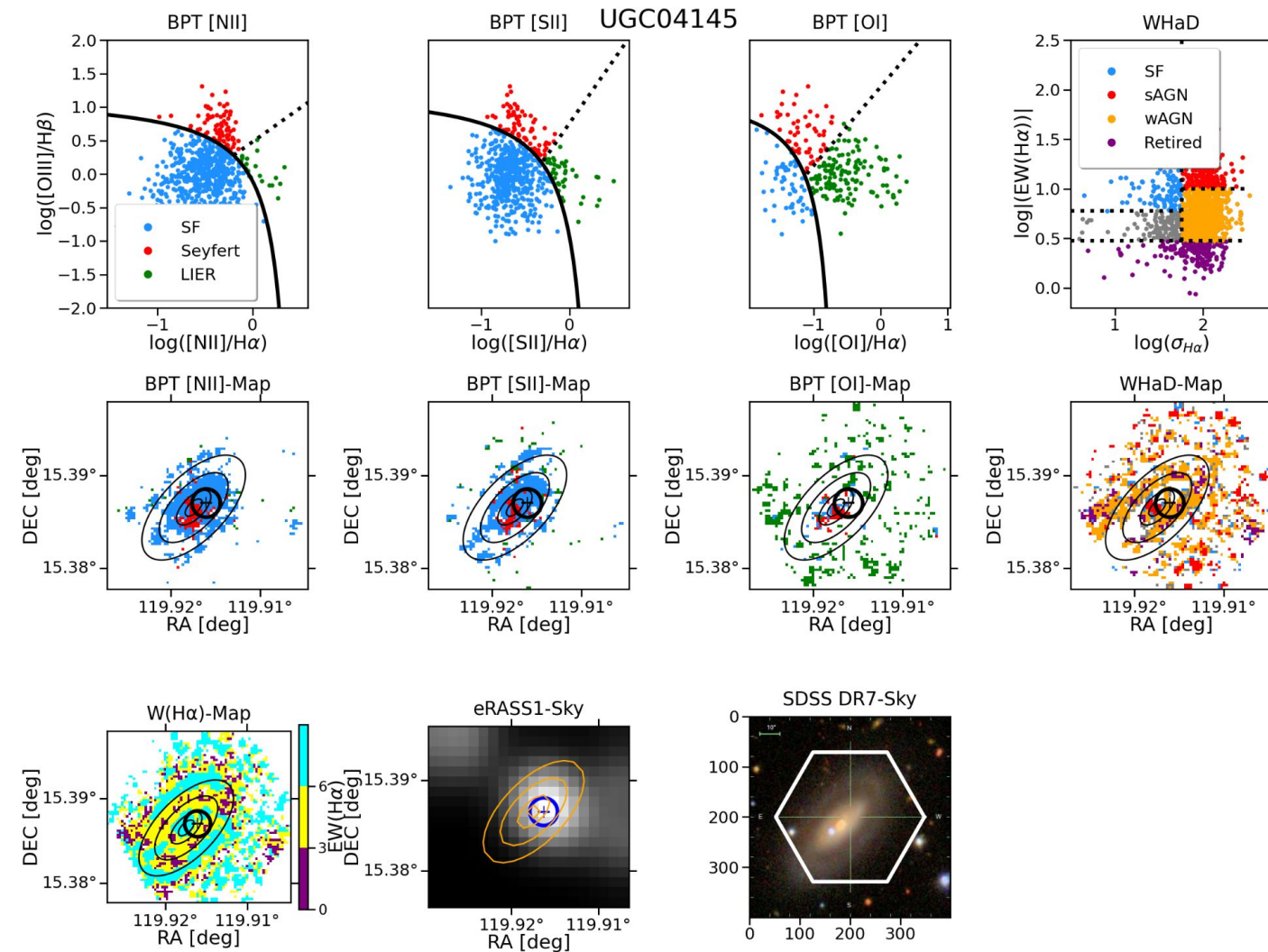


(Kast et al. submitted)

# Combining the data sets

- eROSITA Data Release 1 restricted to western galactic hemisphere
- 254 (24%) eCALIFA galaxies
- Include all X-ray point sources (PS) of main source catalogue (Merloni+24)
- Catalogue matching to find X-ray PS at galaxy center
- X-ray AGN candidate if positional agreement within  $3\sigma$

