赤方偏移 z < 1 における SDSSクエーサー母銀河の性質

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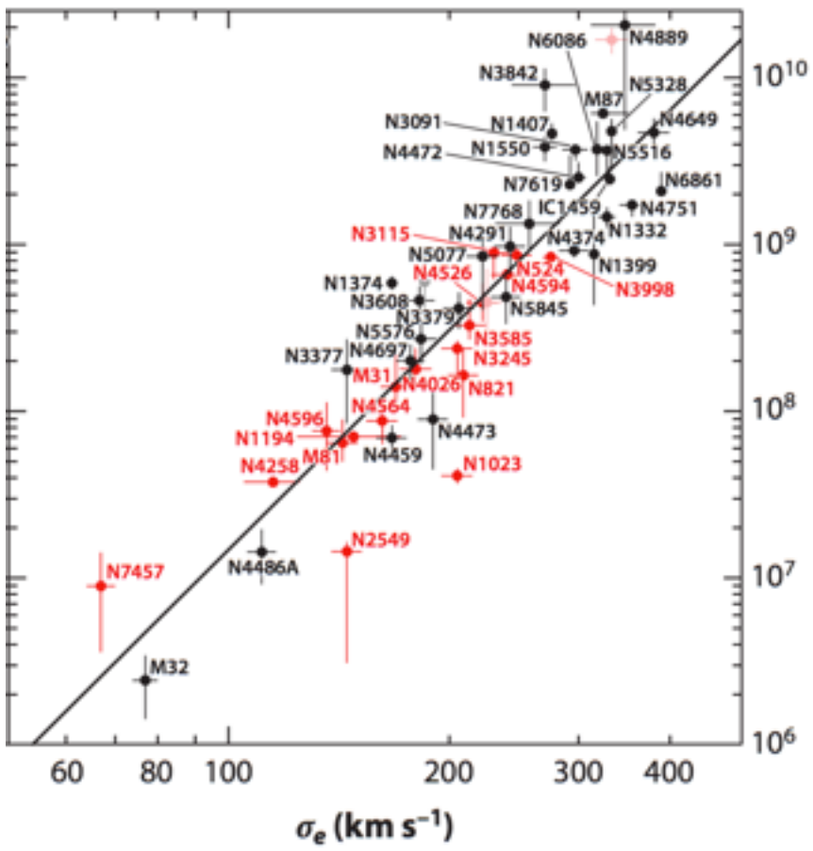
One-page introduction

✶ AGNs/quasars are observed in (~10 % of) galaxy cores throughout the Universe.

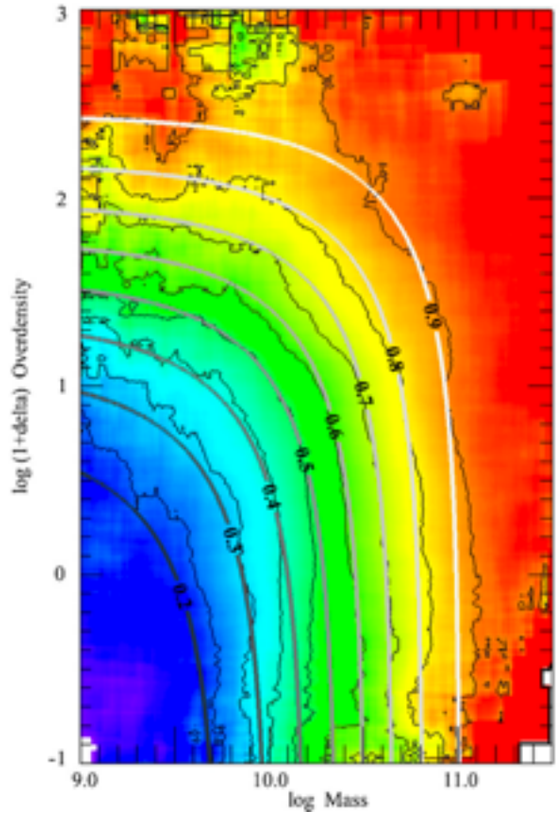
✶ Almost every bulge harbors a SMBH in the local Universe, and the Soltan argument suggests that local SMBHs have acquired most of the mass through AGN/quasar phases.

✶ Galaxies and SMBHs may or may not co-evolve.

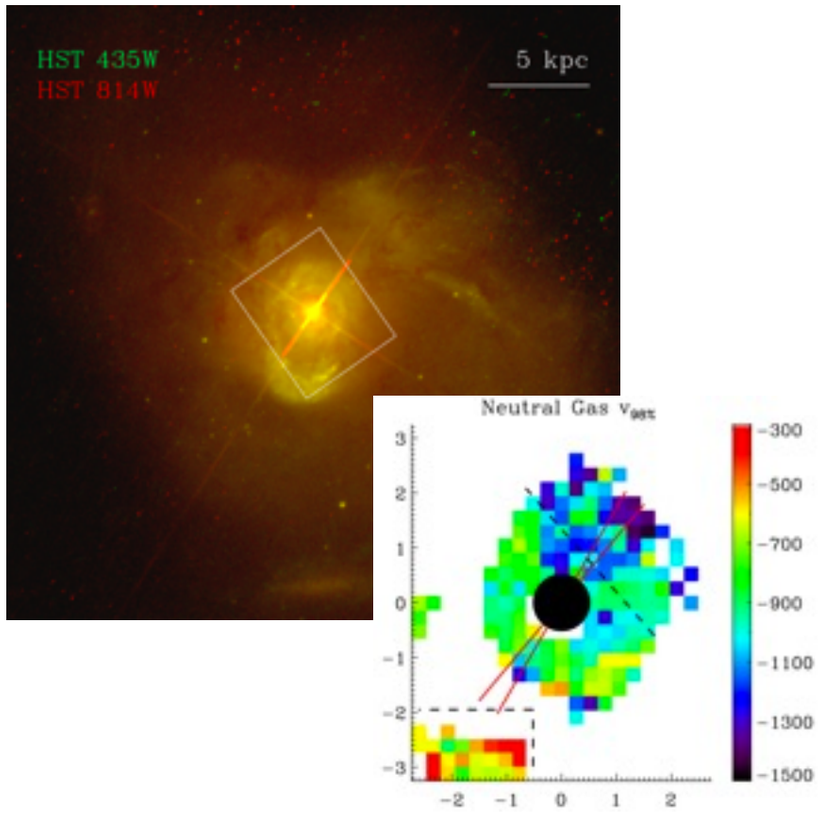
bulge-SMBH correlation (Kormendy+13)



passive fraction of galaxies (Peng+10)



