Insights on the AGN-Galaxy Connection at z~2 from CANDELS

Dale Kocevski

Colby College

with

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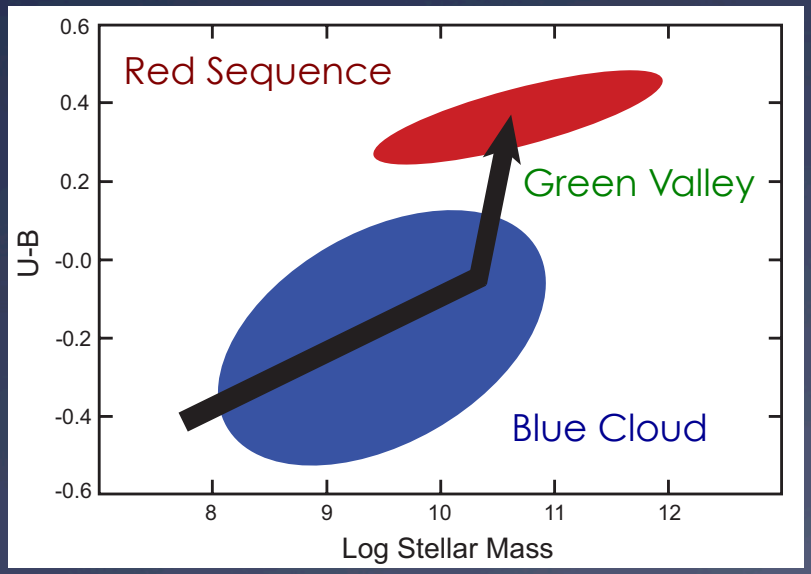
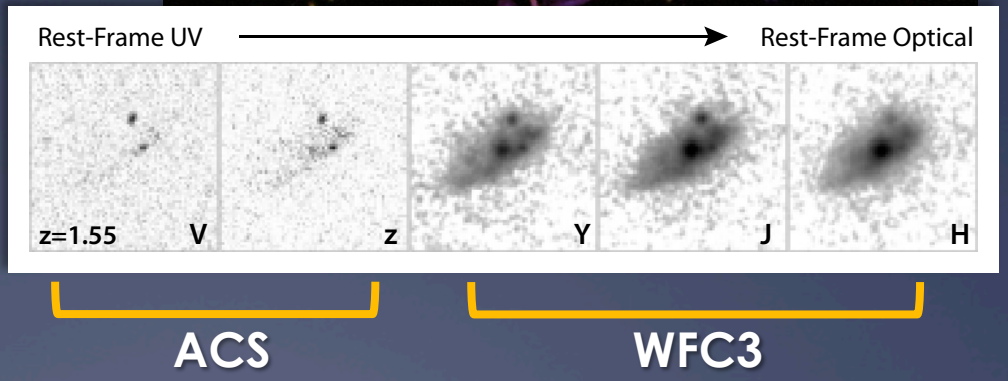
Guillermo Barro, and the CANDELS Collaboration

CANDELS and the AGN-Galaxy Connection

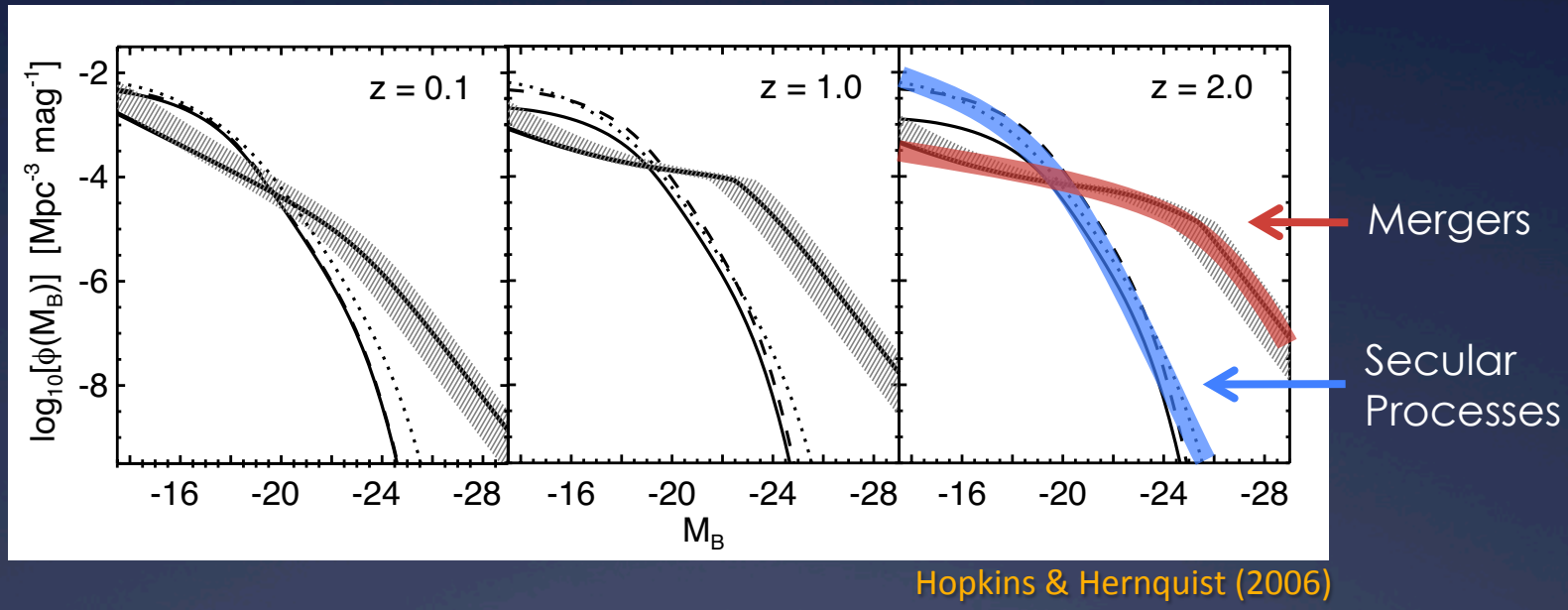
* What triggers AGN activity at z~2?
  Using host morphologies to determine mechanisms that fuel BH growth.

* What role do AGN play in quenching first generation of passive galaxies?
  Using host stellar populations to study SF shutdown in AGN hosts at z~2-3.





Redshift Evolution of AGN Fueling Modes

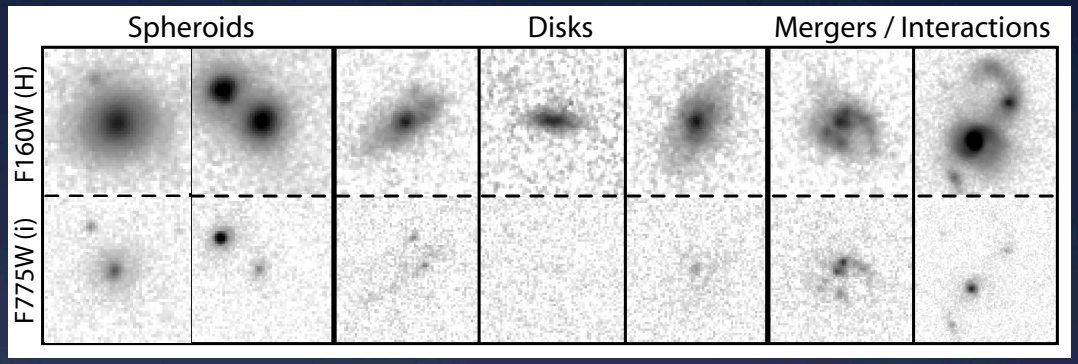


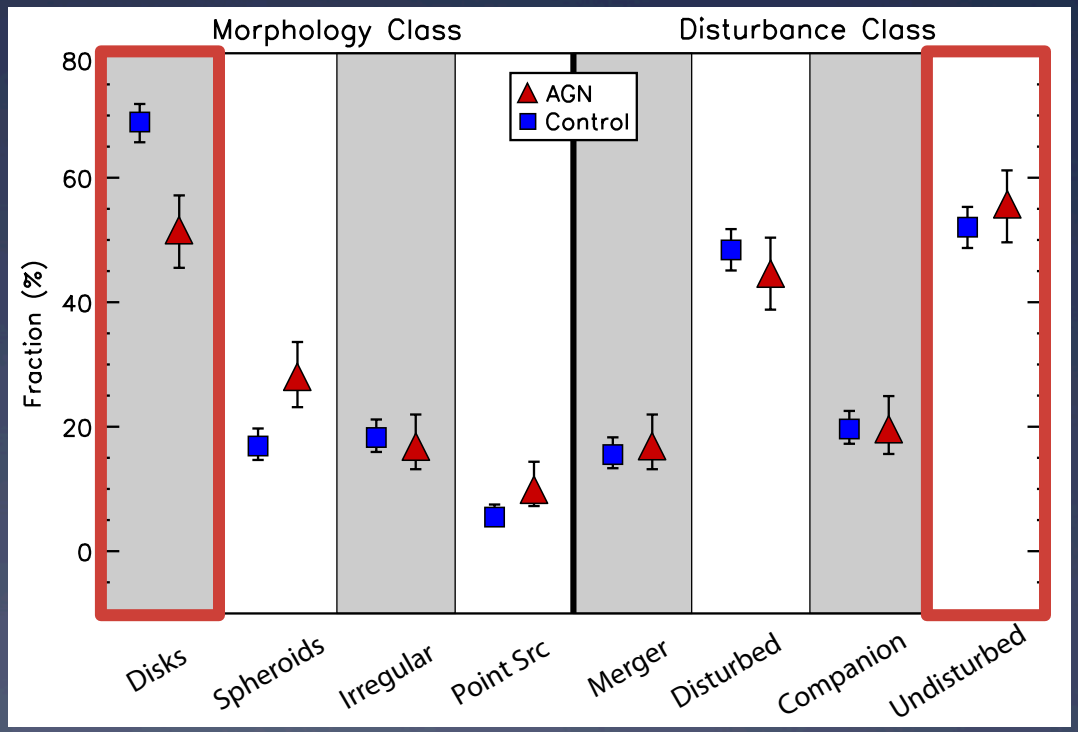
Hopkins & Hernquist (2006)

* Two fueling modes: merger-driven accretion & stochastic accretion
* Frequency of merger-driven accretion evolves rapidly with redshift. At z~2, mergers expected to be dominant fueling mode.

AGN Host Morphologies at z~2

* Most X-ray selected AGN at z~2 are not found in interacting galaxies.
* High disk fraction suggests stochastic fueling more important than predicted by fueling models.
* In agreement with previous results:
  * Grogin et al. (2005)
  * Cisternas et al. (2011)
  * Schawinski et al. (2011)





Kocevski et al (2012)

New Constraints for AGN Fueling Models

Do We Expect Most AGN to Live in Disks?

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[2]*University of California Observatories/Lick Observatory, and Department of Astronomy and Astrophysics, University of*
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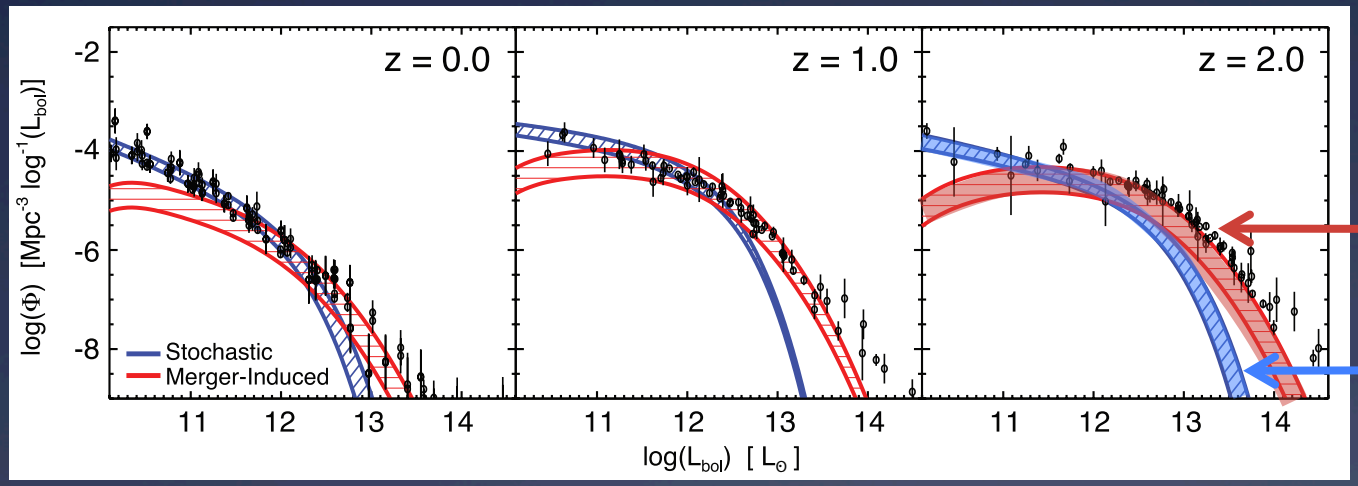
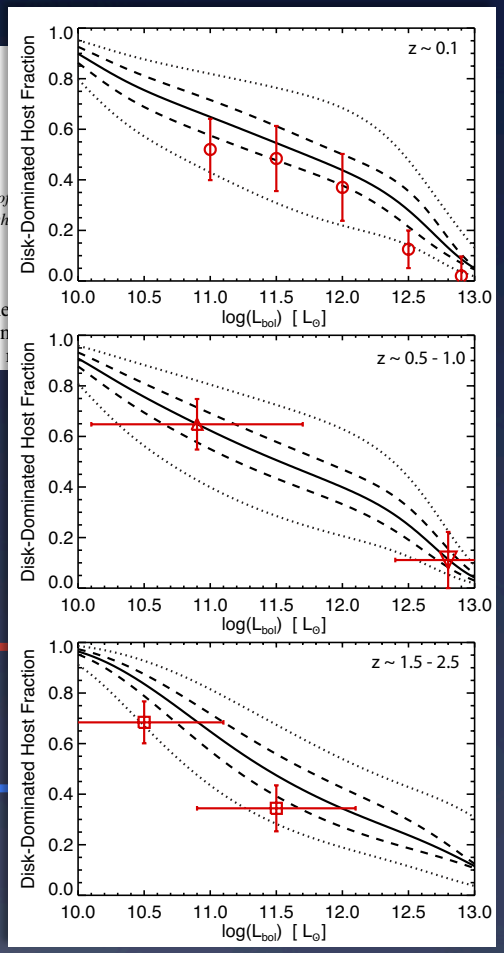
ABSTRACT

