UNIVERSITY OF CAMBRIDGE

A Merger History?

The Star-Forming Hosts of Luminous, Dust-Obscured Quasars

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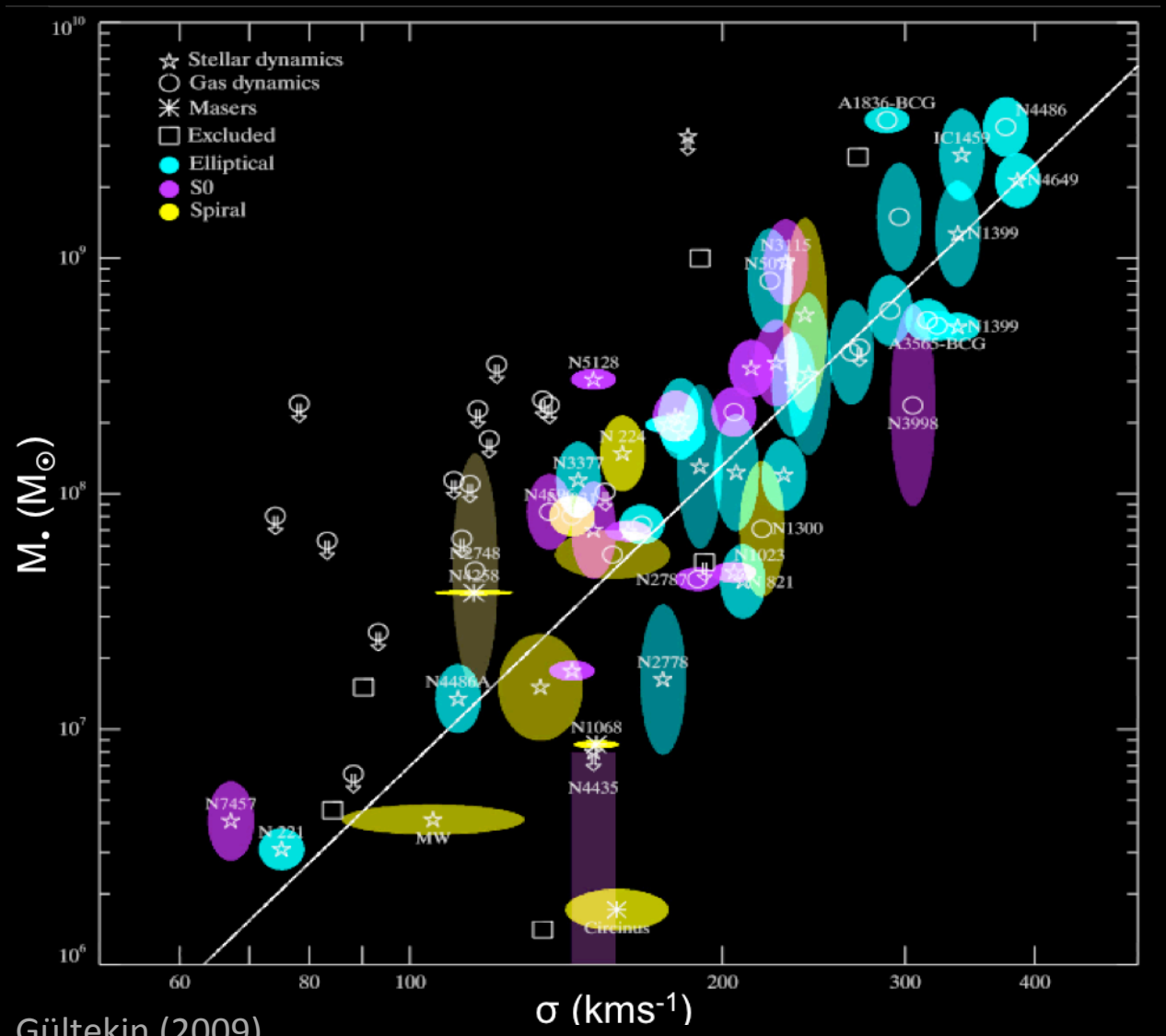
WHY STUDY QUASARS?

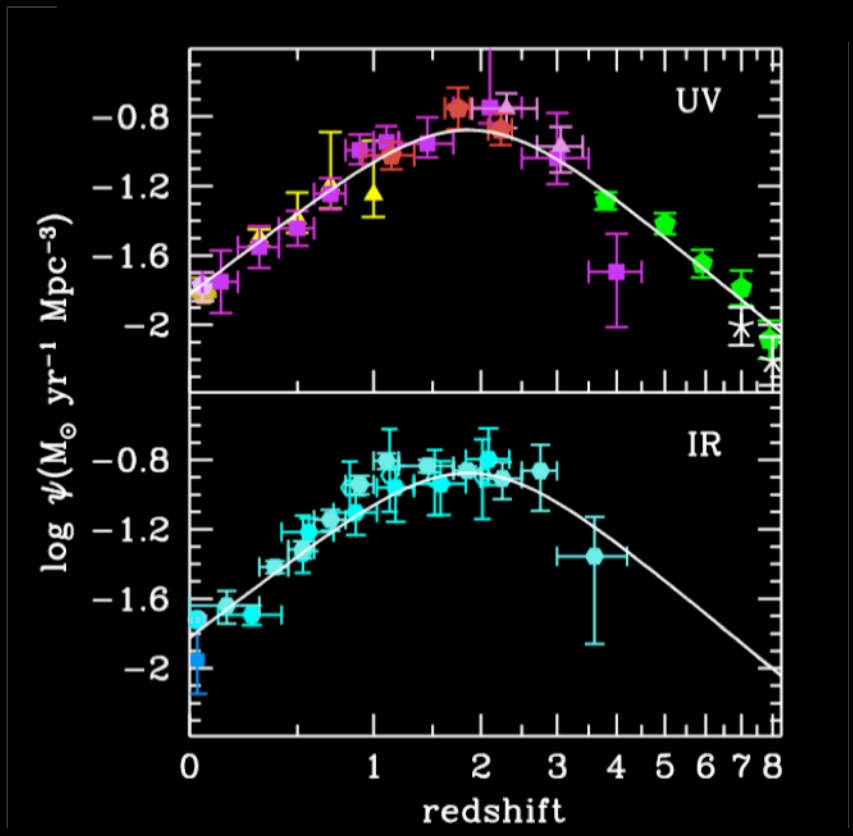


Gültekin (2009)

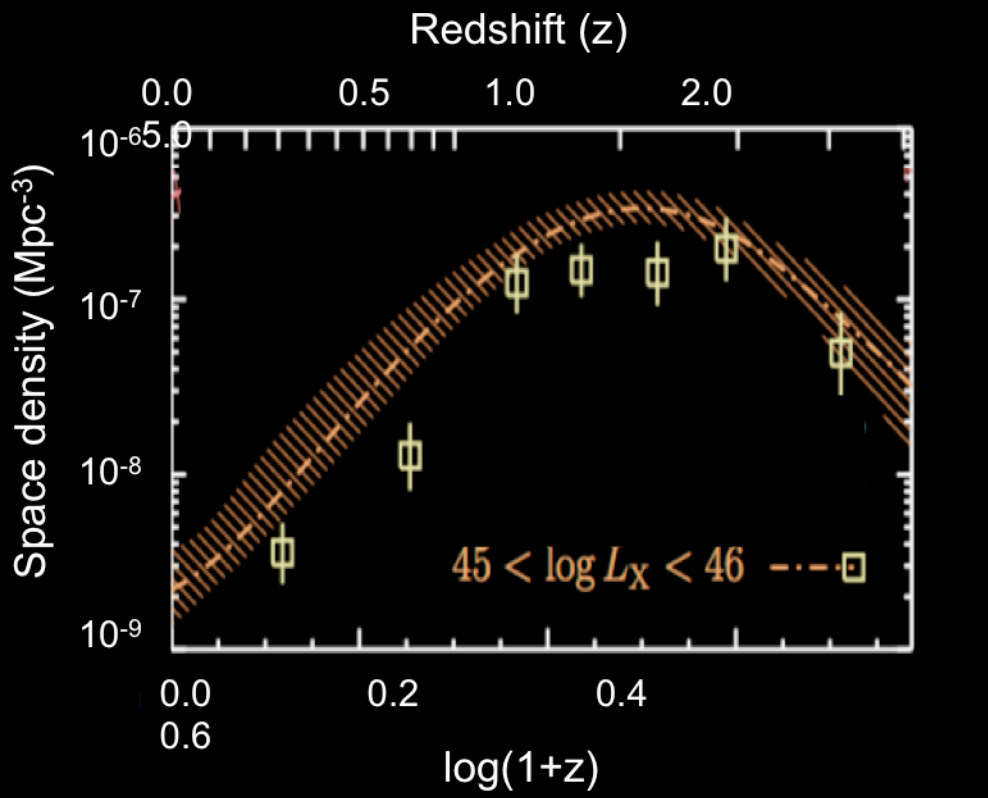
There appears to be an intrinsic link between quasars and their host galaxies

WHY STUDY QUASARS?