# Diagnostic overview per galaxy



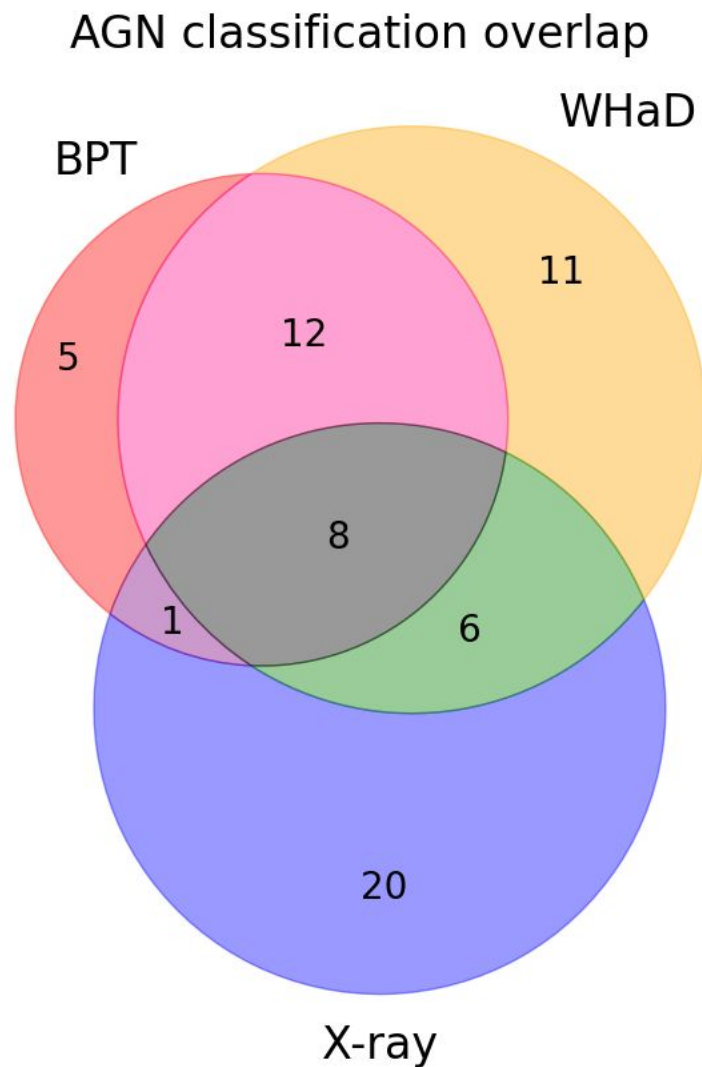
# Comparison of Optical Classifications

- 57% of WHaD AGN also active in BPT
  - True difference in classification + partially poor quality BPT spaxels
- 81% of BPT AGN also active in WHaD
  - Poor quality WHaD spaxels

Sánchez et al. 2024:

- BPT and WHaD: comparable results
- WHaD increases AGN number

(Kast et al. submitted)



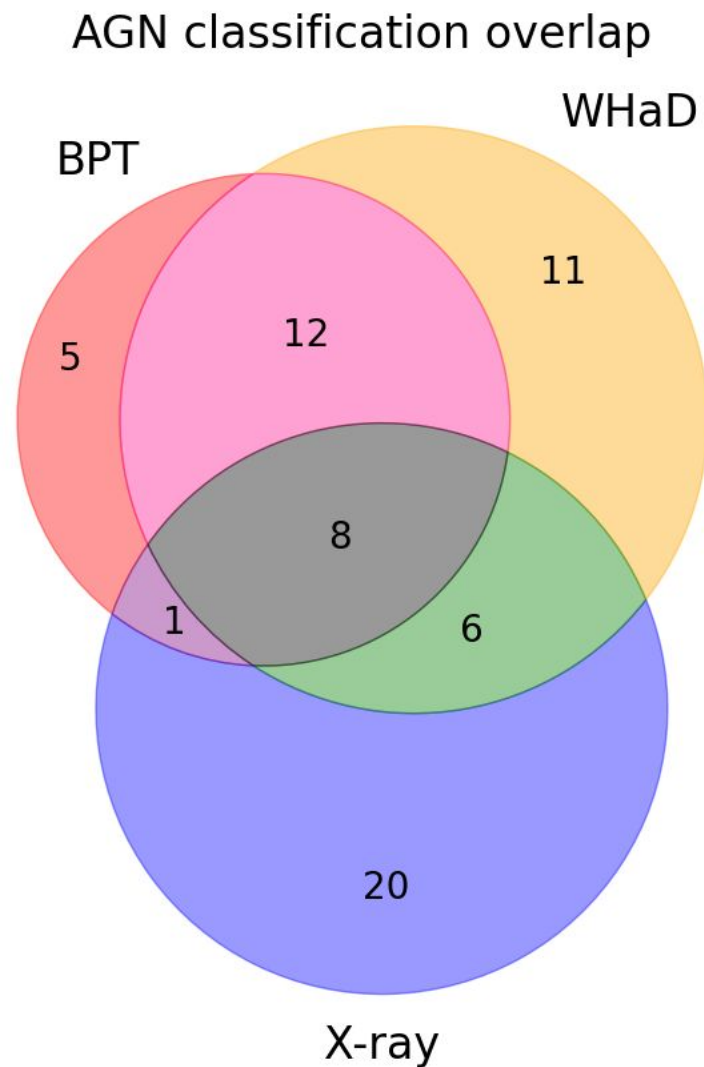
# Comparison of Optical and X-ray Classifications

