Fuelling AGN - the impact of mergers on luminous unobscured AGN and reddened AGN with powerful outflows

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Carolin Villforth - Supermassive Black Holes & Environment - Corfu - 19-22 June 2019

The host galaxies of FeLoBAL quasars at $z \sim 0.9$ are not dominated by recent major mergers

C. Villforth,[1,2★] H. Herbst,[3] F. Hamann,[4] T. Hamilton,[5] C. Bertemes,[1] A. Efthymiadou,[1] and T. Hewlett[2]

MNRAS, 2019, 483, 2441

Host galaxies of luminous $z \sim 0.6$ quasars: major mergers are not prevalent at the highest AGN luminosities

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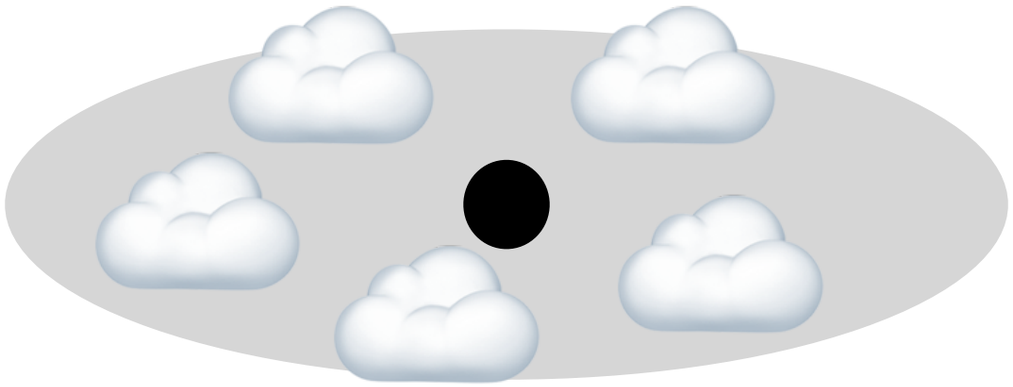
MNRAS, 2017, 466, 812

The redshift evolution of major merger triggering of luminous AGNs: a slight enhancement at $z \sim 2$

Timothy Hewlett,[1★] Carolin Villforth,[1,2] Vivienne Wild,[1] Jairo Mendez-Abreu,[1,3,4] Milena Pawlik[1] and Kate Rowlands[1,5]

MNRAS, 2017, 470, 755

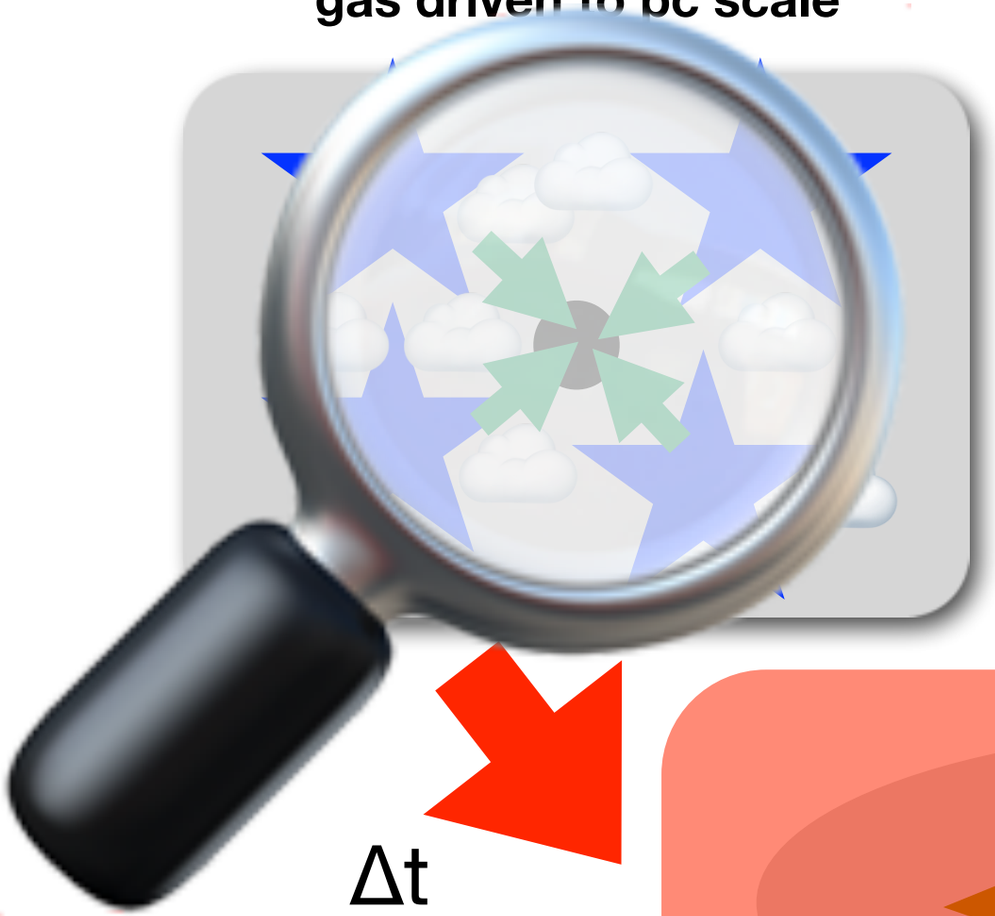
galaxy (gas-rich or poor), inactive black hole



"AGN fuelling event"
gas supplied and/or driven to central kpc

Δt

"AGN triggering event"
gas driven to pc scale



Δt

tral starburst?

