The fingerprints of galaxy assembly with PFS and Roman

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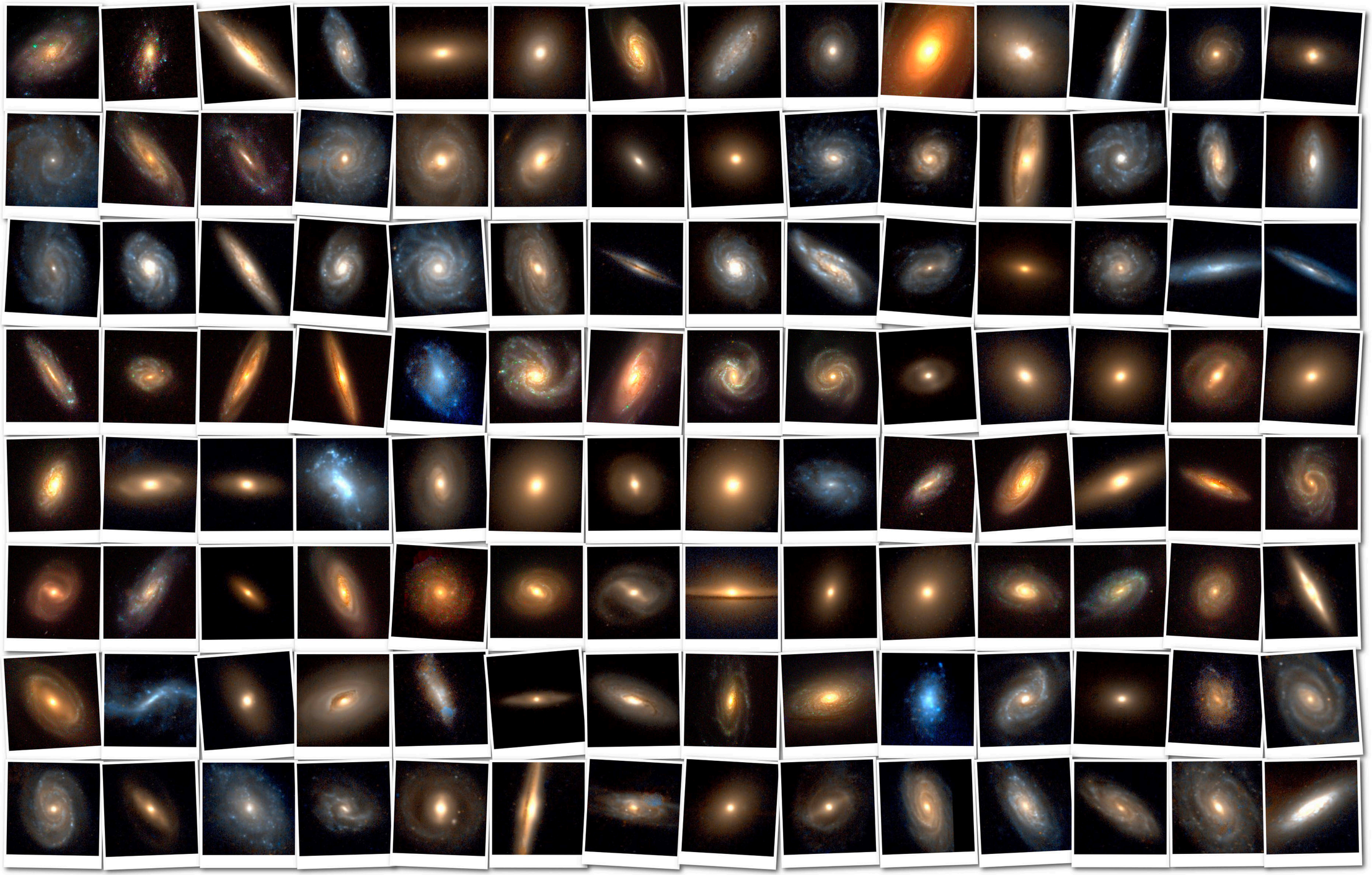
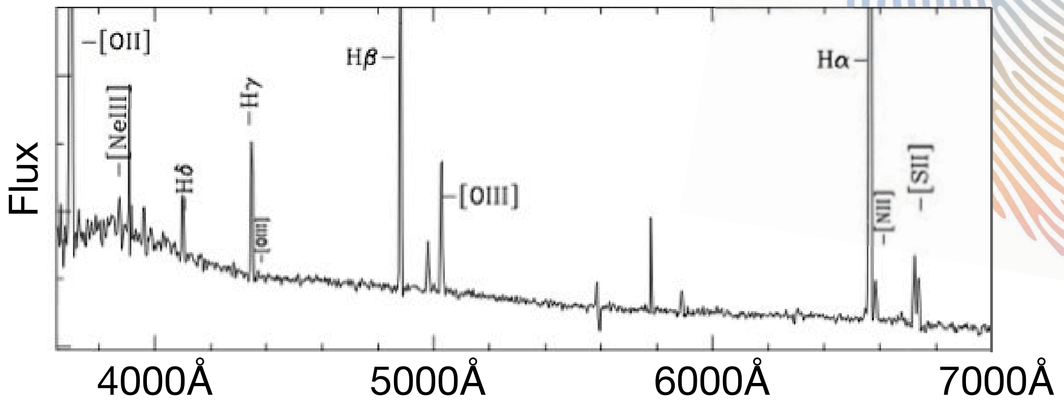
PFS Galaxy Evolution Working Group (co-chairs: Rachel Bezanson, Jenny Greene, Masami Ouchi, John Silverman)