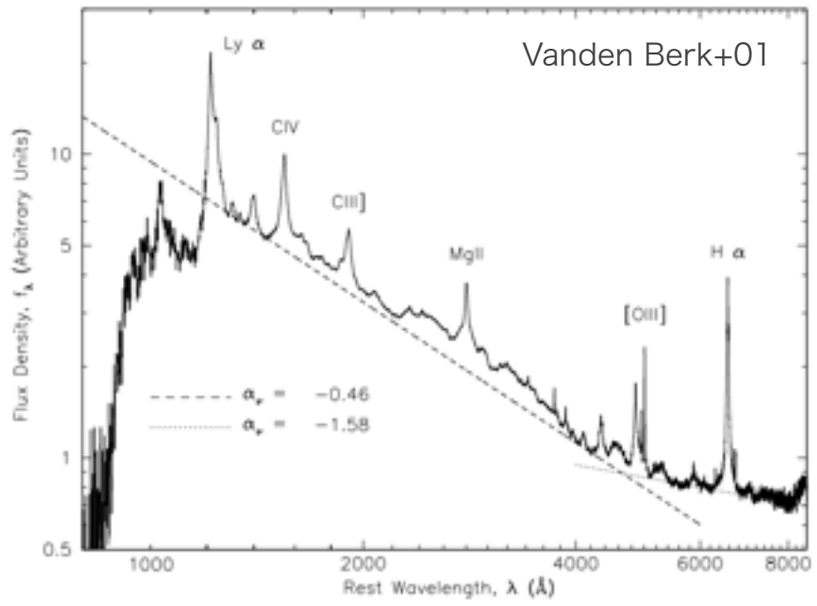
large energetic outflows (Rupke+11)



What is AGN/quasar, in the whole story of galaxy evolution?

- In which galaxies do AGNs/quasars occur?
- What impact do AGNs/quasars have on the galaxies?

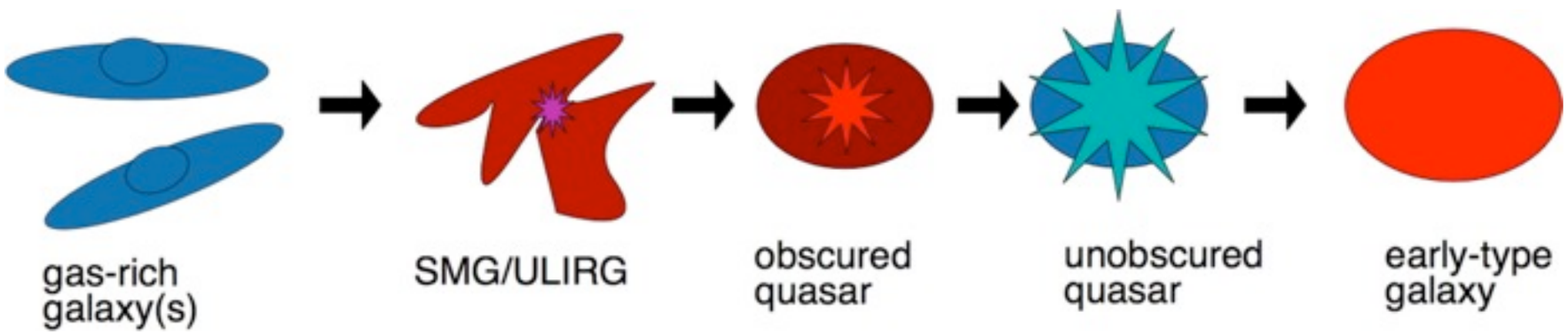
We focus on unobscured (type-1) quasars



✶ They are “classical” high-luminosity AGNs.

✶ Most, if not all, of previous statistical studies are based on obscured (type-2) quasars selected with X-ray luminosity or optical narrow lines. These studies are certainly biased toward dusty systems, perhaps with enhanced star formation. They may also be subject to scattered AGN light in host galaxies.

✶ If the merger-driven AGN/SF evolution scenario is correct (which may be questionable), unobscured AGNs precede the phase of obscured AGNs.



Merger-driven evolution model (Alexander+12)