2 < z < 3 is a peak epoch in both star formation and BH accretion

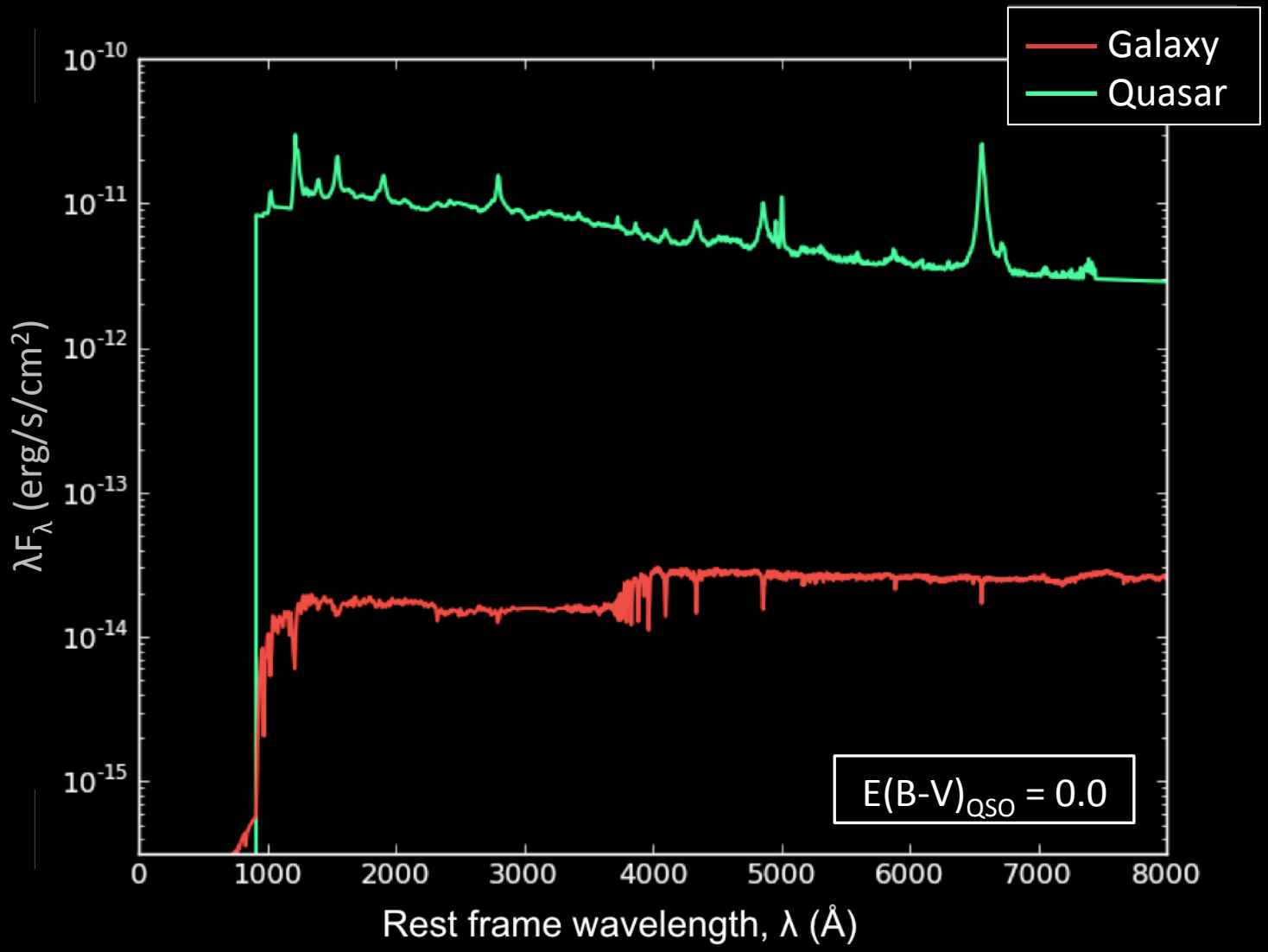


Madau & Dickinson (2014)



Aird *et al.* (2015)

DUST OBSCURATION



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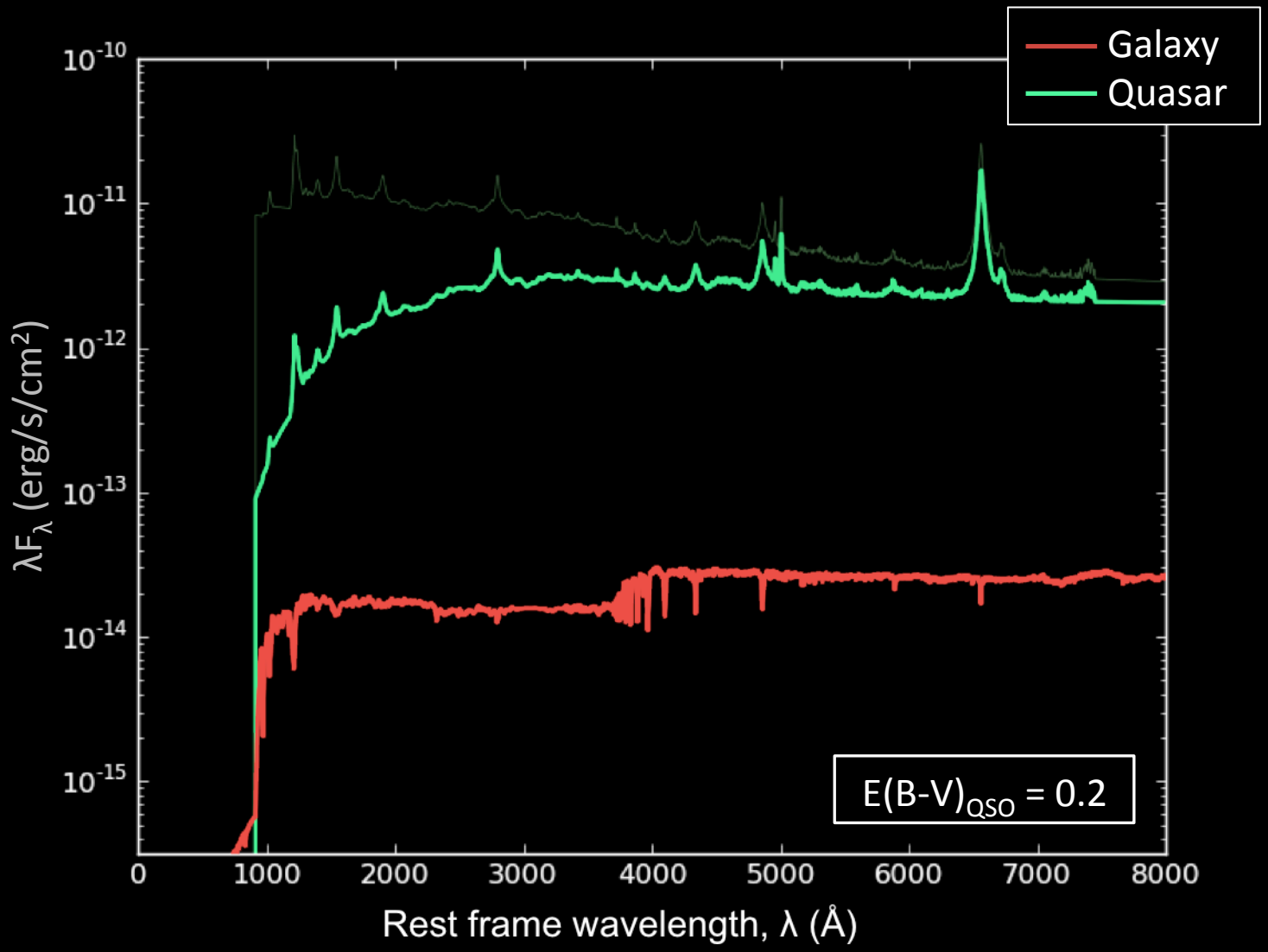

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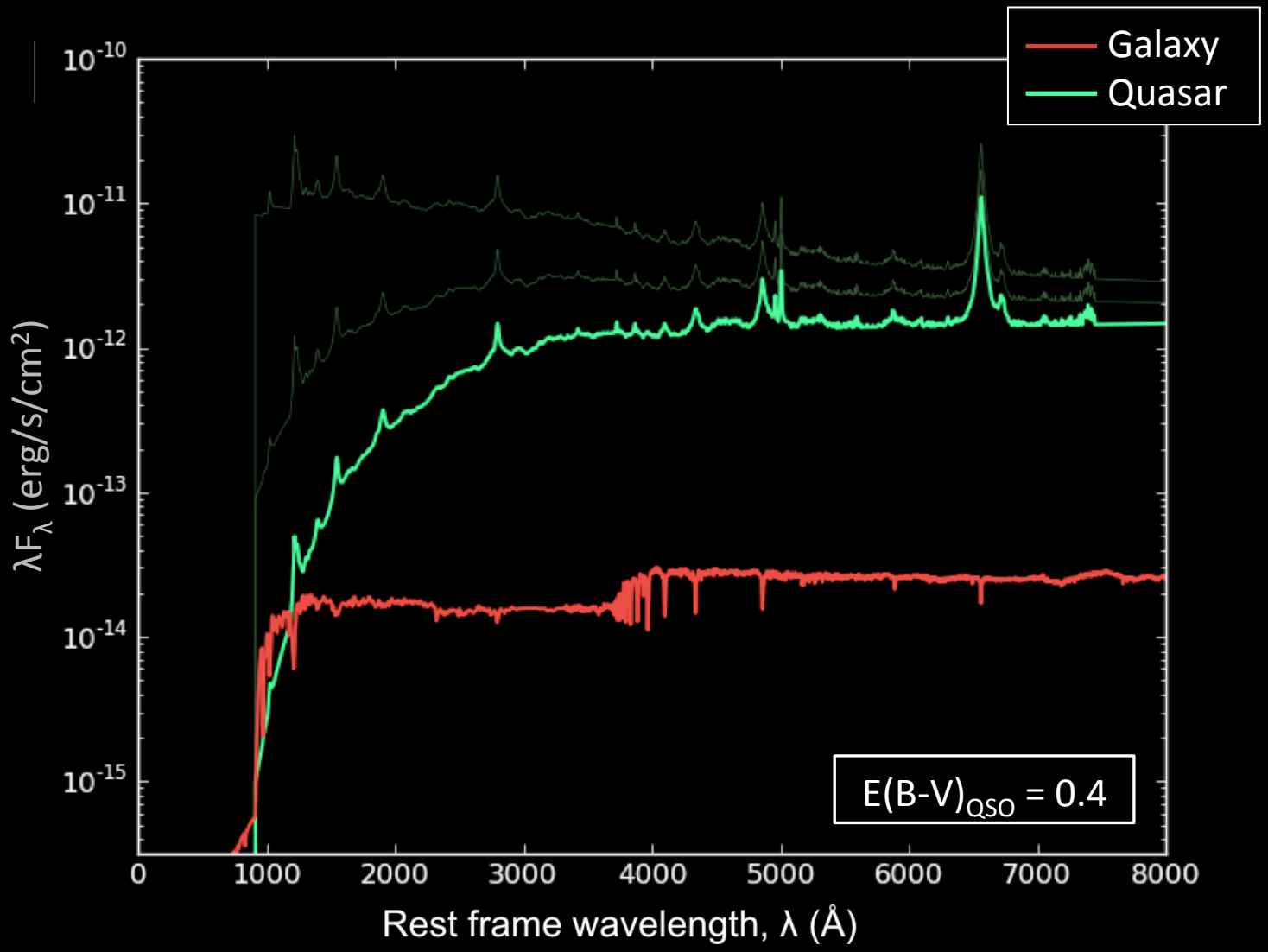

