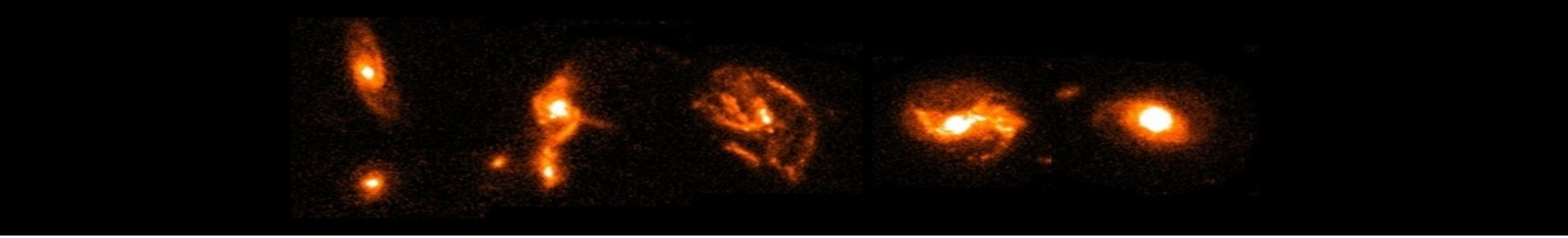


Underneath the Monster: In which galaxies are black holes growing?

Mauricio Cisternas

Instituto de Astrofisica de Canarias, Spain

+

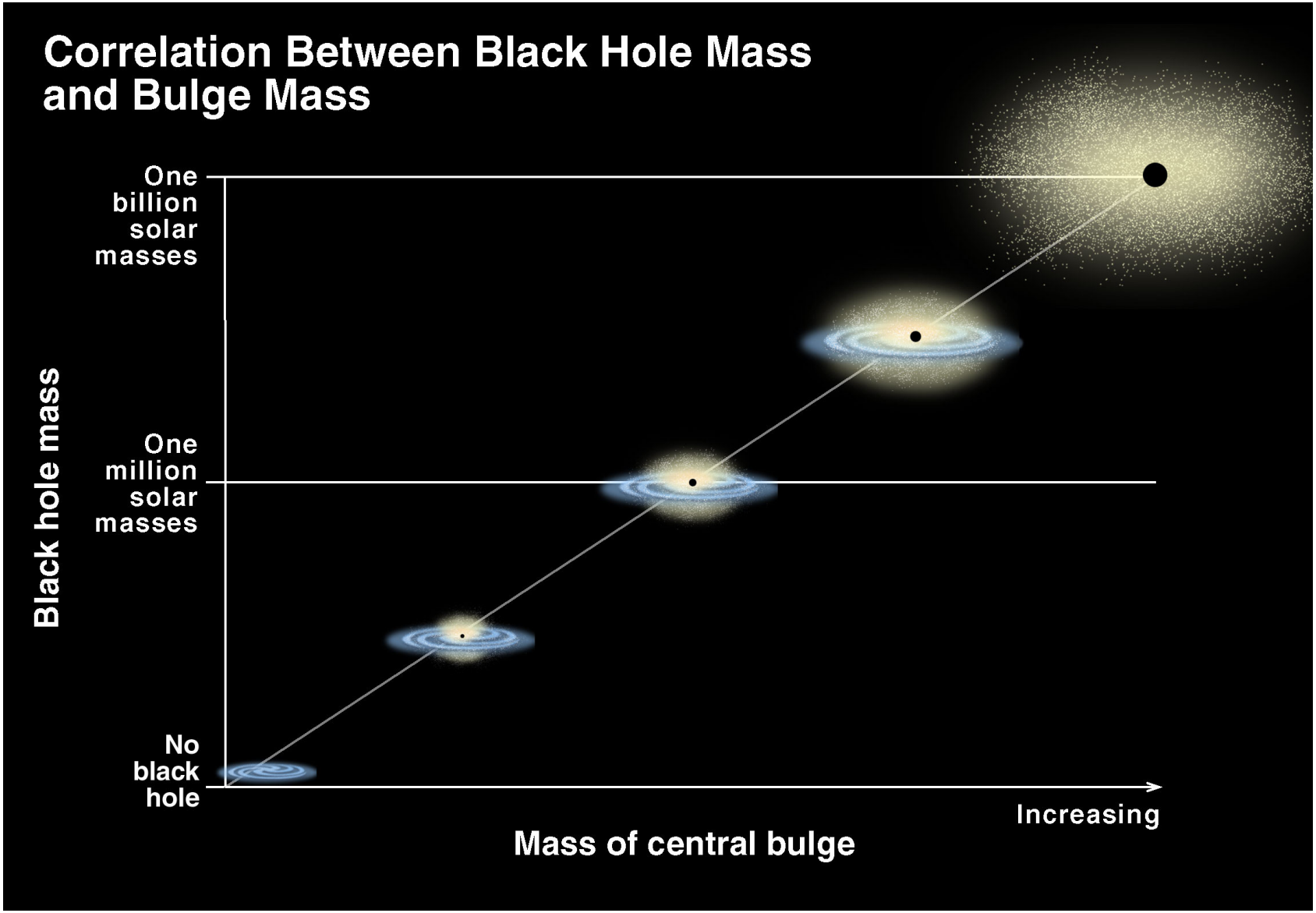
Nacho Trujillo

Jürgen Fliri

Johan Knapen

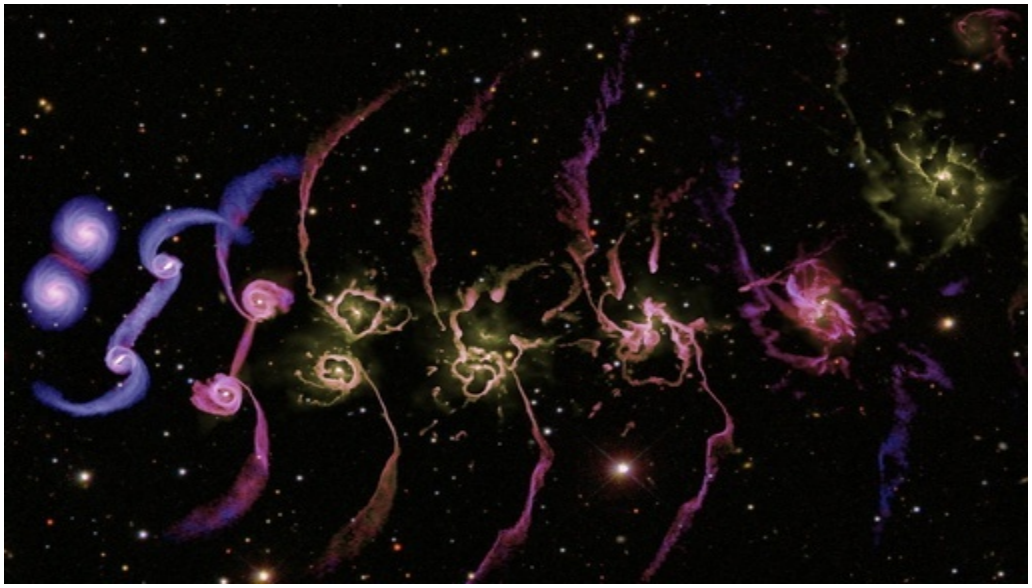
dagalnetwork.eu

ESO Santiago, November 20, 2013

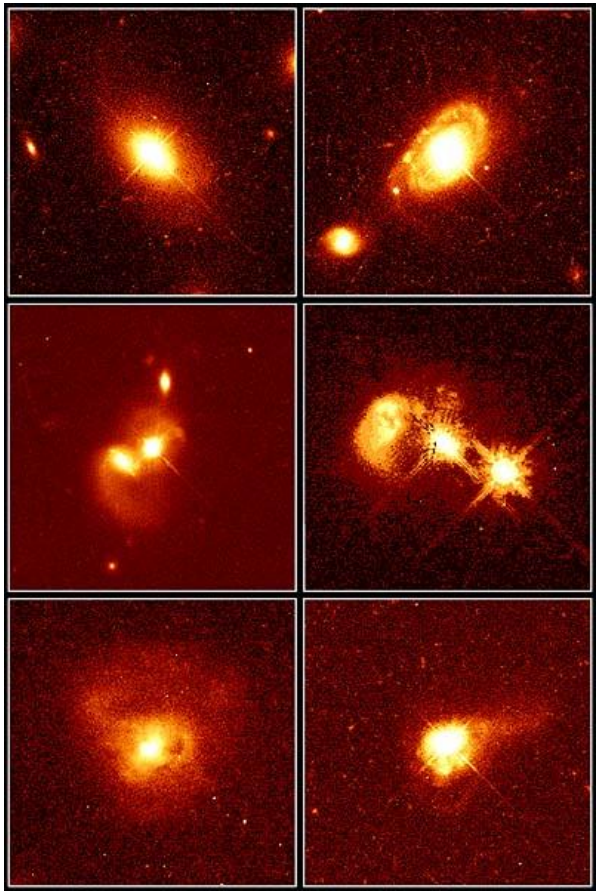

Correlation Between Black Hole Mass and Bulge Mass
One billion solar masses
One million solar masses
No black hole
Black hole mass
Increasing
Mass of central bulge

Galaxies, Black Holes, and Active Galactic Nuclei

- Black hole growth: accretion-- or AGN phase(s)
- How to activate (feed) a black hole?
- The usual suspect: major galaxy mergers
- AGN expected to live in mergers/spheroids
- Is this picture supported by observations?