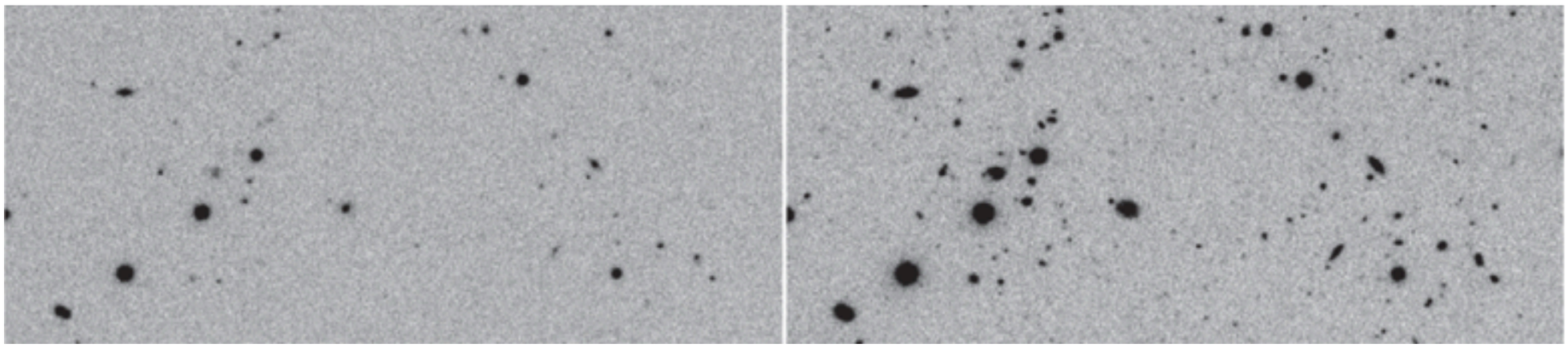
Sample and Data

1. Imaging decomposition analysis

"Massive star-forming host galaxies of quasars on SDSS stripe 82" (Matsuoka, Strauss, Price, and DiDonato, 2014, ApJ, 780, 162)

✶ Sample: ~1,000 SDSS DR7/DR9 quasars on Stripe 82

✶ Data: SDSS co-add images in u, g, r, i, and z (Annis+14)

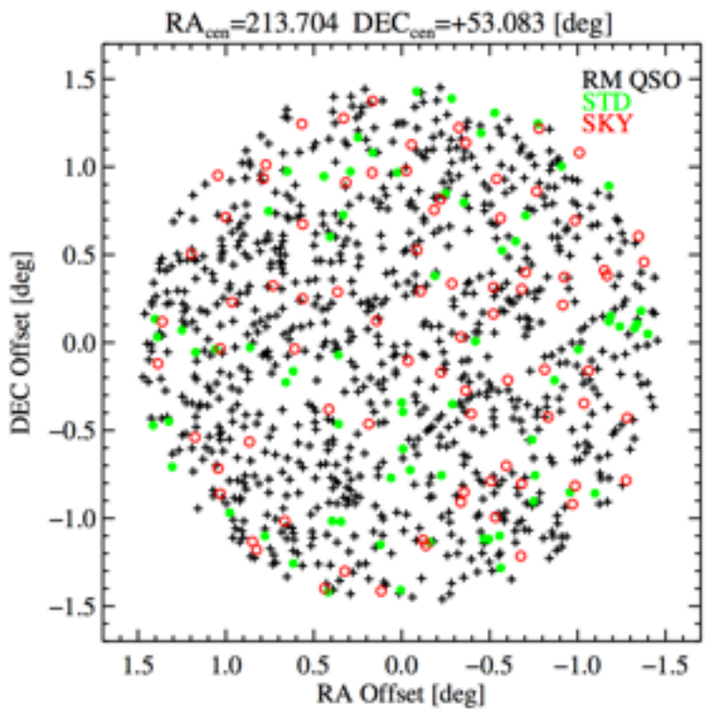


2. Spectral decomposition analysis

"The SDSS reverberation mapping project: post-starburst signatures in quasar host galaxies at z < 1"
(Matsuoka, Strauss, Shen, Greene, Ho, Trump, et al. 2015, in prep.)

✶ Sample: ~200 SDSS quasars on the SDSS-RM field

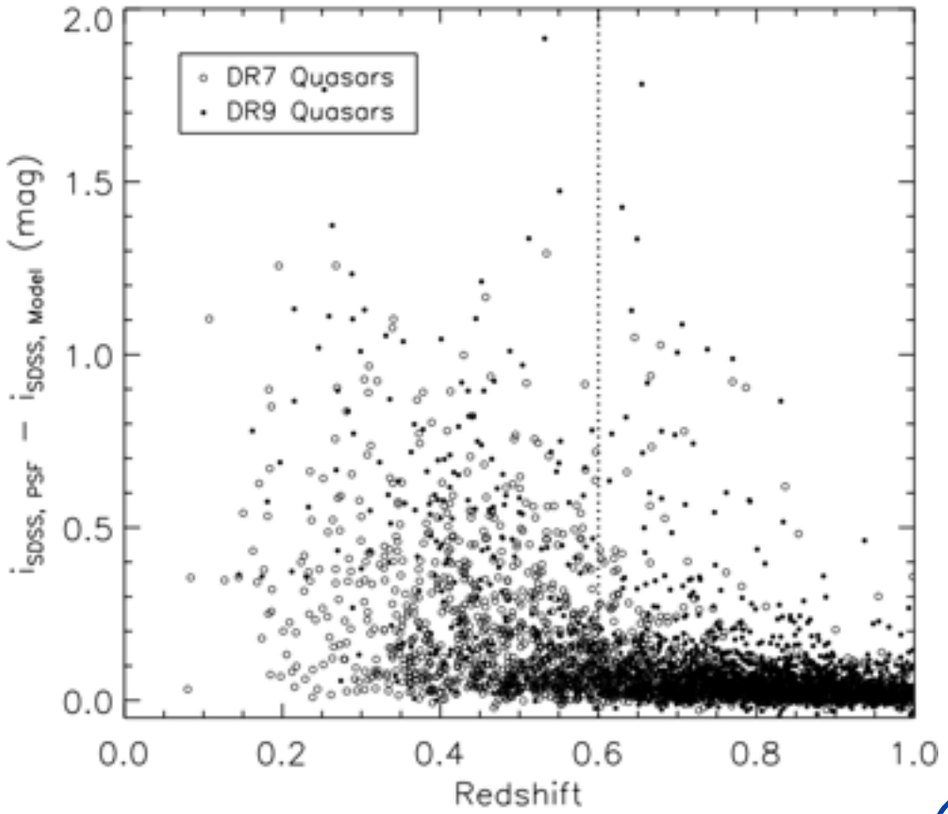
✶ Data: SDSS-RM stacked spectra originating from the BOSS spectrograph
(λ = 3,650 - 10,400 A)