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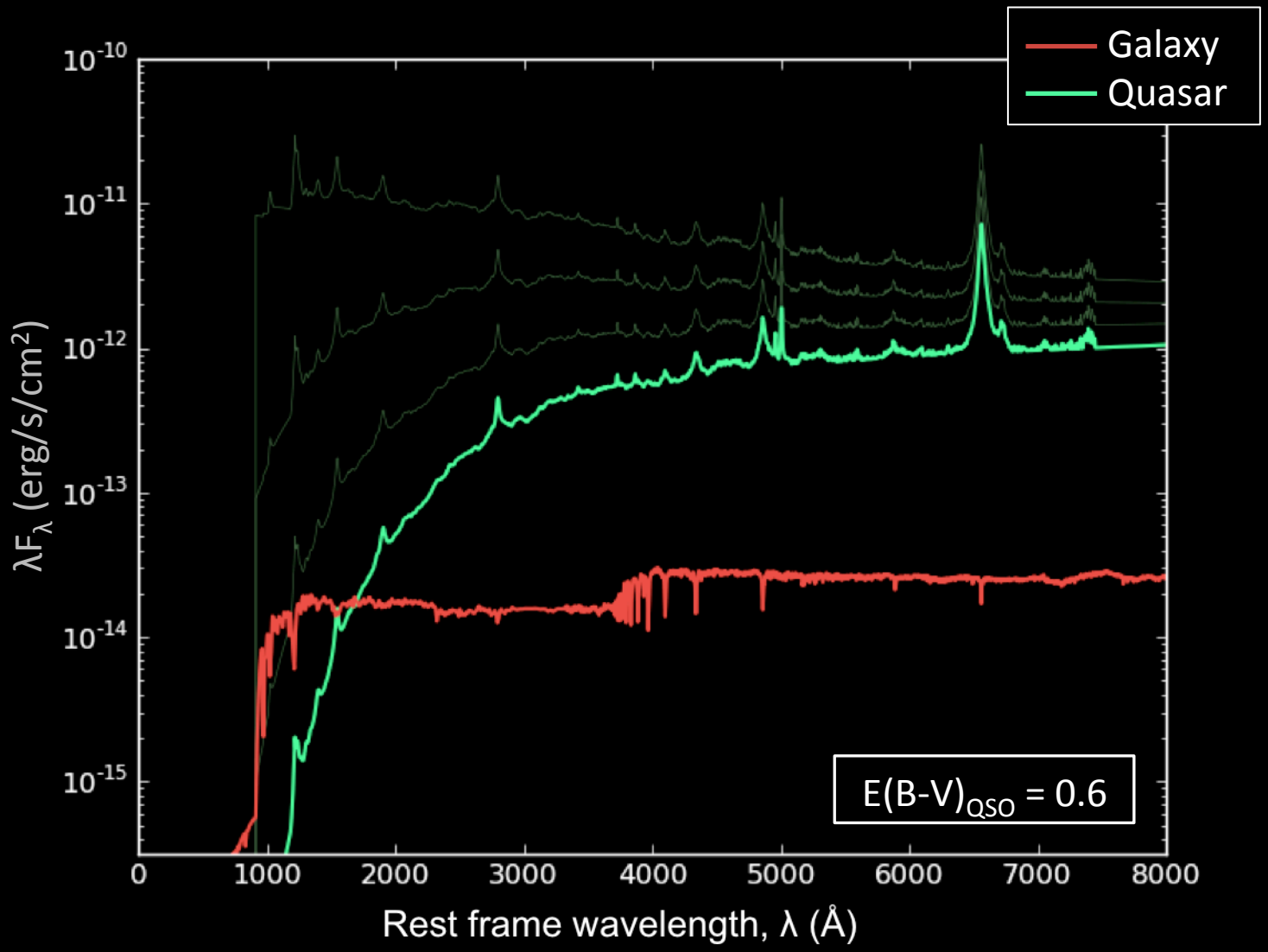

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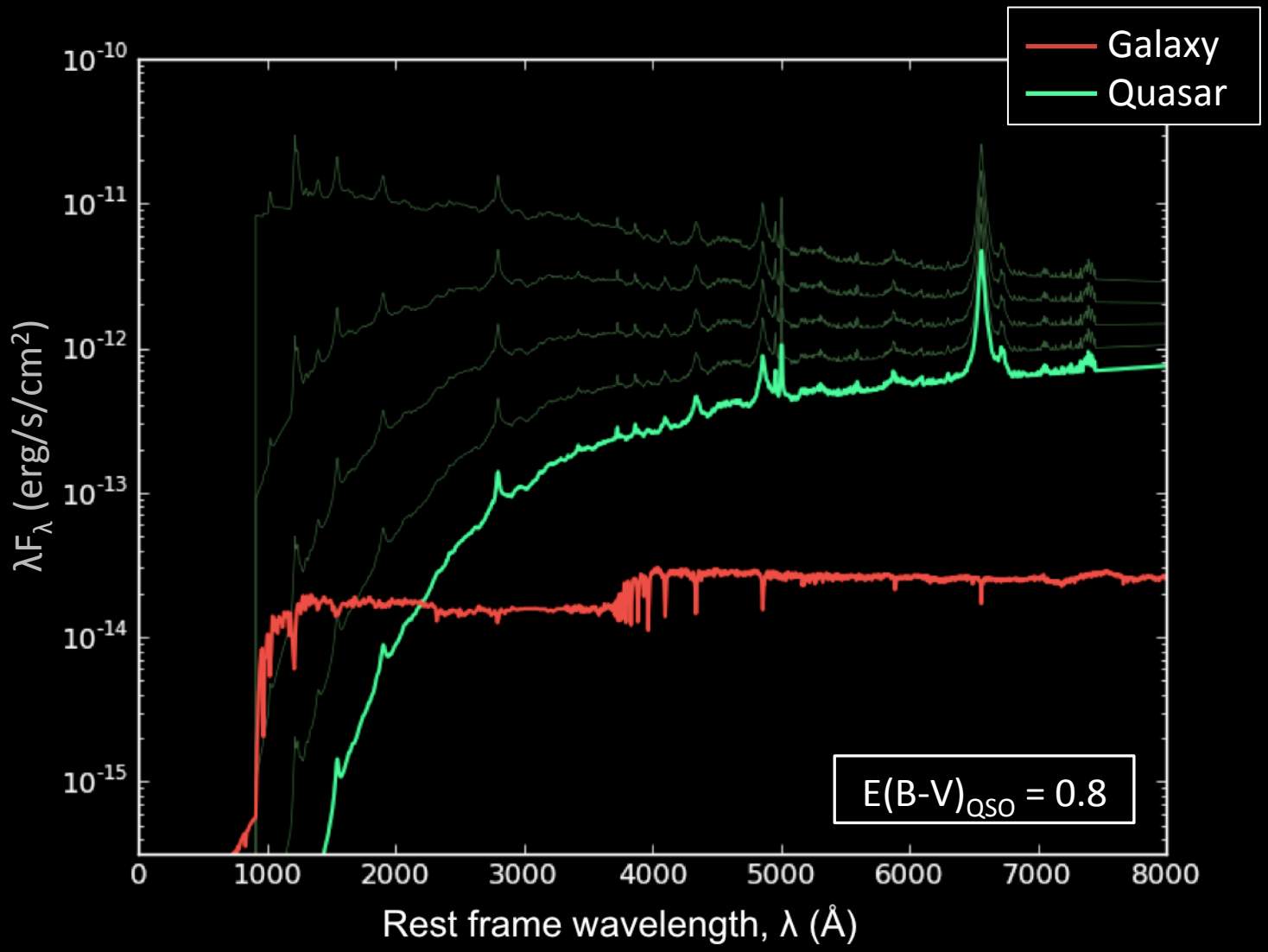