Recent observations have indicated that a large fraction of the low to interme
lation lives in disk-dominated hosts, while the more luminous quasars live in
may or may not be major merger remnants), in conflict with some previous



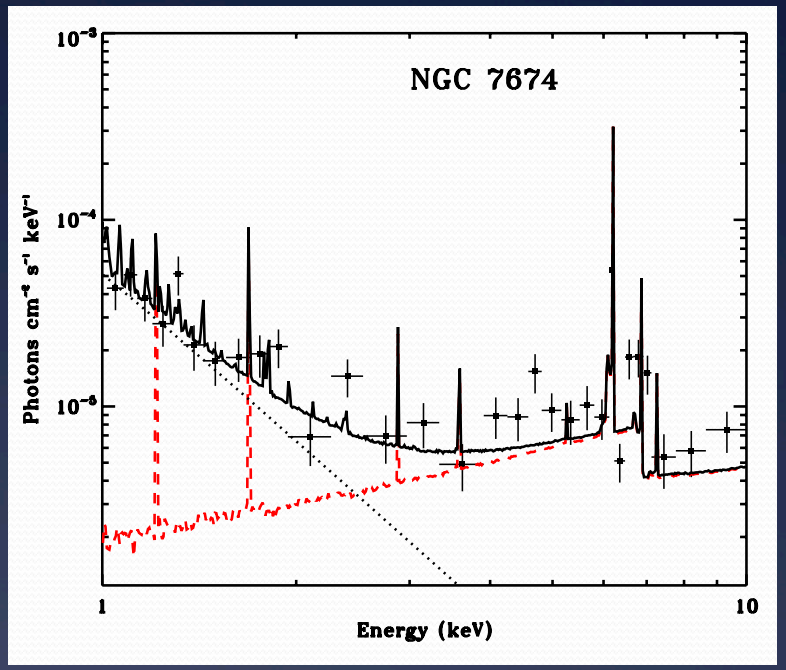


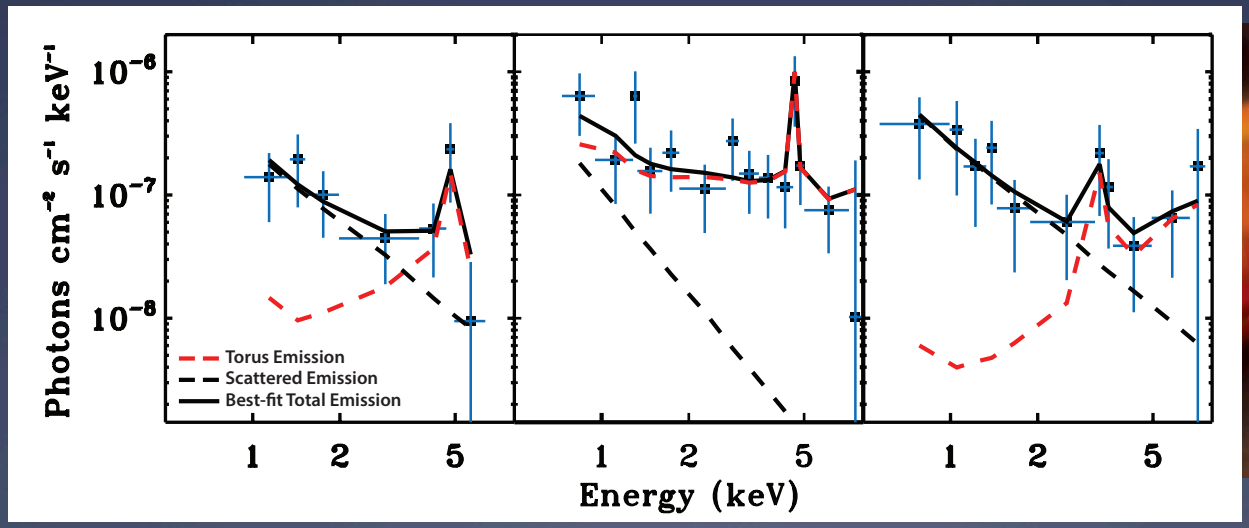
Hopkins et al. (2014)

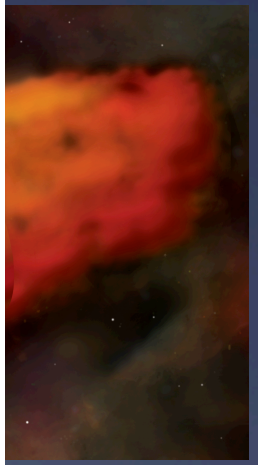
- High gas fractions at z~2 results in ubiquitous AGN activity in undisturbed disk galaxies.
- Substantial merger-driven Black Hole growth still predicted.

Finding Obscured AGN via X-ray Spectroscopy

- Heavily obscured, Compton-thick AGN can be identified using X-ray spectroscopy.
- 'Reflection dominated' spectra exhibit excess soft X-ray emission and intense Iron Kα fluorescence line.
- Deep Chandra observations allow for detection of CT-AGN at high z.



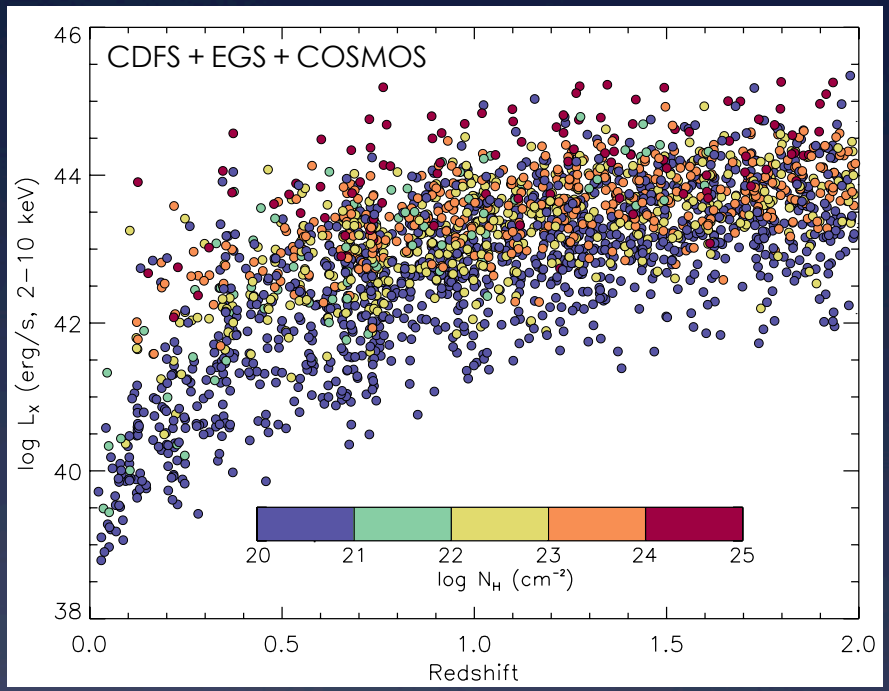


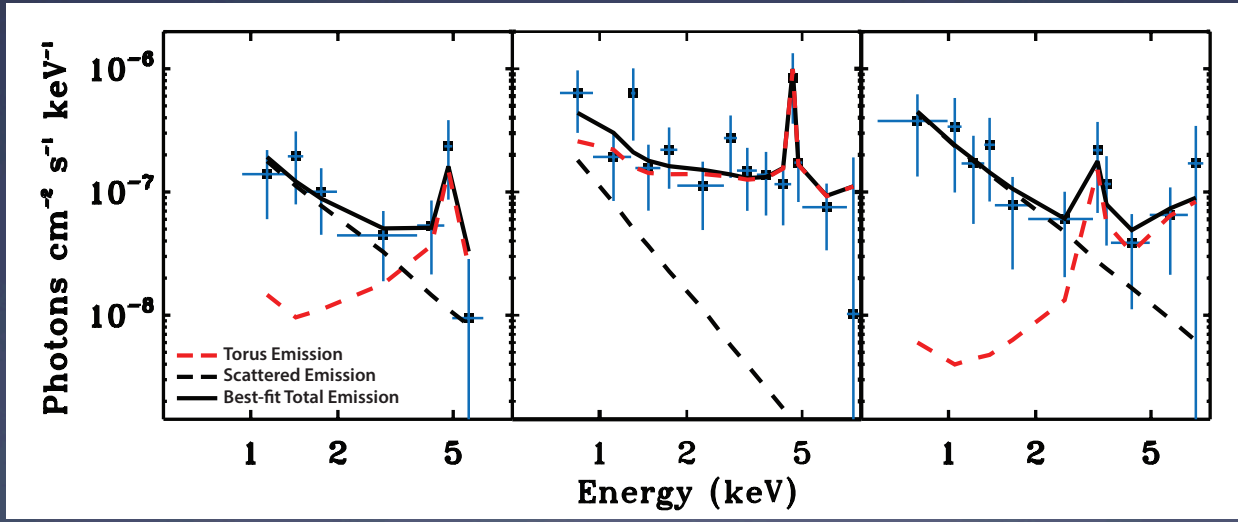


Brightman et al. (2014)

Host Morphology vs Obscuration

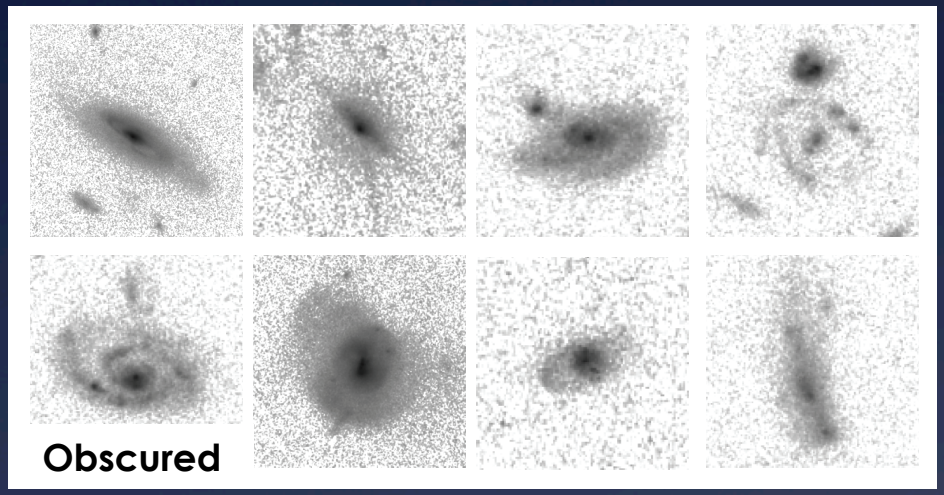
- Heavily obscured, Compton-thick AGN identified by their 'reflection dominated' X-ray spectra.
- Host Morphology Comparison (z~1):
  - 121 Heavily Obscured AGN with $N_H > 10^{23.5}$ cm^{-2}
  - 279 Moderately Obscured AGN with $N_H = 10^{22 - 23.5}$ cm^{-2}
  - 281 Unobscured AGN with $N_H < 10^{22}$ cm^{-2}