- Of X-ray AGN candidates:

|            |     |
|------------|-----|
| Only X-ray | 60% |
| BPT        | 26% |
| WHaD       | 37% |

- Methods disagree, little overlap
- Mix: true difference + poor quality spaxels

(Kast et al. submitted)



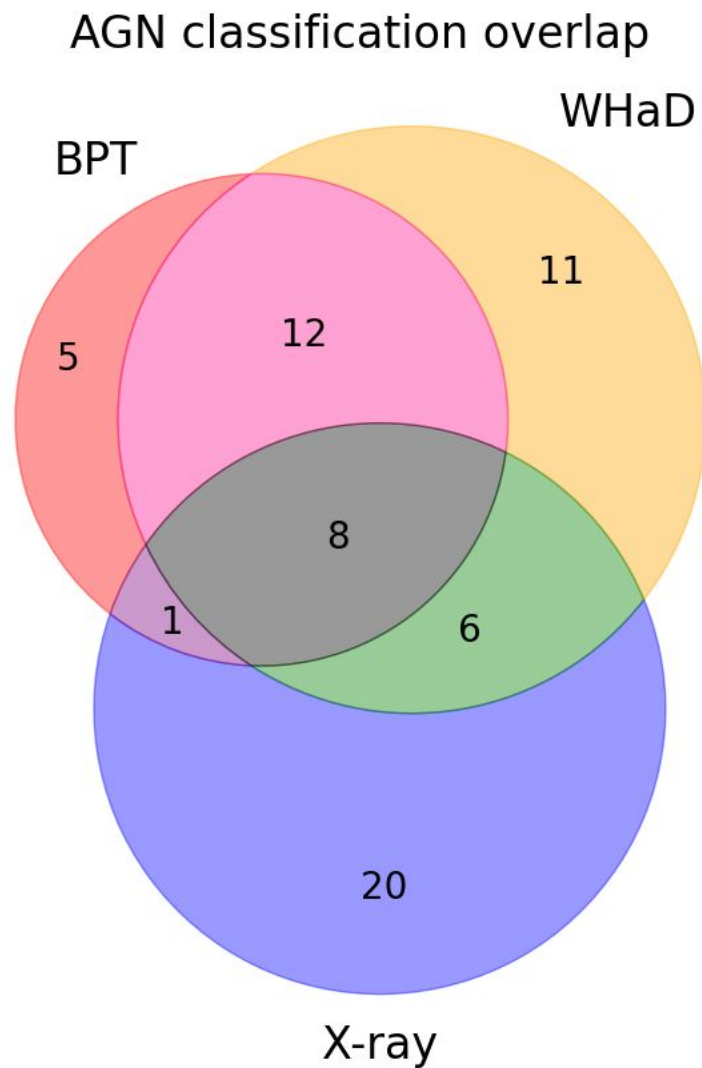
# Comparison of Optical and X-ray Classifications

- Of X-ray AGN candidates:

|            |     |                                                 |
|------------|-----|-------------------------------------------------|
| Only X-ray | 60% | 47% <small>(Bickley et al. 2024)</small>        |
| BPT        | 26% | 17% <small>(Osorio-Clavijo et al. 2023)</small> |
| WHaD       | 37% | ~ 50% <small>(Sánchez et al. 2024)</small>      |