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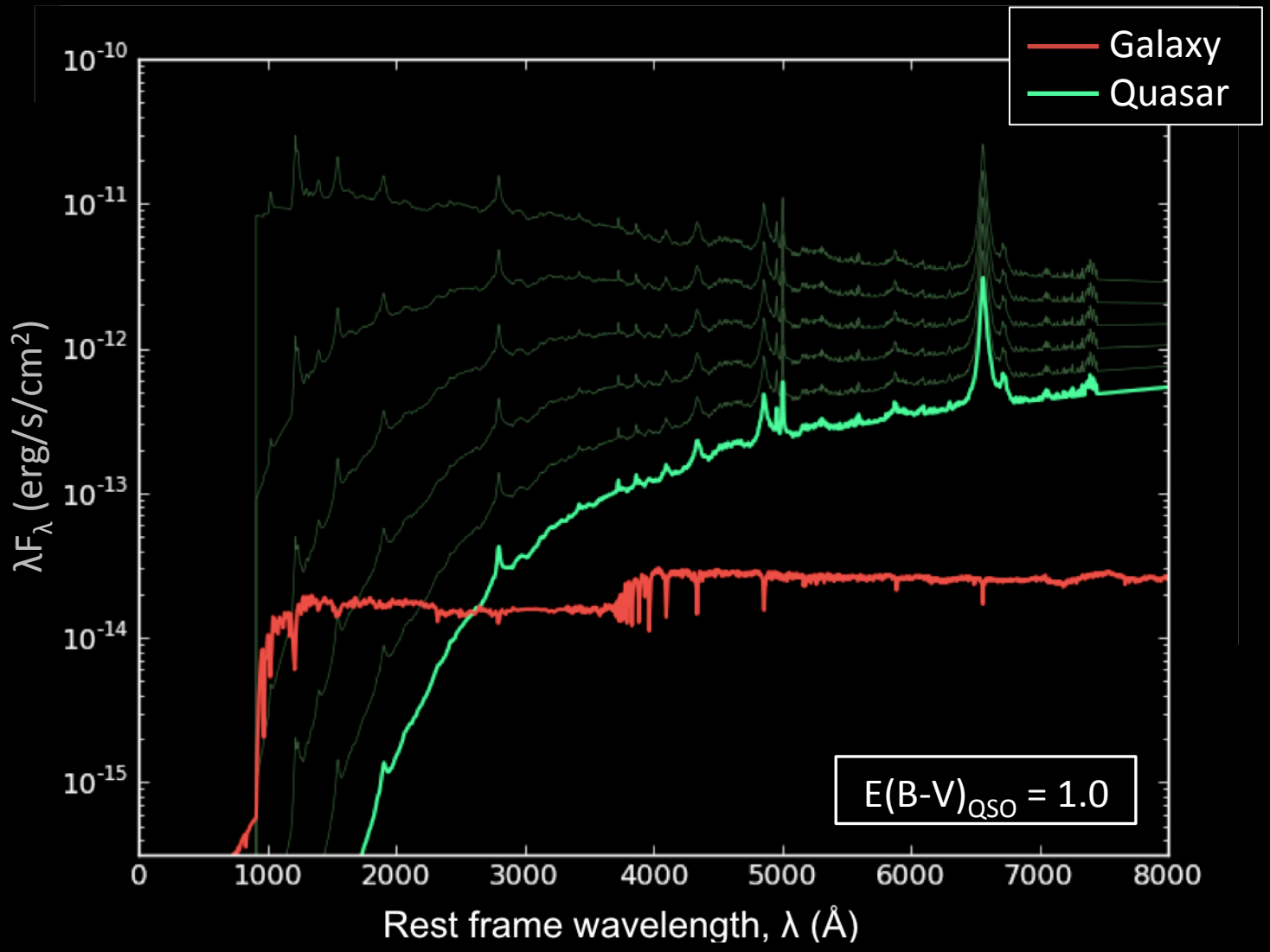
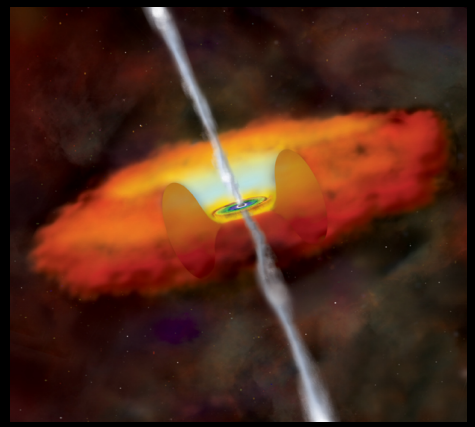


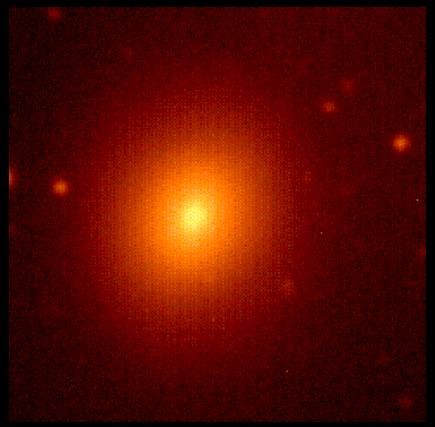
EVOLUTION?

Merger-driven starburst galaxy



Blowout phase

UV- luminous Quasar



'Red and dead' elliptical

Dust obscuration may trace the evolutionary phase of the quasar.

THE DATA

NIR SELECTION

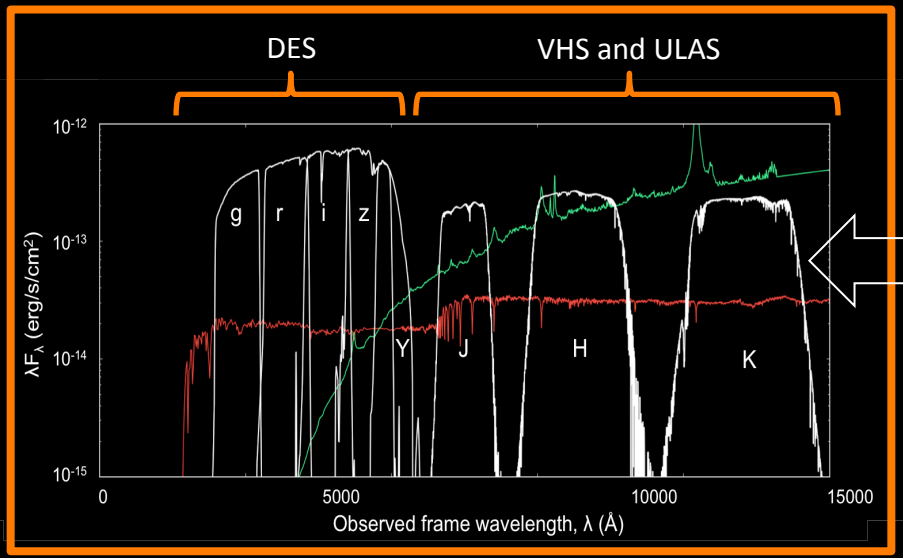
Extremely red quasars selected from wide-field NIR surveys:

- VISTA Hemisphere Survey (VHS)
- UKIDSS Large Area Survey (ULAS)

SPECTROSCOPIC CONFIRMATION

38 quasars spectroscopically-confirmed to be type-1 BL

(Banerji et al. 2012,2013,2015)

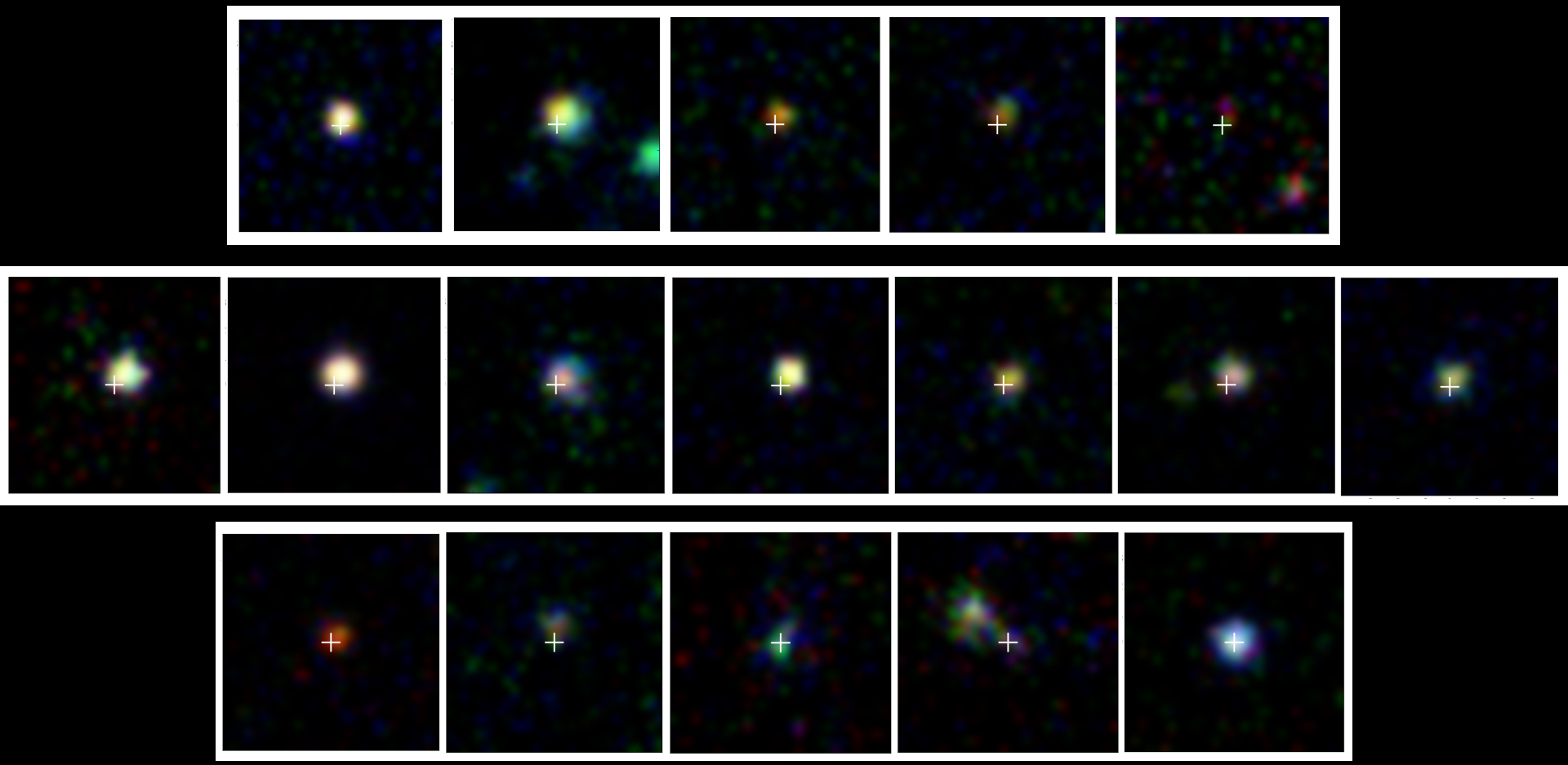


REST-FRAME UV

17 of the quasars overlap with year 1 Dark Energy Survey (DES) observations.