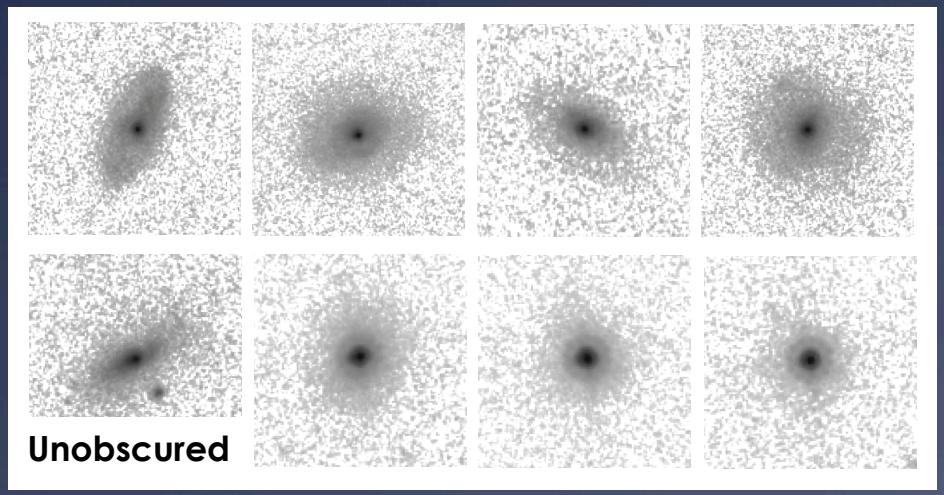


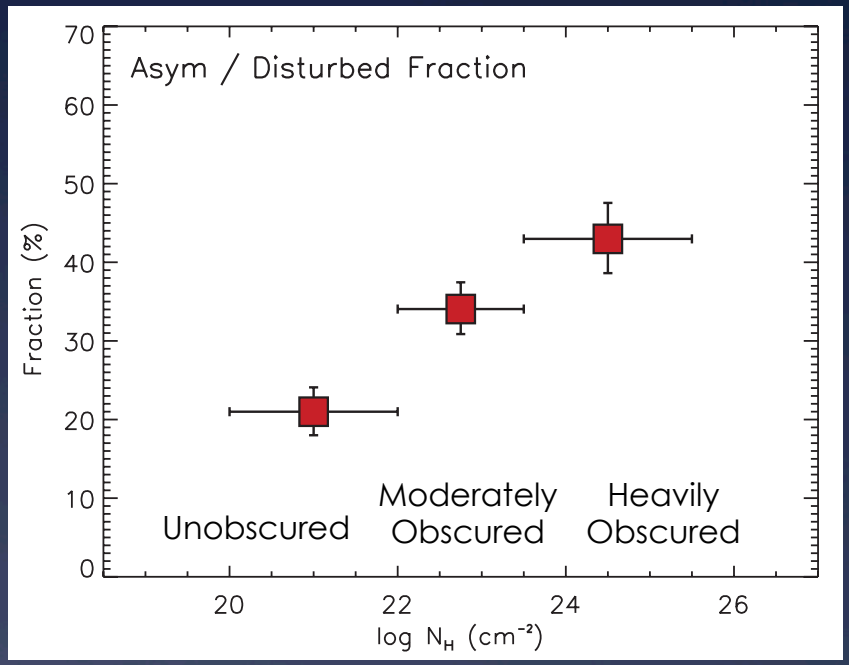


Brightman et al. (2012)

Mergers Hidden by Obscuration?



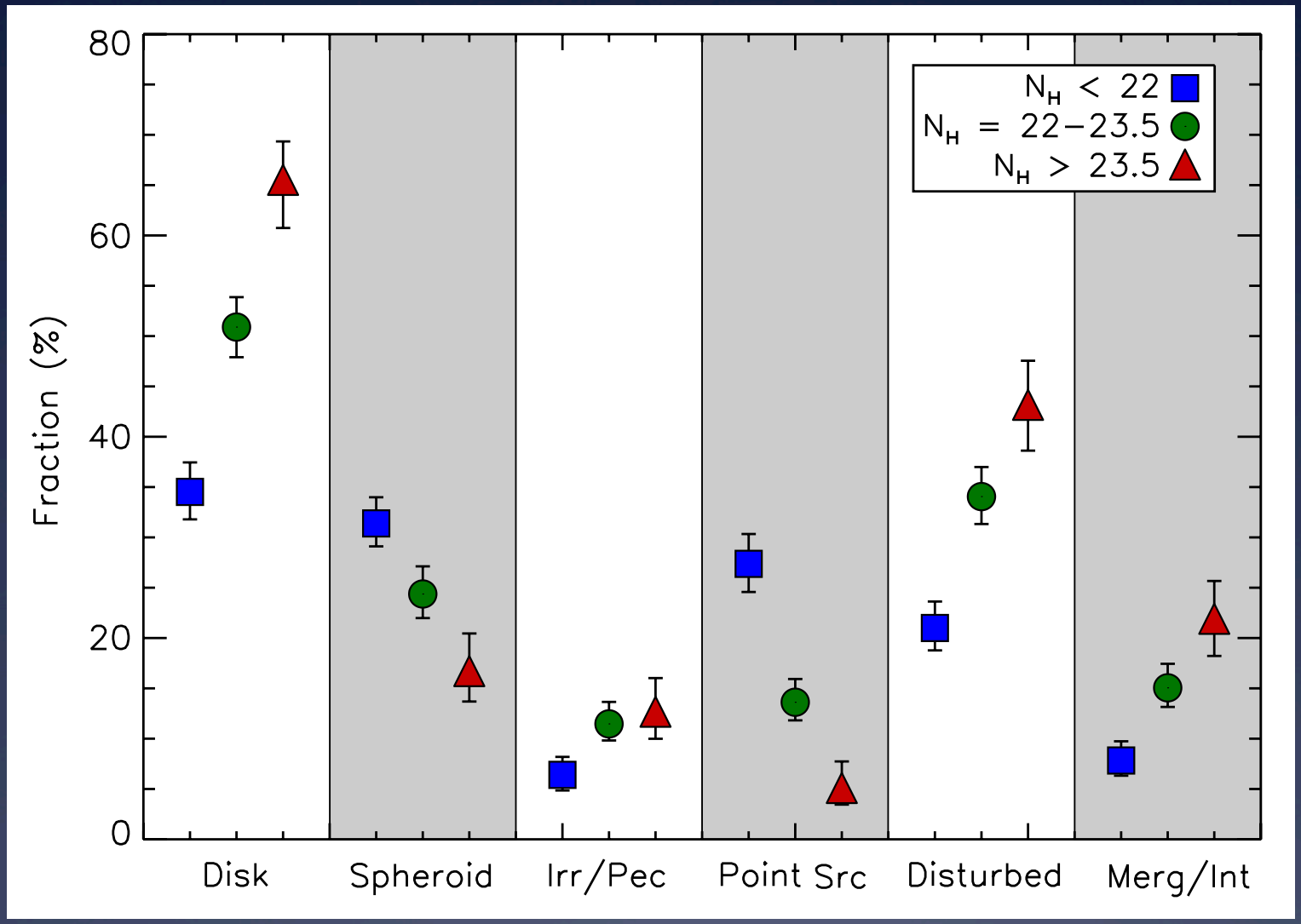




Kocevski et al. (2014)

* Heavily obscured AGN are more disturbed than their unobscured counterparts *at fixed luminosity*.

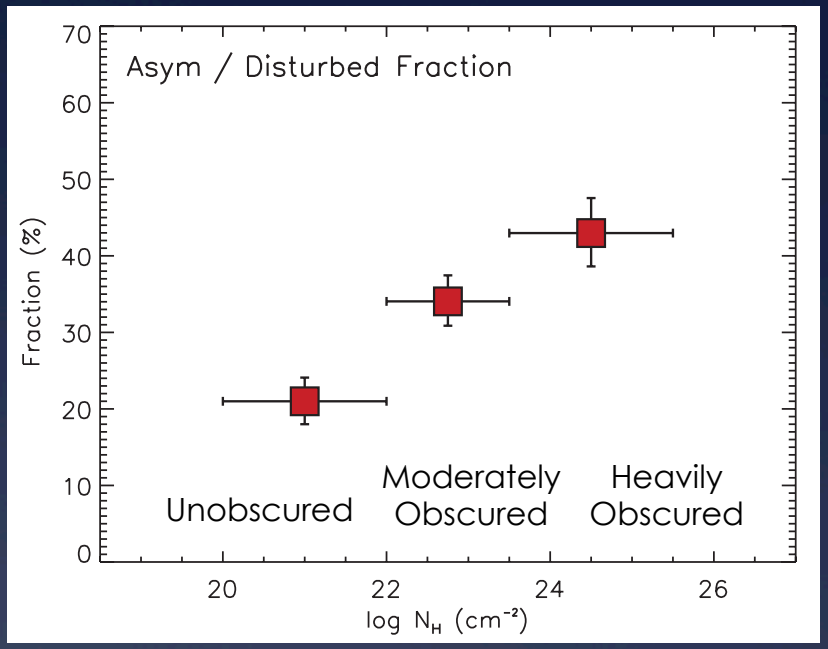
Host Morphology vs Obscuration



Kocevski et al. (2014)

Mergers Hidden by Obscuration?

* Excess of disturbed morphs vs obscuration consistent with evolutionary sequence.
* Incompleteness at high obscuration may explain lack of convincing AGN-merger connection.