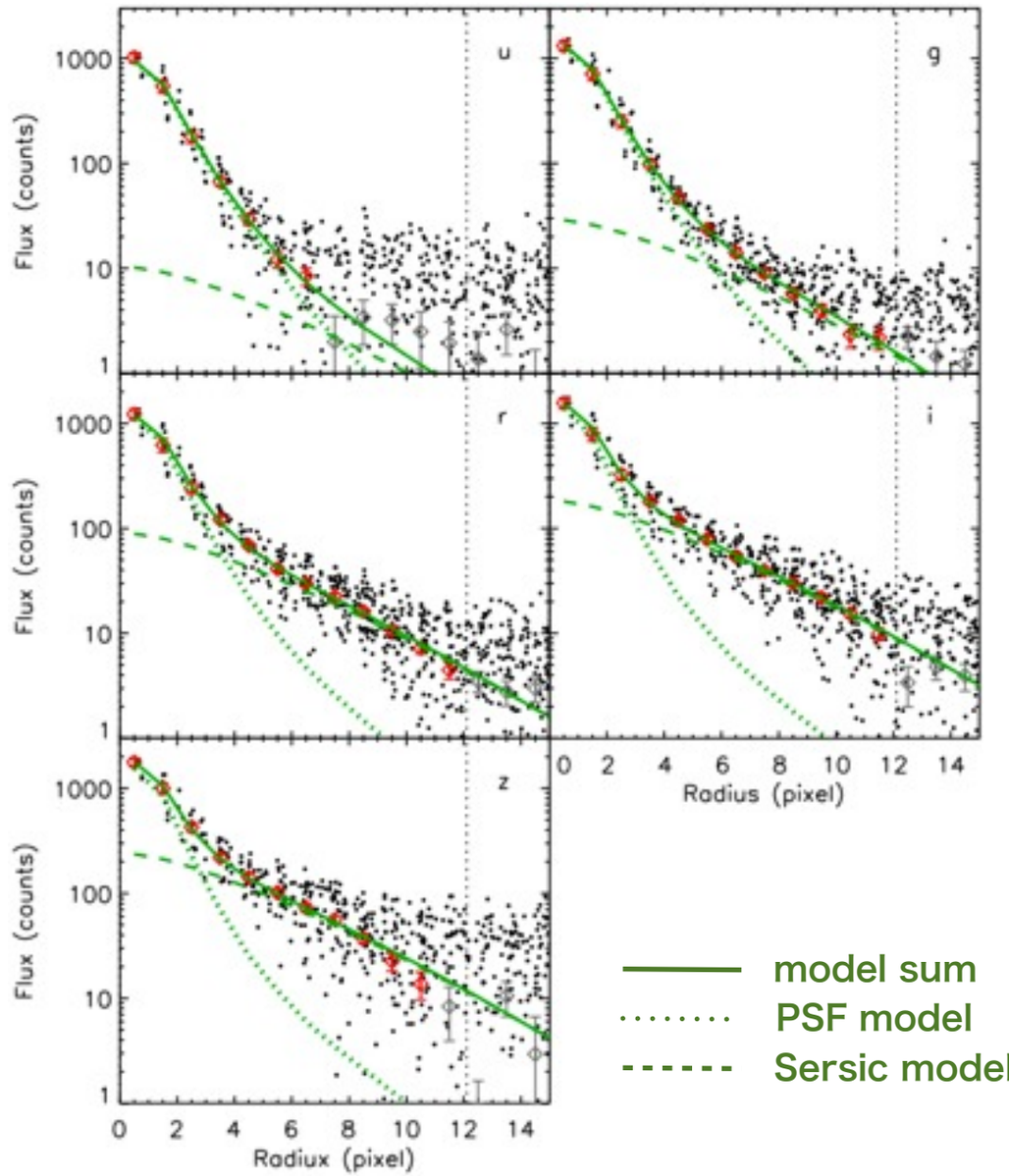


1. Imaging decomposition analysis

The majority of SDSS quasars are resolved on the deep stripe 82 images out to z ~ 0.6

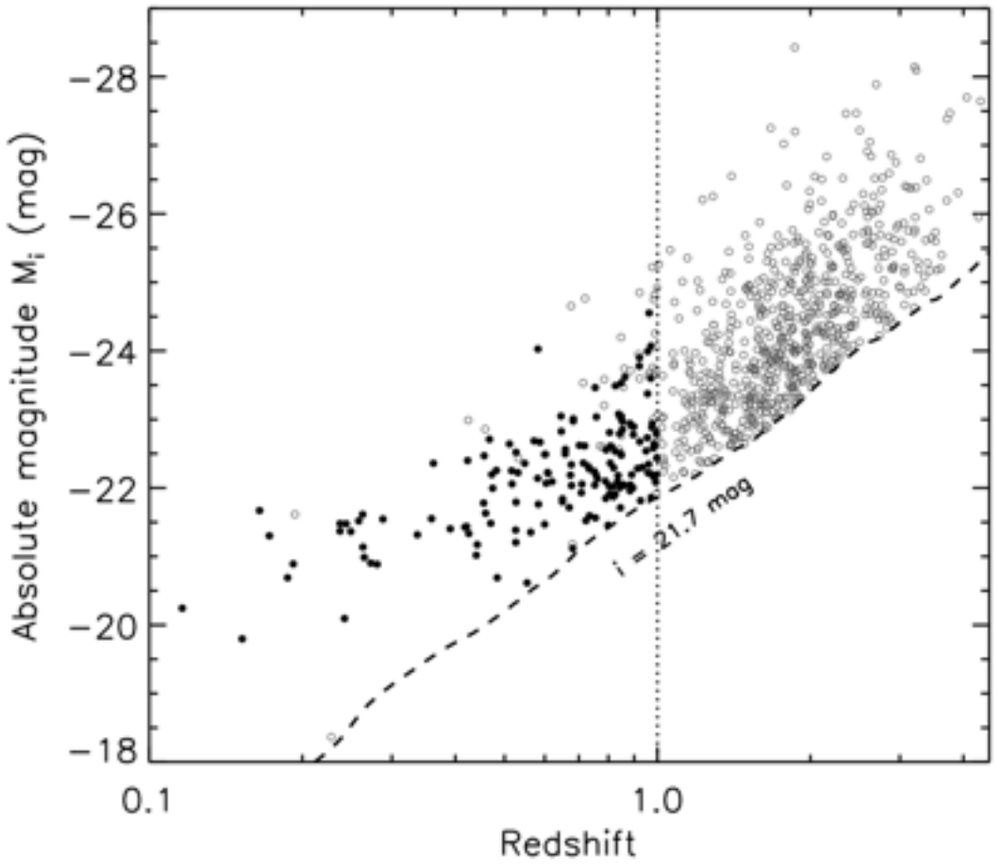
g, r, i composite – PSF model = extended comp.