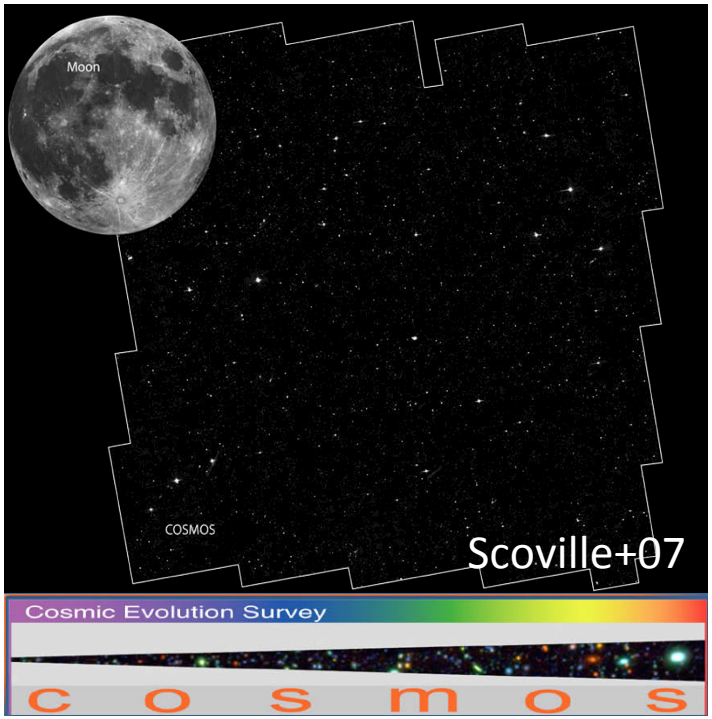
Di Matteo+ 05

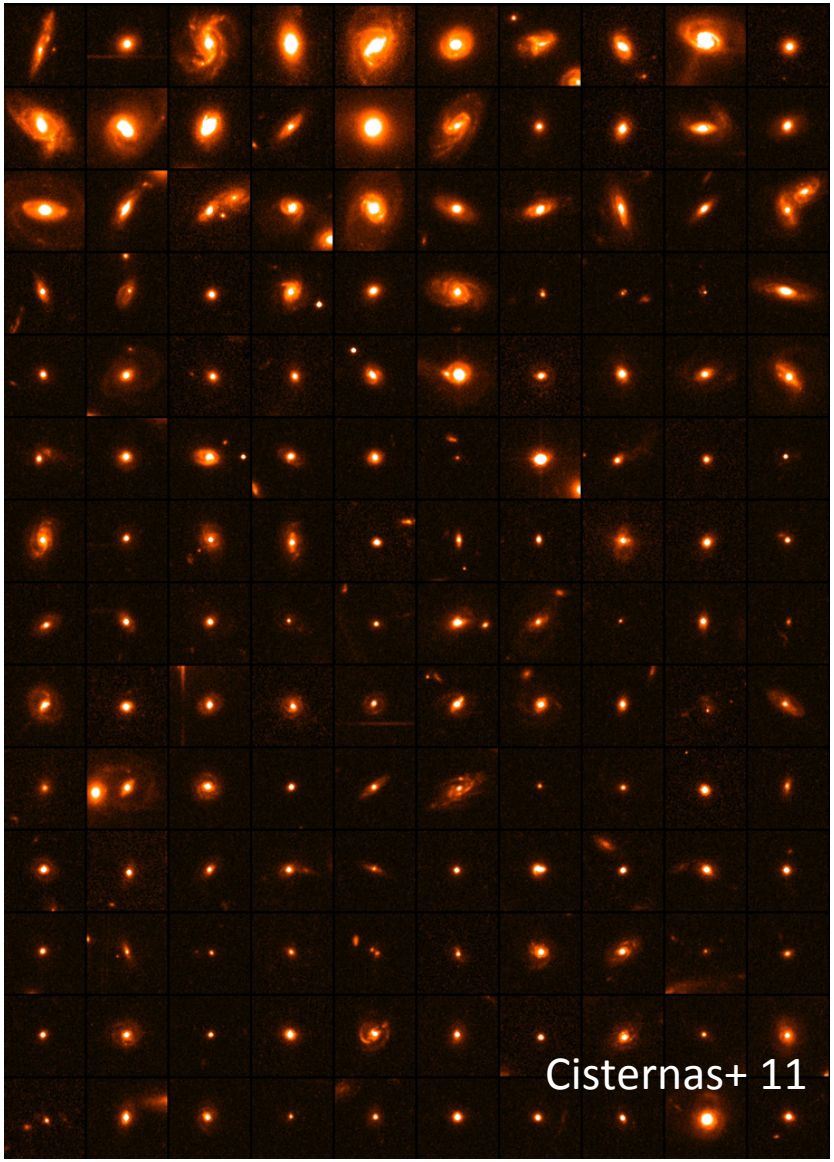


Boyce+ 96; Bahcall+ 97

Recent Observational Results: COSMOS

- 2 deg^2: Largest contiguous *HST* field
- Ancillary coverage from X-ray to radio
- *XMM-Newton*: large/clean AGN sample
- *HST*/ACS, F814W: optical morphologies out to z=1
- 140 X-ray selected AGN at 0.3 < z < 1.0

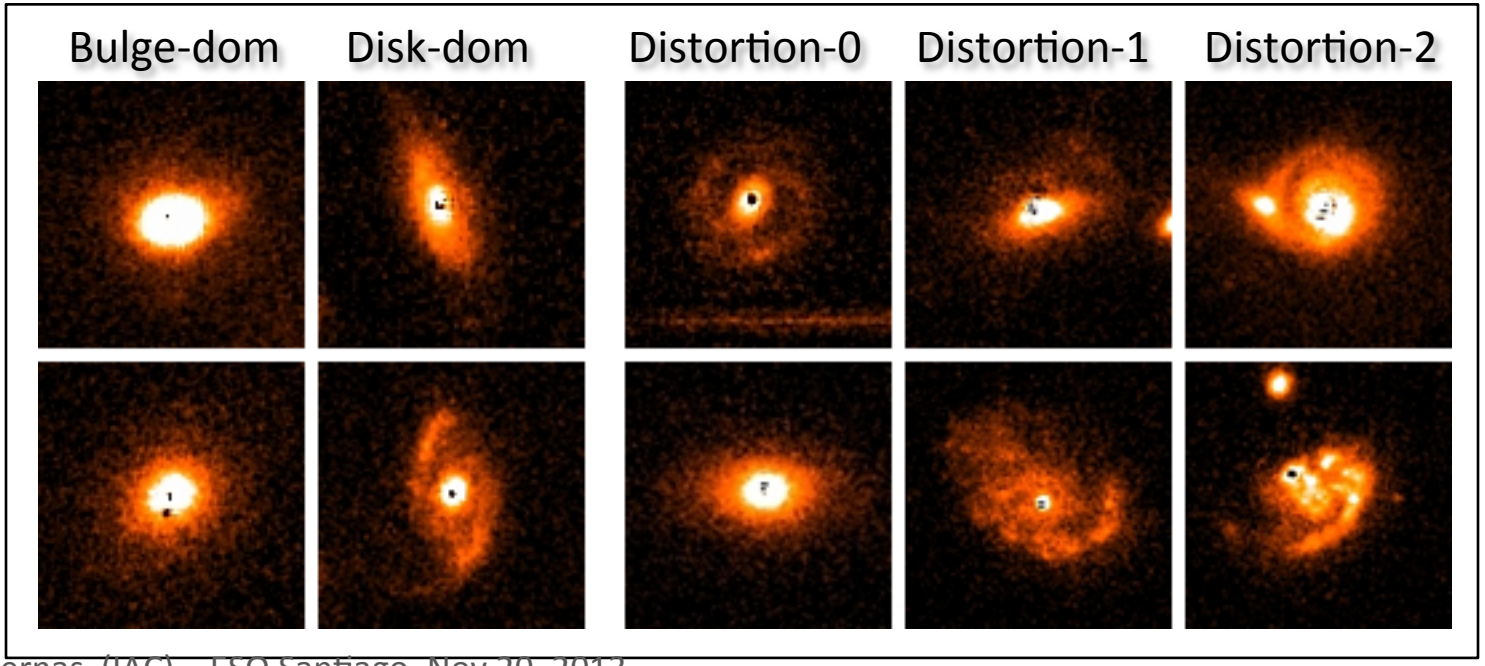




Recent Observational Results: COSMOS

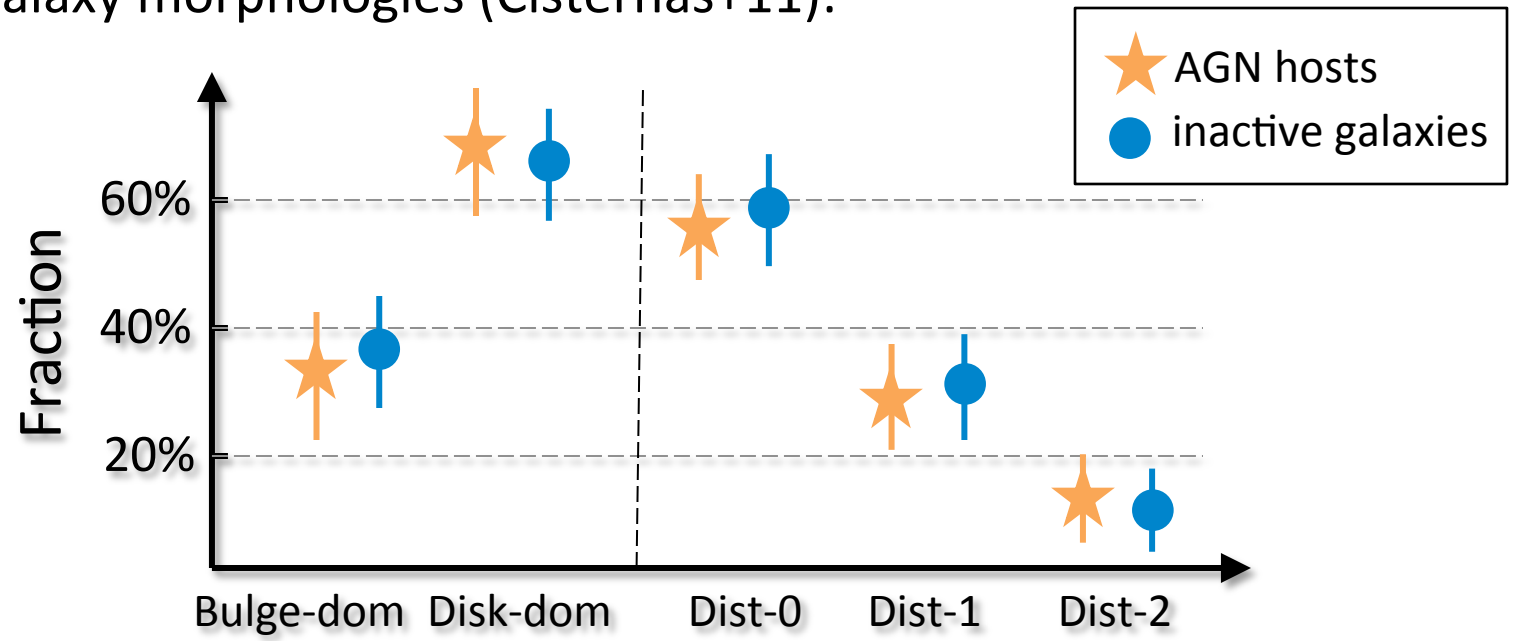
COSMOS AGN host galaxy morphologies (Cisternas+ 11)