Typical X-ray Selected AGN

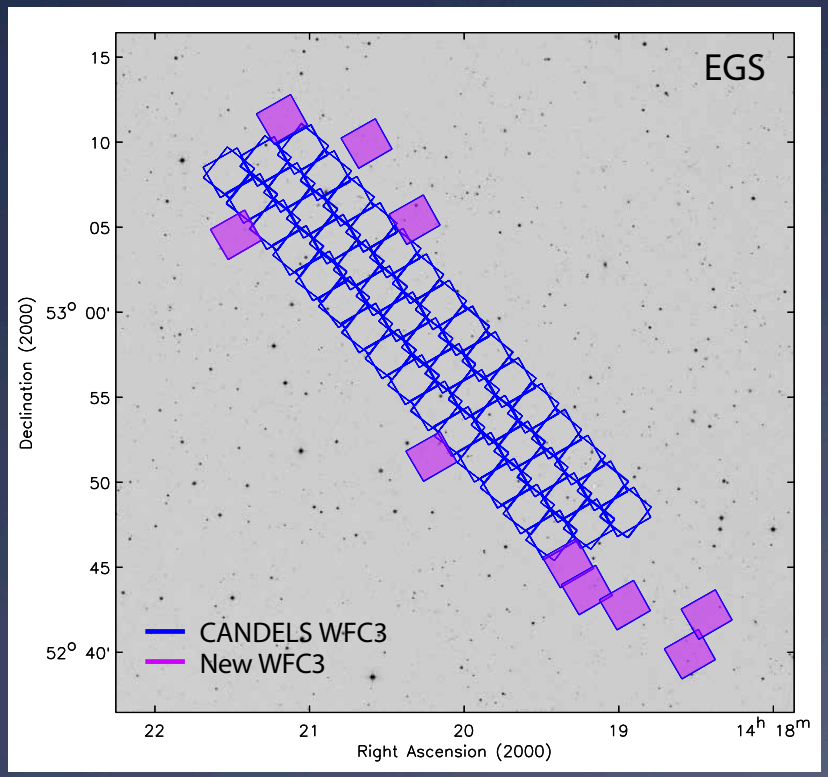
Heavily Obscured AGN

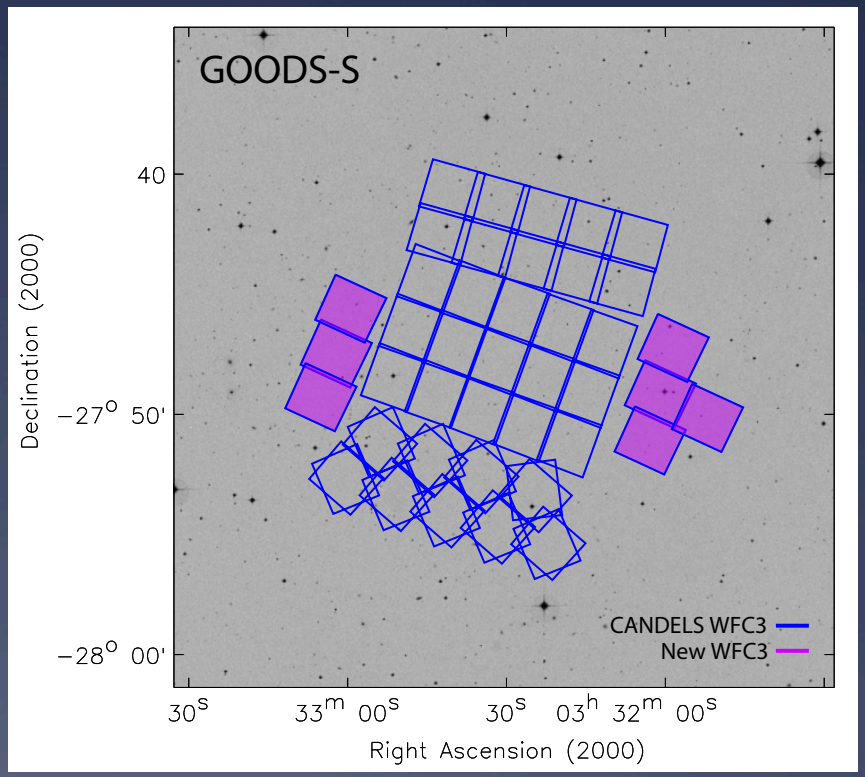
X-ray Undetected

Preferentially Unobscured

WFC3 Imaging of Obscured AGN at z~2

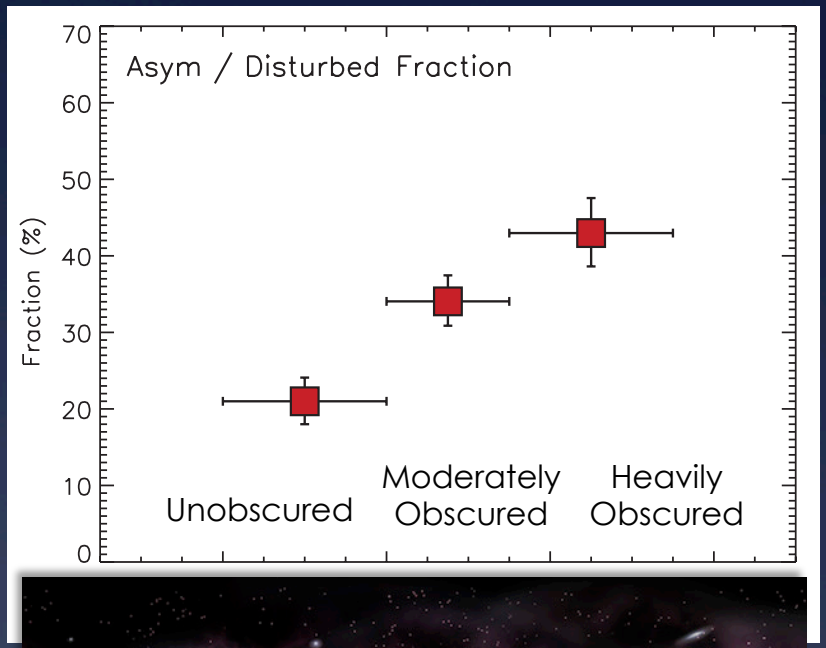
* Approved Cycle 22 program to obtain WFC3/F160W imaging of 33 Compton-thick AGN at z~2.
* 25 orbits in GOODS-S, EGS, and COSMOS fields. All pointings have existing ACS imaging.





What Triggers AGN Activity at z~2?

- High gas fractions at z~2 means secular processes more important than previously expected. High disk fraction consistent with updated fueling models.
- Heavily obscured AGN are more disturbed than their unobscured counterparts at fixed luminosity.
- Conclusion: Many luminous AGN in disks + incompleteness at high obscuration may explain lack of convincing AGN-merger connection at z~2.



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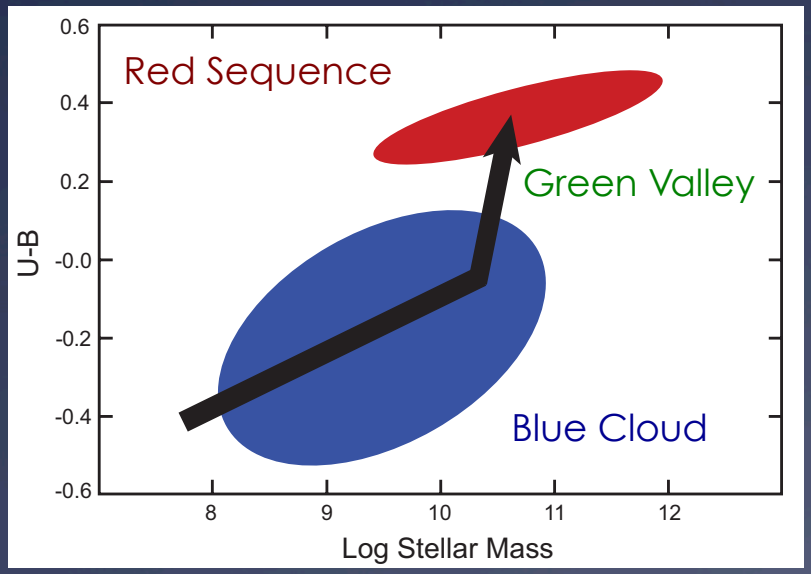
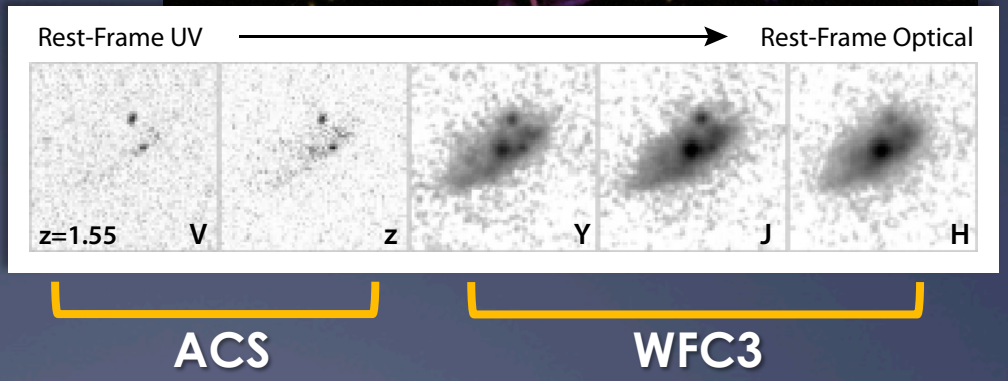
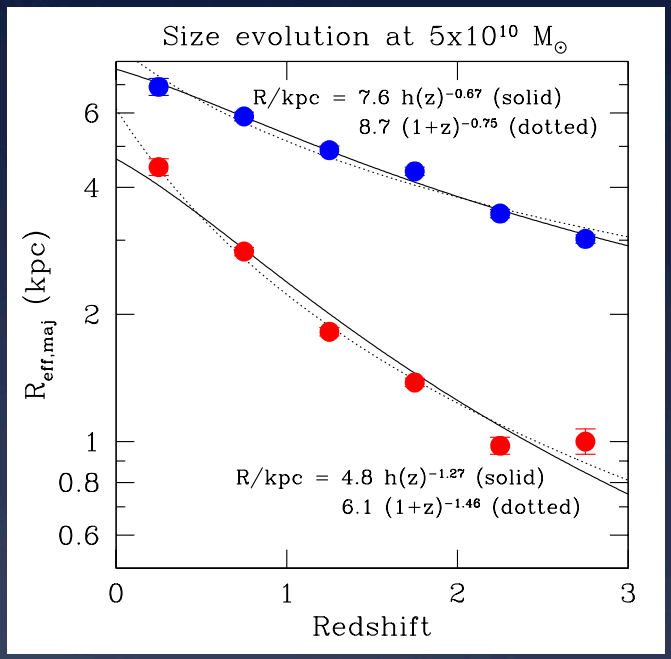


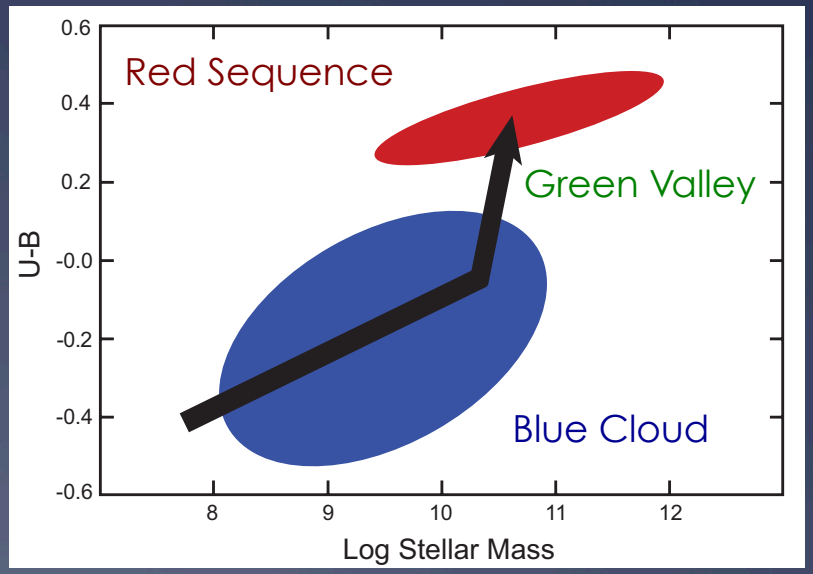


AGN at the Quenching Threshold

* Quenched galaxies at z~2 are substantially more compact than present day counterparts.
* Quenching pathway: galaxies need to shrink in size and reduce their star formation activity.
* CANDELS has identified the compact star forming progenitors of the "Red Nugget" population: Barro et al. (2013)



van der Wel et al. (2013)



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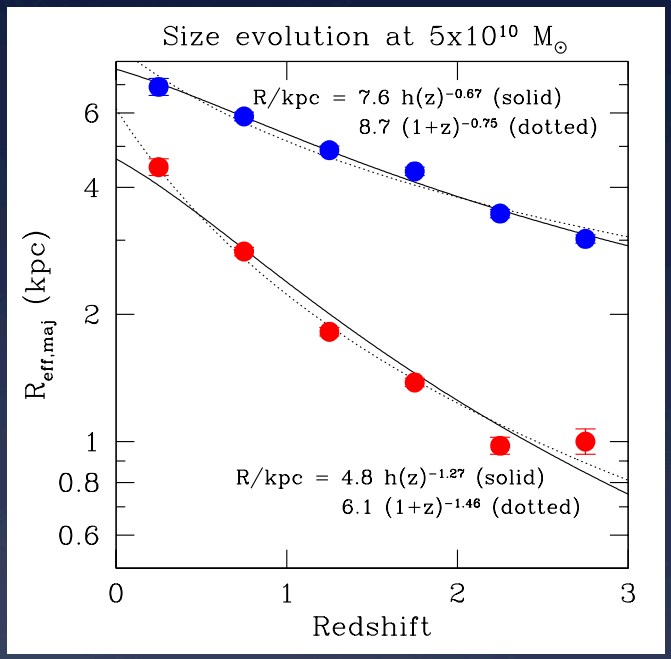
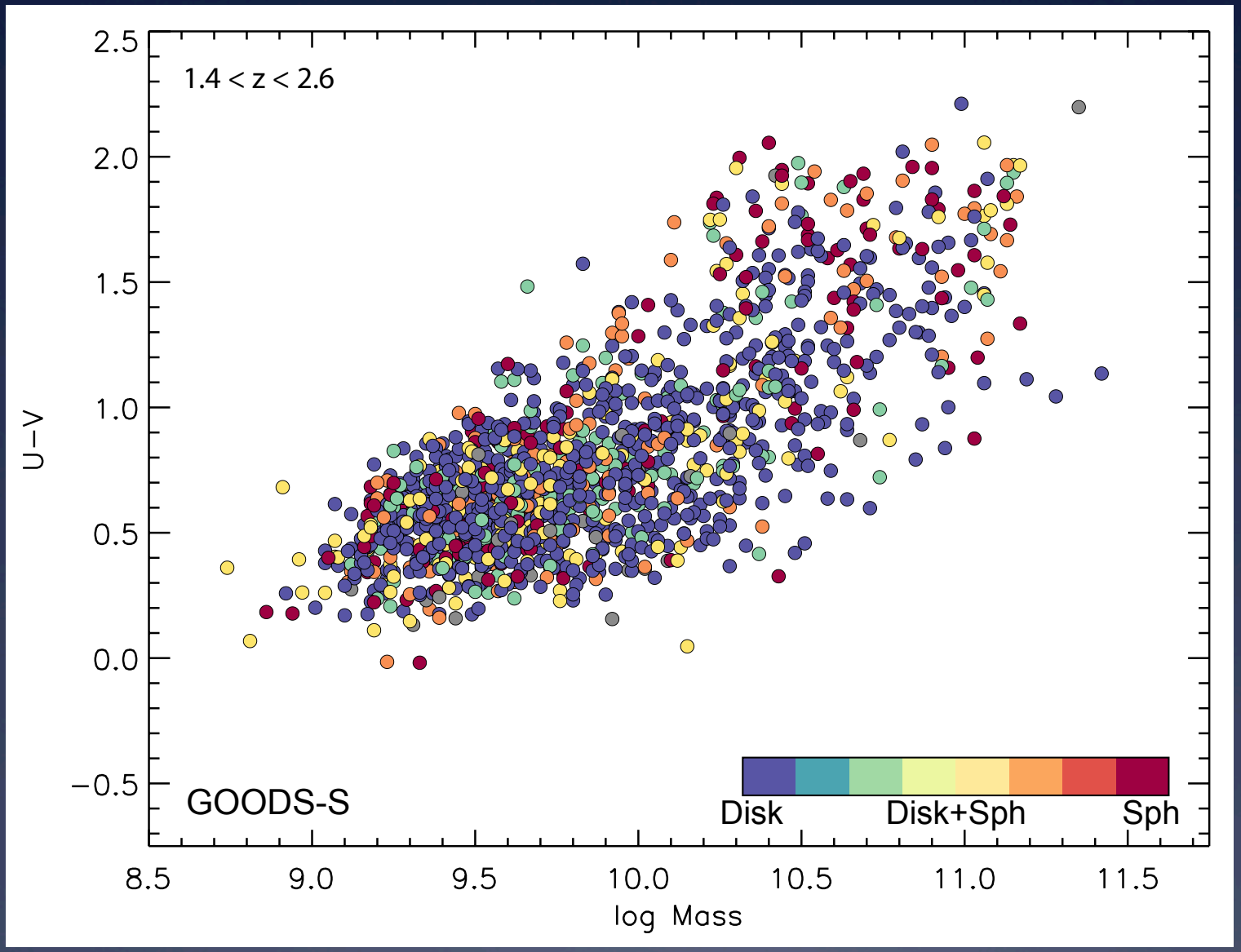


van der Wel et al. (2013)

