The fingerprints of galaxy assembly with PFS and Roman

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Bright emission lines from star-forming galaxies are among the most commonly-observed spectral features.

- **Rest-optical (3700 – 7000 Å) emission lines**
  - **Balmer lines**: dust, SFR, outflows
  - **Collisionally-excited metal lines**: metallicity, gas density, AGN activity

- **Rest-UV (1000 – 2000 Å) features**
  - **Lyα emission and absorption**: production and escape of ionizing radiation
  - **High-ionization metal emission lines**: metallicity, gas density, AGN activity
  - **Absorption features**: outflows
Galaxy astrophysics from UV+optical spectra

determining ionizing sources in galaxies: massive stars, AGN, shocks

understanding SFHs and feedback: inflows, SNe and BH-powered feedback

Shapley et al. (2015)

Strom et al. (2021)
The next frontier in galaxy evolution studies

- Significant progress characterizing galaxy populations at $z \sim 0$ and $z \sim 2-3$ using rest-UV-optical spectra

- Measurements of, e.g., ISM conditions and gas chemistry are interesting on their own...

- But are ultimately tracers of the flow of gas in, through, and out of galaxies — the “baryon cycle”
Looking to the past for clues about the present

~75% of stars were formed in the first half of the Universe’s history (z>1)
The Subaru Prime Focus Spectrograph

- **2400 fibers** across a 1.3 deg diameter FoV
- Observed wavelength coverage **0.38-1.26 μm**
  - density-sensitive [S II] to z~0.8
  - metallicity, dust, SFR with [N II]+Hα to z~0.9
  - metallicity and ionization with [O III] to z~1.5
  - ionization and density with [O II] up to z~2.4
  - ionization, density, and abundance ratios with [C III] above z~1.0
PFS+Roman perfect for studying “cosmic afternoon”

- A key time to study to the baryon cycle is the peak ($z \sim 2-3$) and decline ($z \sim 0.5-2$) in cosmic star formation.

- Wavelength coverage of PFS+Roman is well-suited to rest-optical studies of $z \sim 0.5-2$ galaxies, with PFS-blue pushing to the rest-UV:
  - **PFS**: 0.38-1.26 μm
  - **Roman/WFI grism**: 1.00-1.93 μm
Wide wavelength coverage provides access to key features
PFS Galaxy Evolution Survey spans most of cosmic history

- Based in Hyper-Suprime Cam (HSC) deep fields with a total of 15 deg$^2$ (grizy + u-band, J-band, and Spitzer)
- Three main components
  - 250,000 galaxies at $0.5 < z < 2.0$
  - 42,000 galaxies for IGM tomography
  - 35,000 drop-outs and LAEs

“SDSS at $z \sim 1$”
Large fields-of-view link galaxies to environments

PFS footprint (~2400 fibers)

Original Illustration: NASA
Background Sky: DSS and R-Gendler
Moon: NASA/GSFC/ASU/LRO
Studying galaxies with PFS and Roman

- Enormous discovery space in the next decade enabled by wide wavelength coverage and large fields-of-view
  - Roman grism observations in PFS Galaxy Evolution Survey fields would **build on a substantial existing investment of HSC+PFS time** and provide additional constraints on galaxy physical conditions at red rest-optical wavelengths (Hα, [N II])
  - PFS observations in Roman fields, including SN Survey and any deep fields, could provide **more precise redshifts** and help **characterize host galaxies** — leading to the largest the scientific return on investment for Roman and generating more opportunities for community engagement