Δt

AGN Phase

What happened so far…..
Mergers & AGN - The great confusion

Visual Disturbances, control, no enhancement

Grogin 2005; Cisternas et al. 11; Böhm et al. 2012; Kocevski et al. Villforth et al. 2014, 17, 19; Mechtley et al. 2016; Hewlett et al. 2017, **Marian et al. 2019** etc.

Visual Disturbances, control, enhancement

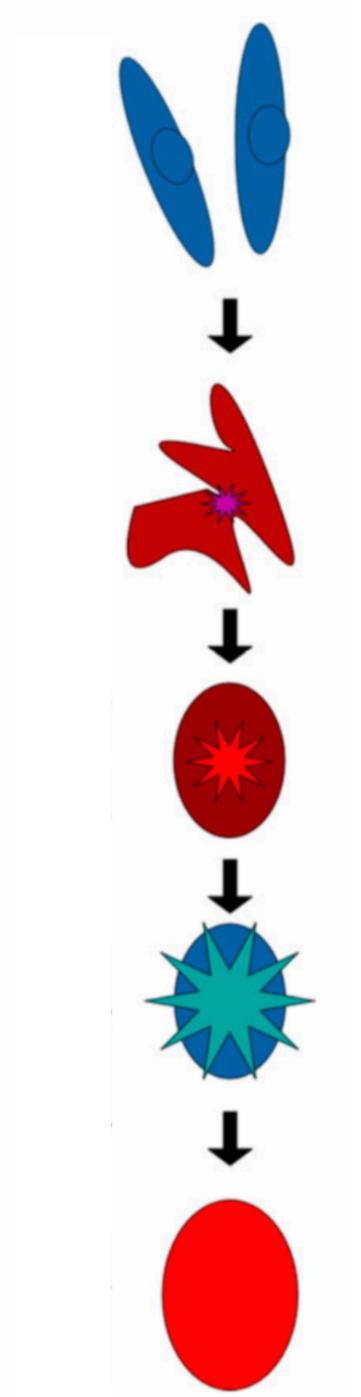
Koss et al. 2010; Ramos-Almeida et al. 2011, Ellison et al. 2019

Neighbours, control, enhancement

Ellison et al. 2008, 2011, 2019; Satyapal et al. 2014; Sabater et al. 2013, though Sabater et al. 2015 this is due to starburst connection, not merger;