- Visually classified according to:
  - Hubble type: Bulge- or disk-dominated
  - Distortion level: smooth, mildly distorted, or wrecked
- Direct comparison to matched inactive galaxies



Recent Observational Results: COSMOS

AGN host galaxy morphologies (Cisternas+11):



1. Only a minority (~15%) of AGN found in merging systems…
2. … consistent with the merger rate of “normal” galaxies
3. Most AGN (65%) reside in disk-dominated galaxies

Recent Observational Results: COSMOS

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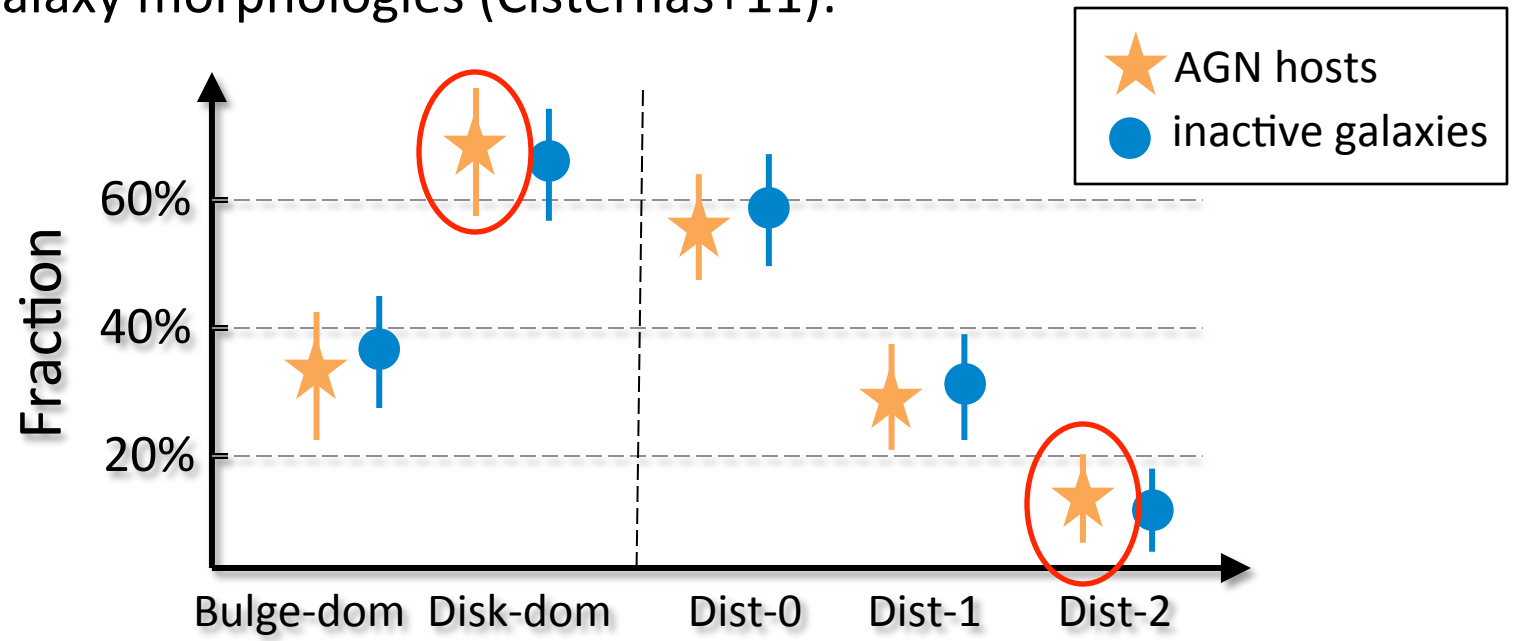

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Recent Observational Results: COSMOS

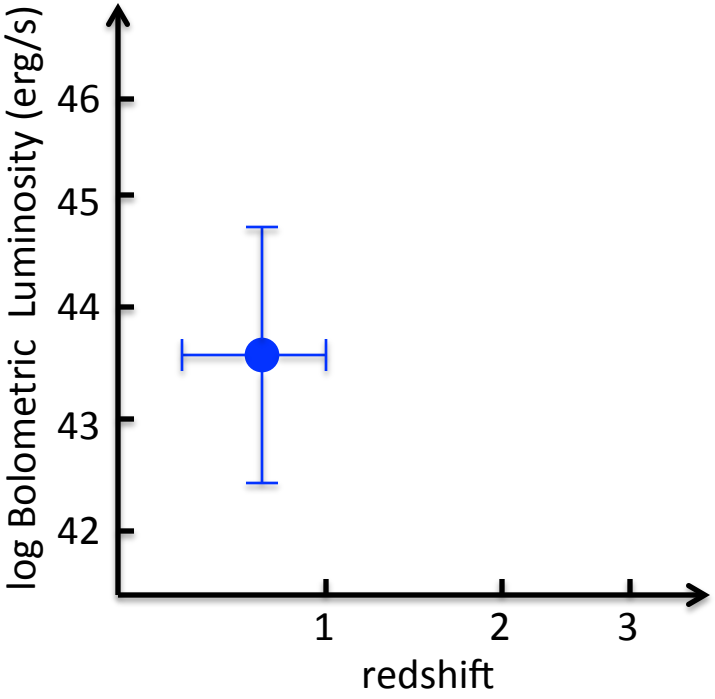
AGN host galaxy morphologies:

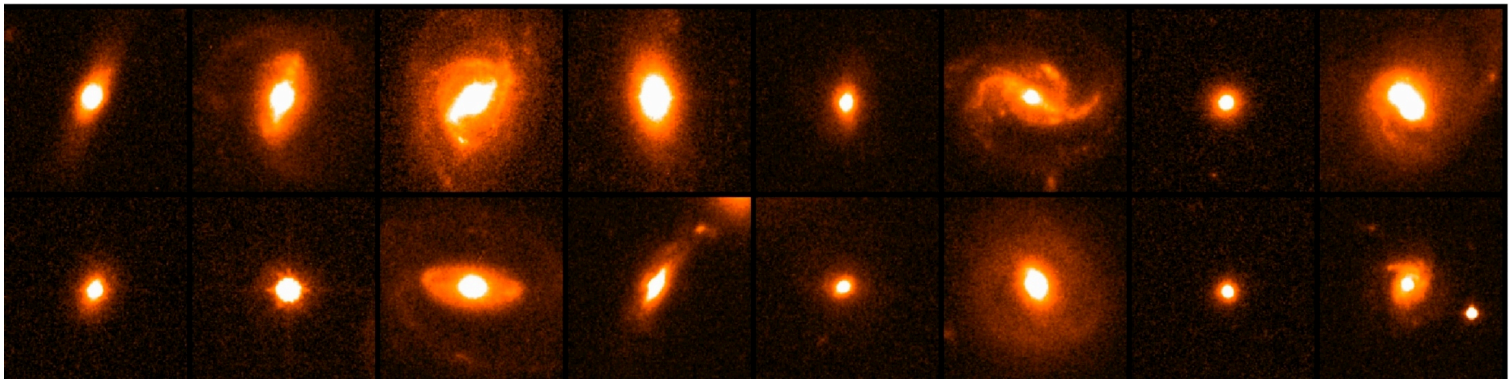
mostly disky and undisturbed

Surprising?