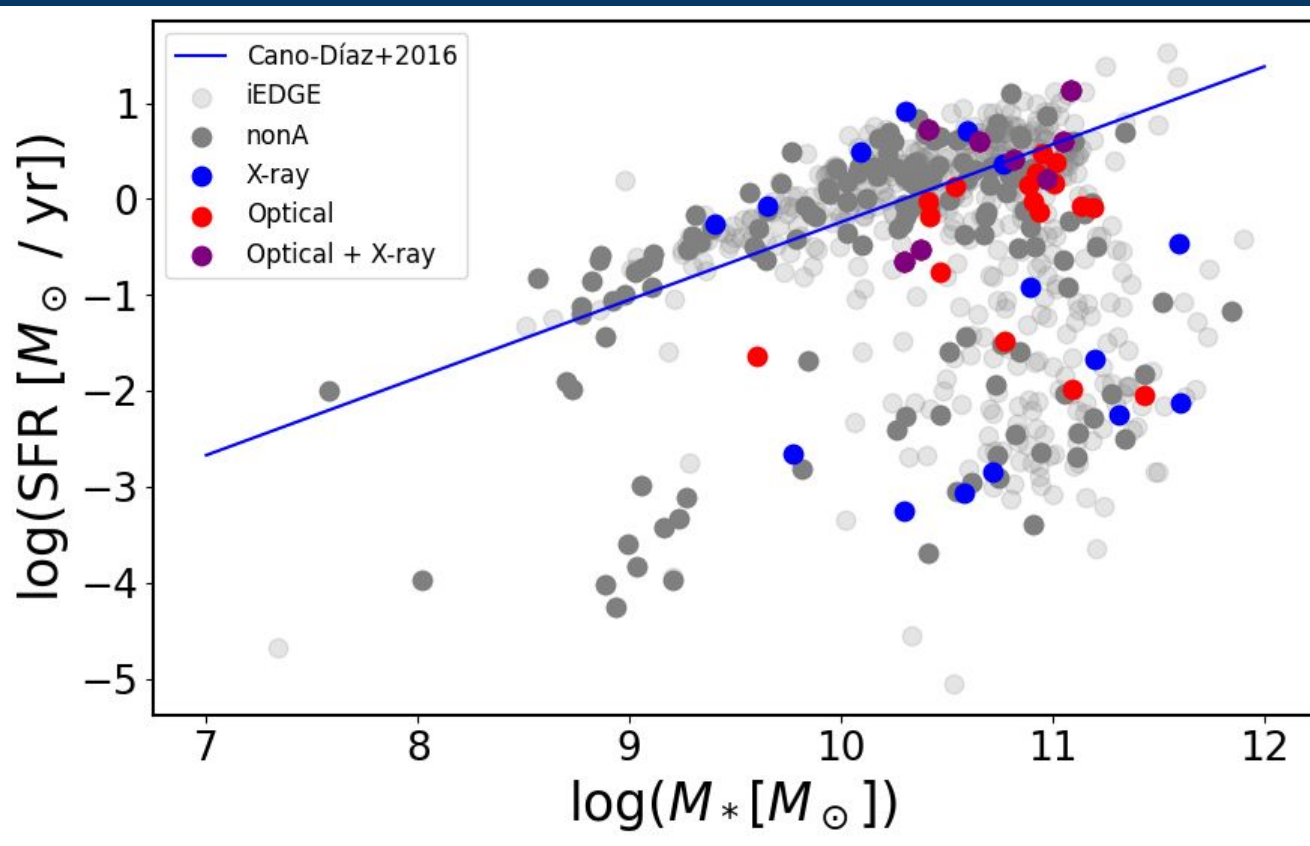
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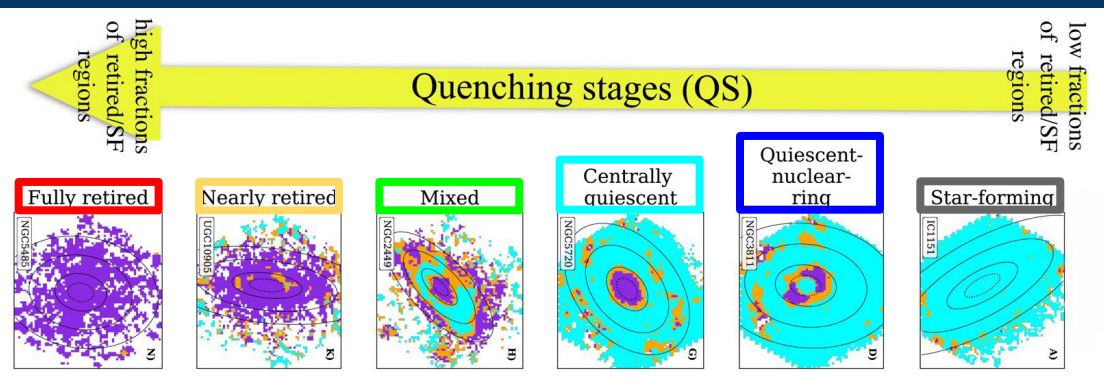