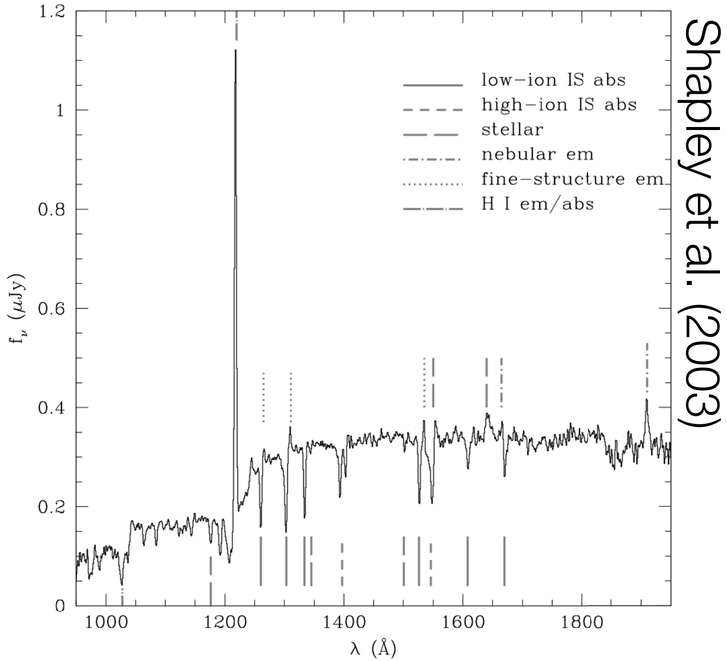


Created by Zsolt Frei and James E. Gunn

Galaxy astrophysics from UV+optical spectra

- 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

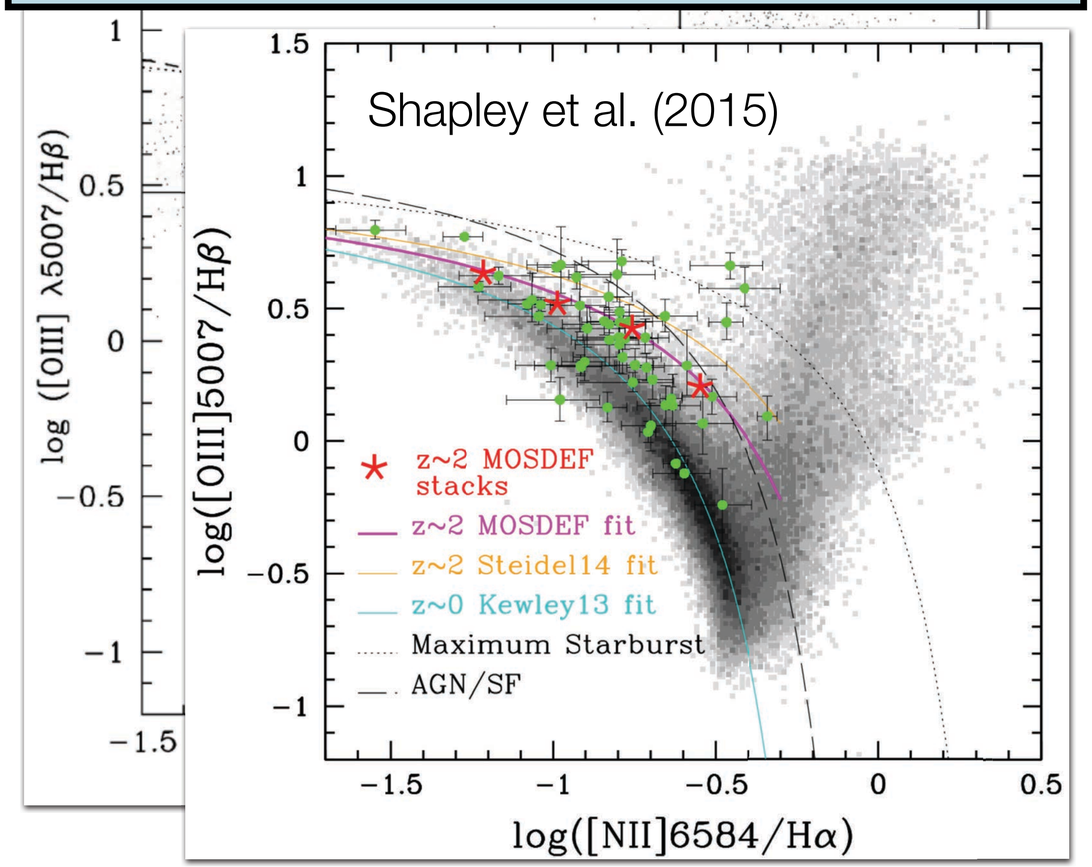




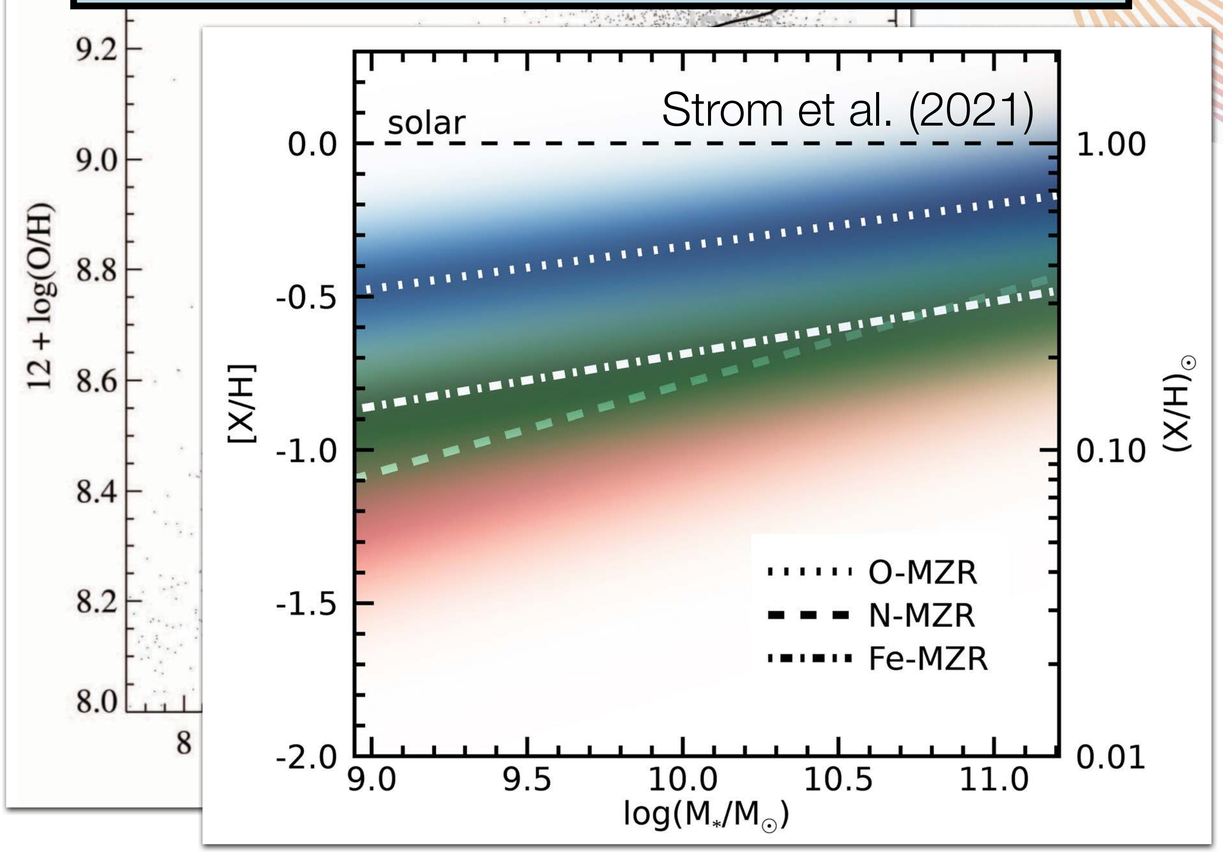
Shapley et al. (2003)