AGN with suspiciously high detected merger fractions

Urrutia at al. 2008; Glikman et al. 2016; Chiaberge et al. 2015



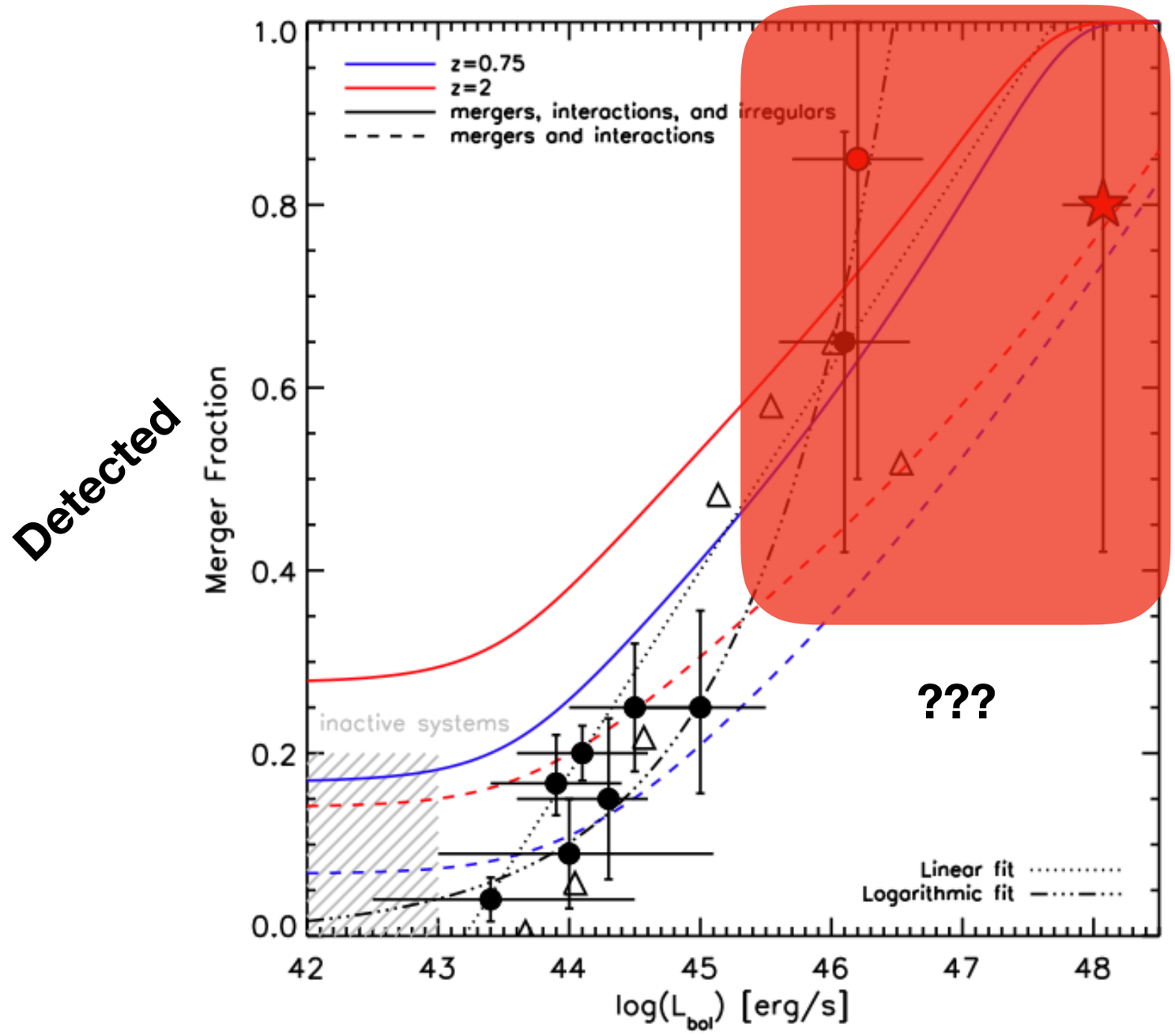
Alexander & Hickox 2012

This talk:

High luminosity AGN

AGN with powerful outflows (FeLoBALs)

Villforth+2014,
Studies with control samples

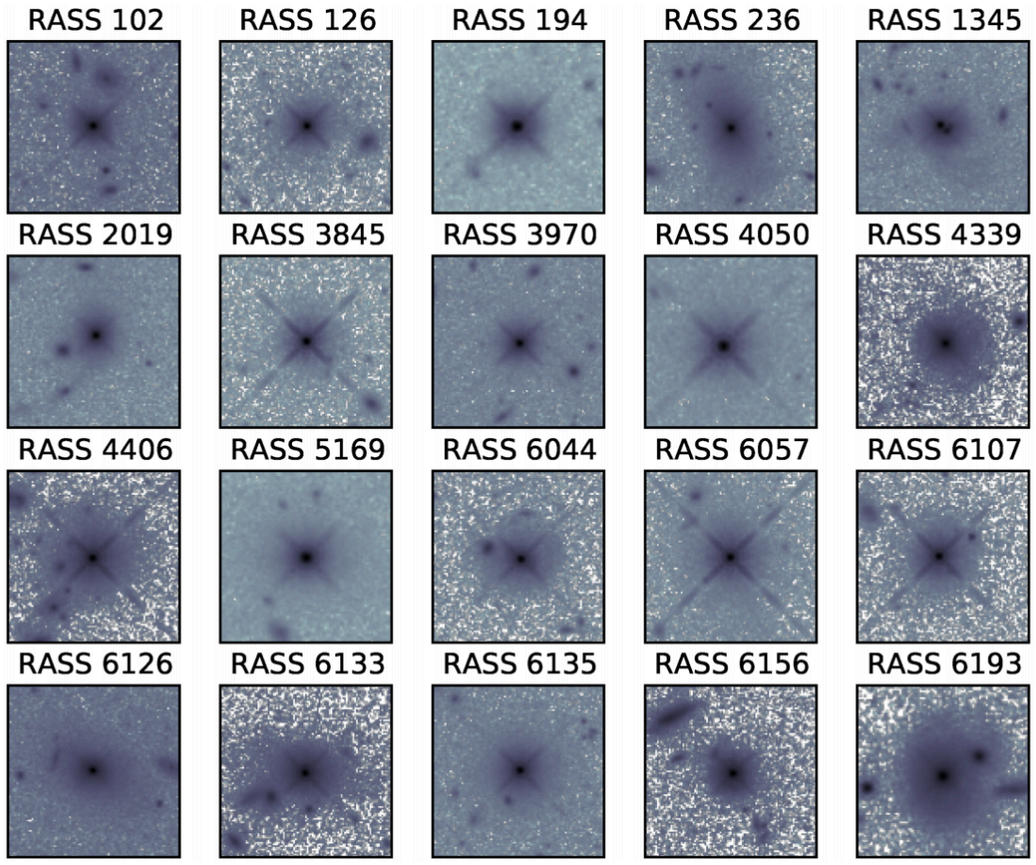


No control samples

Glikman et al. 2016 (most data from Treister et al. 2012)