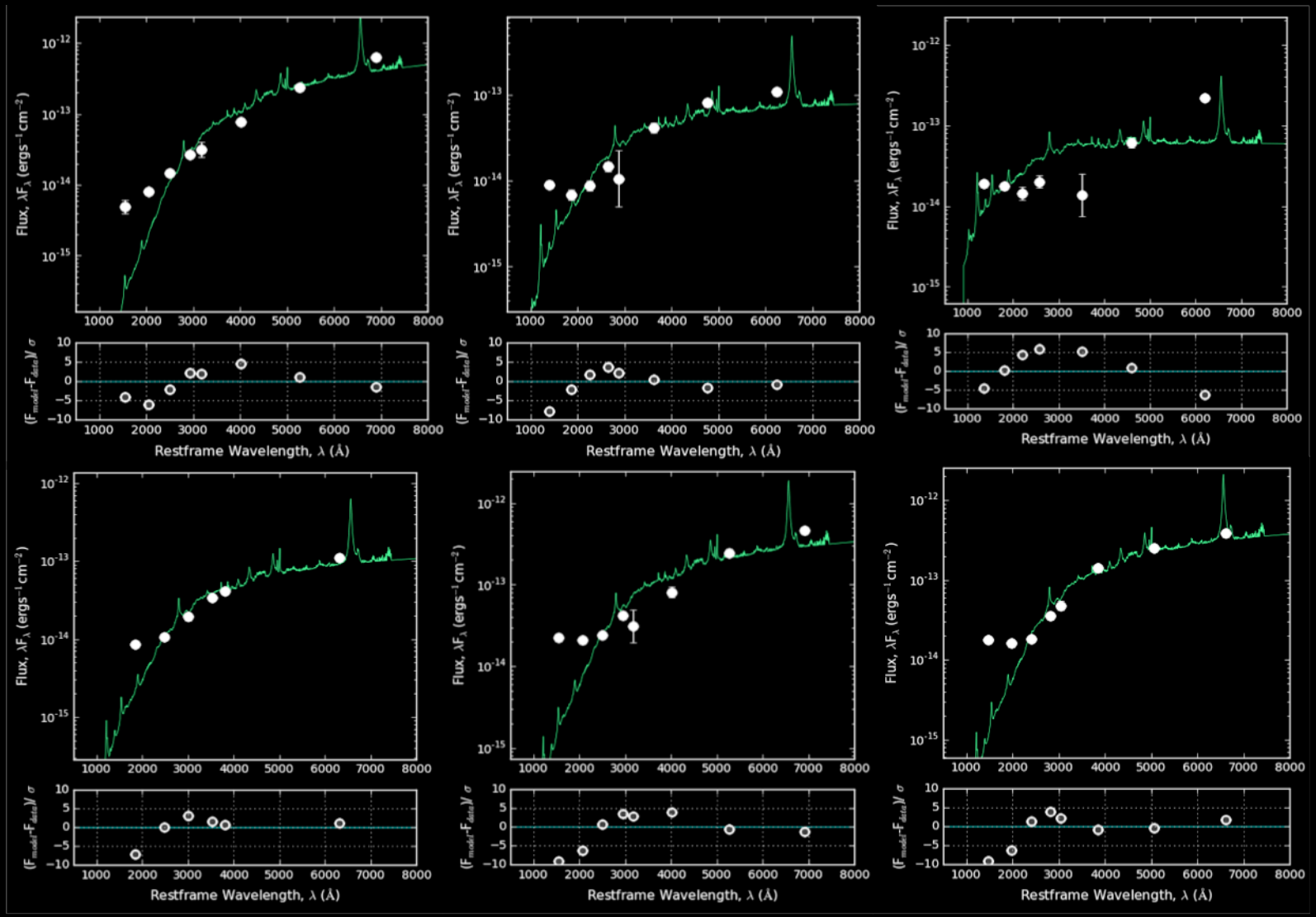
THE REST-FRAME UV

DES *g,r,i,*-band colour images for 17 of the most luminous (L_{bol} ~ 10^{47} erg/s) and massive (M_{BH}~ 10^{9} $M_{\odot}$) quasars at a peak epoch of star formation/ BH accretion.



C. Wethers *et al.* (2017) - *submitted*

THE REST-FRAME UV



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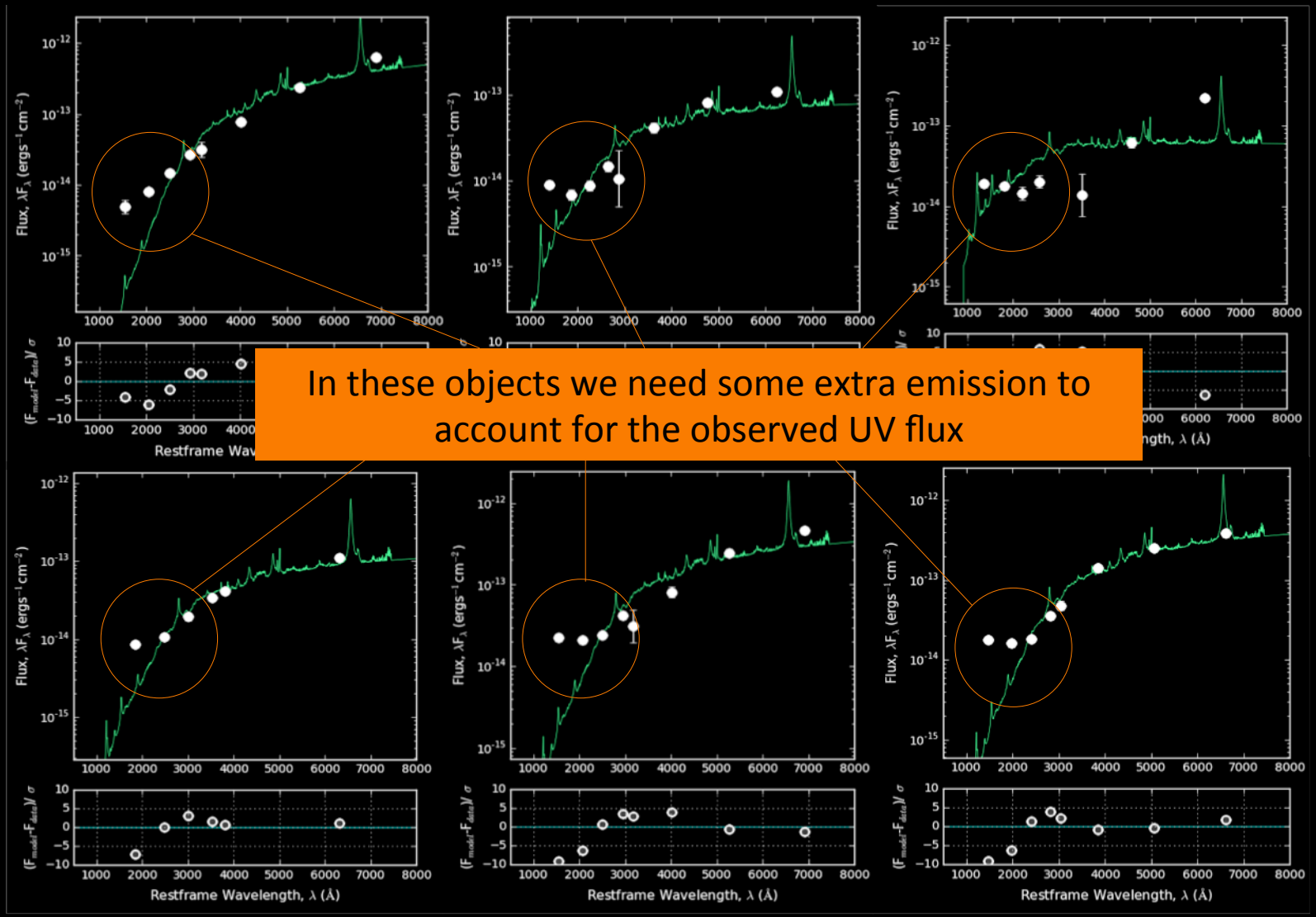
THE REST-FRAME UV