Parameter space:

- relatively ”local”
- at z<1, universe is rather secular
- much more action at z~2





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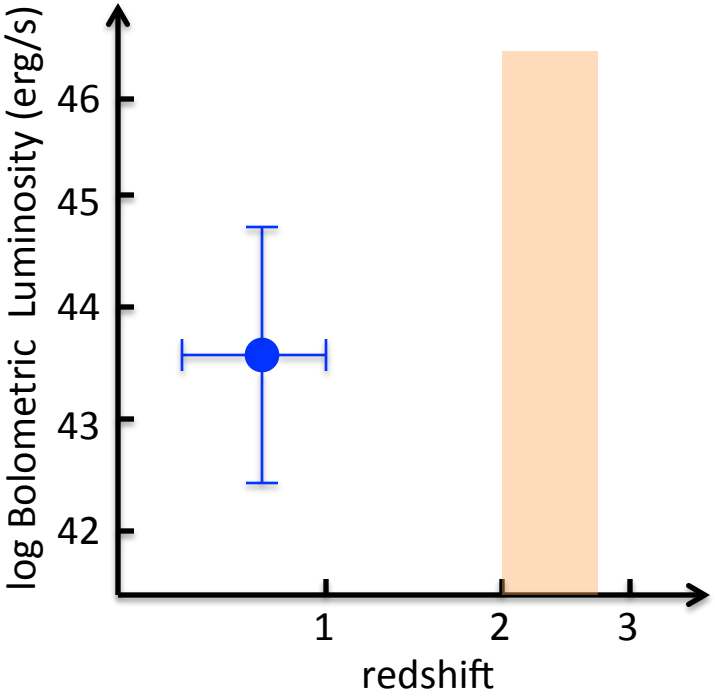
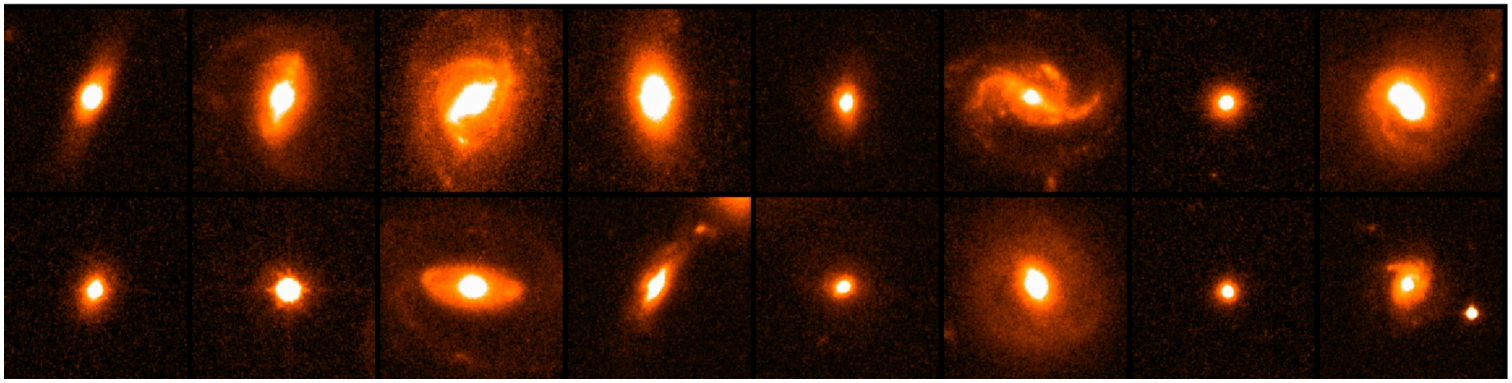
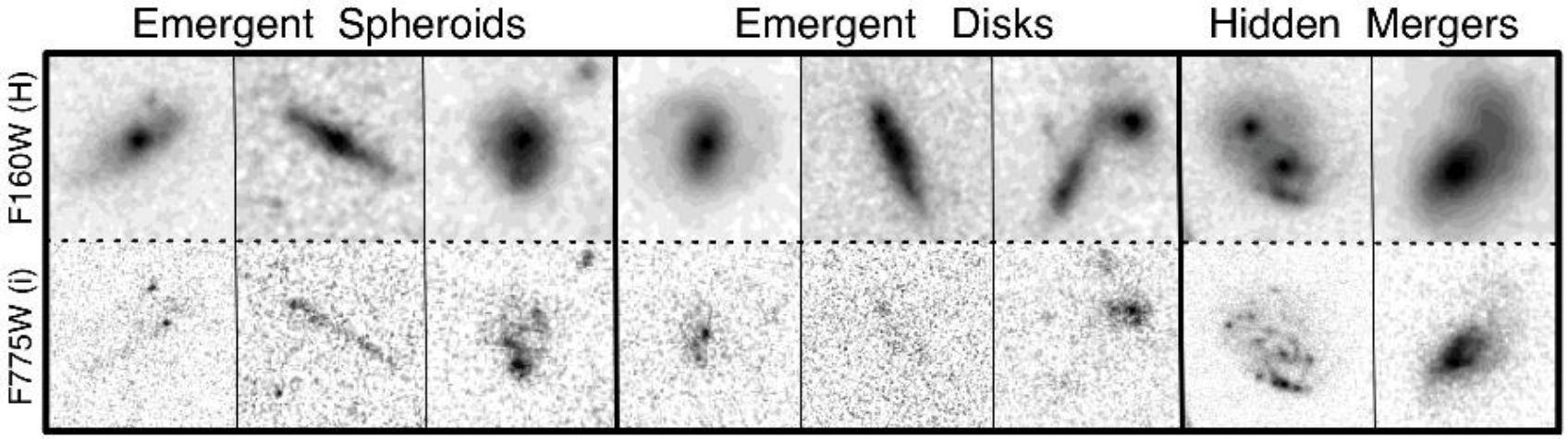




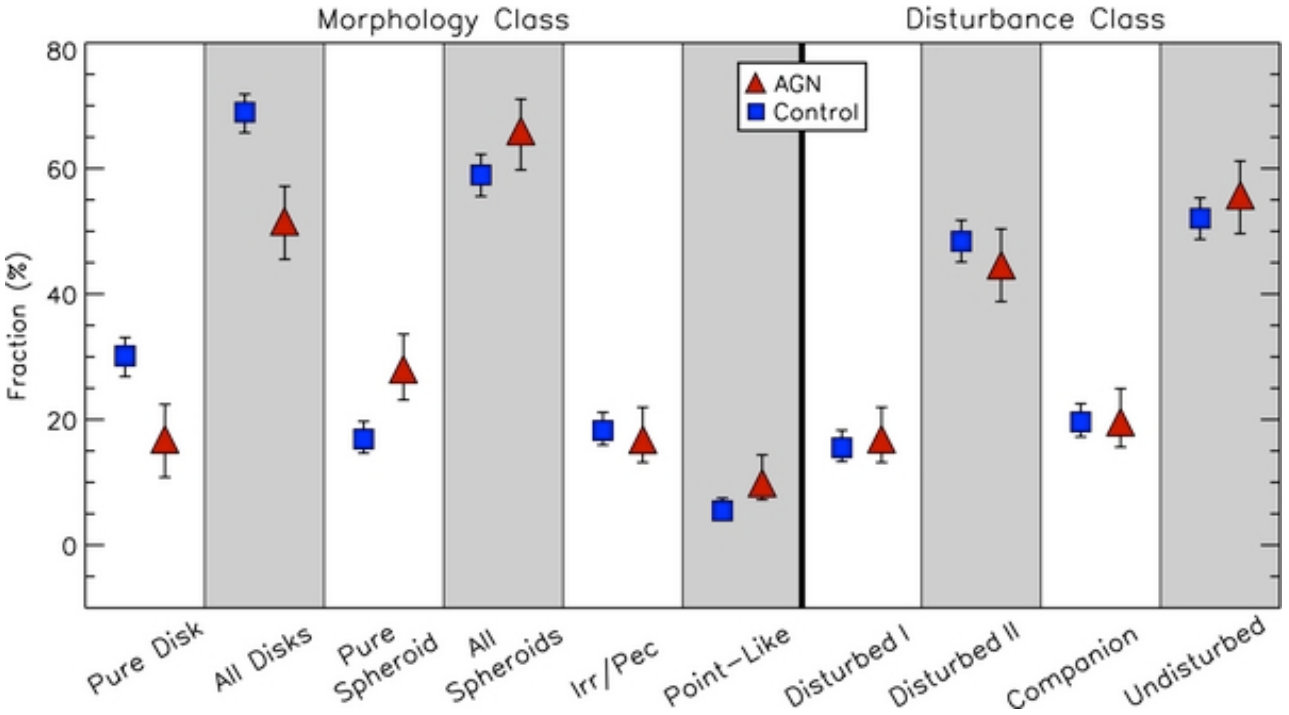
Recent Observational Results: CANDELS

- Largest HST program (PIs: Faber, Ferguson)
- Deep (GOODS) and wide (COSMOS, UDS, EGS) surveys
- WFC3 (J and H): optical morphologies at z~2
- 72 AGN in the CDF-S at 1.5<z<2.5



Recent Observational Results: CANDELS

AGN host galaxy morphologies, now at z~2 (Kocevski+12)

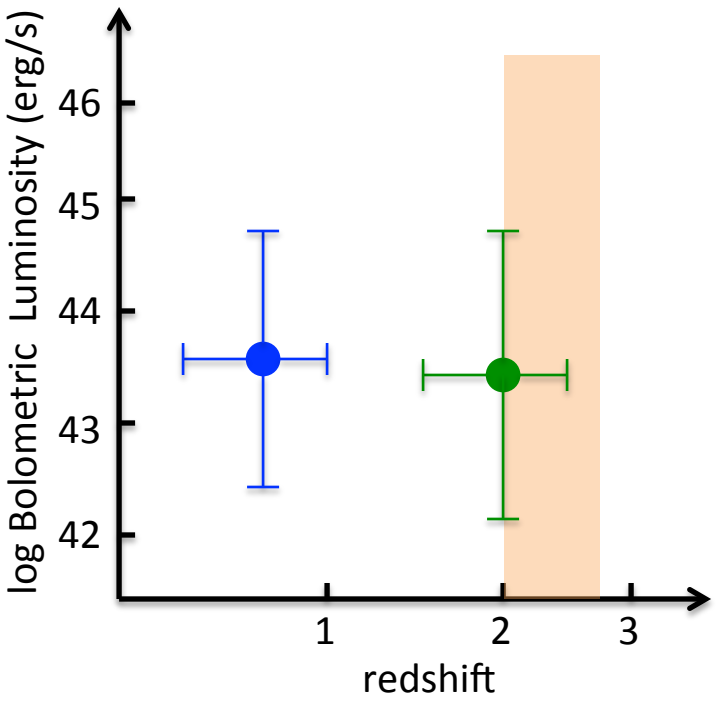


1. Only a minority (~17%) of AGN found in merging systems…
2. … consistent with the merger rate of “normal” galaxies
3. Significant fraction of AGN hosted by disks

Where to find enough quasars?