Mergers & Extreme AGN

High Luminosity AGN



Villforth et al. 2017

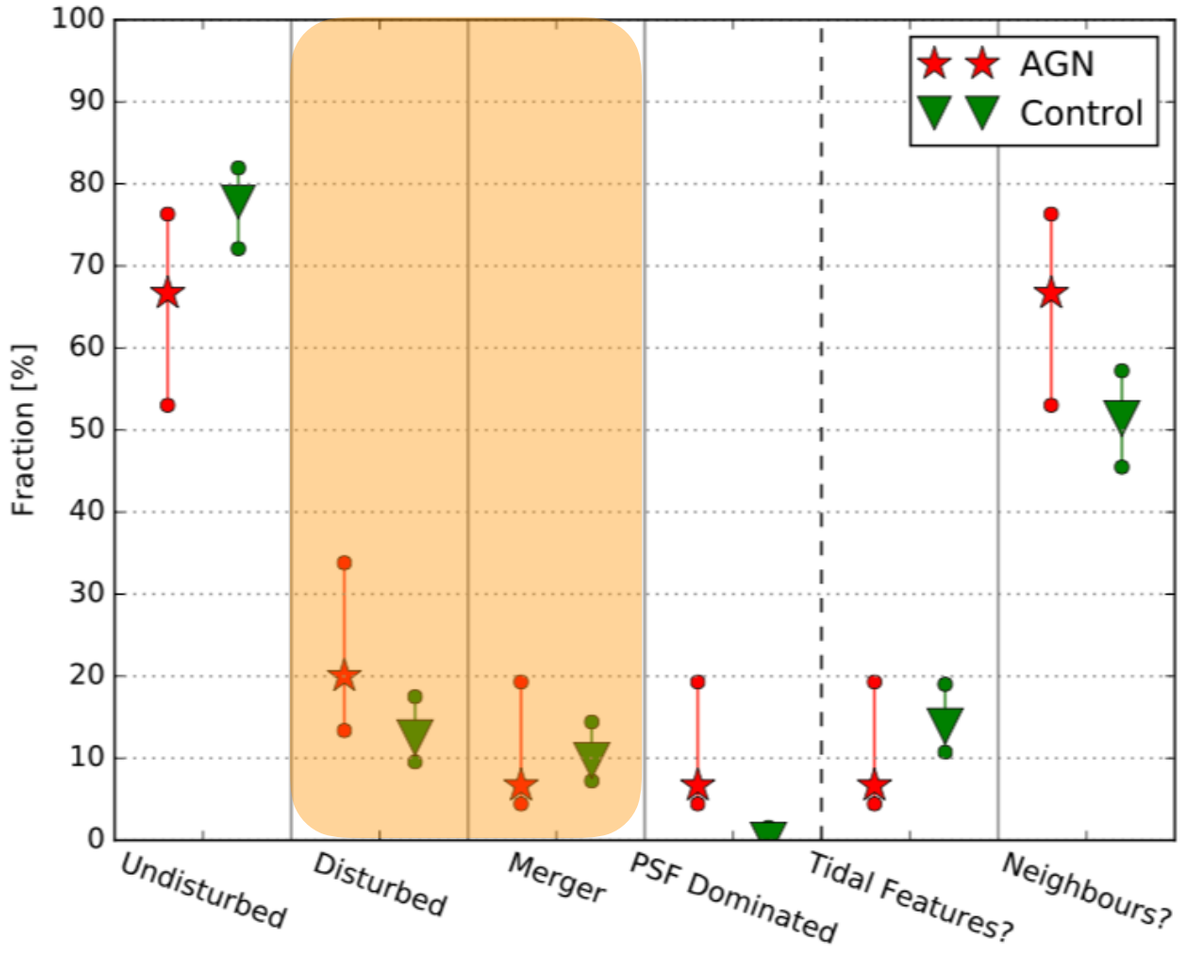
Why we think high luminosity AGN are associated with mergers?