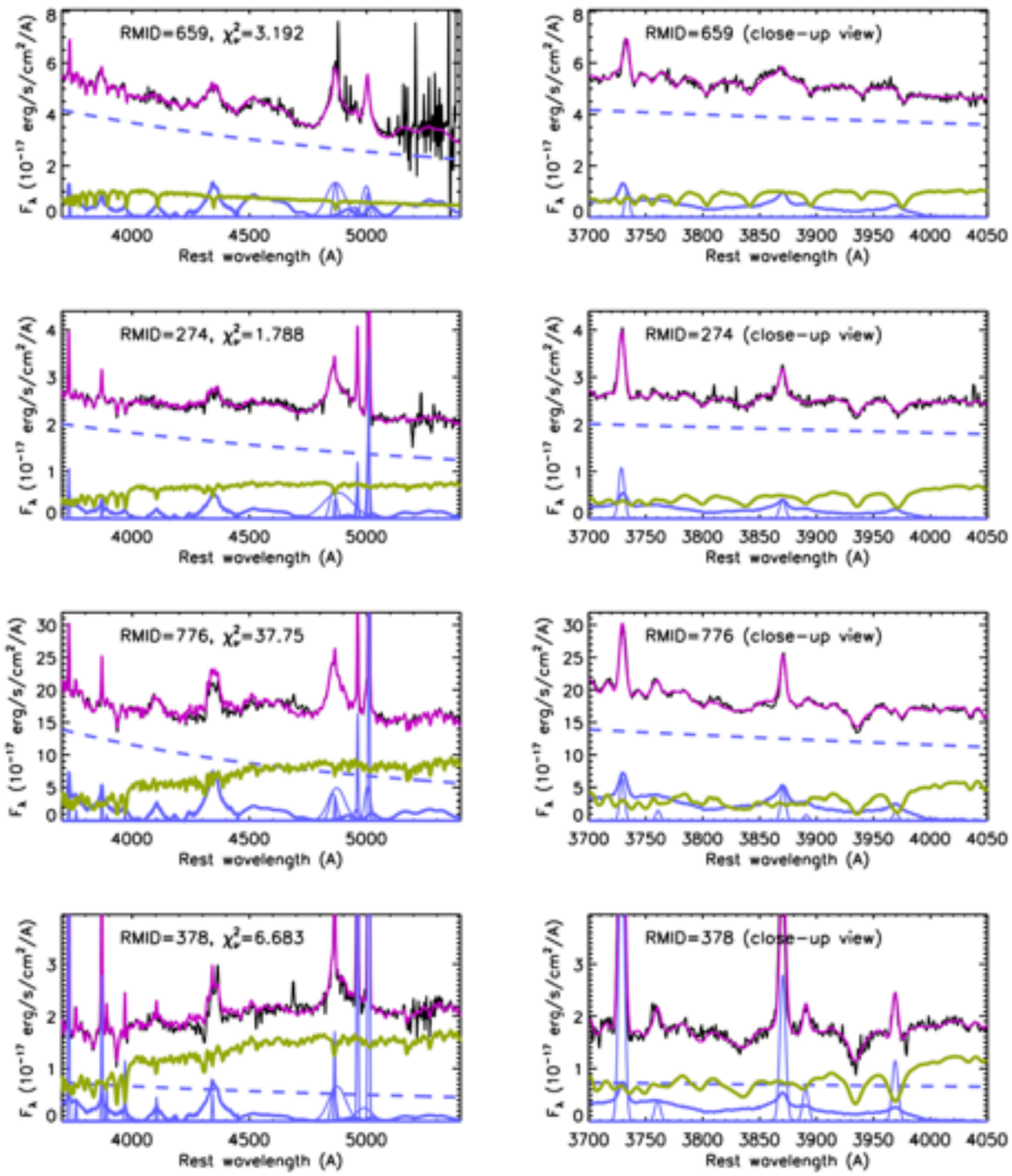


→ ~80 % of the initial sample are successfully decomposed into nuclear and host components in at least three of the g, r, i, and z bands.