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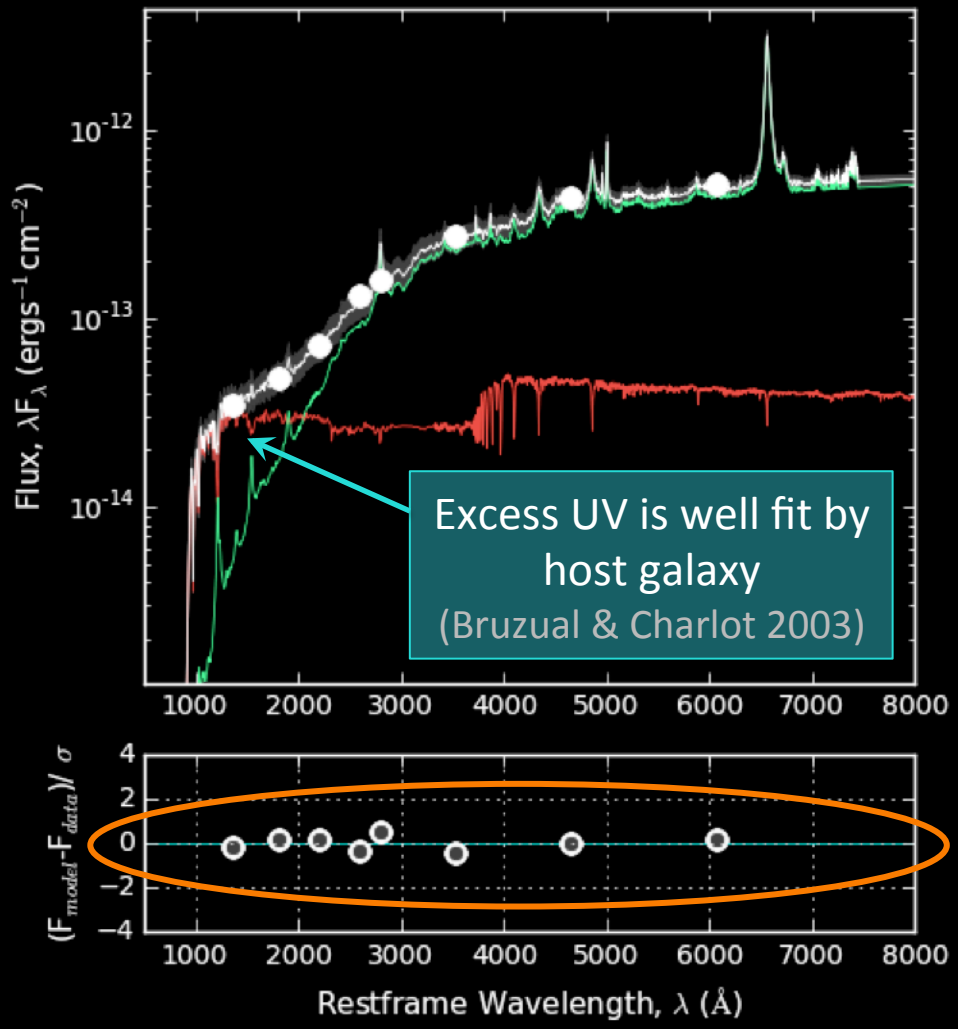
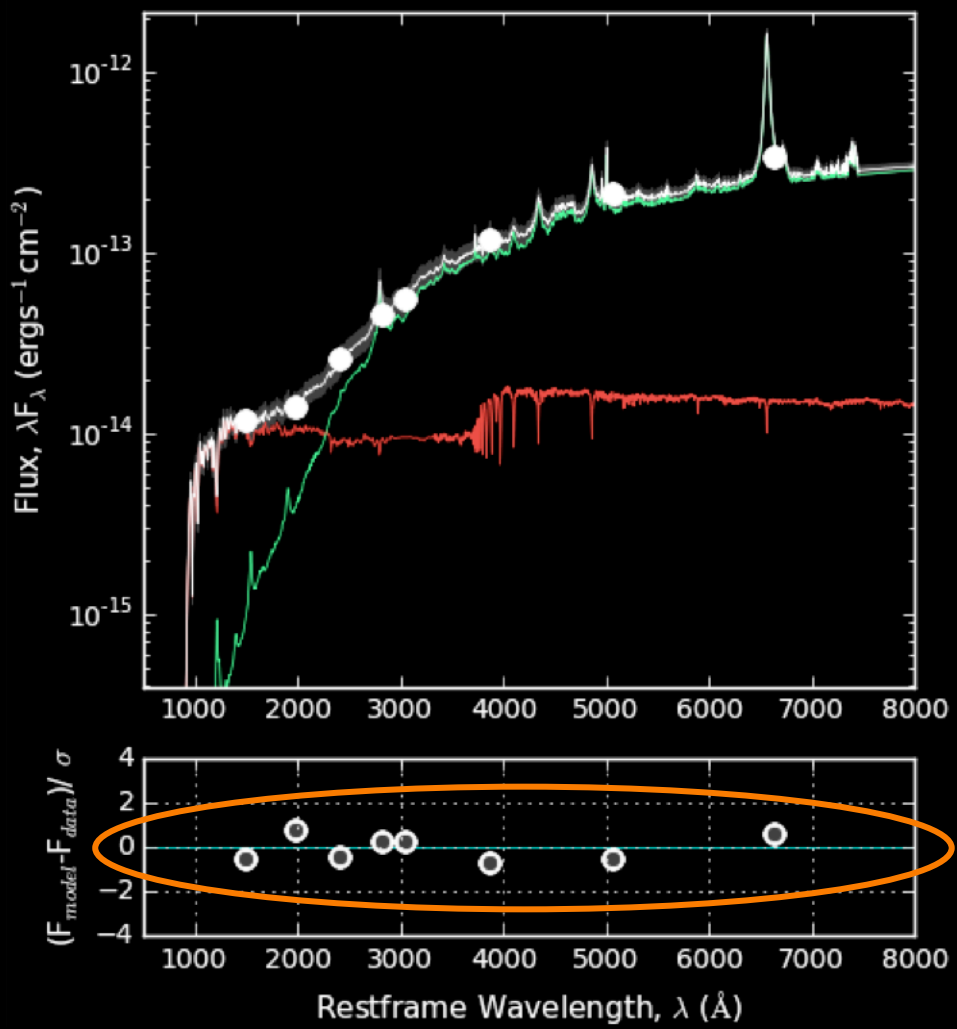
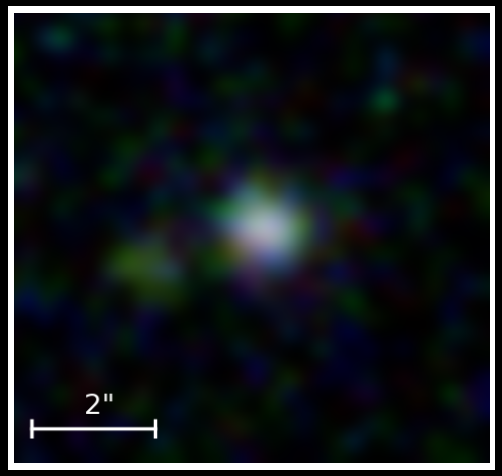
THE REST-FRAME UV