CANDELS: THE PROGENITORS OF COMPACT QUIESCENT GALAXIES AT $z \sim 2$

Guillermo Barro[1], S. M. Faber[1], Pablo G. Pérez-González[2,3], David C. Koo[1], Christina C. Williams[4], Dale D. Kocevski[1], Jonathan R. Trump[1], Mark Mozena[1], Elizabeth McGrath[1], Arjen van der Wel[5], Stijn Wuyts[6], Eric F. Bell[7], Darren J. Croton[8], Ceverino Daniel[9], Avishai Dekel[9], M. L. N. Ashby[10], Edmond Cheung[1], Henry C. Ferguson[11], Adriano Fontana[12], Jerome Fang[1], Mauro Giavalisco[4], Norman A. Grogin[11], Yicheng Guo[1,4], Nimish P. Hathi[13], Philip F. Hopkins[14], Kuang-Han Huang[11], Anton M. Koekemoer[11], Jeyhan S. Kartaltepe[15], Kyoung-Soo Lee[16], Jeffrey A. Newman[17], Lauren A. Porter[18], Joel R. Primack[18], Russell E. Ryan[11], David Rosario[6], Rachel S. Somerville[19], Mara Salvato[6], and Li-Ting Hsu[6]

Quenching Pathways at z~2



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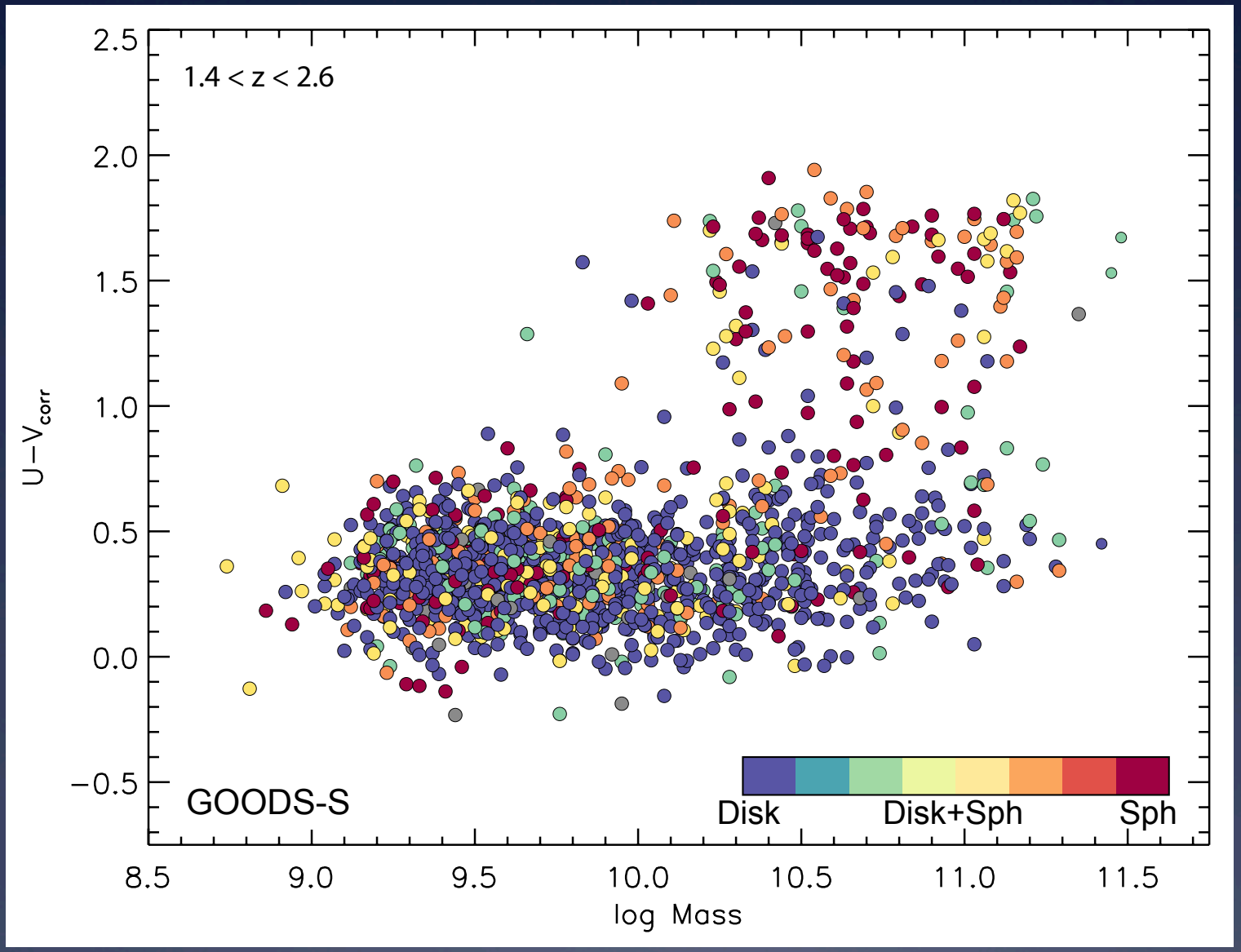

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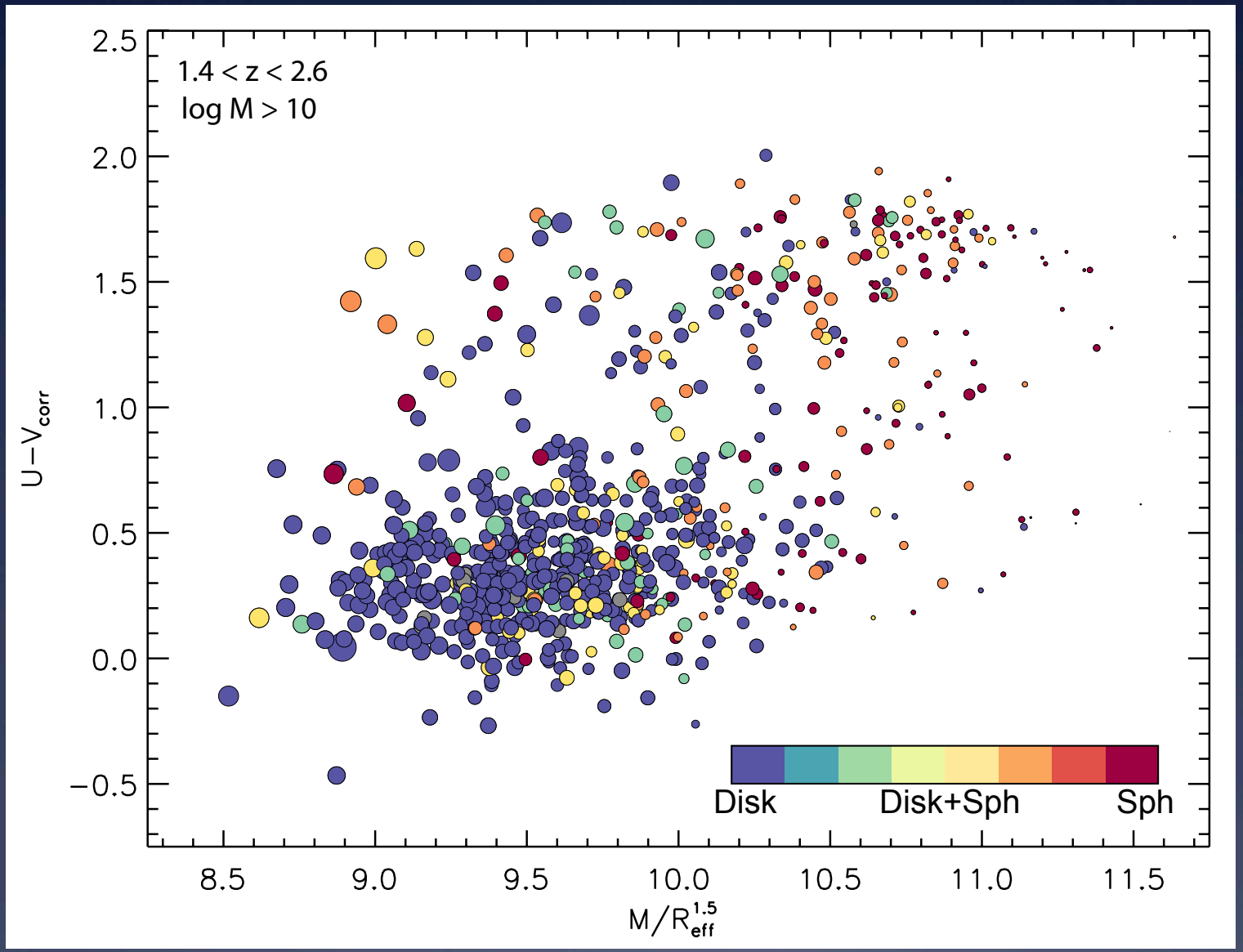

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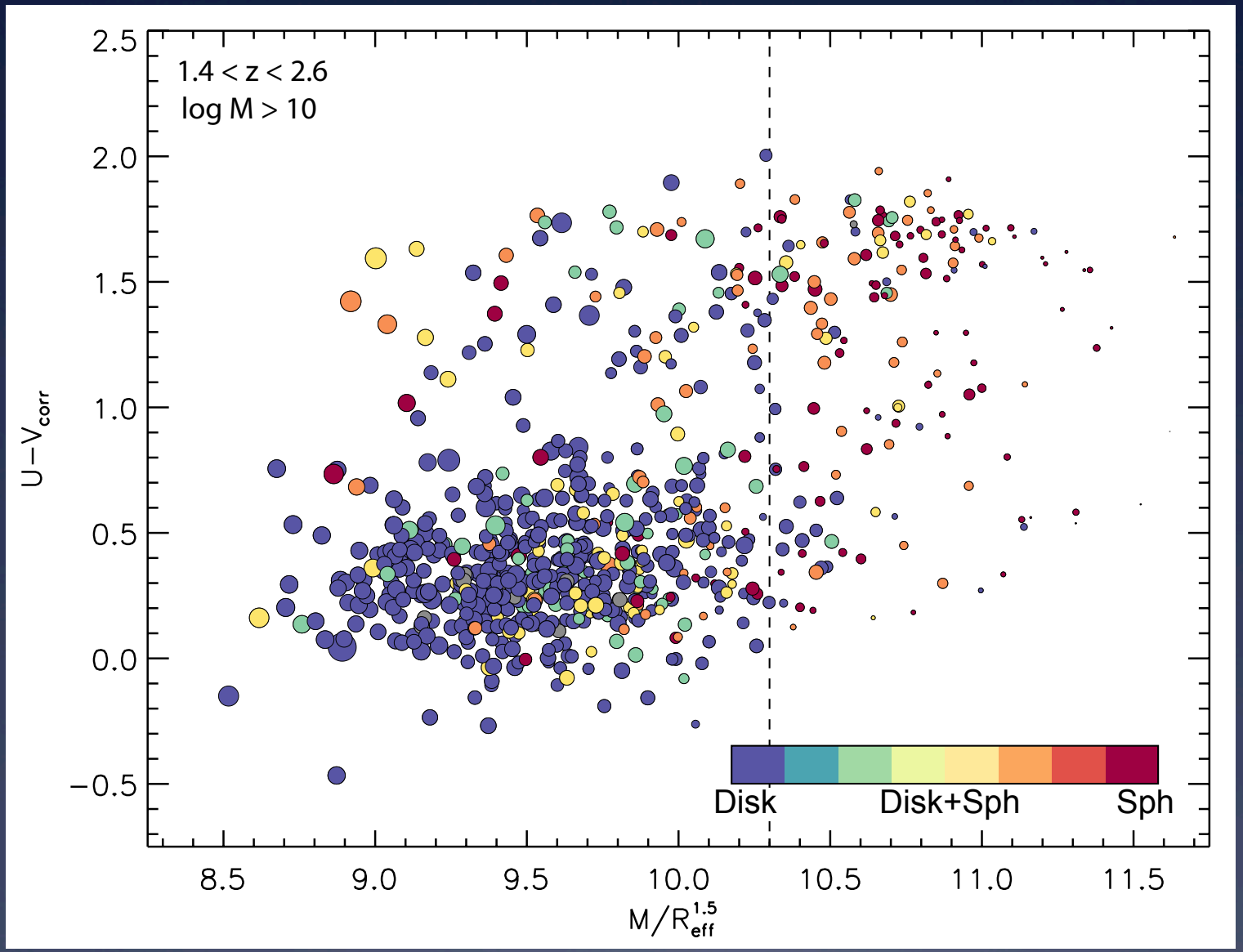
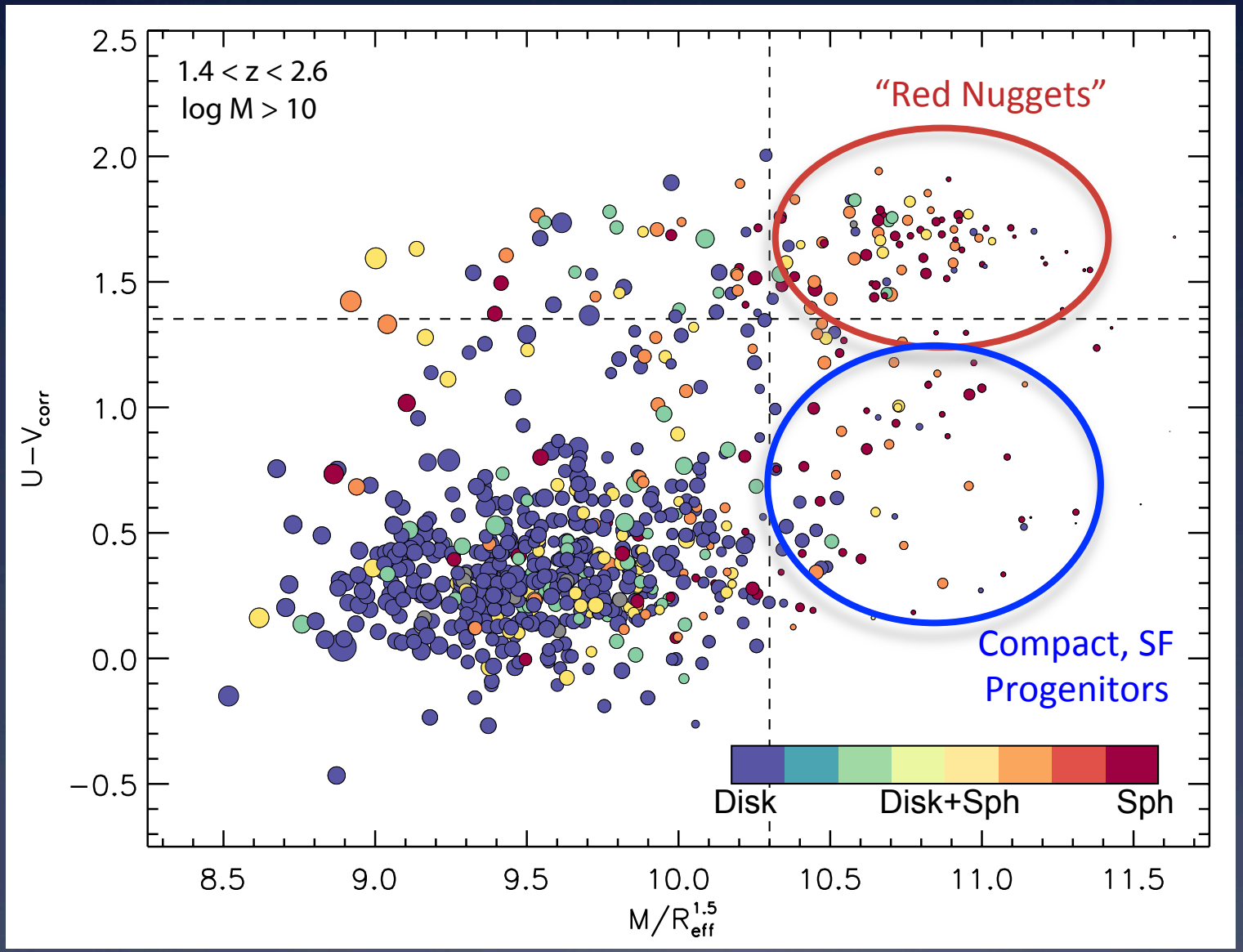