2. Spectral decomposition analysis



Black: observed
Red: model sum
Blue: quasar power-law (A_{pl}, α_{pl})
BLR/NLR templates (A_q)
ISM lines (A_{lines}, σ_{lines})
Green: Maraston+11 SSP (t_{age}, M_{star}, σ_{star})



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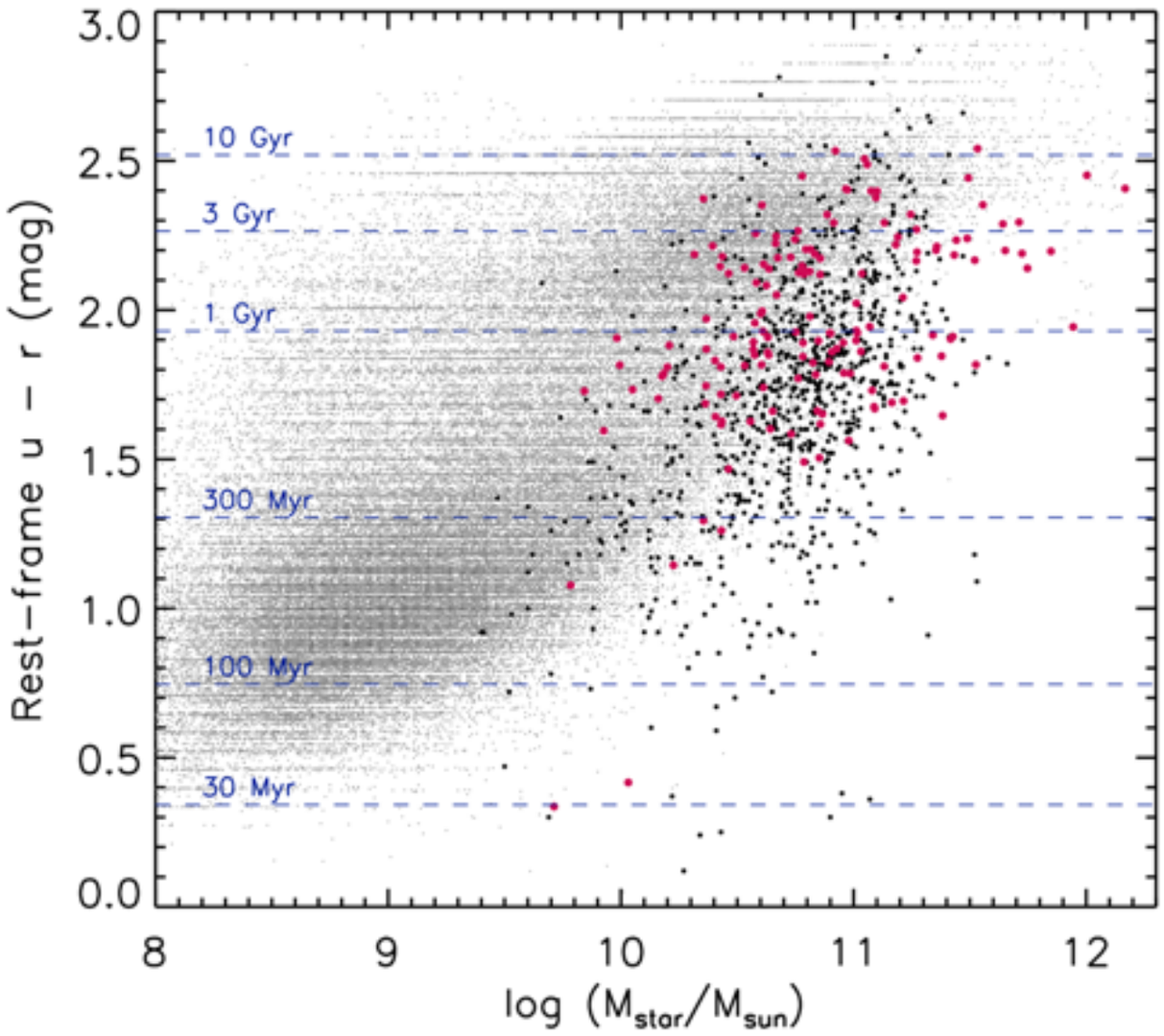
Stellar properties



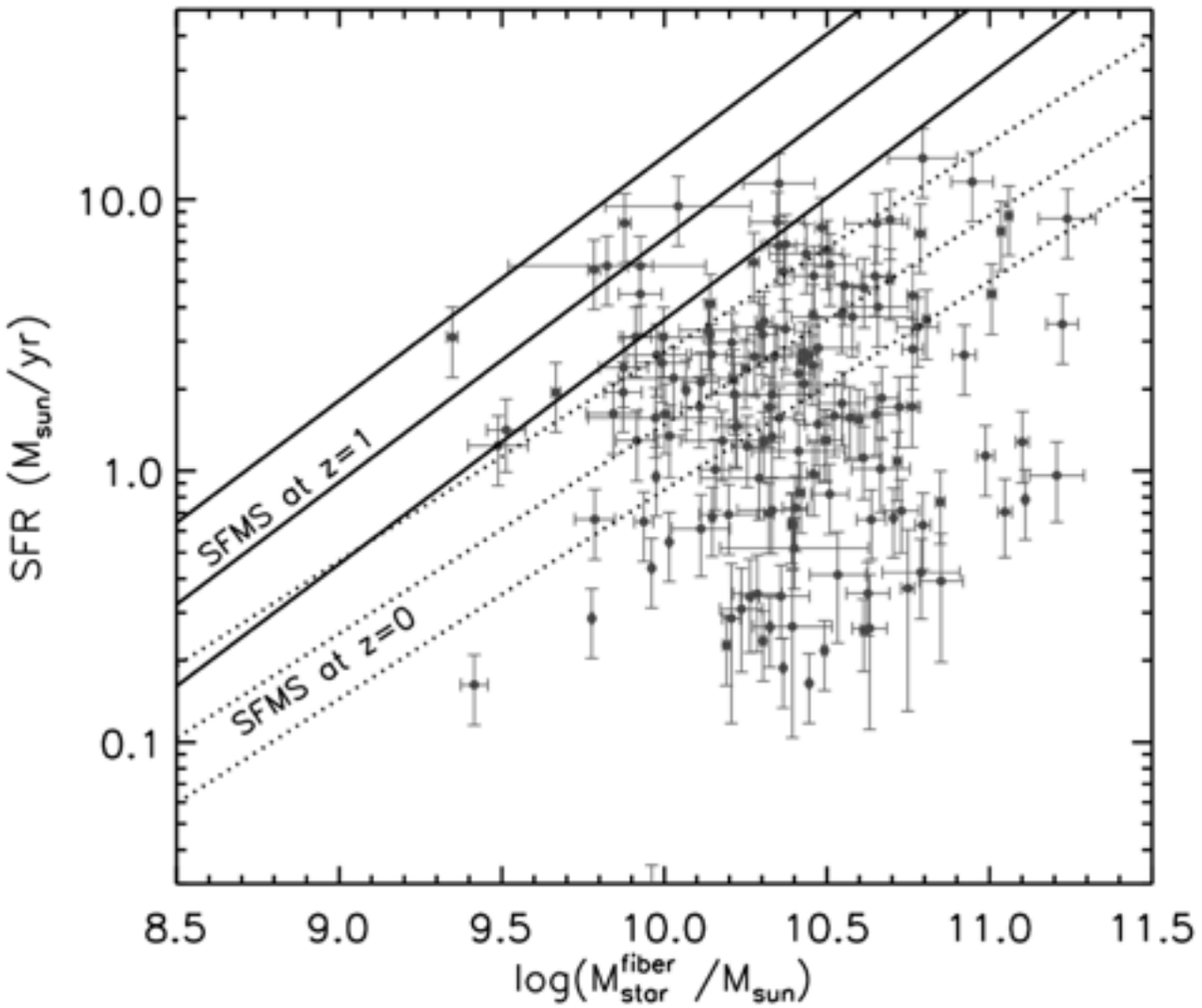
- quasar hosts; imaging decomp.
- quasar hosts; spectral decomp.
- COSMOS/UltraVISTA
  normal galaxies (0.5 < z < 1)

