Shedding New Light on AGN Demographics with PFS

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$6.5 \times 10^9 \, M_{\odot}$ black hole at the center of M87
Soltan argument tells us that local SMBHs were formed via AGNs.

\[ \rho_{\text{BH}}(z = 0) = \int_0^\infty \frac{dt}{dz} \int_{L_{\text{min}}}^{\infty} \frac{1 - \epsilon}{\epsilon} \frac{L_q}{c^2} \Phi(L, z) dL, \]

Soltan (1982); Davies et al. (2019)

- SMBH (L_q)
- AGN LF at redshift z
- Total SMBH growth via AGNs over the cosmic history
- SMBH seed
- Total SMBH density at z = 0
Remaining mysteries about AGNs (my biased view)

Where do AGNs live within the cosmic web?

Do AGNs impact the galaxy evolution? How?

How is the mass structured around BHs? (accretion disk, corona, BLR, “torus”, NLR, jet, …)

How are the BHs fueled?

What are SMBH “seeds”?
AGN spectrum is extremely rich in information

* In the first place, it is difficult to identify and measure redshift of AGNs without spectra.

Selsing et al. (2016)
Legacy of SDSS

Paris et al. (2018)
HSC is going much deeper than SDSS, in imaging

Quasar luminosity function at $z \sim 4$ (Akiyama et al. 2018)
What we aim to do: “Shedding New Light on AGN Demographics with PFS”
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*List of the science topics proposed so far*

✓ Charting broad-line AGNs at $0 \leq z \leq 6$ and beyond (Akiyama, Ikeda, Matsuoka, et al.)
✓ Dust-obscured phase of SMBH growth in mid-IR AGNs (Toba et al.)
✓ Nature of sub-millimeter galaxies, in particular the energy source (Tamura et al.)
✓ Radio activities of AGNs and surrounding environments (Yamashita et al.)
✓ Metal-poor AGNs to trace an early phase of galaxy - SMBH co-evolution (Nagao et al.)
✓ SDSS/BOSS/HETDEX quasars to complement near-IR spectra and look for changing-look quasars (Morokuma, Schulze, et al.)
✓ Search for intermediate mass black holes in low-luminosity AGNs (Morokuma et al.)
✓ CGM properties along the sightlines of quasar pairs (Misawa et al.)
✓ Search for lensed quasars from HSC imaging candidates (Suyu et al.)
✓ SMBH mass measurements via reverberation mapping (Minezaki, Trump, et al.)

* Much more diverse projects can/will be done with the legacy dataset.*

All of these can be achieved with PFS, by using a few % of the fiber-hours in the present SSP plan!
A case of target selection: Broad-line AGNs

- **$z < 3$:** UVX selection without morphology cut to include Seyfert 1s.
- **$z > 3$:** All point sources outside the stellar locus, with explicit exclusion regions.

We need CLAUDS!

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UVX select

- **$u-g$:** quasar model
- **$g-r$:** WD + M binaries
- **$r-z$:** Akiyama+18
- **$i-y$:** Niida+19

HST stars

HST galaxies

HSC stars

HSC galaxies
Conclusion

PFS will provide an unprecedented opportunity to explore AGN demographics across the Universe. This is crucial for understanding not only the AGNs themselves and the ubiquitous presence of supermassive black holes today, but also the entire galaxy evolution from the earliest time.