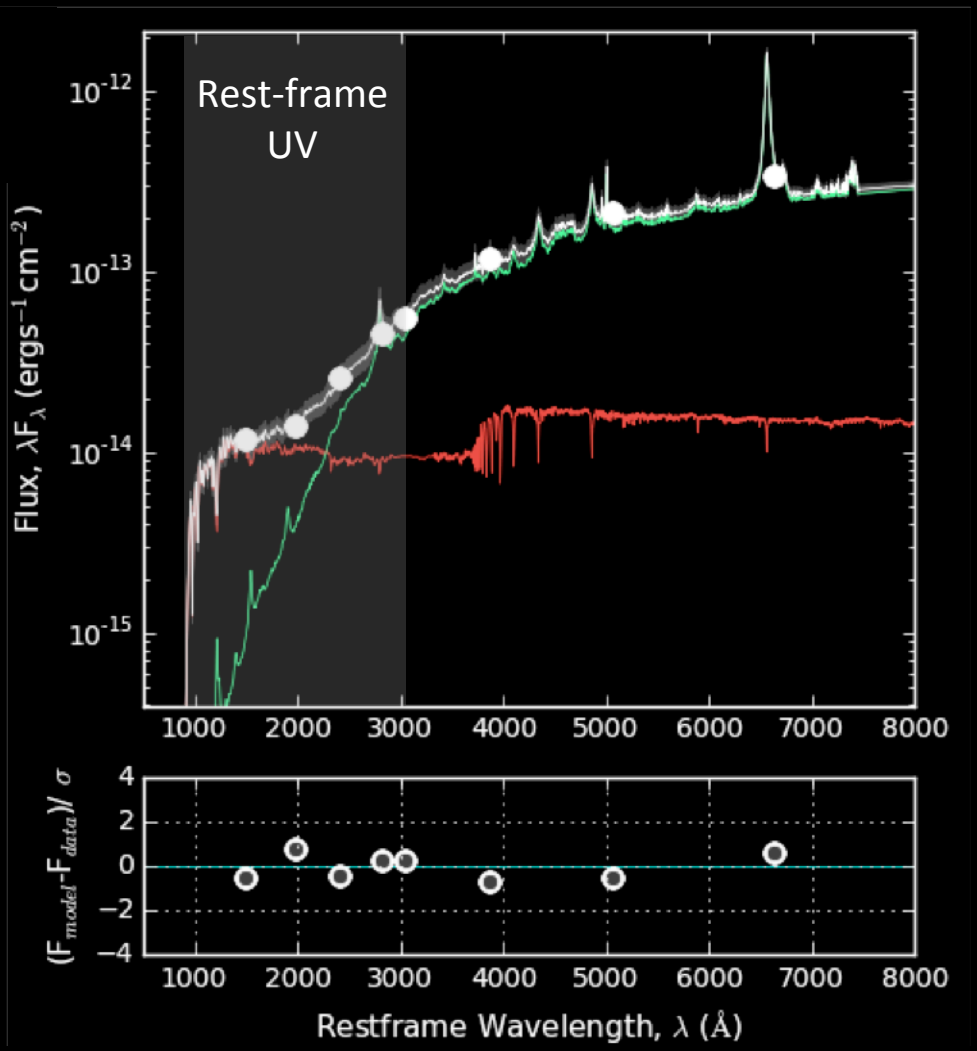




HOST GALAXY SFR

SFR = 95 ± 10 $M_\odot yr^{-1}$





NB: SFR in corner plot has not been corrected for dust

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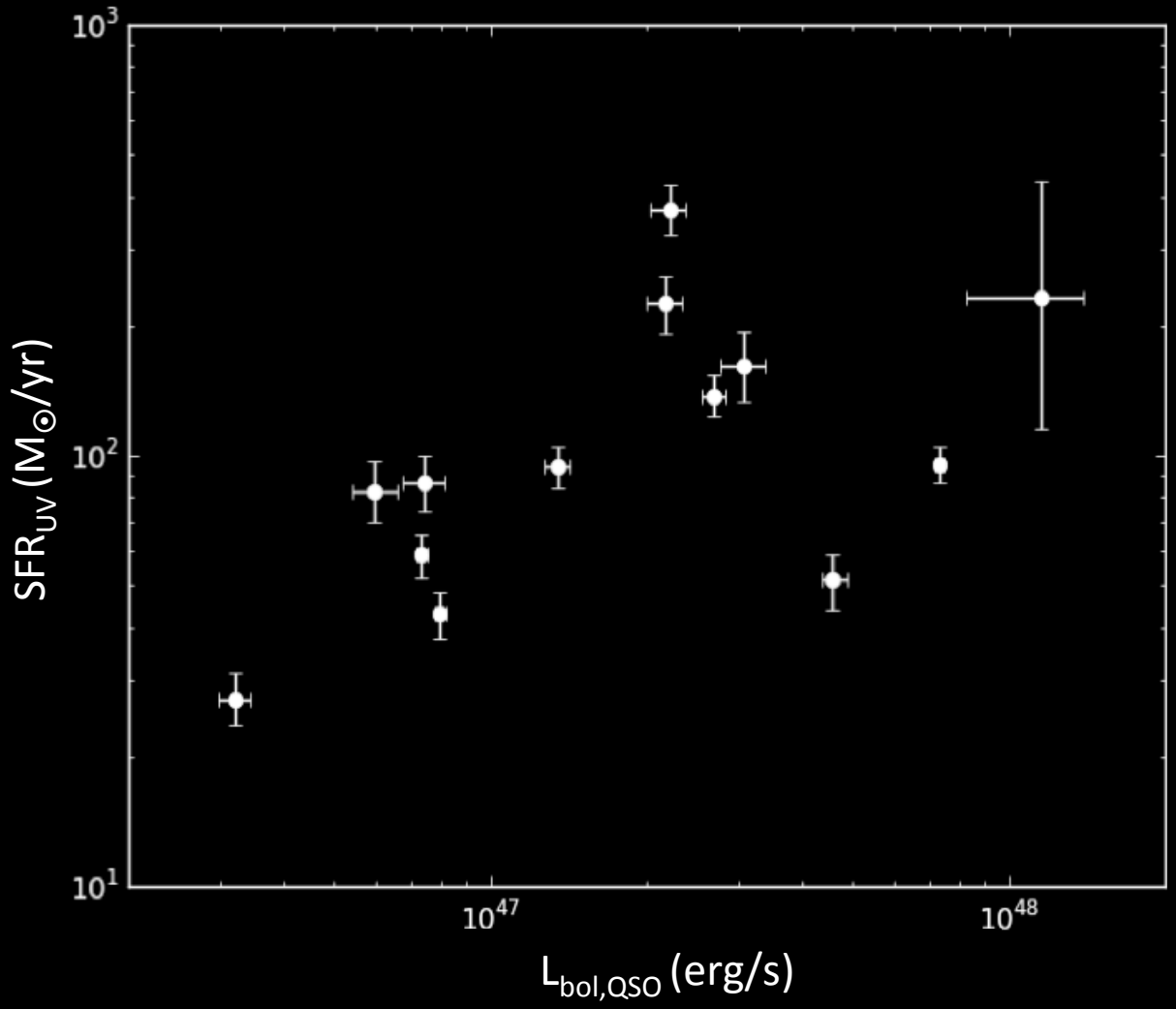
SFR vs. LUMNOSITY



We see an indication of a trend at these high QSO luminosities

(Spearman's Rank = 0.6
P value = 0.03)

Same gas triggering both star formation and BH accretion

Mergers?

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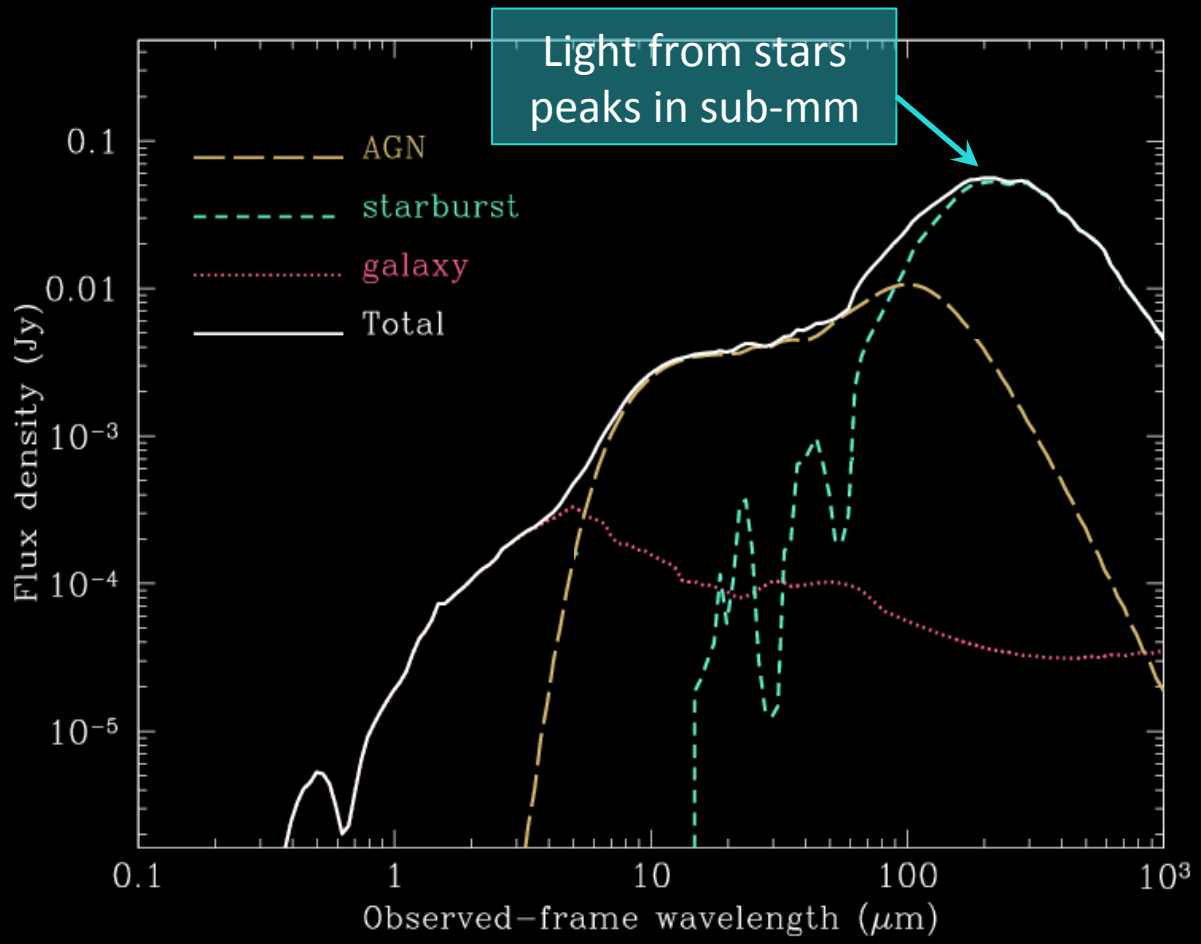
SFR vs. LUMNOSITY

… But the rest-frame UV emission only makes up a small fraction of the total SFR

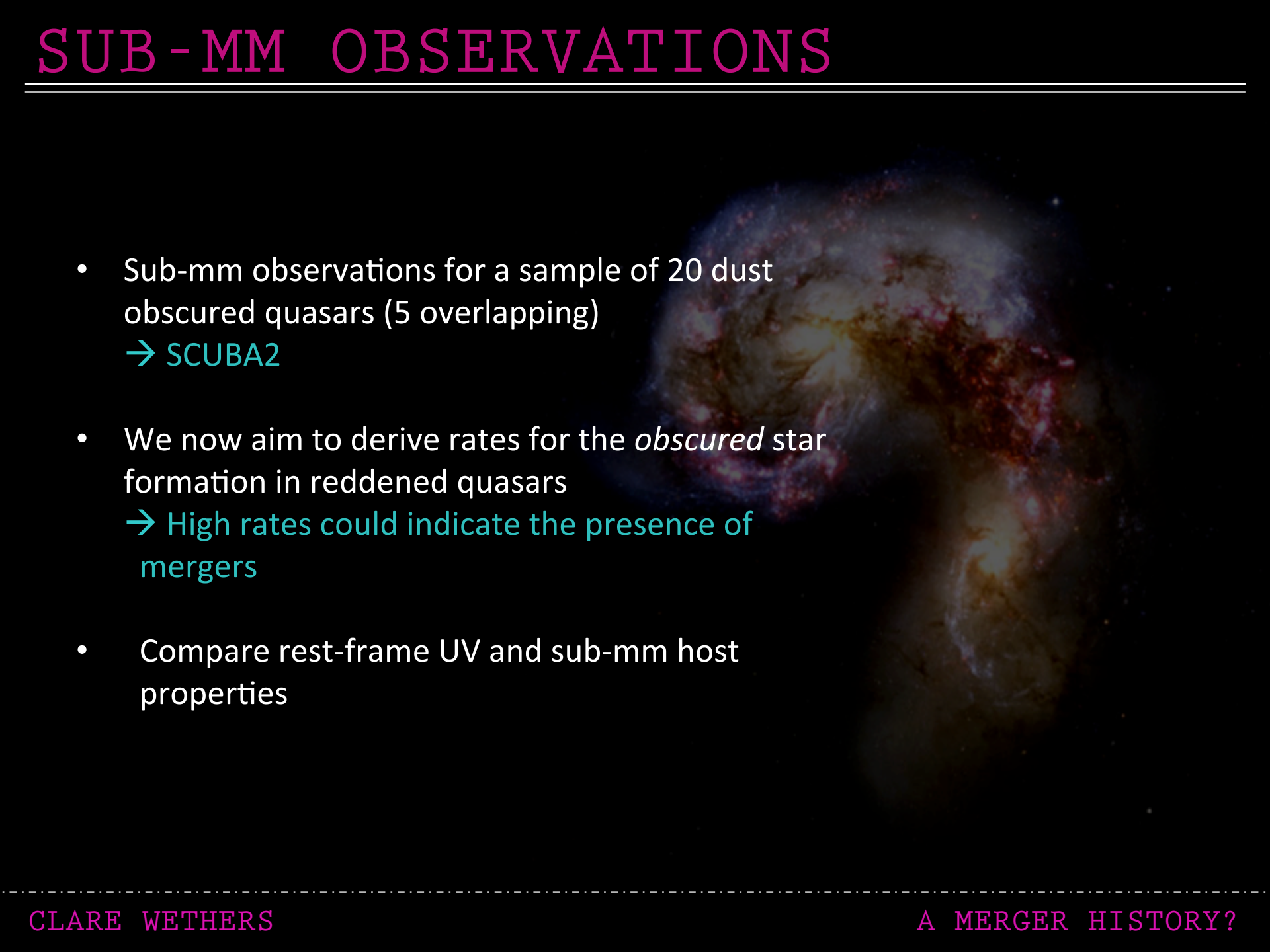
Much of the UV emission is absorbed and re-radiated in the sub-mm