Quenching Pathways at z~2



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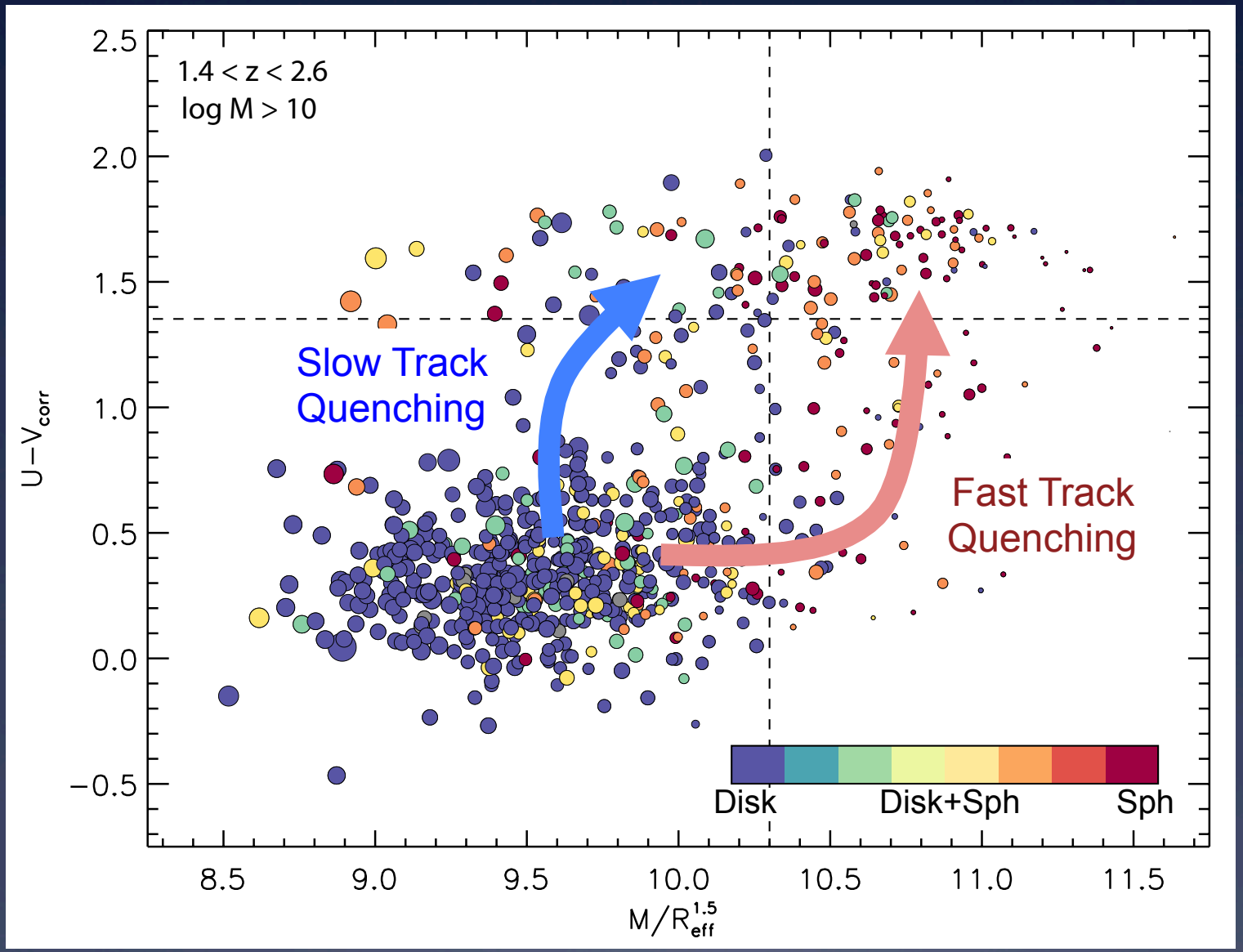
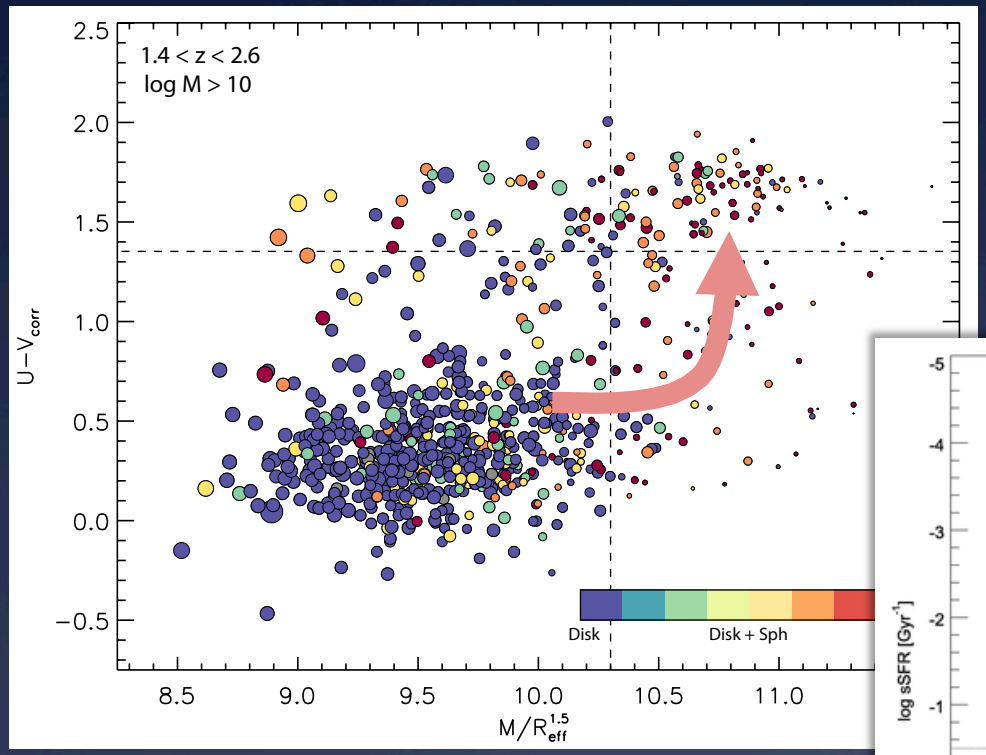
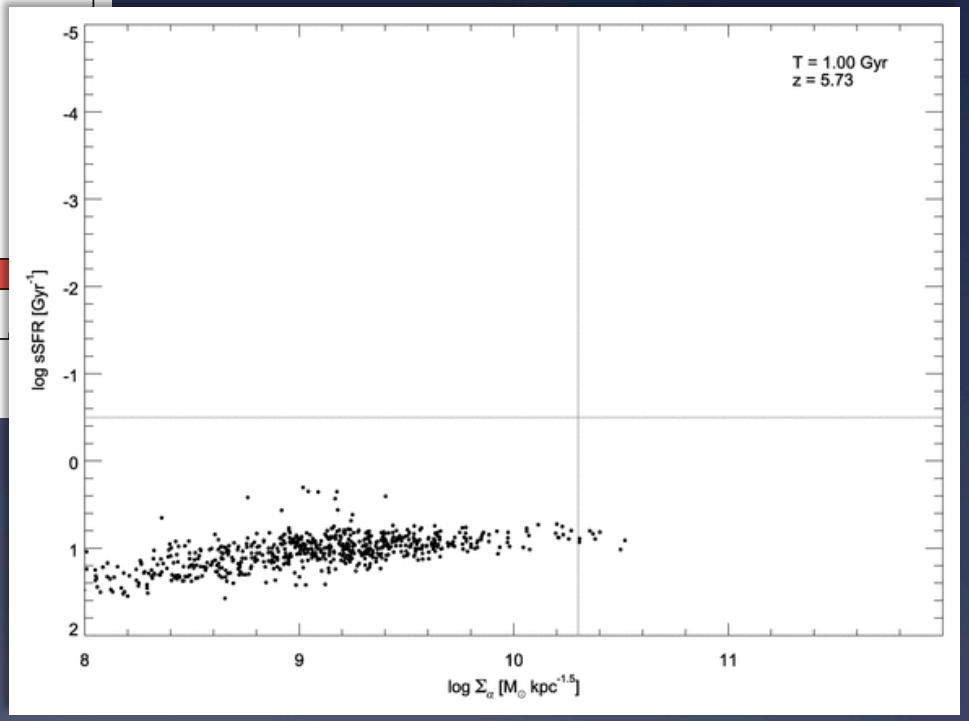