- **Luminosity ∝ Accretion Rate**
- **L = 10^{46} erg/s is ~2 $M_\odot$/yr**

➡ **High luminosity AGN require high fuel rates**

z~0.6
L_{bol} ~10^{46} erg/s
HST F160W/H Imaging
20 sources + mock AGN control

Mergers & Extreme AGN
High Luminosity AGN



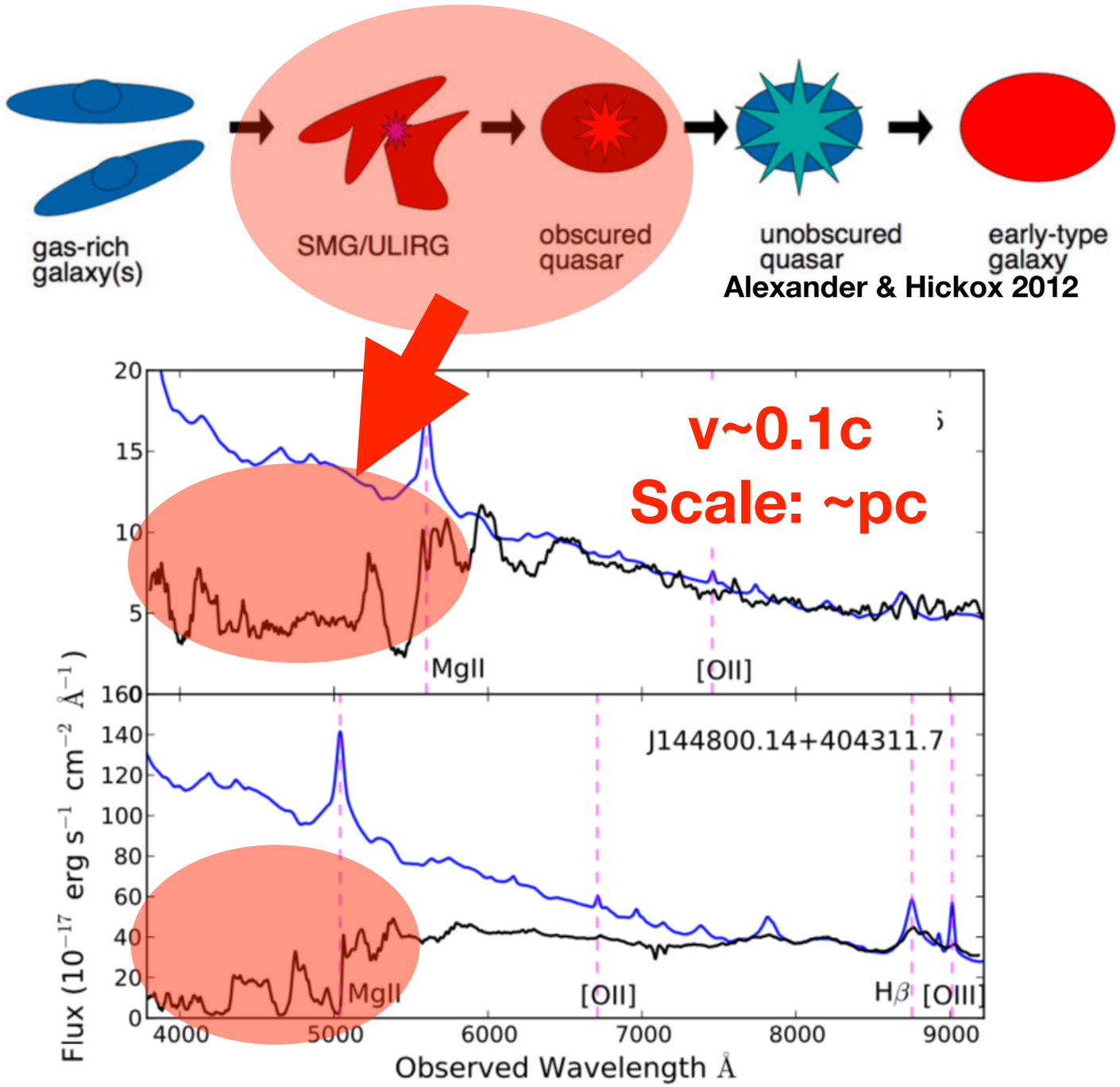
Villforth et al. 2017

- **No enhancement of merger fraction compared to matched control sample**
- **Upper limit of excess major merger fraction <15%**

z~0.6
L_{bol} ~10^{46} erg/s
HST F160W/H Imaging
20 sources + mock AGN control

Mergers & Extreme AGN

Red AGN with extreme outflows



Why we think FeLoBALs are associated with mergers?

- **High reddening and luminosity**
- **Strong outflows**

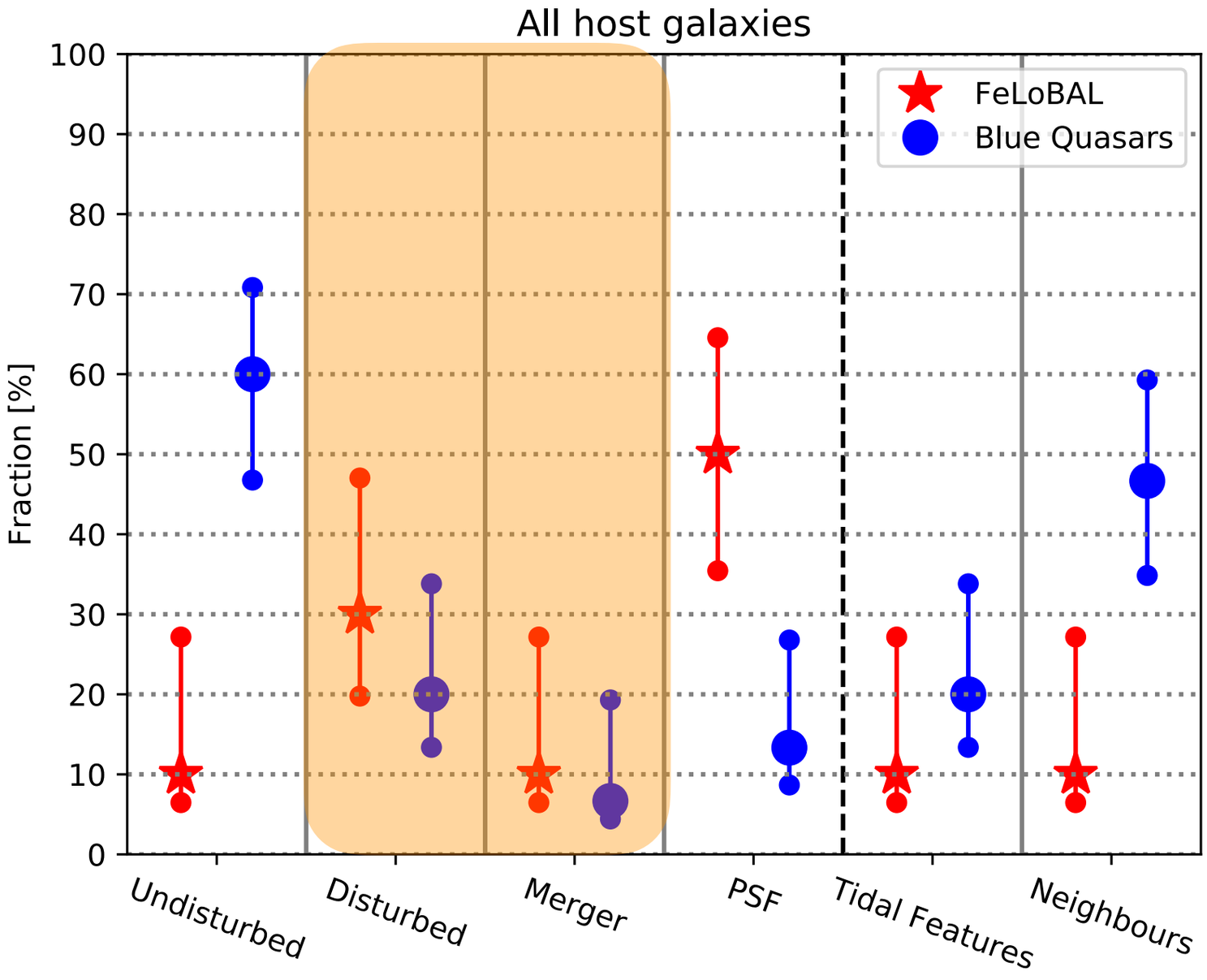
➡ **Suspected to be in "blow-out" phase**