Galaxy astrophysics from UV+optical spectra

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

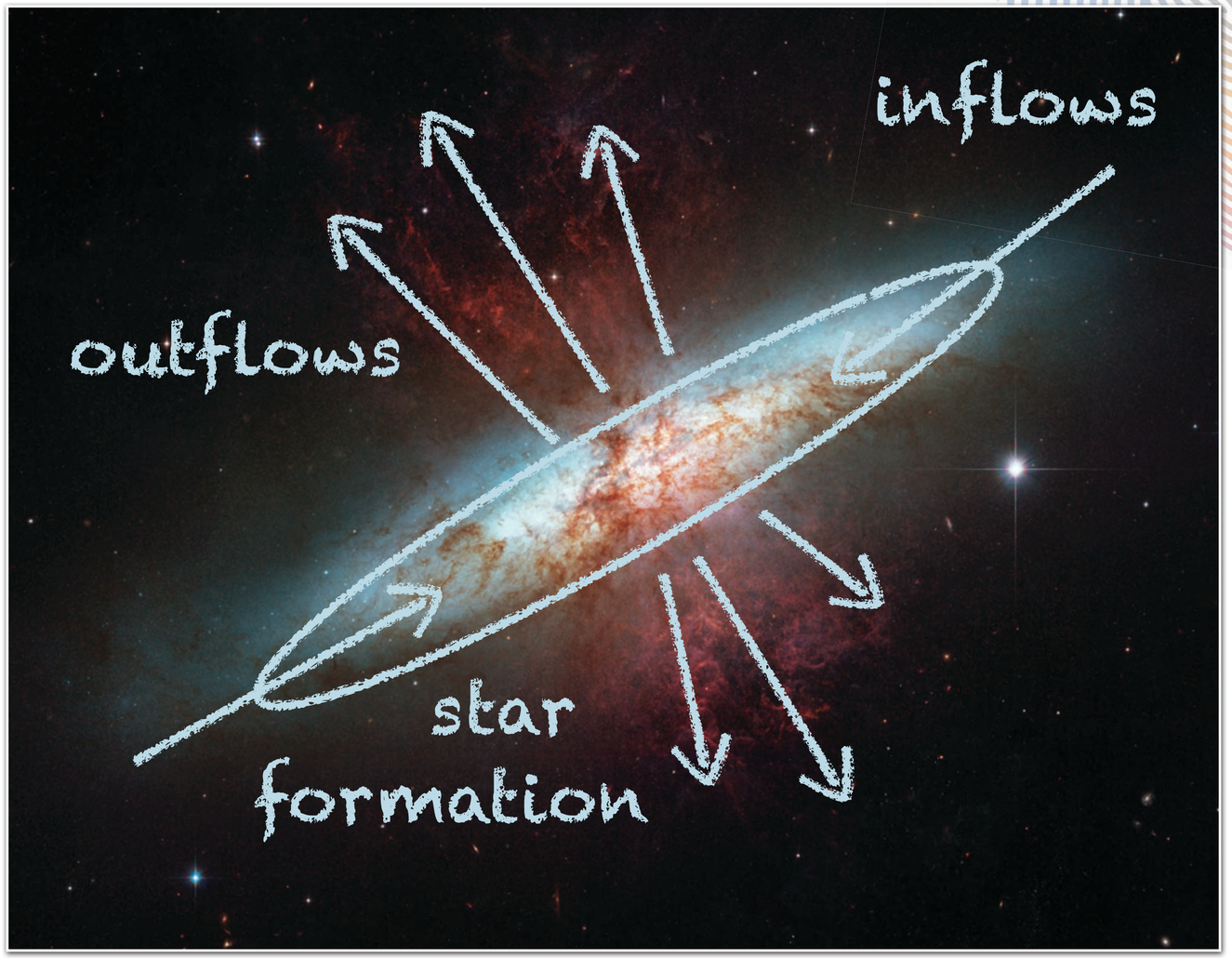


understanding SFHs and feedback: inflows, SNe and BH-powered feedback

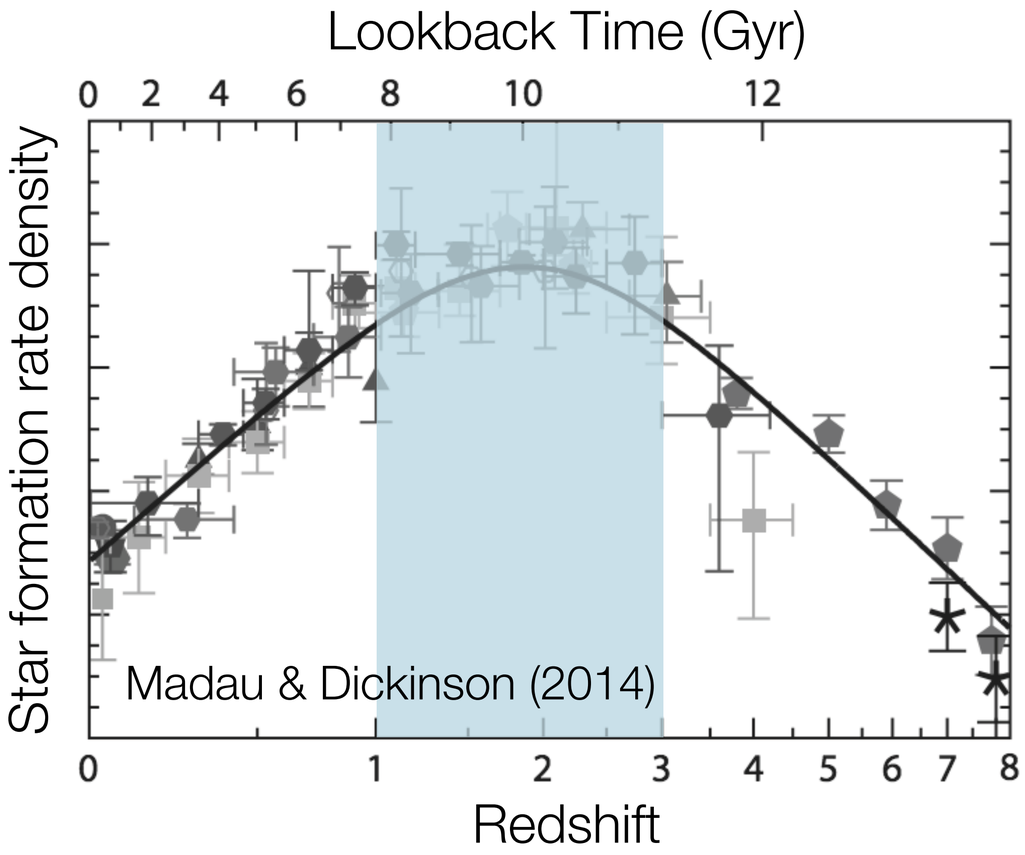


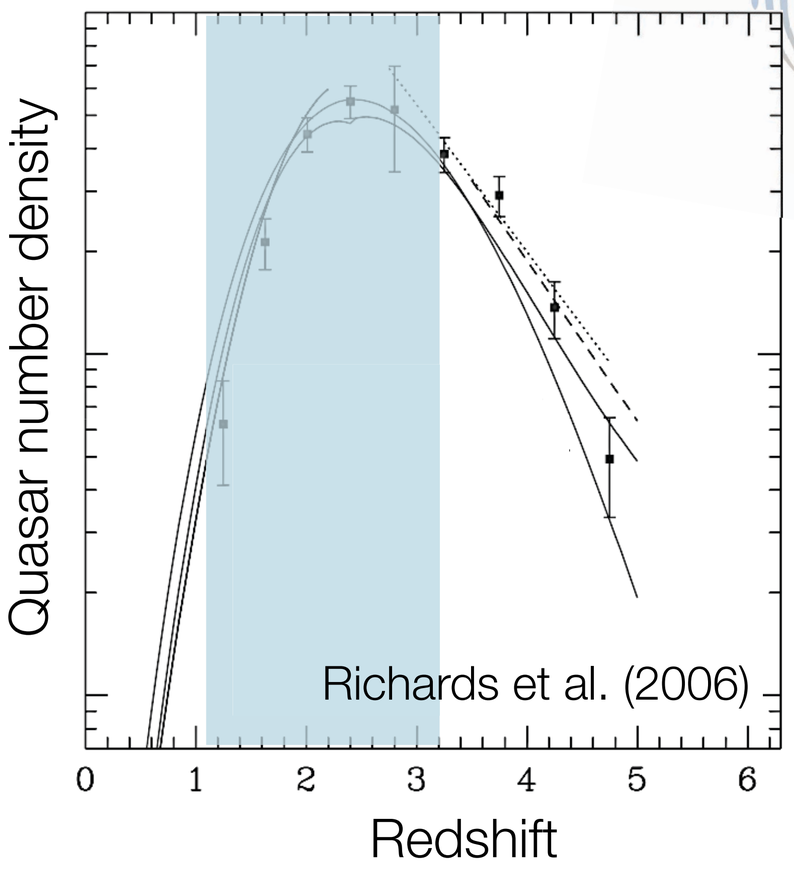
The next frontier in galaxy evolution studies