# Investigation of global SFR- $M_*$ relation

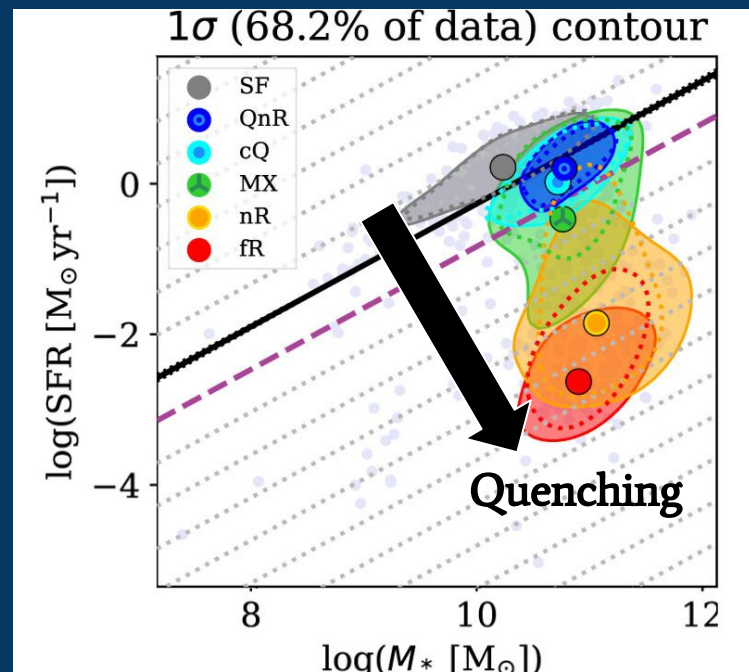
- Strong bimodal distribution
- Optically active galaxies mostly at high SFR
- Optical AGN identification alone could bias against low SFR AGN hosts



# Quenching stage investigation

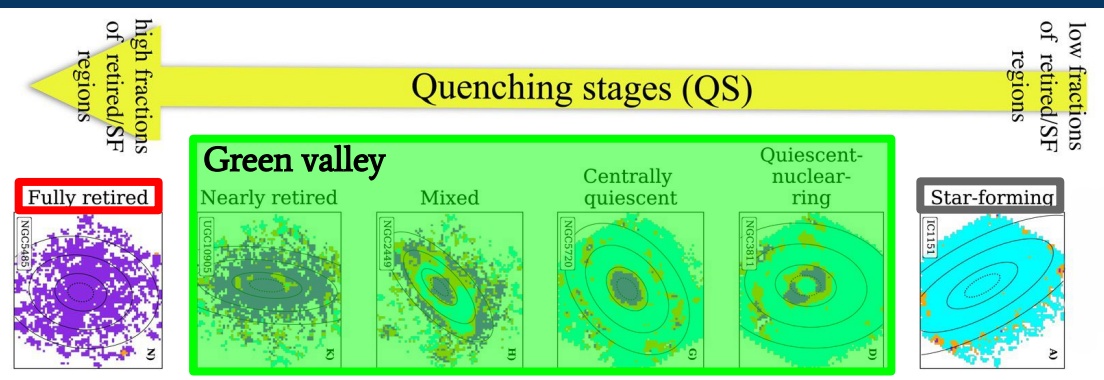


(Kalinova et al. 2021)

