Synergistic PFS Lyman Alpha Spectrosopy at High-z (SPLASH)

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Subaru Instrument: Prime Focus Spectrograph (PFS)
Number of nights (hours): 10 nights

Condition of nights (moon phase, airmass, seeing): Grey or dark time preferred - "normal" conditions for high-redshift galaxy spectroscopy.
Time critical (year, season, date, time): Subaru follow up of deep Roman observations, so, after the Roman data are taken (2028? 2029?). Likely: when northern Roman CVZ is available to Subaru

Relevant CCS/other Roman program: SPQR (Spectroscopic Probes of Quantitative Reionization)

Category(exoplanet, galaxies, large scale structure, solar system, stellar physics, stellar population/ISM, super massive blackhole/AGN, IGM/CGM): Reionization (=> Galaxies, IGM.)

Key words: Reionization, early universe, high redshift galaxies, IGM

Scientific Motivation for SPLASH

- *Roman* slitless spectroscopy will be a powerful tool to identify Lyman alpha galaxies in the epoch of reionization, with a sensitivity and uniformity of redshift selection that is unachievable from the ground, and survey volumes unachievable with JWST (Wold et al. 2024).

- One key goal of the SPQR Widefield Preparatory Science program is to plan for such observations, in order to explore the Epoch of Reionization.

- Lyman alpha galaxy samples uniquely probe the ionization state of the intergalactic medium (IGM), because Lyman alpha is strongly scattered by neutral gas.

- Roman spectroscopy can identify Lyman alpha galaxies across many square-degrees and $\Delta z > 2$.

- Subaru PFS followup spectroscopy can study the line profiles of these Lyman alpha galaxies at higher spectral resolution, and (with sufficient integration time) higher S/N to further refine the diagnostics of neutral fraction in the IGM

Description of Observations

We forecast a deep *Roman* spectroscopic survey area of ≥ 5 deg^2.

Subaru PFS can cover 5 deg^2 in about 5 pointings.

At 1.03 microns, Subaru PFS achieves S/N = 5 at a line flux of 8×10^{-18} erg cm^{-2} in 16 hours of integration per fiber setup.

This results in an estimate of 2-2.5 nights per pointing, depending on assumptions about observing efficiency.

Any place we have a deep *Roman* spectroscopic survey, we would expect a high surface density of other spectroscopically and photometrically identified objects that could make efficient use of PFS fibers.

Synergies with other synergistic programs

The program we describe in these slides could potentially be merged with one or more additional observing programs.

A prominent option for a deep *Roman* spectroscopic survey field is within the deepest portion of the High Latitude Time Domain Survey.

Indeed, deep prism observations are anticipated over that region as part of HLTDS.

Deep Lyman alpha galaxy spectroscopy with PFS in such a region could be combined with targets from other programs in a fiber-sharing arrangement.

The SPLASH science could benefit from longer PFS integrations, which would yield higher S/N lines allowing detailed measurements of line profiles. Such longer integrations could be enabled by fiber sharing arrangements with other high-priority science cases in common regions of sky.

Summary

- The synergy of Subaru and Roman for studying Lyman alpha galaxies in the epoch of reionization can be used to identify ionized bubbles over a complete range of redshifts from z = 7 at least to z = 9, from the central to the ending phases of reionization.

- No other existing observatory can provide a comparable data set.

- The same data set from Roman and Subaru will also provide unique contextual data on the environments of the high-redshift Lyman alpha galaxies.