z~0.9
L_{bol} ~$10^{46\text{-}47}$ erg/s
HST F160W/H Imaging
10 sources + blue quasar control

Villforth, Herbst et al. 2019

Mergers & Extreme AGN

Red AGN with extreme outflows

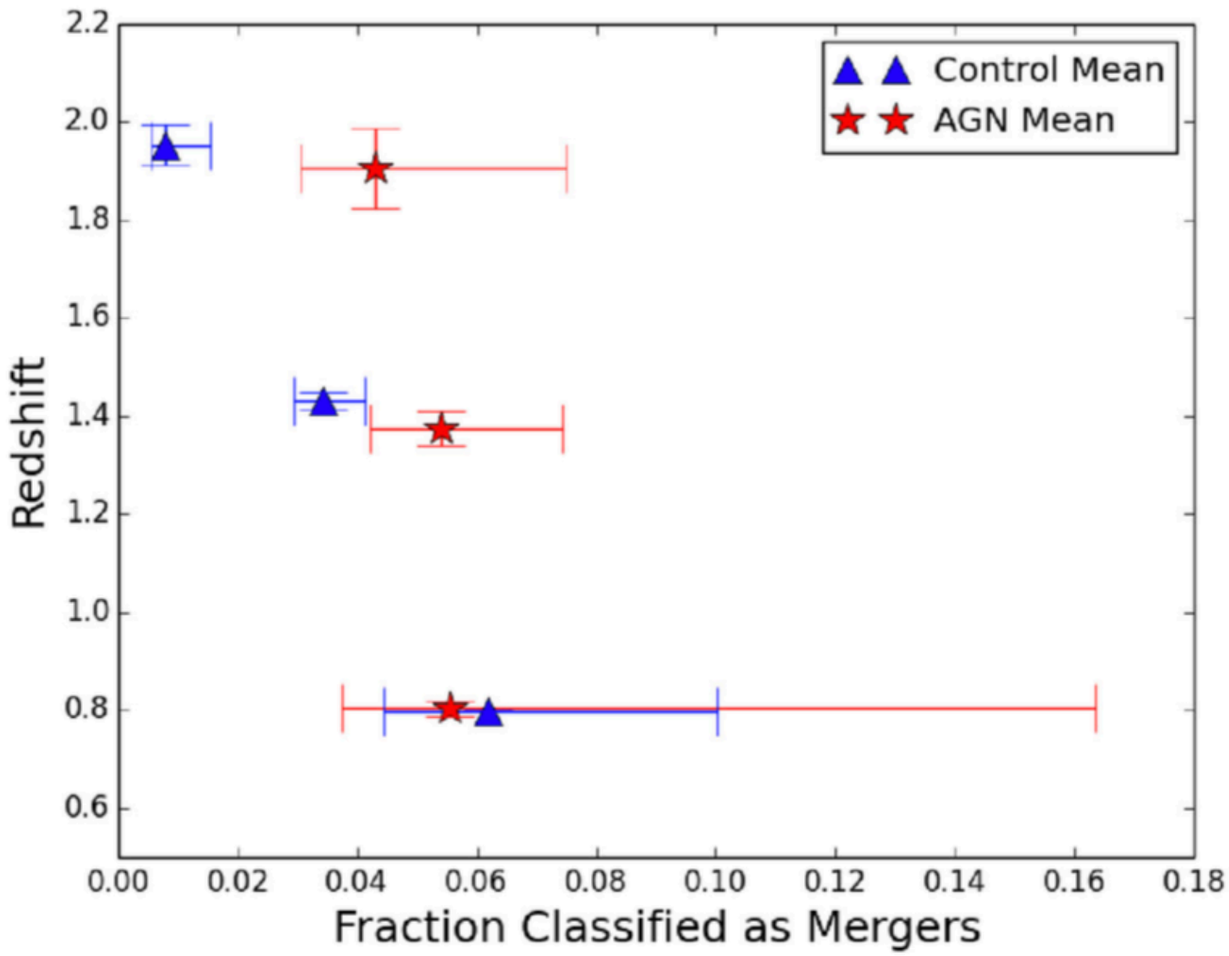


Villforth, Herbst et al. 2019

No enhancement of merger fraction compared to matched blue quasar sample

z~0.9
L_{bol} ~$10^{46\text{-}47}$ erg/s
HST F160W/H Imaging
10 sources + blue quasar control