- Significant progress characterizing galaxy populations at *z*~0 and *z*~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"



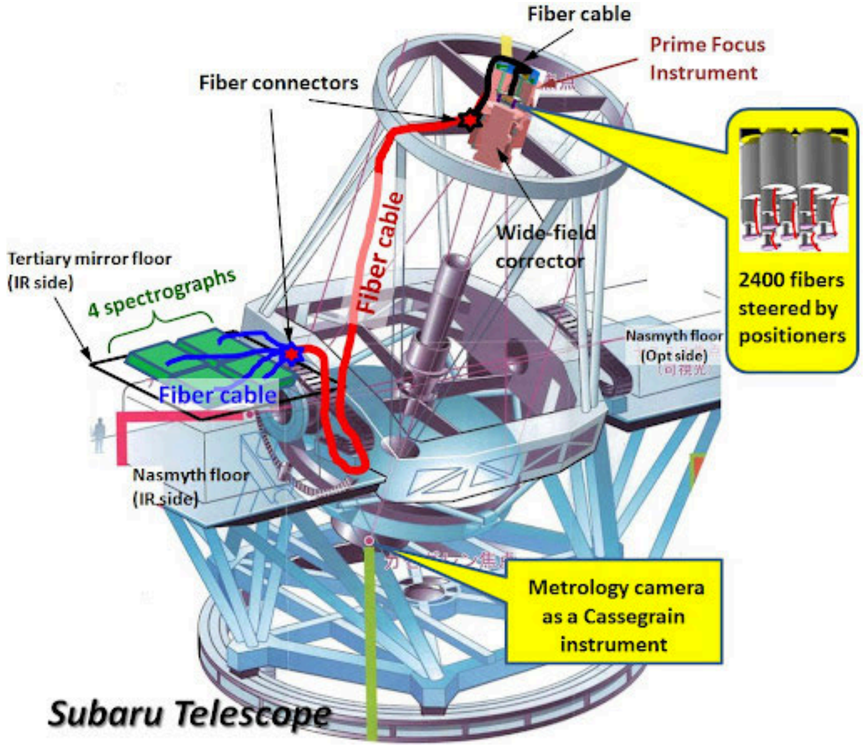
Looking to the past for clues about the present





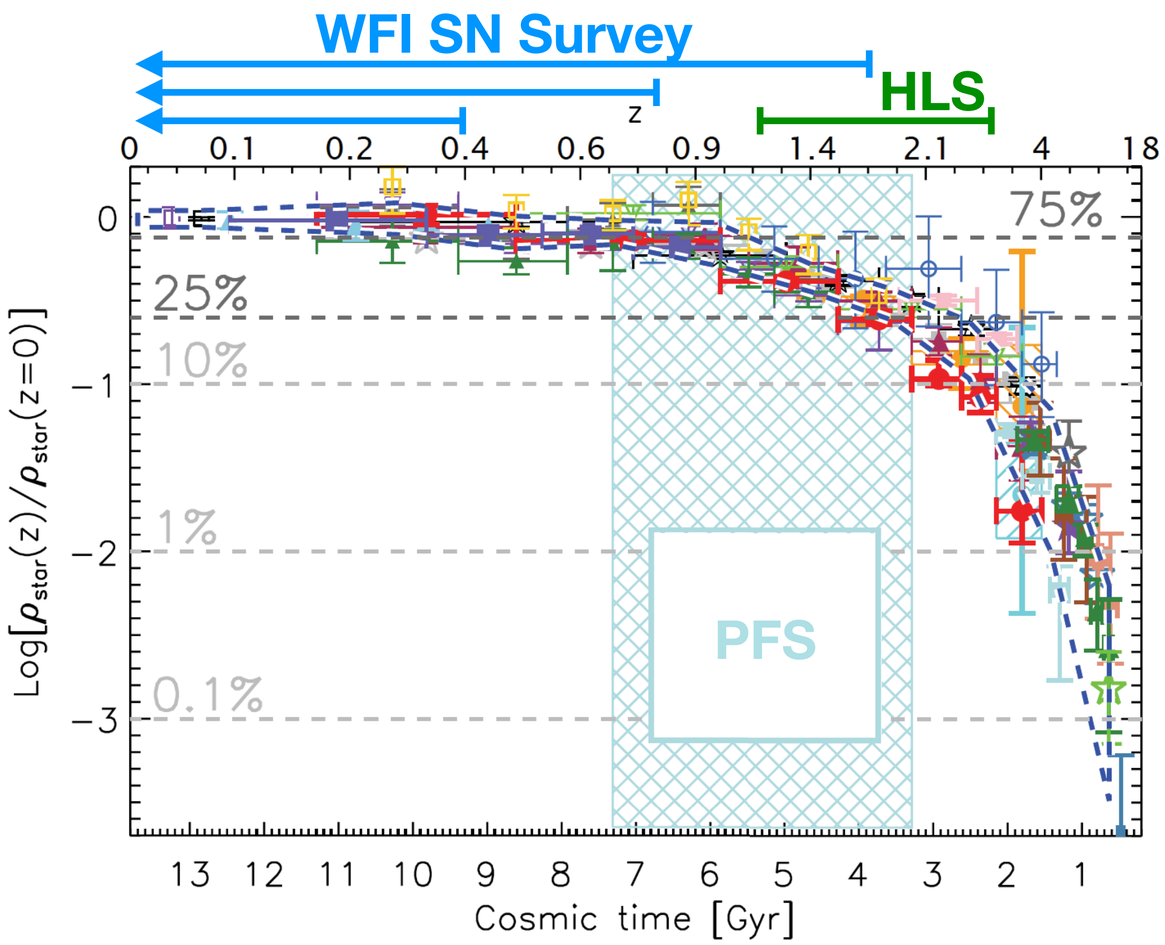
~75% of stars were formed in the first half of the Universe's history (z>1)