- Equivalent results from both COSMOS and CANDELS
- Luminosities probed: just below quasar cutoff
- Small area surveys: very few quasars
- SDSS: tens of thousands of QSOs…

  … but: shallow, arcsec resolution
- Bright quasar dominates the overall light distribution



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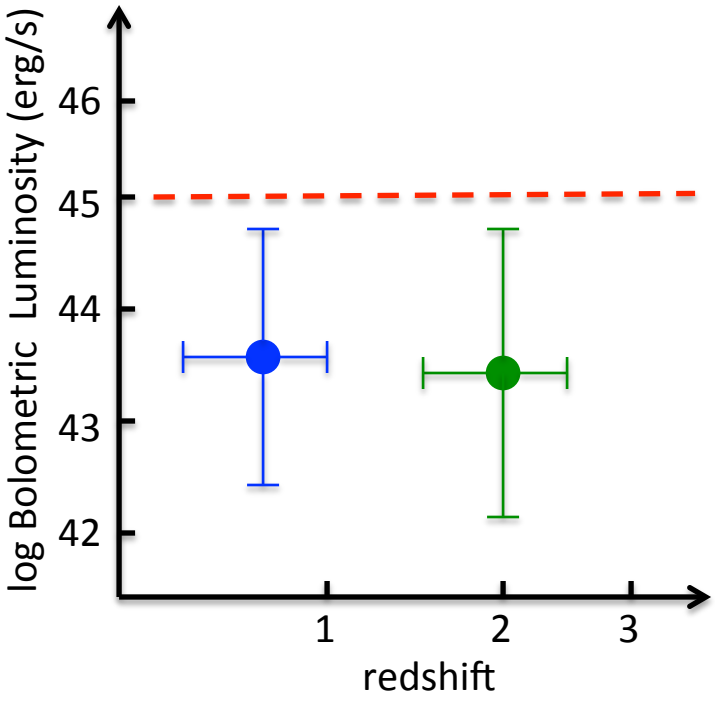
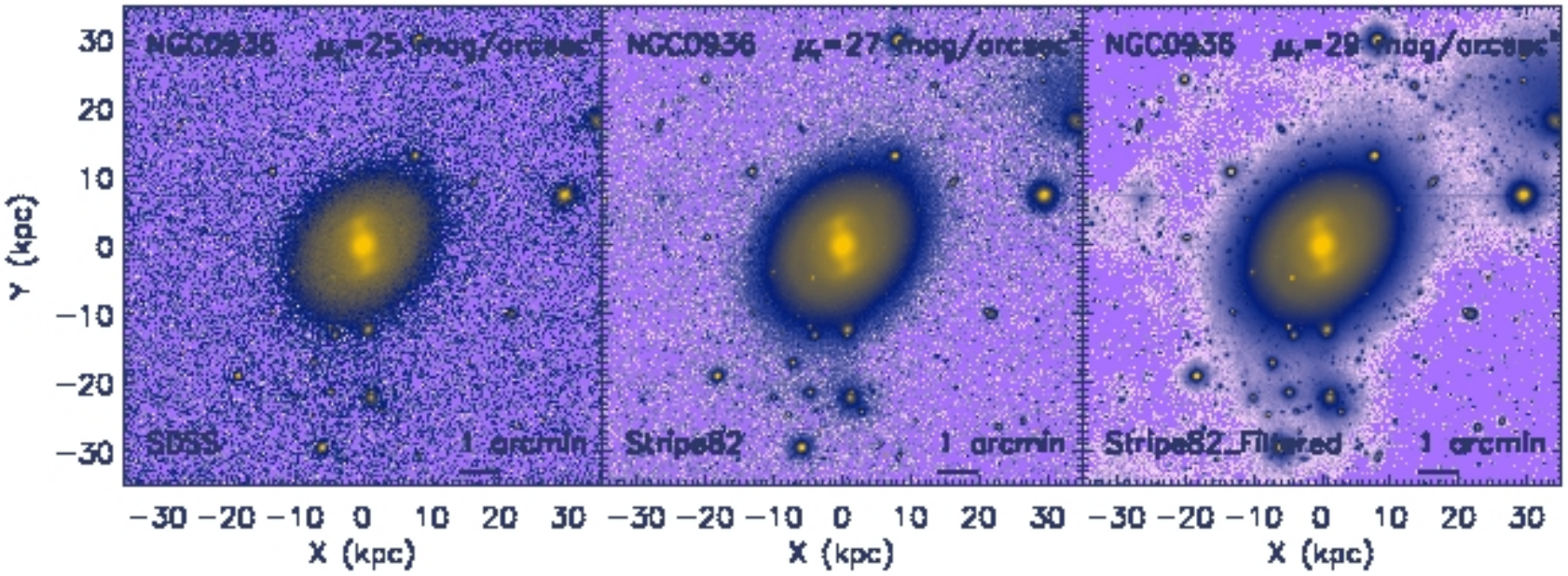


IAC Legacy Stripe82 co-add (Fliri & Trujillo '14)

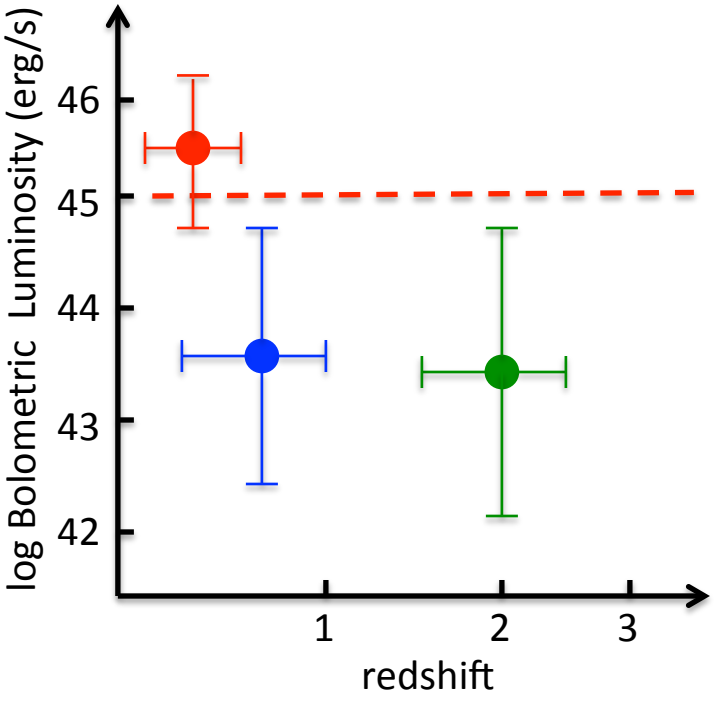
www.iac.es/proyecto/stripe82

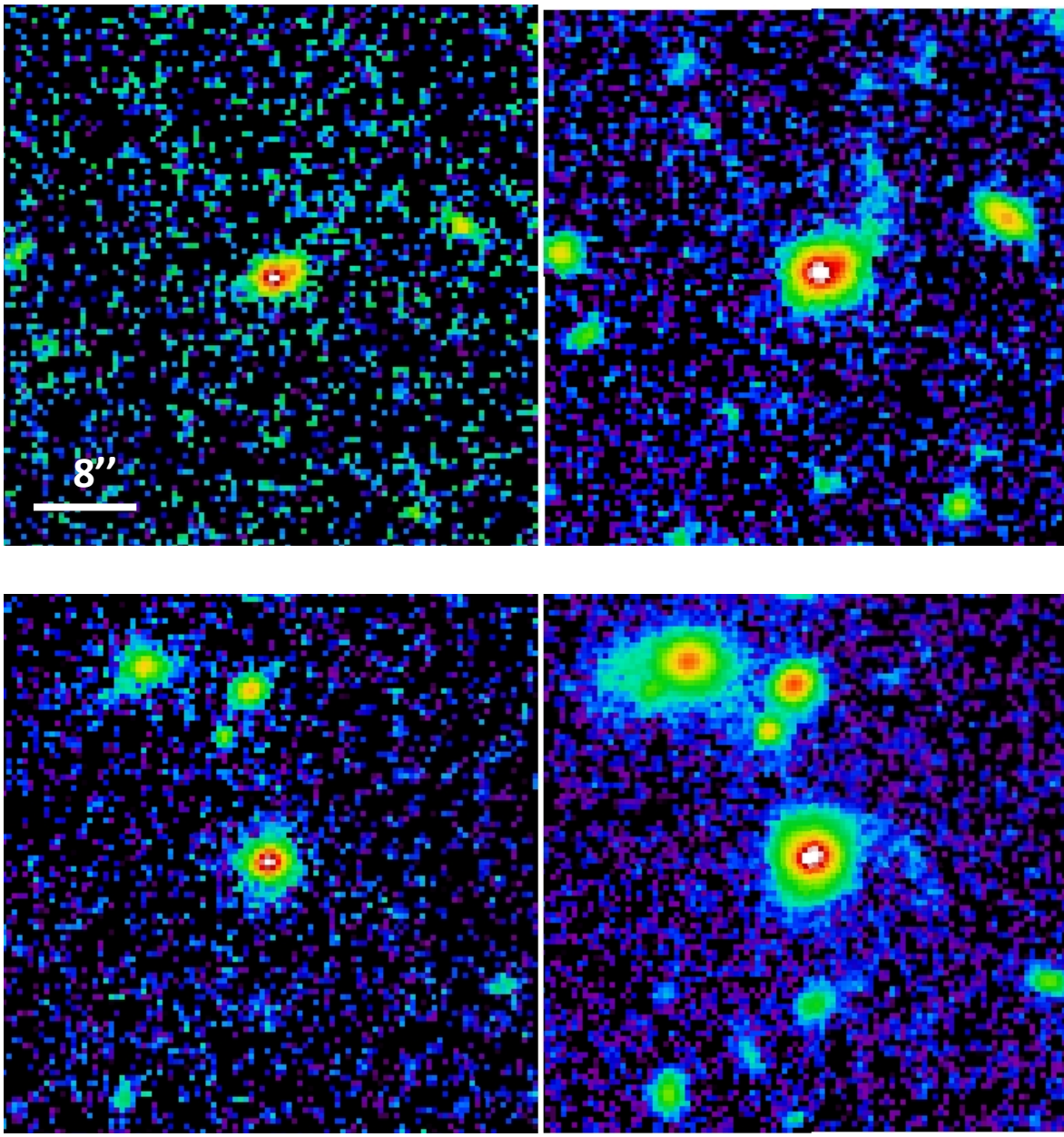
- SDSS Stripe 82: 275 deg^2 equatorial stripe observed ~80 times
- IAC S82 project: produce a co-add of only the *best* images
- 50% of images thrown away due to: bright sky, major sky gradients, poor seeing, clouds
- Result: extremely flat sky; 2 mag deeper than standard SDSS