Mergers & Extreme AGN
Redshift Evolution

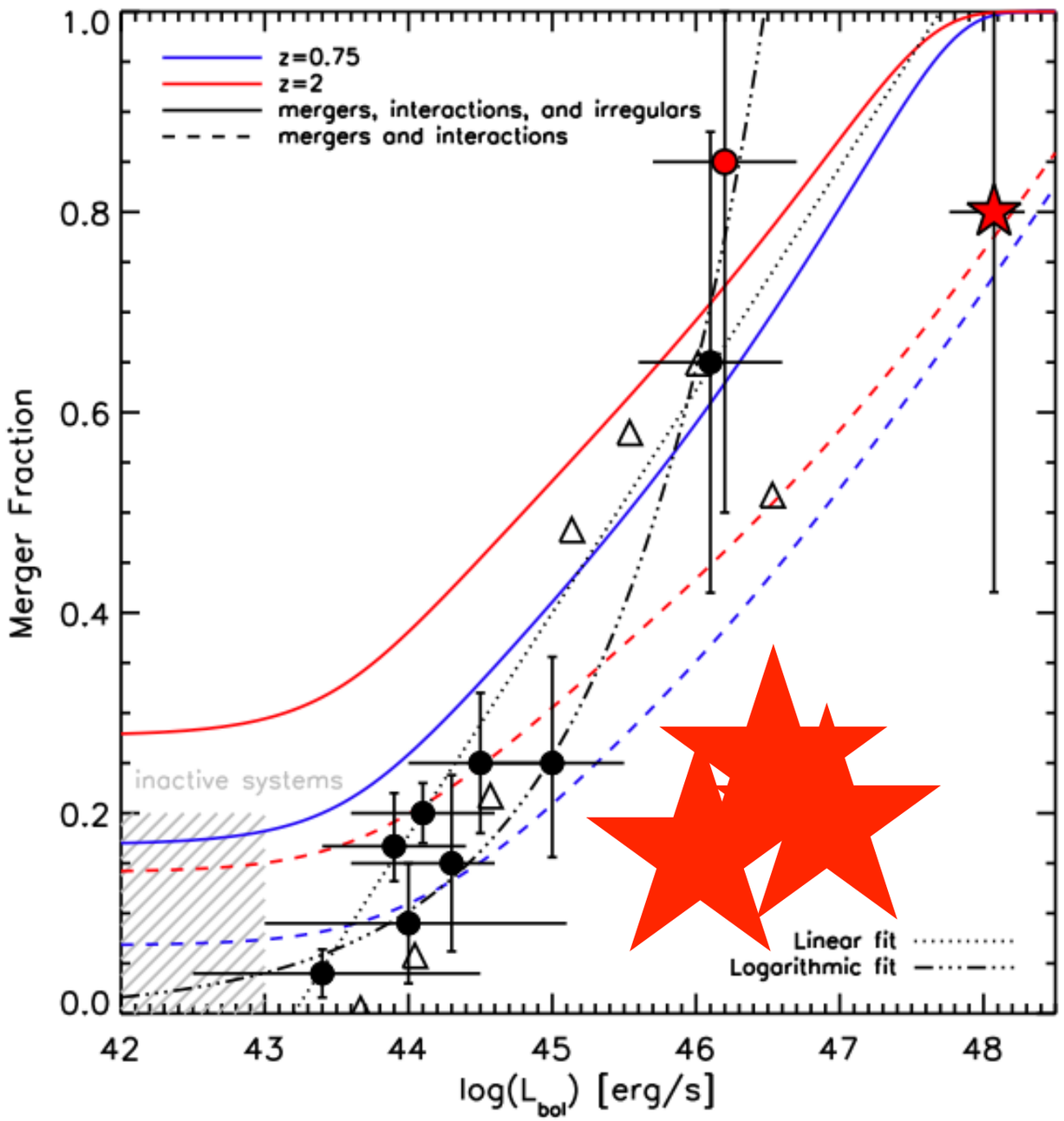


Hewlett, Villforth et al. 2017

- **No enhancement of merger fraction compared to matched control up to z~1.5**
- **At z~2, enhancement at 2.4σ is detected**

COSMOS AGN Xray
106 AGN
Z = 0.5-2.2
L_{bol} ~10^{43-45} erg/s
F814W
Matched mocked controls

Detected



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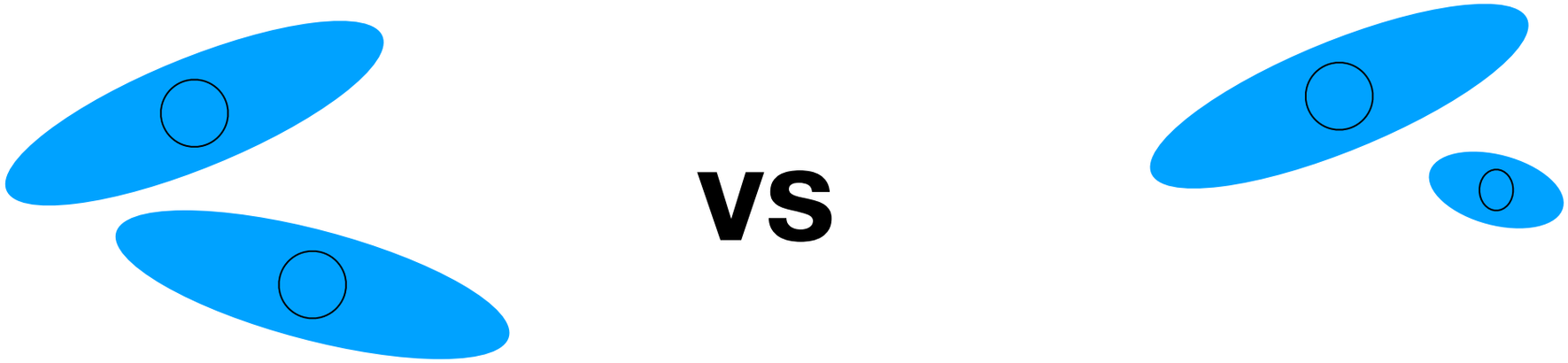
Glikman et al. 2016 (also, Treister et al. 2012)