The Subaru Prime Focus Spectrograph



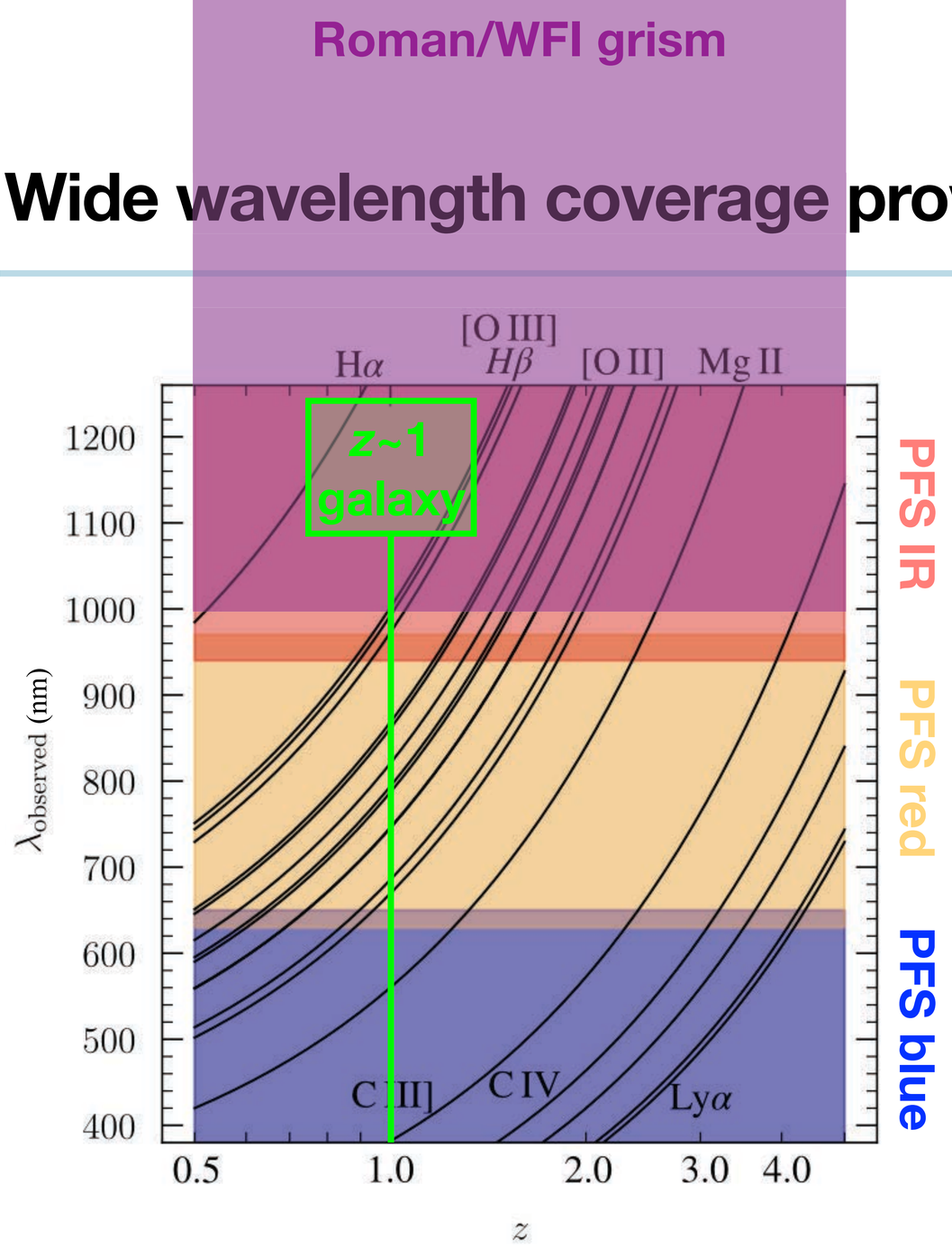
- **2400 fibers** across a 1.3 deg diameter FoV
- Observed wavelength coverage **0.38-1.26 μm**
  - density-sensitive [S II] to *z*~0.8
  - metallicity, dust, SFR with [N II]+Hα to *z*~0.9
  - metallicity and ionization with [O III] to *z*~1.5
  - ionization and density with [O II] up to *z*~2.4
  -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

