Subaru/PFS-Roman Synegertic Observations for Galaxy Evoltion and Cosmic Reiozation

Proposers (name/affiliation): Yuichi Harikane (U. Tokyo), Masami Ouchi (NAOJ/U. Tokyo), Kimihiko Nakajima (NAOJ), James Rhoads (NASA), Sangeeta Malhotra (NASA), Koki Kakiichi (DAWN), Yusei Koyama (NAOJ), Yoshiki Matsuoka (Ehime U.), Kentaro Nagamine (Osaka U.), Tsutomu Takeuchi (Nagoya U.), Masayuki Tanaka (NAOJ)

Subaru Instrument: PFS

Number of nights (hours): Nominal: ~30 clear nights (180 hours; assuming 6 hours/night). Will be finalized after the CCS designs are determined.

Condition of nights (moon phase, airmass, seeing): grey/dark nights, any airmass, seeing <~1”

Time critical (year, season, date, time): after the CCS prism/grism spectroscopy is completed

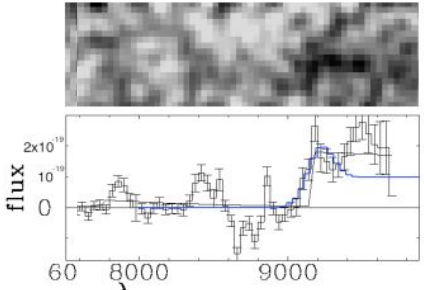
Relevant CCS/other Roman program: High Latitude Wide Area/Time Domain Surveys

Category: galaxies, supermassie black hole/AGN, IGM/CGM

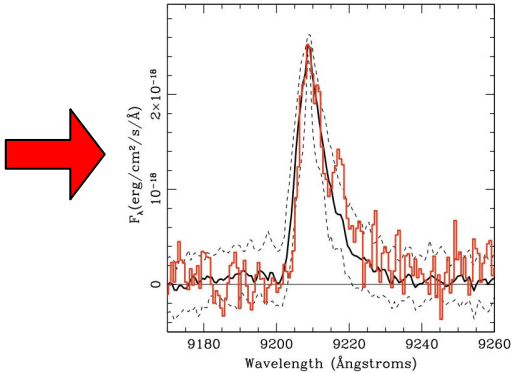
Key words: Galaxy Formation, Galaxy Evolution, Cosmic Reionization, AGN, Pop-III

Cosmic Reionization History & PopIII Candidates

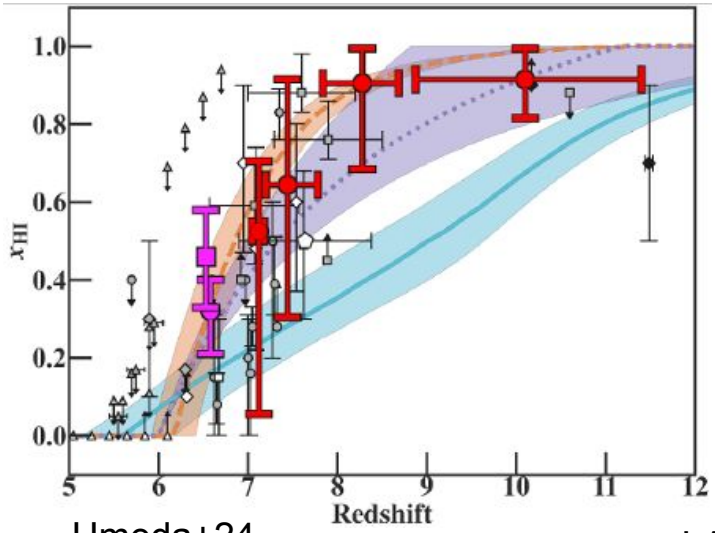
HST grism (R~100) obs



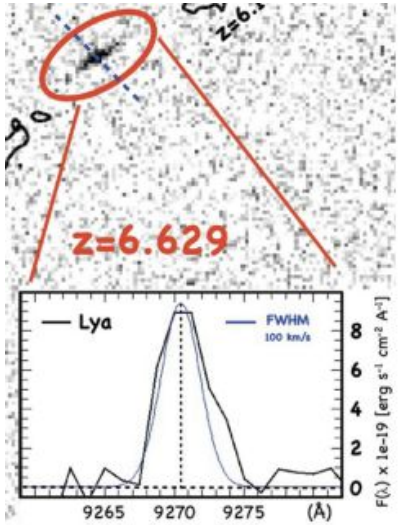
Ground med res (R~3000) spec



Rhoads+13



Umeda+24



LAE at z=6.6 w EW_0(Lya)>564A
→ <0.004Zo (Vanzella+20/+23)