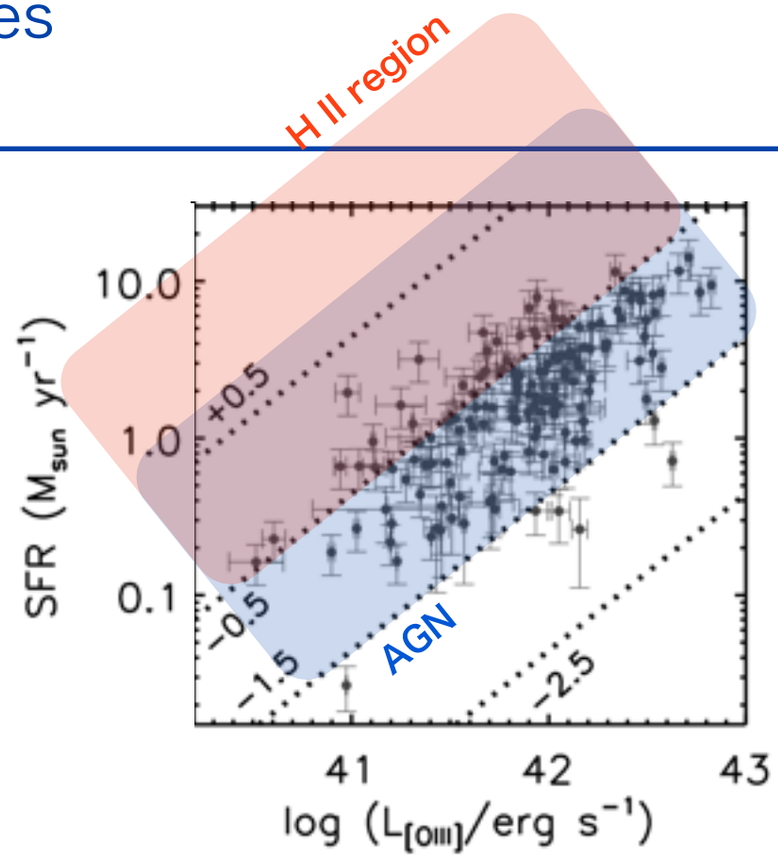
✶ The quasars are preferentially hosted by massive (> $10^{10.5}$ M_{sun}) galaxies.

✶ The hosts are distributed around the transition area between blue and red galaxies, or the massive tip of the blue cloud, corresponding to t_{SSP} ~ 1 Gyr. (This may indicate that quasars are directly/indirectly related to the quenching of star formation in galaxies.)

✶ When compared to normal galaxies with similar masses, quasar fraction increases toward bluer colors.