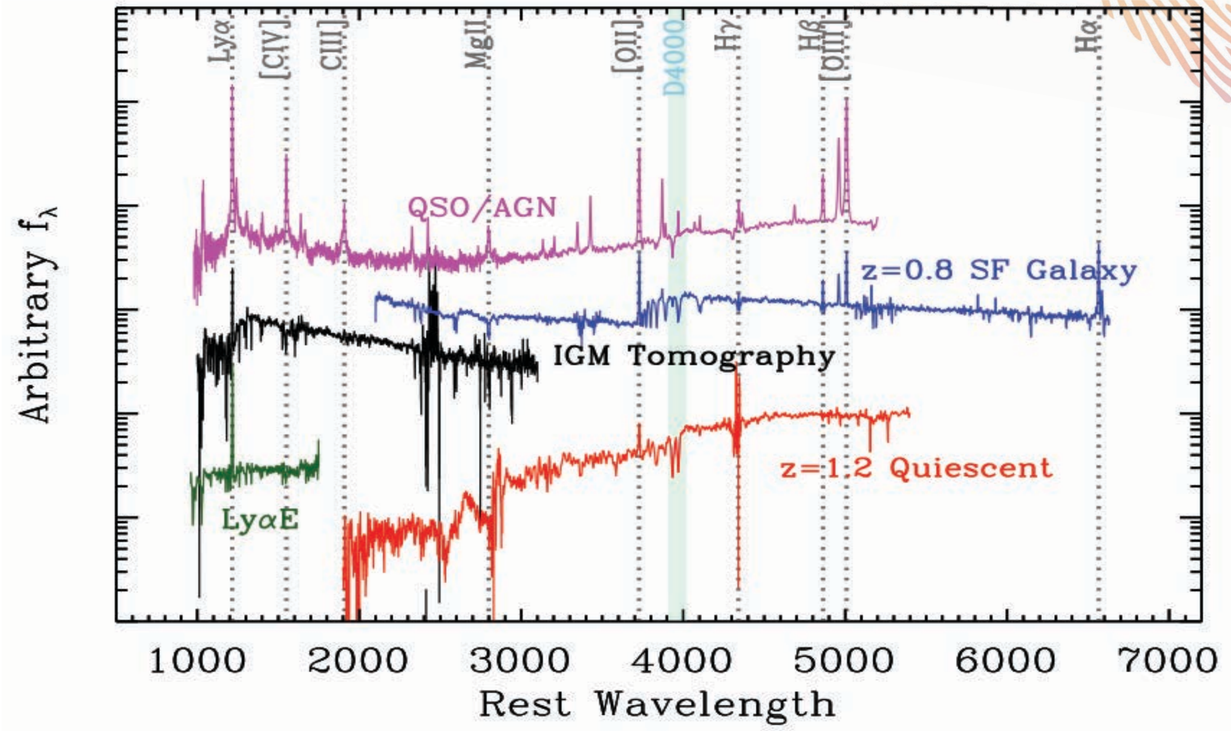
PFS+Roman perfect for studying “cosmic afternoon”



- A key time to study to the baryon cycle is the peak (*z*~2-3) and decline (*z*~0.5-2) in cosmic star formation
- Wavelength coverage of PFS+Roman is well-suited to rest-optical studies of *z*~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

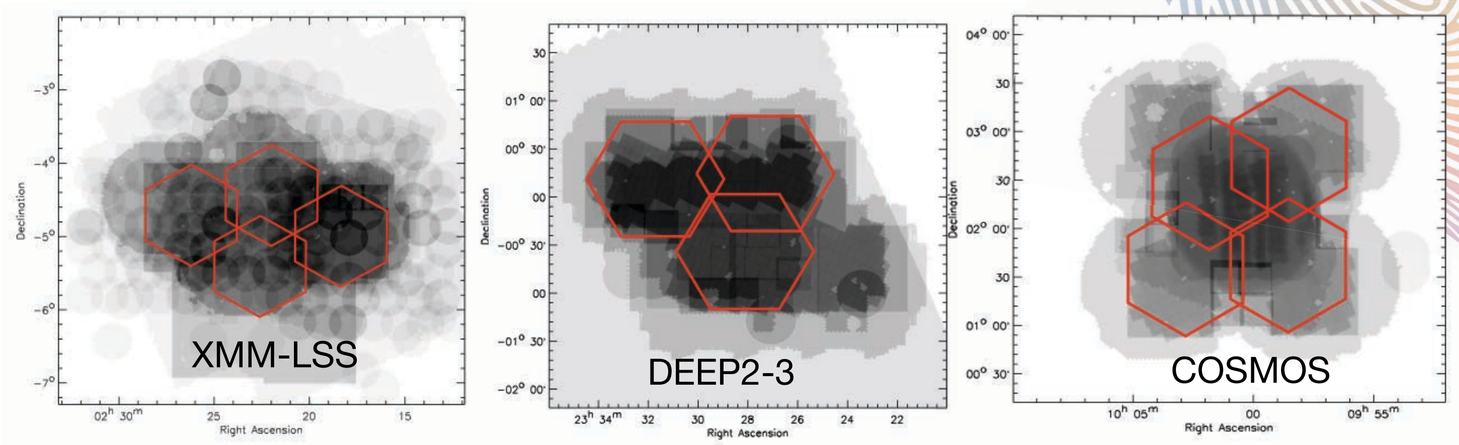
Wide wavelength coverage provides access to key features

