Reionization-era galaxies are observed to have a wide variety of stellar populations, ranging from populations dominated by young, massive stars produced in a recent starburst to those with old stars with ages of several hundred million years. Notably, at the redshifts of reionization when the universe is < 1 Gyr old, stellar ages of several hundred million years suggests that these are the products of the first star formation in the Universe. However, at the redshifts probed by current measurements (z ~ 6 - 9), continuum emission from old stellar populations is impossible to photometrically disentangle from nebular emission powered by young stars, making it difficult to cleanly identify old stars. To be confident in the presence of an old stellar population, galaxy candidates must be spectroscopically confirmed to lie at z > 9. Hence, we propose spectroscopic follow-up of a sample of six galaxies whose photometric redshifts suggest they lie at z > 9 using deep Keck/MOSFIRE, VLT/X-shooter, Gemini/FLAMINGOS-2, and ALMA observations. The sensitivity of these observatories is unmatched on the ground and will allow us to obtain confident spectroscopic redshifts from either Lyman-alpha or [OIII]88μm emission, which we will use to place strong constraints on the ages of these systems via spectral energy distribution modeling. Our project will yield the first sample of reionization-era galaxies at redshifts where the degeneracy between nebular and stellar emission can be broken and stellar population ages can be unambiguously determined, and will provide key insights into the advent of star formation in the Universe.

Original paper (Laporte et al. 2021):

<https://ui.adsabs.harvard.edu/abs/2021MNRAS.505.3336L/abstract>

Original paper abstract:

We discuss the spectral energy distributions and physical properties of six galaxies whose photometric redshifts suggest they lie beyond a redshift z ≃ 9. Each was selected on account of a prominent excess seen in the Spitzer/IRAC 4.5μm band which, for a redshift above z = 9.0, likely indicates the presence of a rest-frame Balmer break and a stellar component that formed earlier than a redshift z ≃ 10. In addition to constraining the earlier star formation activity on the basis of fits using stellar population models with BAGPIPES, we have undertaken the necessary, but challenging, follow-up spectroscopy for each candidate using various combinations of Keck/MOSFIRE, VLT/X-shooter, Gemini/FLAMINGOS2, and ALMA. Based on either Lyman-α or [O III] 88μm emission, we determine a convincing redshift of z = 8.78 for GN-z-10-3 and a likely redshift of z = 9.28 for the lensed galaxy MACS0416-JD. For GN-z9-1, we conclude the case remains promising for a source beyond z ≃ 9. Together with earlier spectroscopic data for MACS1149-JD1, our analysis of this enlarged sample provides further support for a cosmic star formation history extending beyond redshifts z ≃ 10. We use our best-fitting stellar population models to reconstruct the past rest-frame UV luminosities of our sources and discuss the implications for tracing earlier progenitors of such systems with the James Webb Space Telescope.