Stellar properties





[O II]/[O III] luminosity ratios are consistent with quasar photoionization

→ SFRs are upper limits

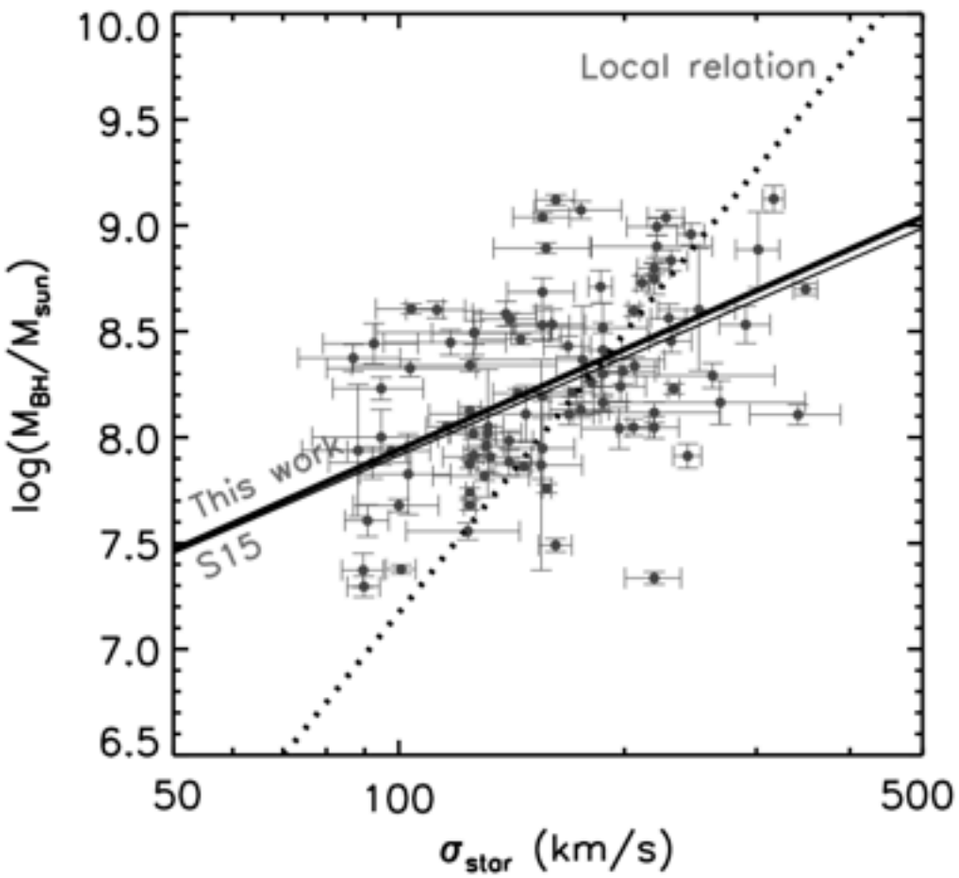
✶ The quasar hosts fall below the “main sequence” of star-forming galaxies.

✶ The intermediate stellar ages (t_{SSP} ~ 1 Gyr) and relatively low SFRs suggest that the quasar hosts have experienced an episode of major star formation sometime in the past ~1 Gyr, which was subsequently quenched.

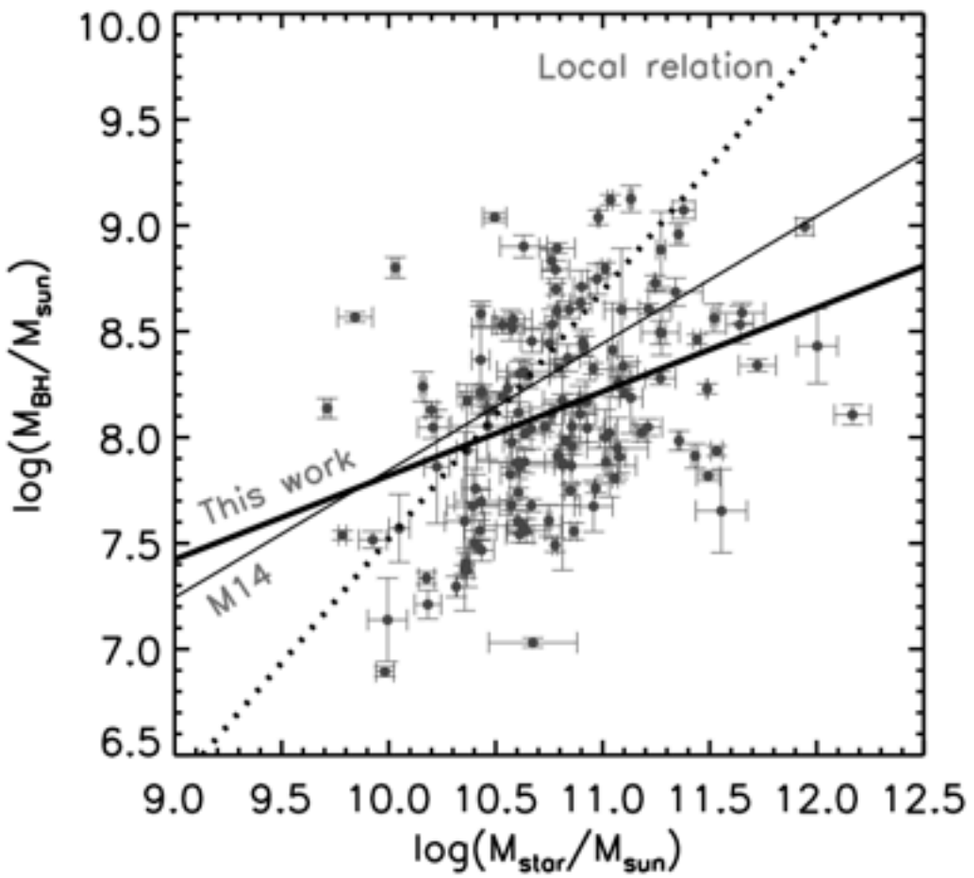
✶ Link to post-starburst galaxies?

Scaling relations

M_{BH} - σ_{star} relation



M_{BH} - M_{star} relation



✶ There are positive (although weak) M_{BH} - σ_{star} and M_{BH} - M_{star} correlations.

✶ While the mean M_{BH}/σ_{star} and M_{BH}/M_{star} ratios are consistent with the local values, the relations seem to flatten toward higher redshifts. This is likely due to selection biases (Shen+15), and no evolution of the scaling relations is favored at $z < 1$.

Summary

✶ AGNs/quasars are a key for understanding galaxy and SMBH evolution.

✶ As a complementary effort to the previous studies of obscured AGNs, we are carrying out a project to explore host galaxies of unobscured quasars in large contemporary surveys.

✶ The results obtained so far indicate that quasars are preferentially hosted by massive galaxies distributed around the transition area between blue and red galaxies, with relatively low SFRs. These facts suggest that the hosts have experienced an episode of major star formation sometime in the past ~1 Gyr, which was subsequently quenched.

✶ The present studies will benefit greatly from future powerful imaging and spectroscopic survey instruments, such as Subaru HSC and PFS.