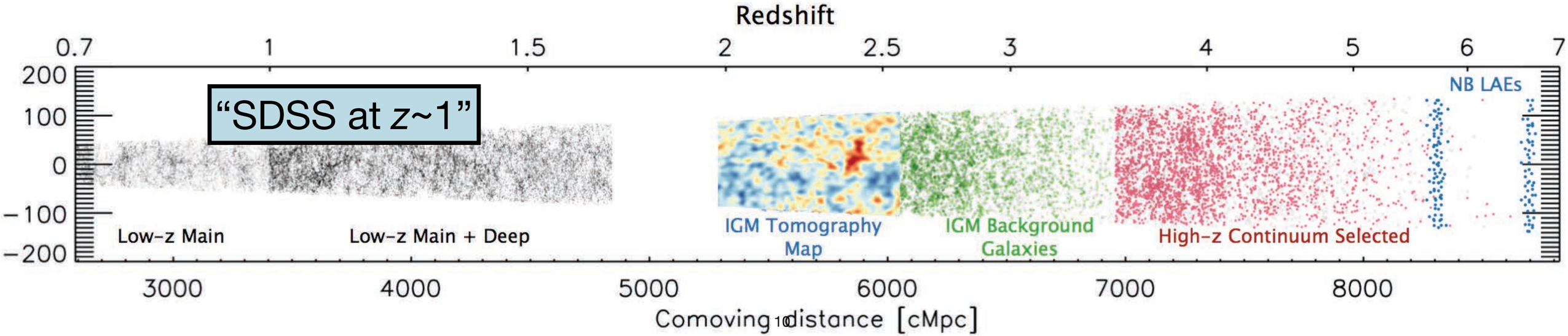


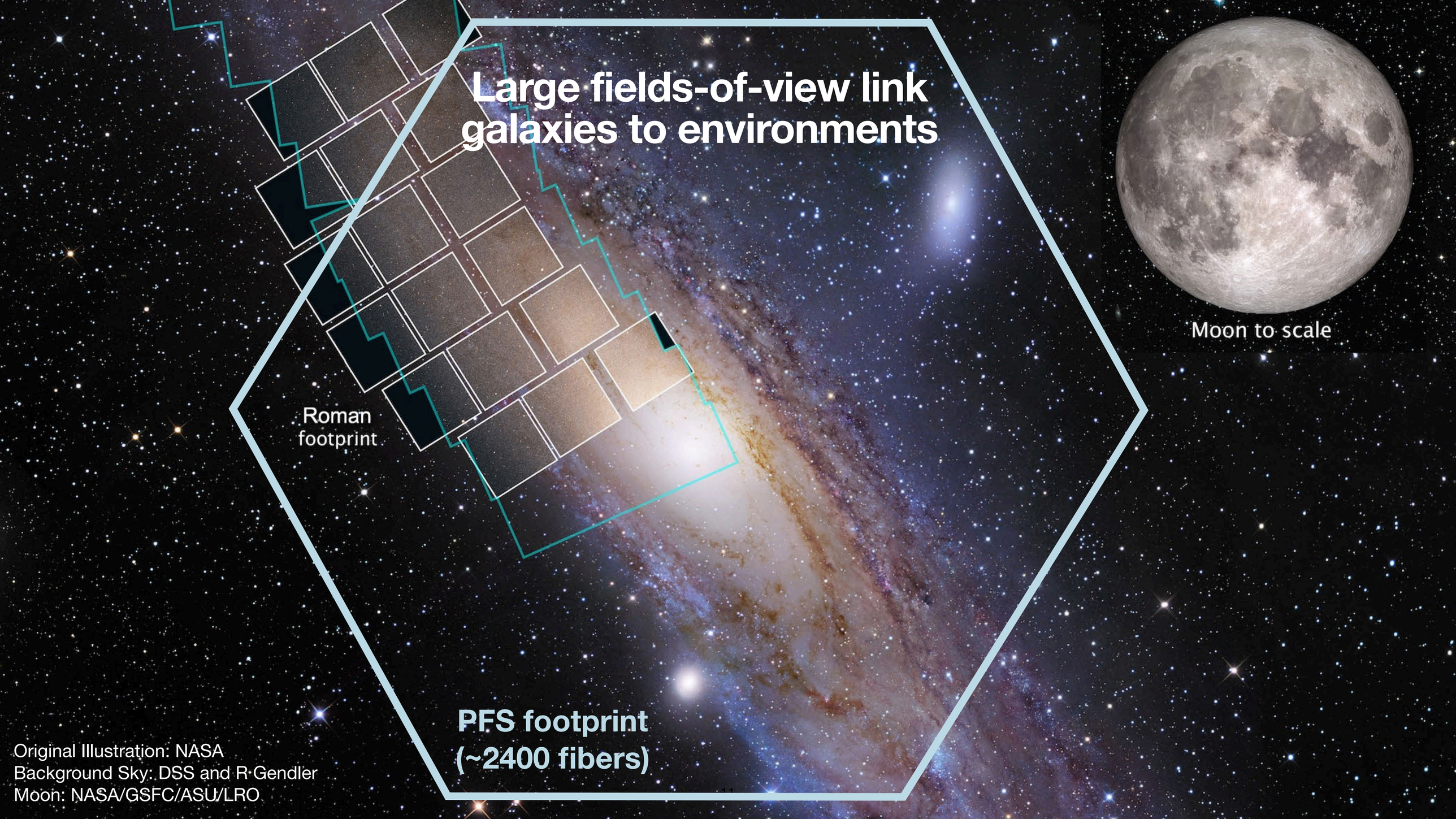


PFS Galaxy Evolution Survey spans most of cosmic history

- 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







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