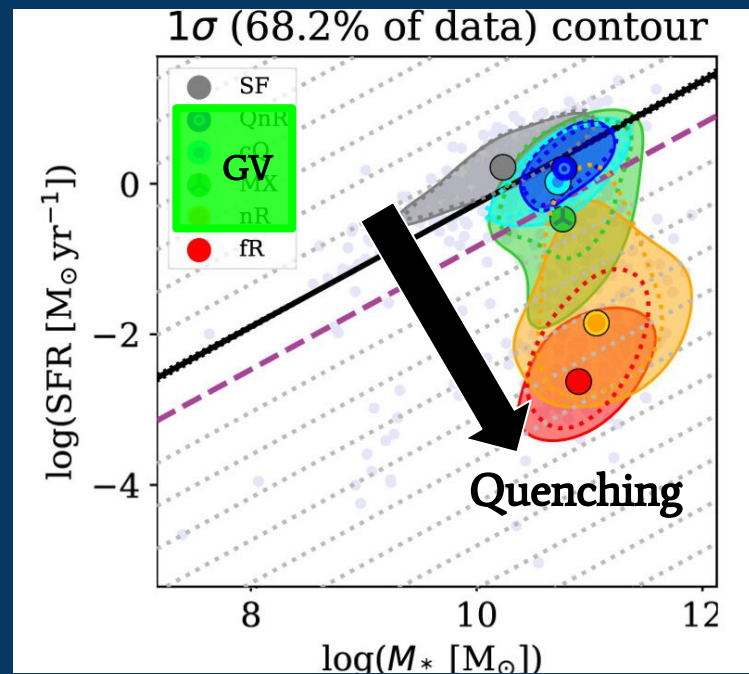


(Colombo et al. 2025)

# Quenching stage investigation

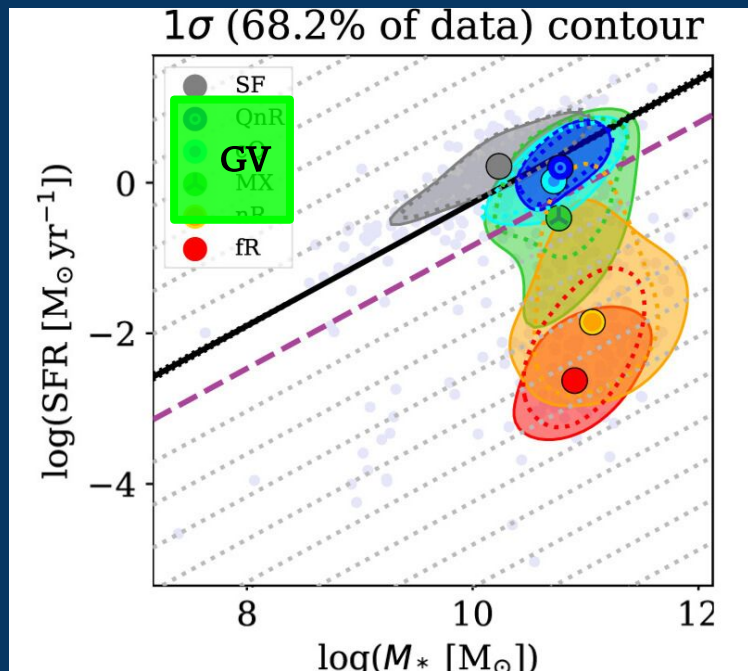


(Kalinova et al. 2021)



(Colombo et al. 2025)

# Quenching stage investigation



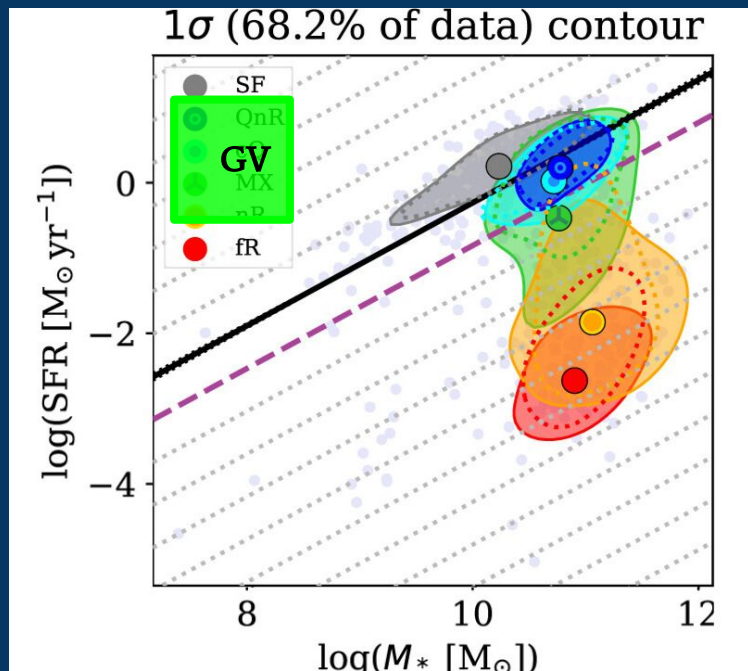
(Colombo et al. 2025)