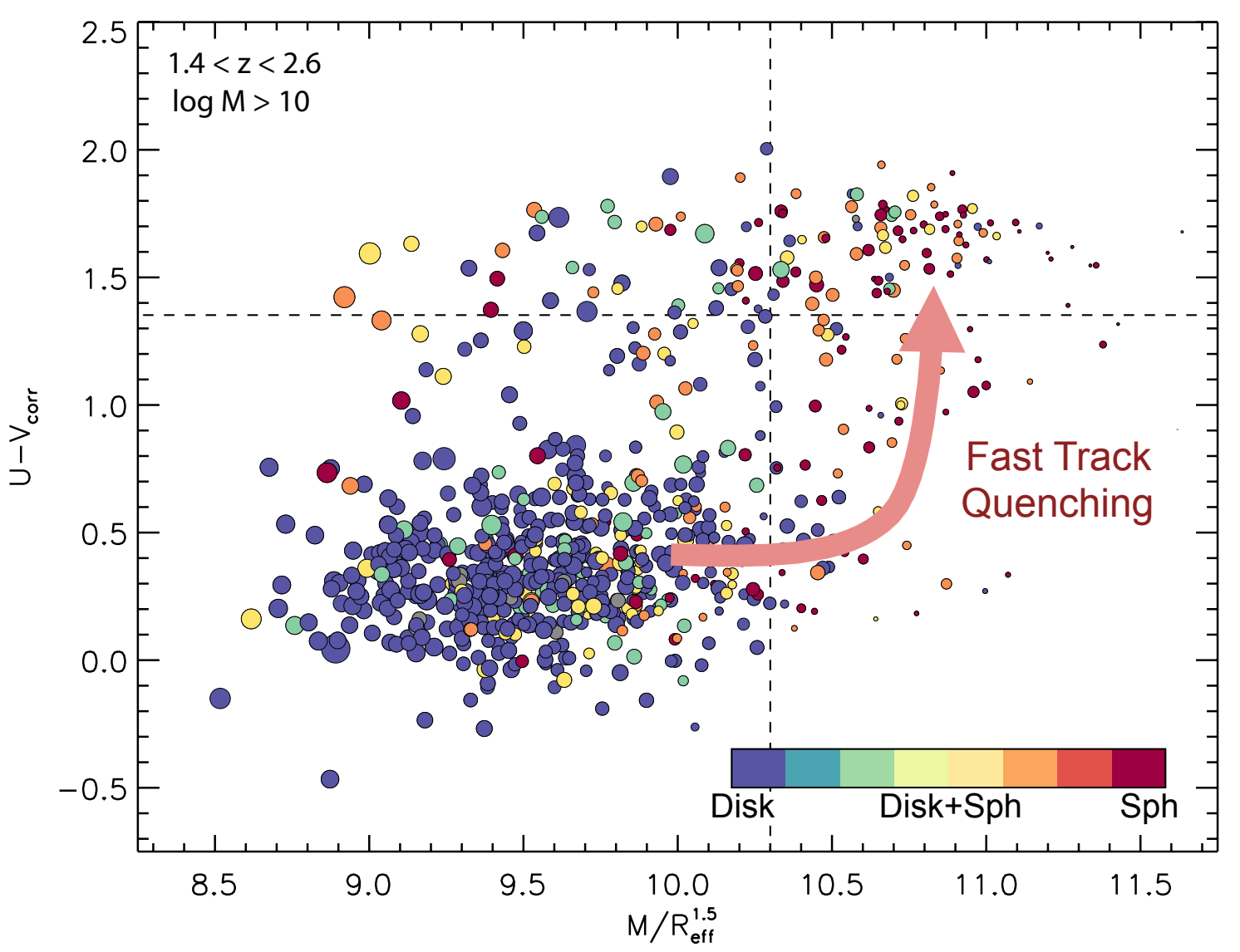
Fast-Track Quenching



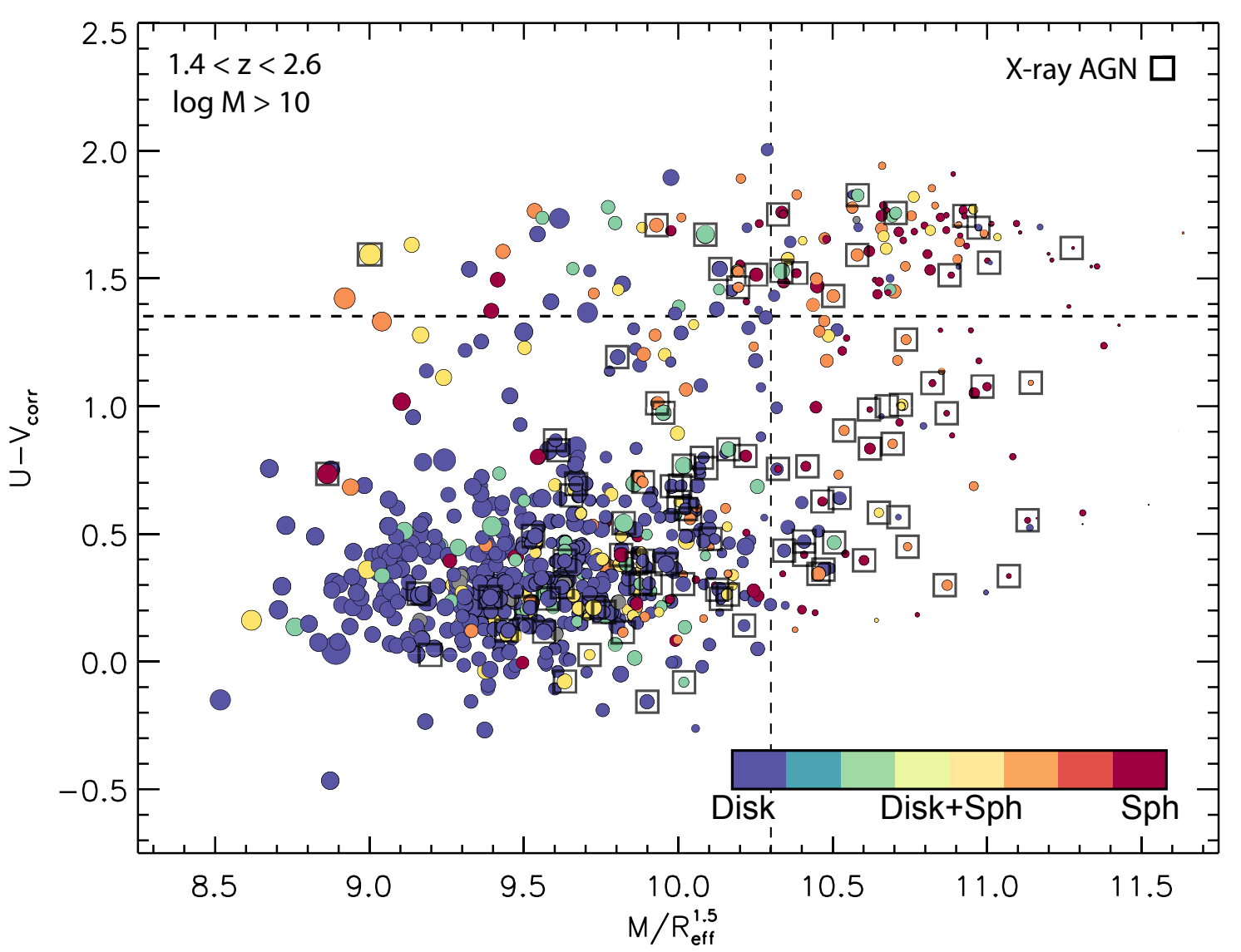


Courtesy Joel Primack & Lauren Porter

Quenching Pathways at z~2



AGN at the Quenching Threshold



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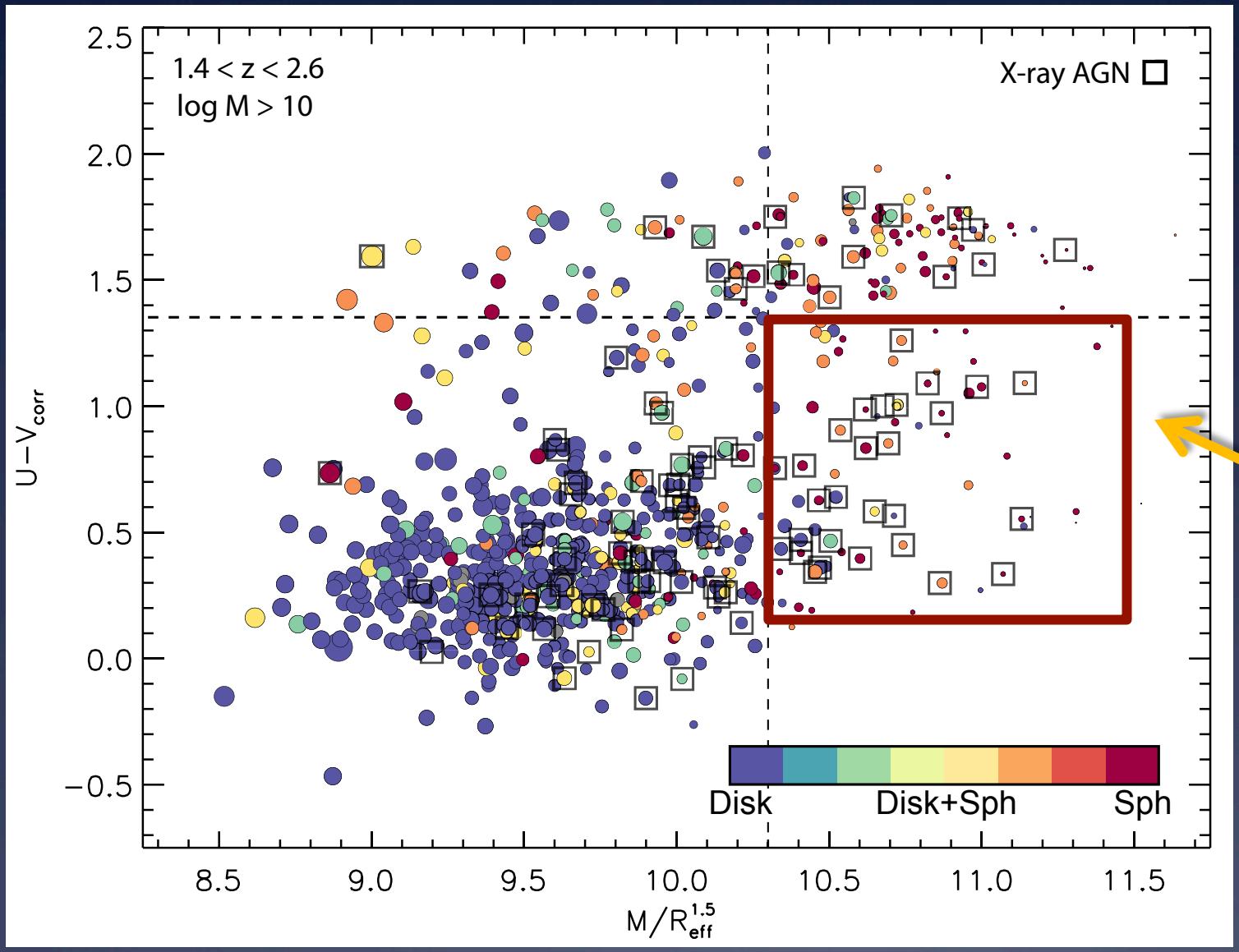
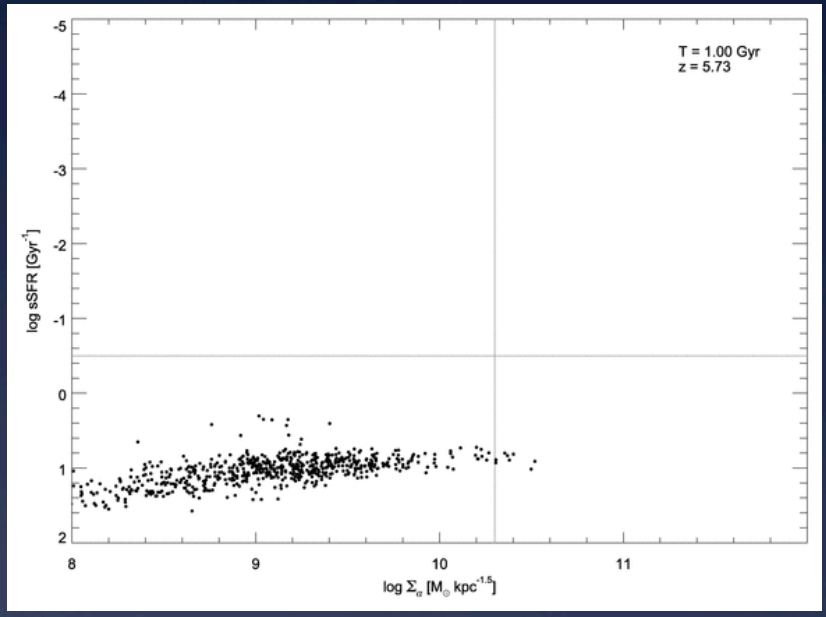
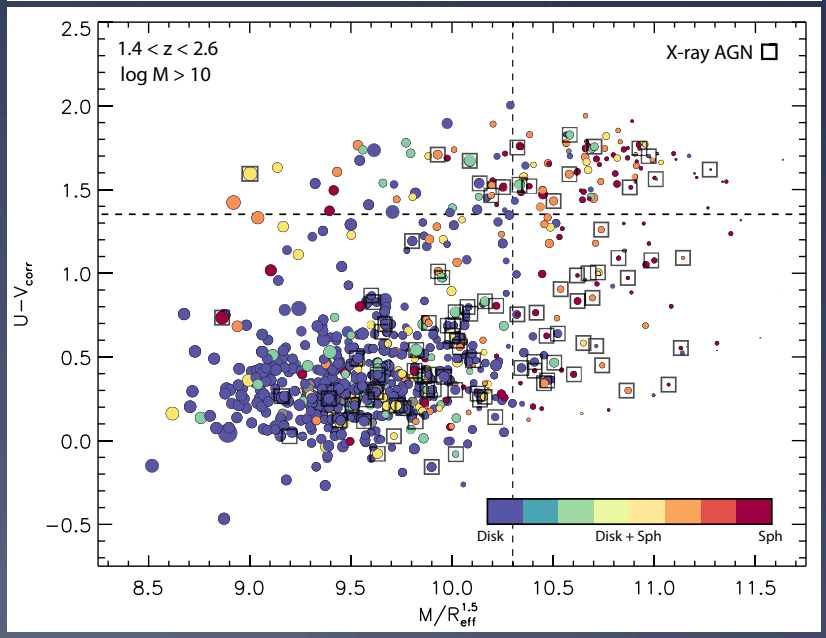


X-ray AGN Fraction: 48%

AGN at the Quenching Threshold

* At log M > 10, large fraction (48%) of compact, star forming galaxies host an X-ray luminous AGN.
* First generation of quenched galaxies emerged directly following a phase of rapid Black Hole growth.
* Hints at possible role of AGN feedback in the quenching process.