Reconciling the merger AGN connection

minor mergers



vs

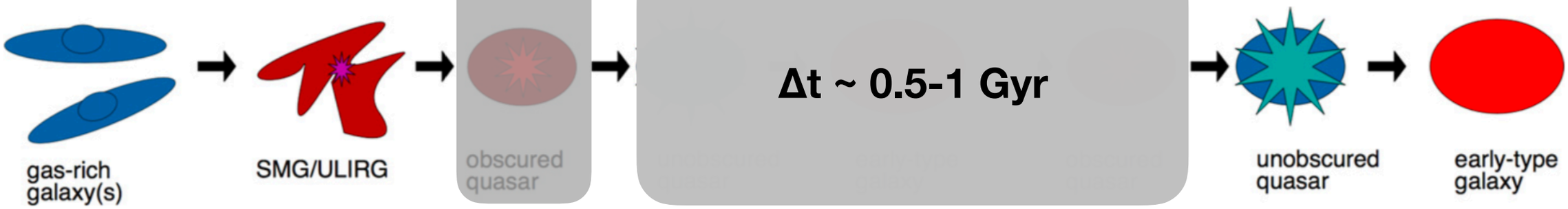
- **strong disturbances**
- **rare**

- **weak disturbances**
- **common**

Can be reconciled with clustering (see Villforth et al. 2017). Needs testing. Causality problematic.

Reconciling the merger AGN connection time delays

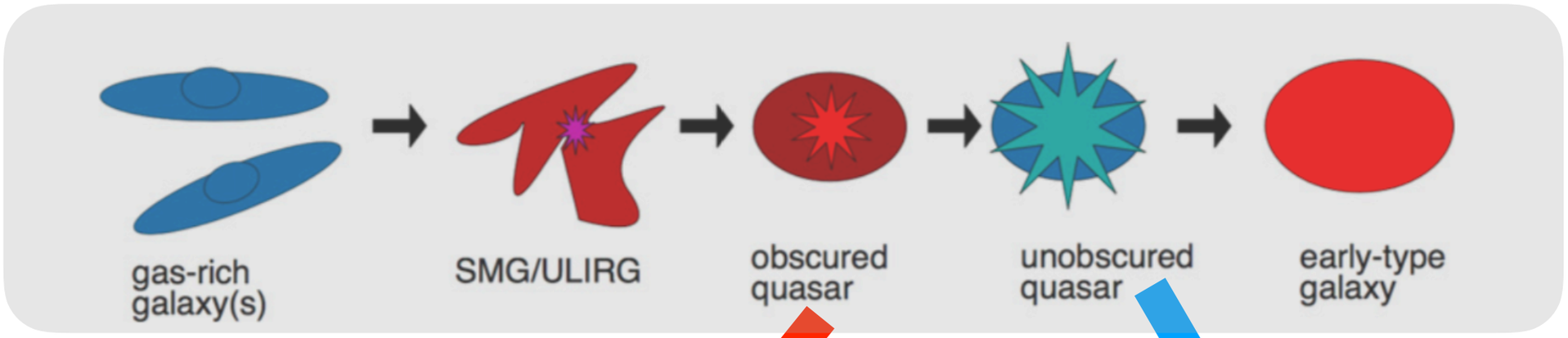
Alexander & Hickox 2012



Only possible if no activity soon after merger, could be problematic for feedback. Causality problematic.

Reconciling the merger AGN connection “young” and “old" AGN

Alexander & Hickox 2012



If mergers detected ☛ “young” AGN

If no mergers detected ☛ “old” AGN

Possible, but number densities & host galaxy properties need to match. FeLoBAL vs blue quasar results do not support this for FeLoBALs. Needs to be distinguished from different populations.

Reconciling the merger AGN connection
Major mergers not dominant

Alexander & Hickox 2012

Other fuelling mechanisms: bars, accretion of gas from halo, other secular processes

Major mergers increase probability of AGN activity, but do not dominate in many AGN populations.

Fuelling AGN and major mergers: still an open question

- When compared to controls, AGN over a wide range of properties are **not** dominated by recent major mergers

  - Minor mergers not excluded by current data

  - Long time delays (>500 Myr) possible, but problematic for feedback

  - Differences between AGN samples need to studied: “evolution” or different populations

  - **Major mergers are not dominant in many AGN populations, other fuelling mechanism required**

- Control samples are import since detected merger fractions cannot easily be translated into intrinsic merger fractions