- AGN fractions vary by quenching stage

## AGN percentage per QS:

| QS         | BPT/WHaD | X-ray | Any  |
|------------|----------|-------|------|
| SF (n=313) | 11 %     | 11 %  | 16 % |
| GV (n=78)  | 22 %     | 12 %  | 28 % |
| fR (n=73)  | 0 %      | 18 %  | 18 % |
| All QS     | 14 %     | 12 %  | 21 % |

# Quenching stage investigation



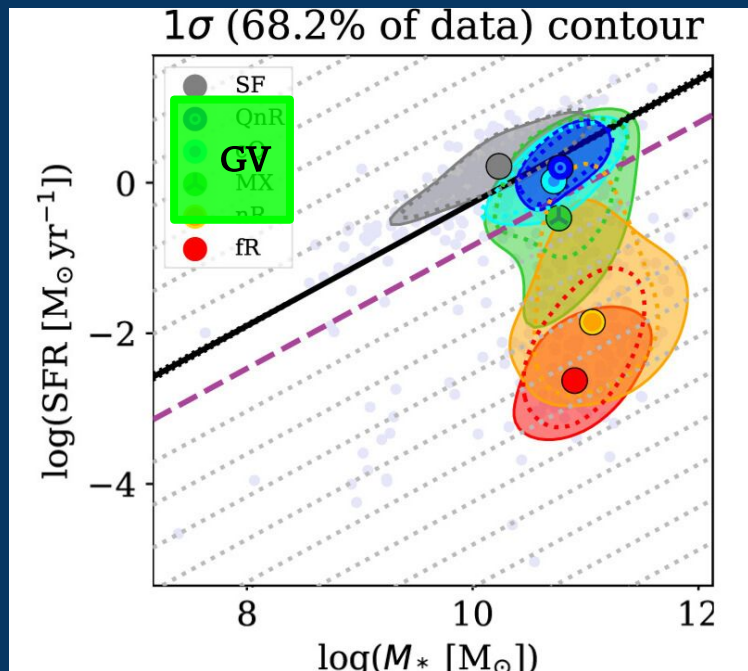
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- AGN fractions vary by quenching stage
- High optical AGN fraction in green valley  $\rightarrow$  AGN in transitional QSs

# Quenching stage investigation



(Colombo et al. 2025)

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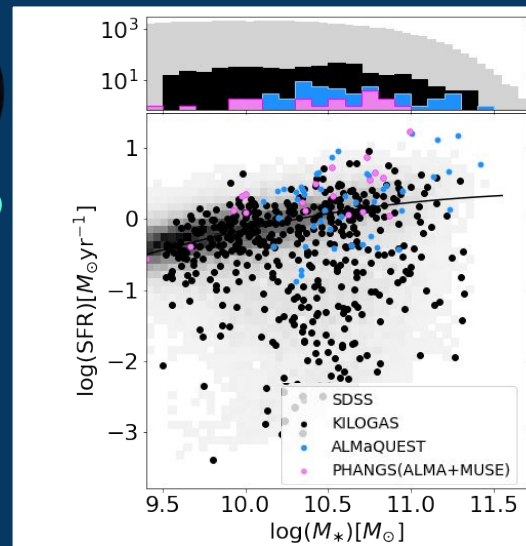
- AGN fractions vary by quenching stage
- Highest X-ray AGN fraction in quenched galaxy population → Missed in optical

# The KILOGAS survey: Complete resolved view of molecular gas and star formation

- ~450 galaxies with ~1 kpc resolution CO(2-1) maps
- Significantly larger, more diverse and complete
- Allows to study multiwavelength AGN implications for the molecular ISM
- X-ray AGNs significantly different population to all optical/IR diagnostics



(<https://kilogas.space>)



# Conclusions

- AGN diagnostics disagree significantly, consistent with previous investigations
- Depending on classification method: Active galaxy properties and quenching stage distribution can alter
- X-ray AGN candidates extend beyond green valley
- Multiwavelength AGN classification essential for next generation of galaxy surveys (e.g. KILOGAS) investigating quenching in local Universe