Sub-mm observations can provide a much better estimate of the total SFR



Vignali et al. 2009

SUB-MM OBSERVATIONS



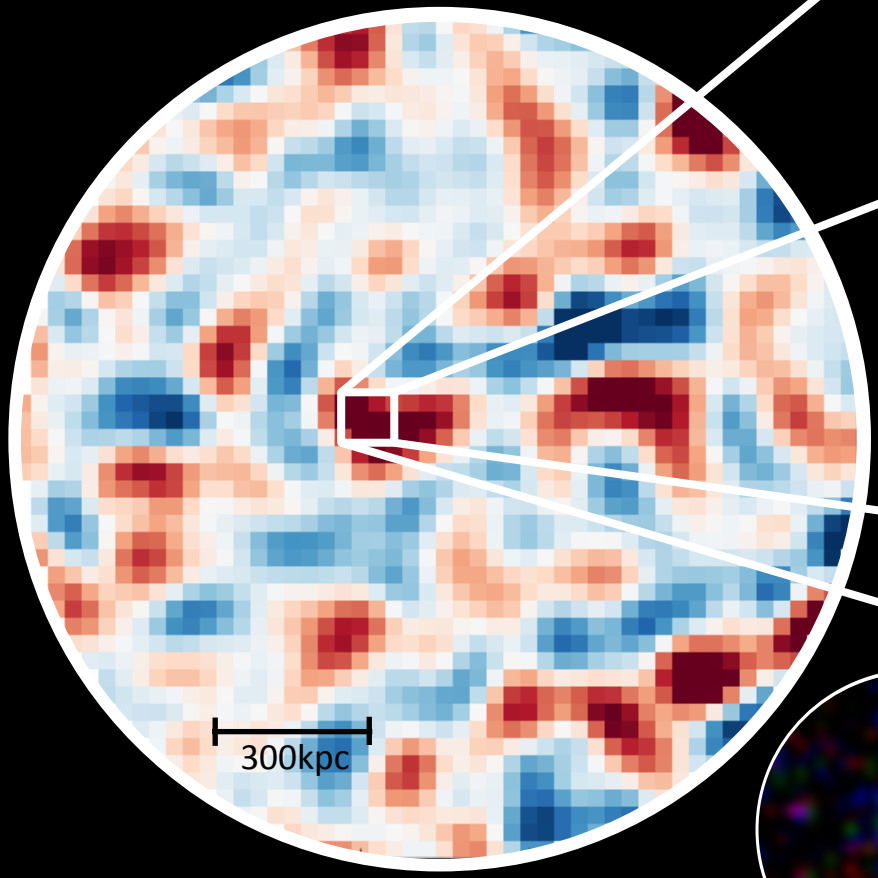
- Sub-mm observations for a sample of 20 dust obscured quasars (5 overlapping)
  → SCUBA2

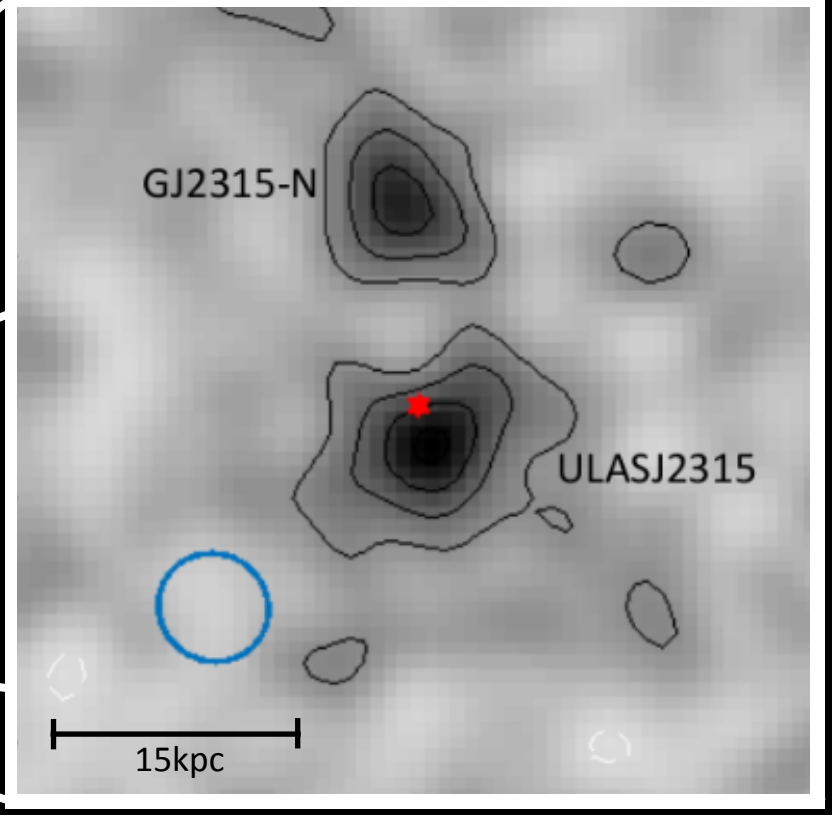
- We now aim to derive rates for the *obscured* star formation in reddened quasars
  → High rates could indicate the presence of mergers

- Compare rest-frame UV and sub-mm host properties

THE SUB-MM: MERGER EVIDENCE?

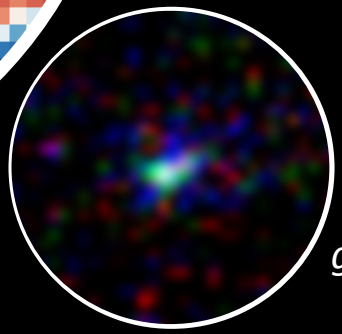
850μm dust map (SCUBA2)





M.Banerji *et al.* – *in prep.*

CO(3-2) gas map (ALMA)

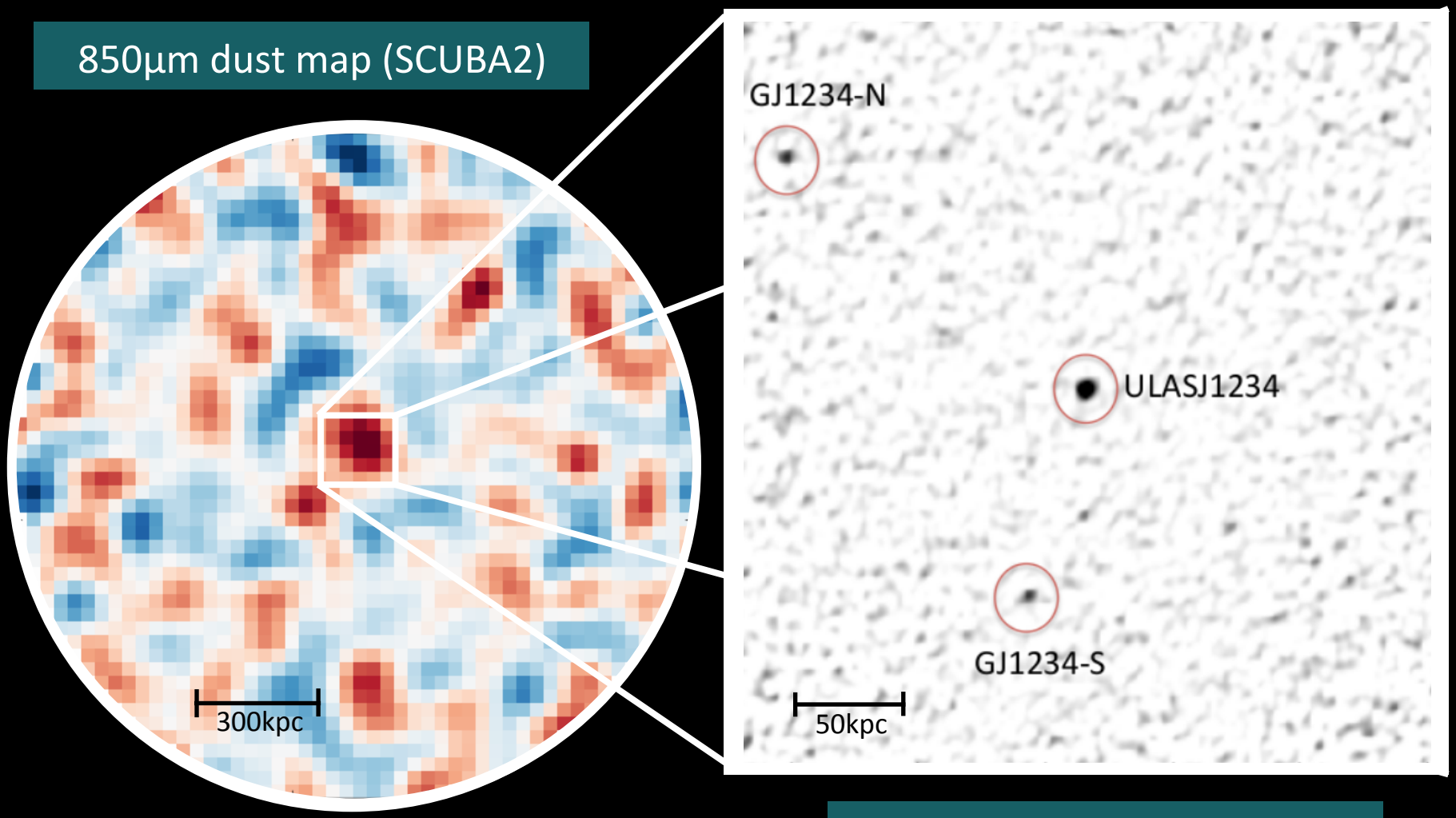


g,r,i colour image
(DES Y1)

C. Wethers *et al.* (2017b) – *in prep.*

THE SUB-MM: MERGER EVIDENCE?

M.Banerji *et al.* (2017)



C. Wethers *et al.* (2017b) – *in prep*

CONCLUSIONS

First rest-frame UV population study of quasar host galaxies at z~2
(a peak epoch in star-formation and BH accretion)

We derive moderate SFRs across the sample…
25 – 375 $M_{\odot}yr^{-1}$

… although the rates we derive are likely tracing only a small fraction of the total star formation
sub-mm observations will provide better estimate of total SFR

Possible evidence for mergers in trend between QSO L_{bol} and UV SFR and in ALMA observations

THANK YOU FOR LISTENING! ☺