QSOs in Stripe 82

- DR7 quasar catalog (Schneider+10)
- 352 quasars in S82





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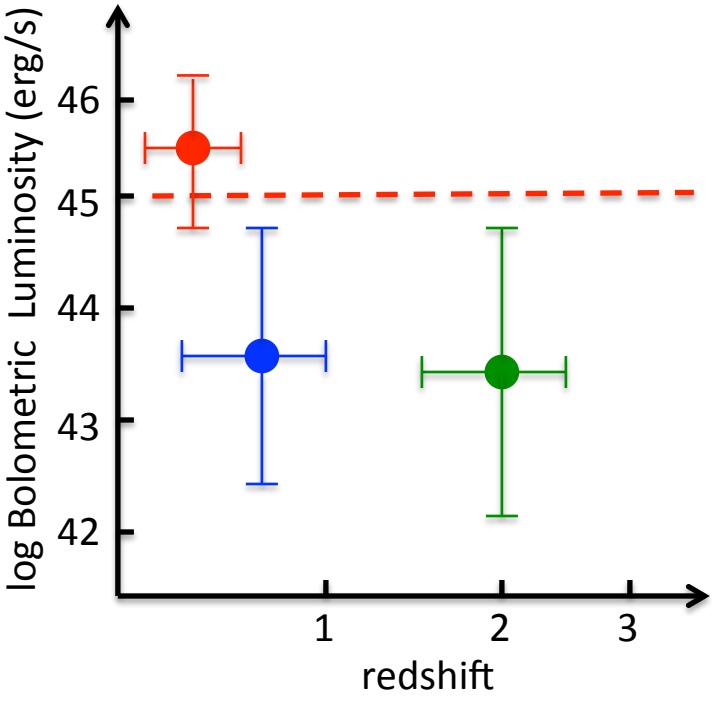
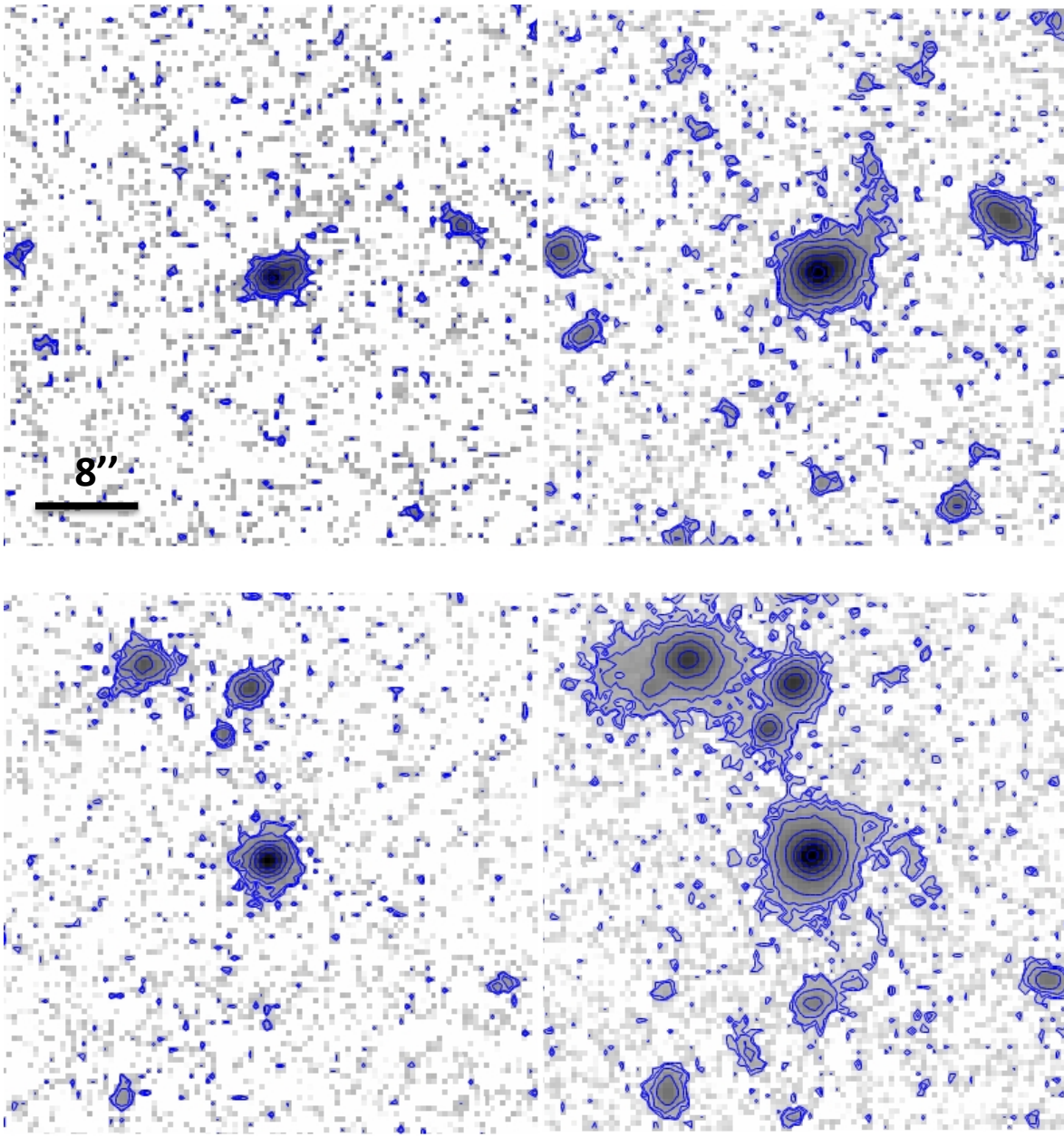
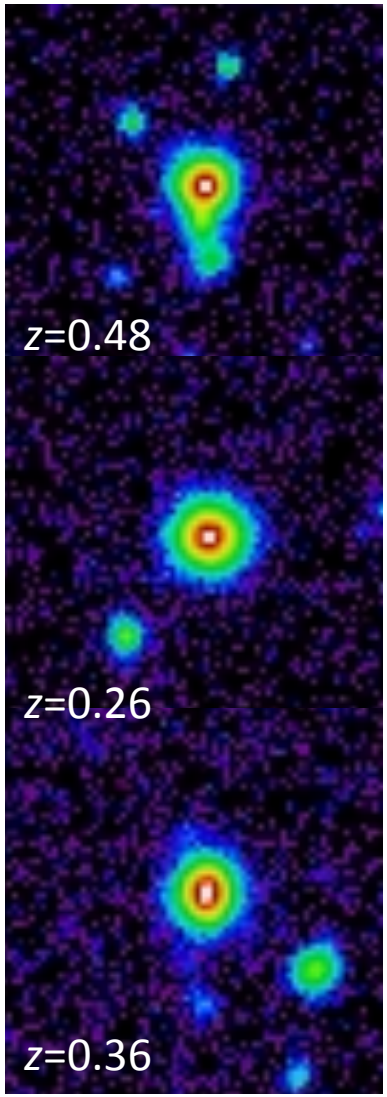
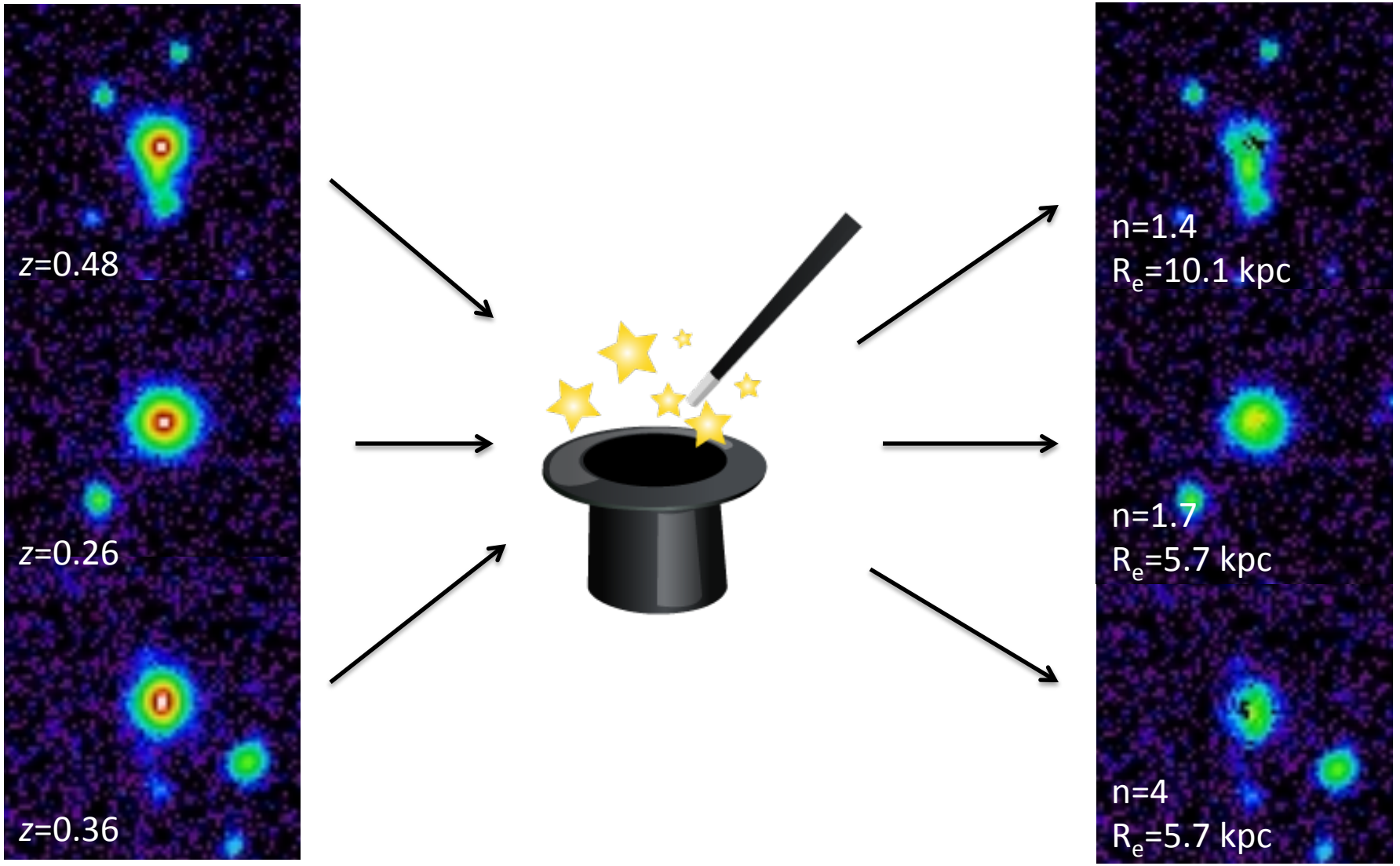