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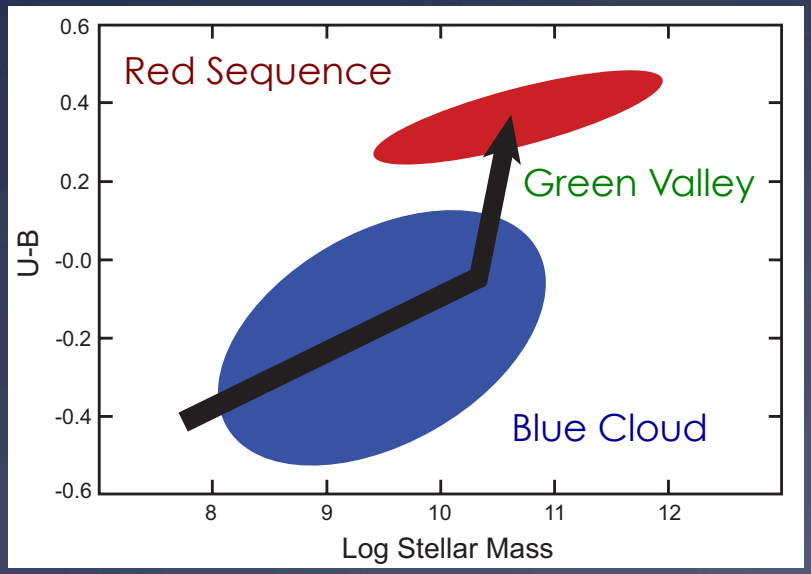

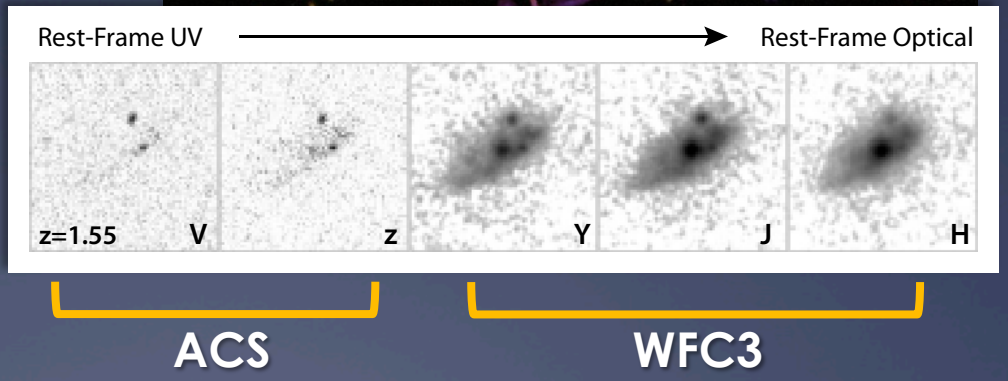

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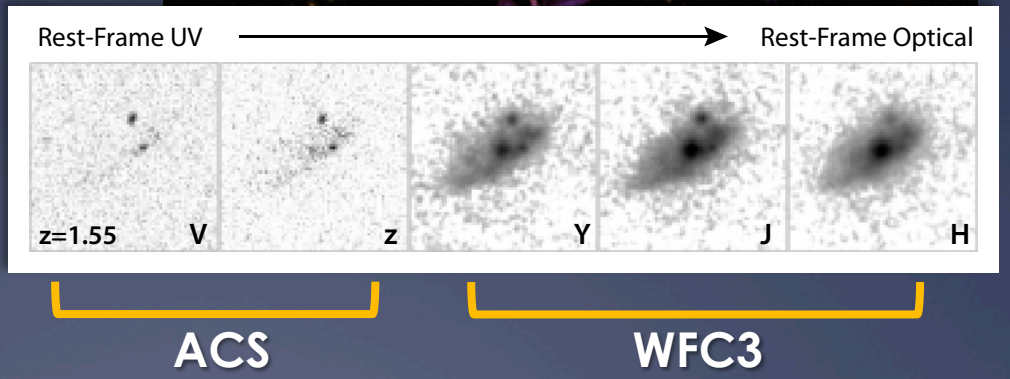
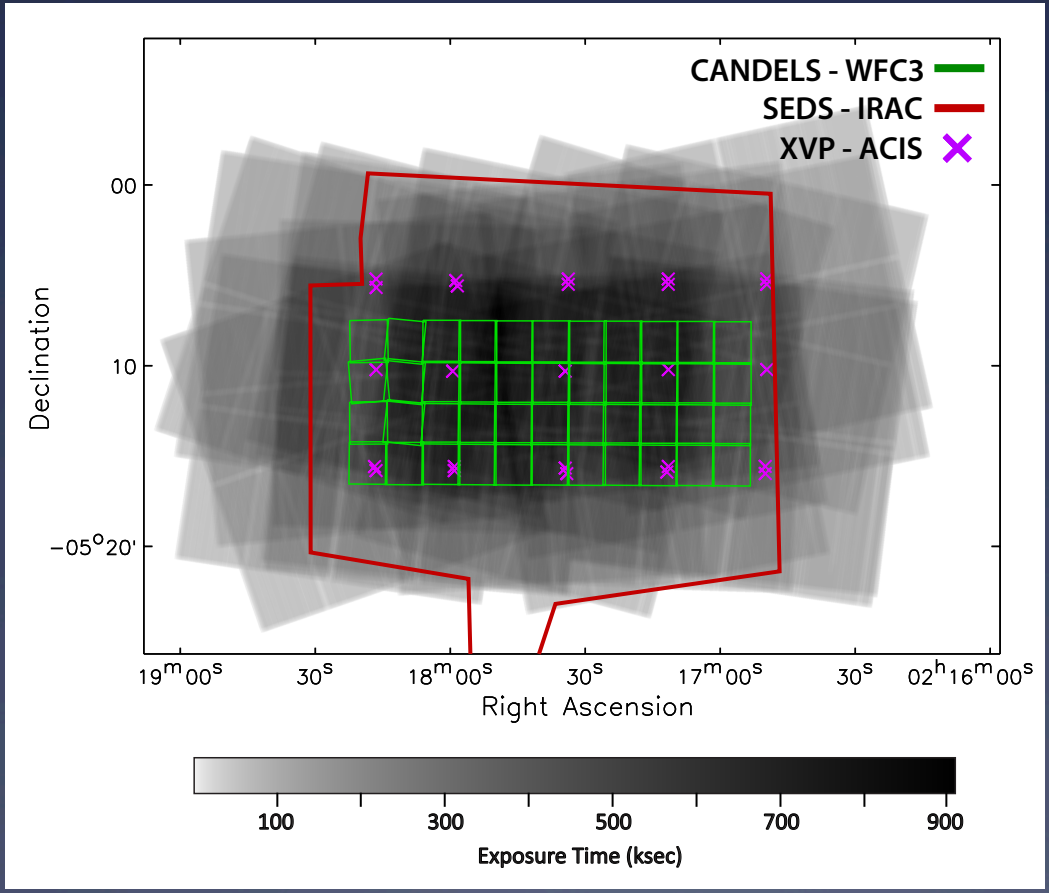
* Future Work: The UDS XVP Survey



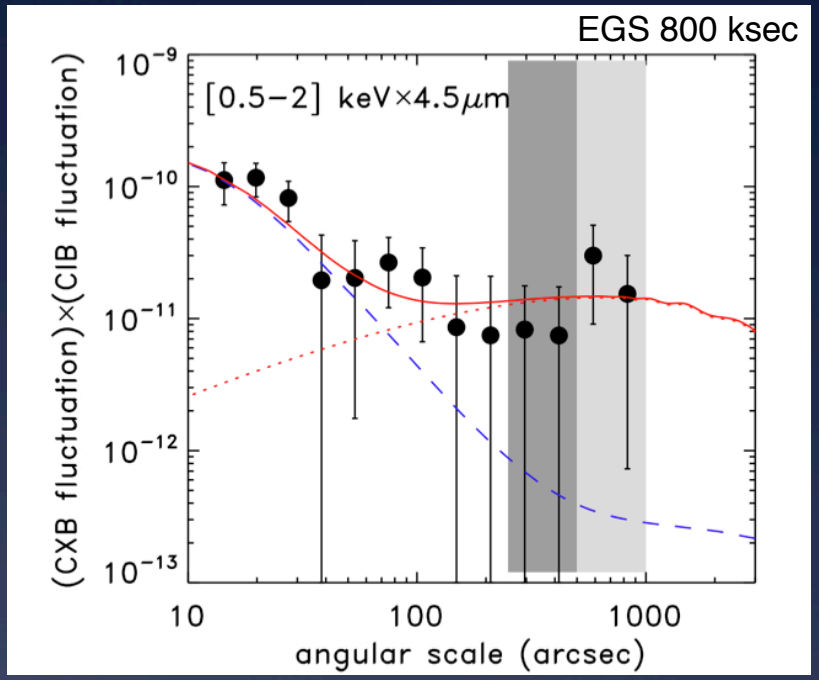
UDS XVP Survey

* Approved Cycle 16 Chandra X-ray Visionary Project
  PIs: G. Hasinger, D. Kocevski
* 25 ACIS-I pointings covering 22'x22' SEDS area in UKIDSS/UDS
* 1.25 Msec total - average exposure of 700 ksec in CANDELS region.

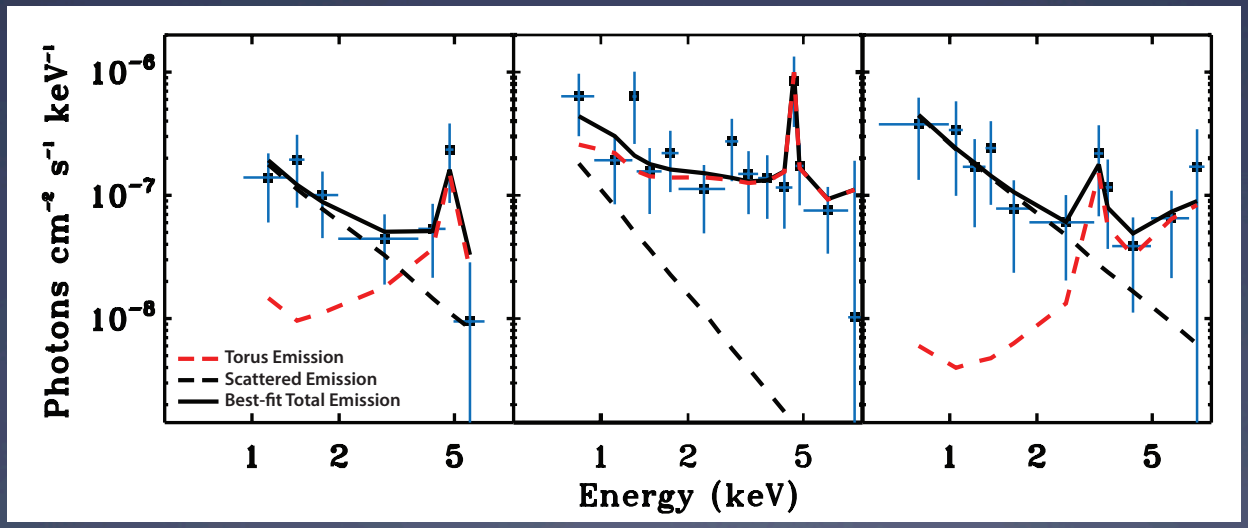


UDS XVP Survey

- XVP Science Goals:
  - Nature of BH seeds at z~6-10 via cross-correlating X-ray and IR backgrounds.
  - Host properties of Compton-thick AGN selected via spectral modeling.
  - Diffuse emission from z~1 clusters.
- Observations start Fall 2014



Helgason et al. (2013)



Summary

- High disk fraction at z~2 consistent with updated fueling models & high gas fractions. (Hopkins et al. 2014).
- Increasing fraction of disturbed host morphologies vs AGN obscuration (Kocevski et al. 2014a).
- CANDELS has identified the compact star forming progenitors of the first quenched galaxies (Barro et al. 2013).
- High fraction of AGN activity (48%) detected along the fast-track quenching pathway at z~2 (Kocevski et al. 2014b).