Roman low-res search for single line emitters w/ prism/grism data over >~20 deg^2 in the CCSs

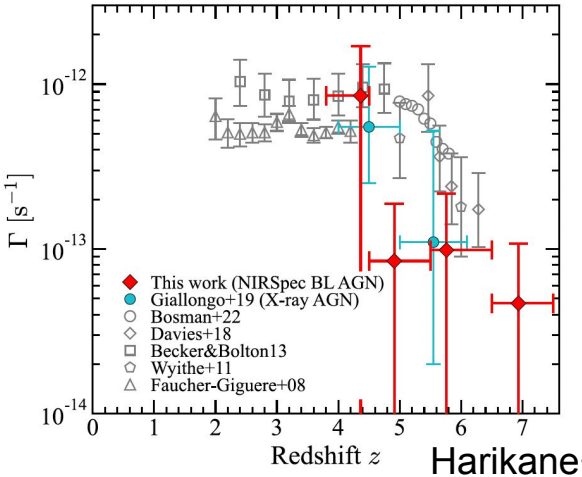
PFS follow-up w/ med-res → Lyman alpha emitters (LAEs) at z=5.2-9.3 w asymmetric Lya (N~10,000)

- Subaru-Roman wide field survey → mapping large ionized bubbles (too large for JWST's small FoV)
- Lya luminosity/correlation function evolution (Ouchi+10) → x_{HI} evolution at the heart of EoR (z~5-8)
- Rare high Lya equivalent width EW_0(Lya) objects → popIII candidates fed to JWST spectroscopy

Census of Faint AGN for Cosmic Reionzation

- Prism/Grism spectroscopy can also detect Ha and [OIII] emitters at cosmic noon (0.1<z<2.9), when the SF/AGN activity may be most active.
- Subaru/PFS follow-up (rest-UV+optical) → investigate AGN activity via broad Ha/Hb line (w/ medium-resolution PFS spectroscopy), BPT diagram (via resolving Ha+[NII]), high ionization line.

- Possible sciences:
  - Abundance of faint AGNs
  - M_{BH}-M_* relation (M_{BH} from PFS spectroscopy, M_* from high quality Roman images)
  - Escape fraction and production efficiency of LyC photons from faint AGNs, to understand their contributions to cosmic reionization



Harikane+23

Intense Emission Line Objects for Galaxy Evolution and Reionization

- Intense Ha emitters are good candidates of metal-poor obj, while [OIII] emitters, a.k.a green peas at z~0, can represent higher-redshift galaxies with large [OIII]/[OII] and potentially associated with high escape fraction
- Subaru/PFS follow-up is powerful to characterize the properties incl. metallicity, ionizing photon production efficiency ξ_ion, SF burstiness

- Possible sciences:
  - Early stage of galaxy formation and chemical enrichment by unveiling the properties of metal-poor obj
  - Sources of Reionization by constraining ξ_ion

Summary

- Subaru/PFS follow-up for emission line galaxies detected in the Roman Prism/Grism spectroscopy in the CCSs (+ photo-z galaxies as fillers)
- Cosmic reionization: investigating LAEs at $5<z<9$, and estimating ionizing photon escape fraction/production efficiency of faint AGNs
- Early galaxy formation: extremely metal poor galaxies and Pop-III galaxy candidates with strong Lya emission
- Any ancillary sciences by taking advantage of the wide-field synergy (e.g., auto/cross-correlation, IGM tomography, calibration of cosmology)

Significance of Synergy: Roman prism/grism can detect only a single/few emission lines from each galaxy with relatively low resolution. The wide FoV of PFS has an excellent synergy with Roman, and its wide wavelength coverage (0.3-1.3 um) and high resolution (R~3000) will fully characterize the spectroscopic properties of galaxies detected with Roman, crucial for understanding cosmic reionization and early galaxy formation.