Revealing the hidden quasar host galaxies



Revealing the hidden quasar host galaxies



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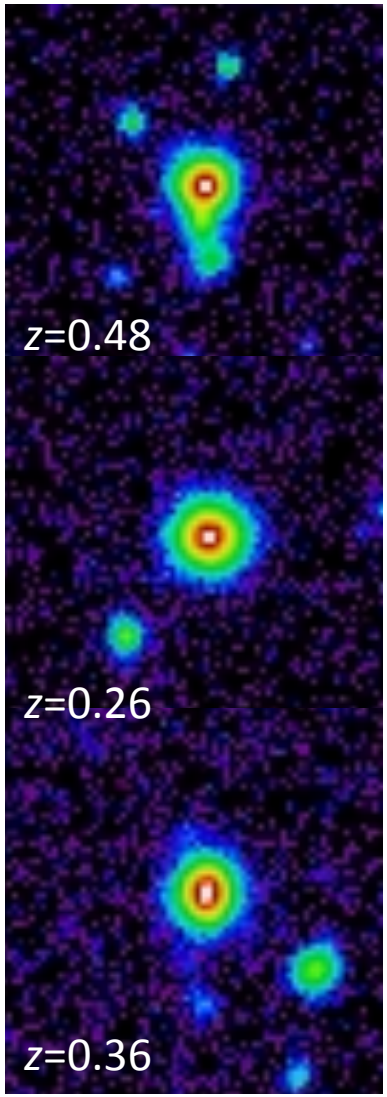


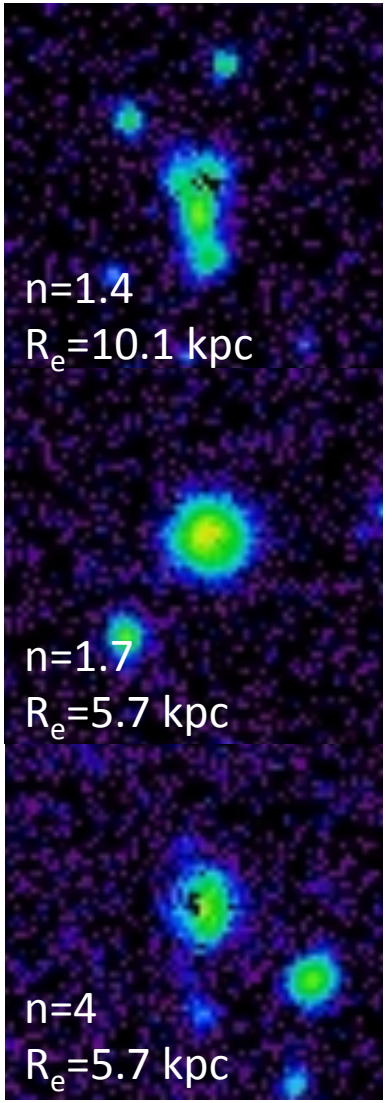
Represent QSO as PSF+Sersic profile

Custom-made PSFs from 100+ stars

2D fitting with GALFIT

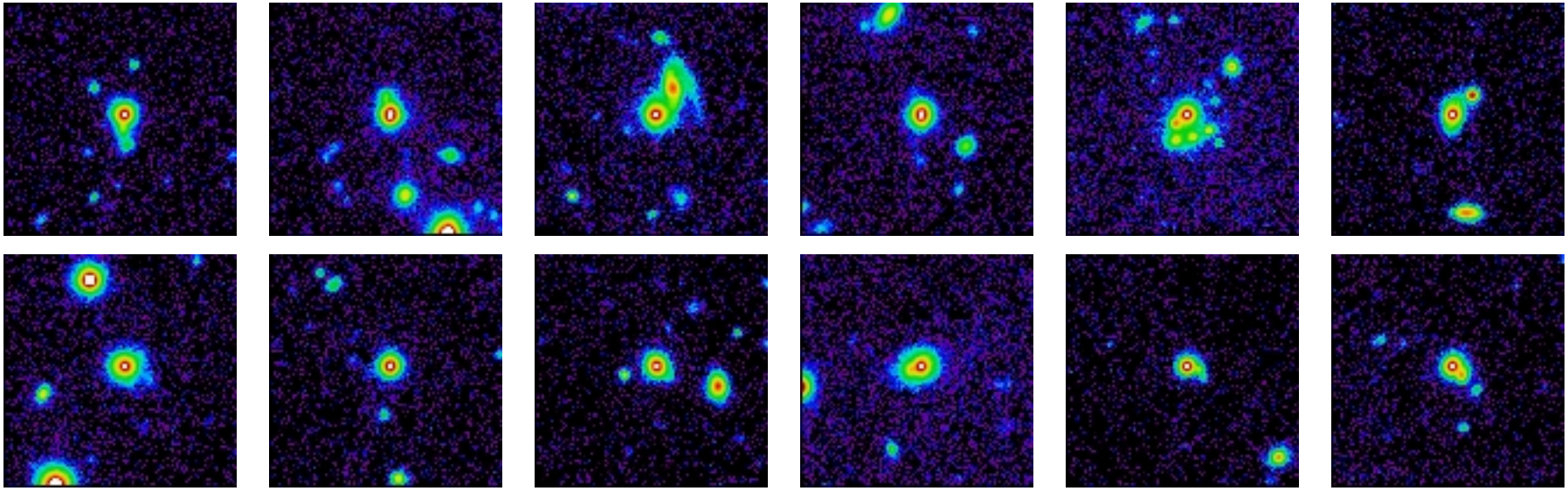
Careful assessment of resulting parameters
(e.g., Sersic n=20, R_e=0.001", etc)

…



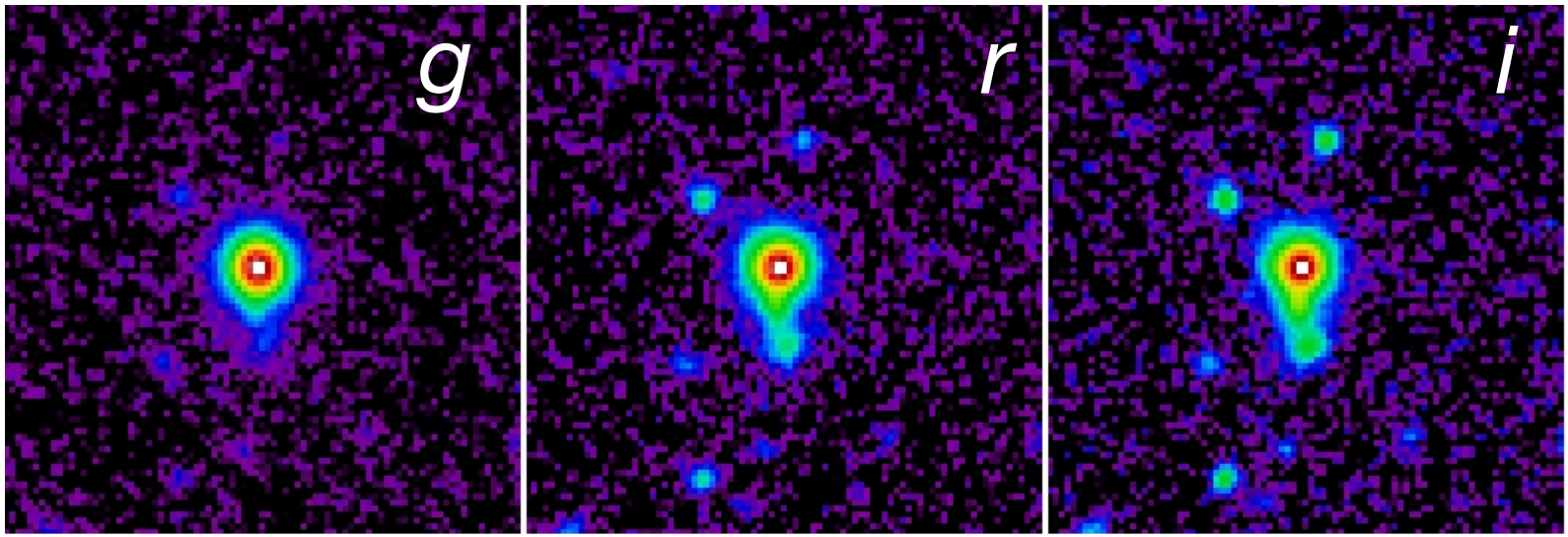
(Preliminary) Results: quasar host galaxies

- 3% not suitable to fit, 15% unresolved
- 50% disks, 36% spheroids, remaining intermediate morphologies
- At least 35% unambiguously interacting/merging



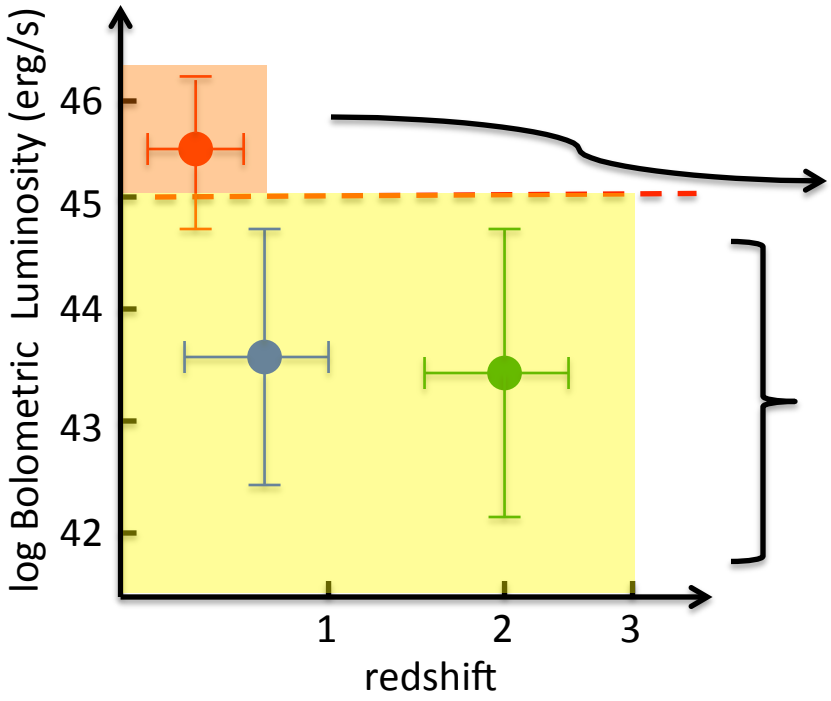
Future work with Stripe82

- Multiband decompositions to investigate, e.g.,:
  - SF properties of host galaxies
  - Gas-richness of merger features



- Compare QSO host galaxies to similar inactive galaxies

Summary: oversimplified picture

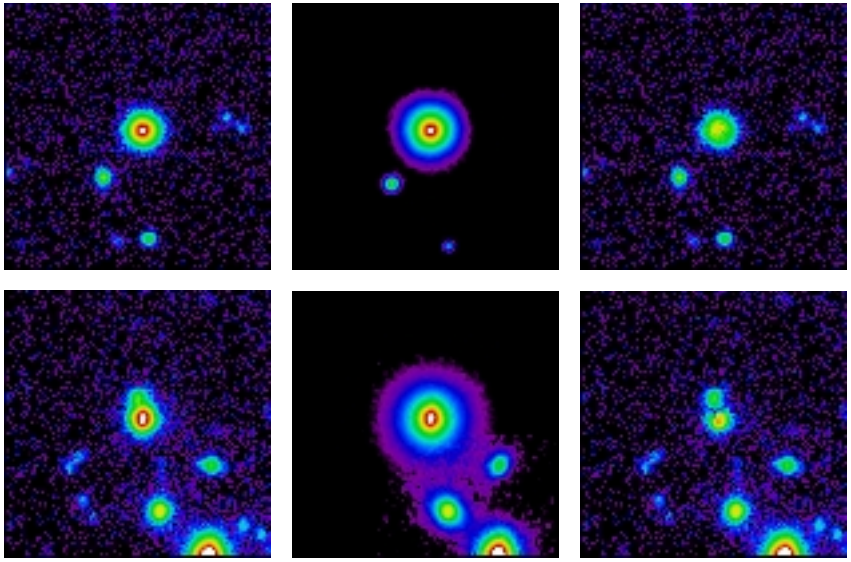


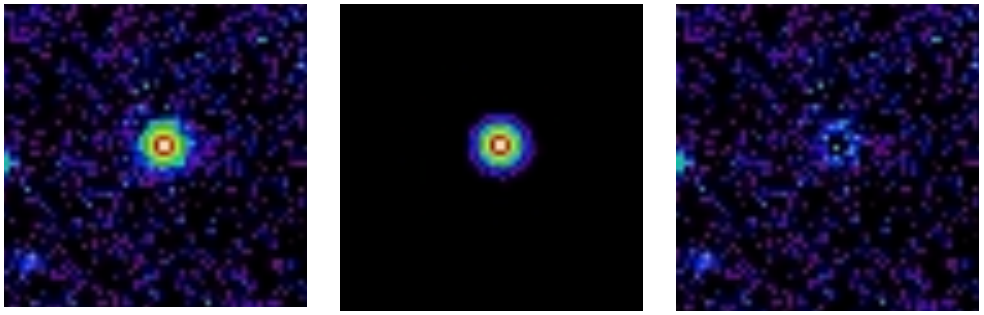
Quasar regime (low-z):
slightly higher merger rates,
mixed host galaxy morphologies

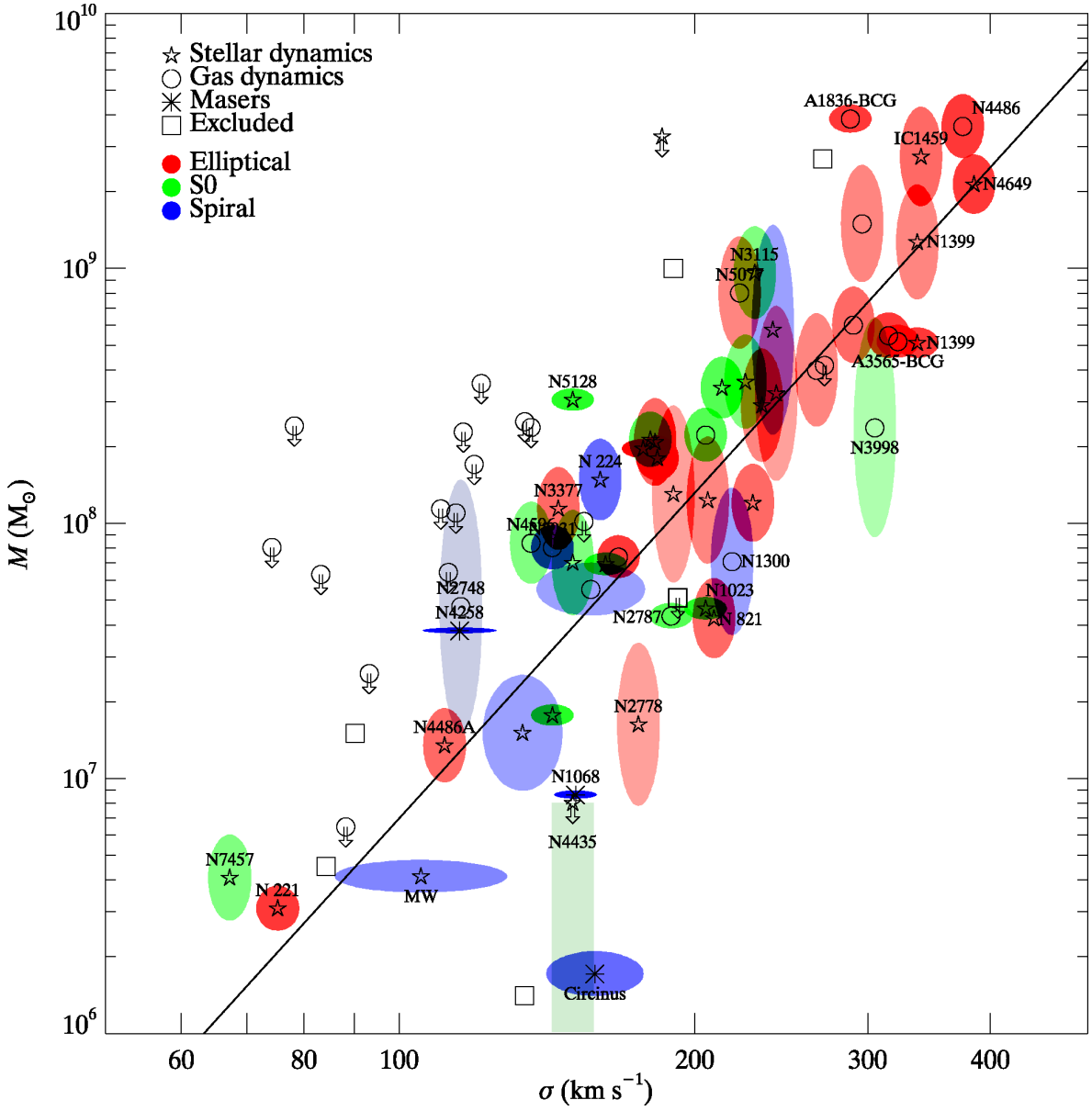
Moderate luminosity/Seyfert regime:
BH growth occurring primarily
through "non-violent" processes

Open question: what parameters reflect the origin of the AGN activity?

(redshift, luminosity, BH accretion rate, stellar mass, gas fractions, …)






Stellar dynamics
Gas dynamics
Masers
Excluded
Elliptical
S0
Spiral
10^{10}
10^{9}
10^{8}
10^{7}
10^{6}
M ($M_\odot$)
60
80
100
200
300
400
σ (km s^{-1})
A1836-BCG
N4486
IC1459
N4649
N1399
N3115
N5077
N1399
A3565-BCG
N5128
N3998
N 224
N3377
N1300
N2748
N4258
N1023
N2787
N 821
N2778
N4486A
N1068
N4435
N7457
N 221
MW
Circinus

Gültekin+ 09