The Last Neutral Islands at the End of Reionization? Characterizing the Nature of the Longest Dark Gaps in IGM Transmission at z~5.3

Scientific Category: High-redshift Galaxies and the Distant Universe

Scientific Keywords: Cosmology, Intergalactic medium, Large-scale structure of the universe, Lyman-alpha forest, Reionization

Instruments: NIRCAM

Proposal Size: Very Small

Exclusive Access Period: 12 months

Allocation Information (in hours):

Science Time: 10.6

Charged Time: 18.4

NASA-Keck: 2.0 nights

Abstract

Understanding when and how reionization happened is crucial for studying early structure formation and the properties of first galaxies in the Universe. During cosmic reionization, ionized regions gradually grew and overlapped in the IGM. At z>6, complete Gunn-Peterson troughs observed in the Ly-a forest of quasar spectra indicate ongoing reionization. At z~5.5, the average Ly-a effective optical depth suggests that most of the IGM is already highly ionized. However, some quasar sightlines still exhibit long troughs with no detectable flux (so-called “dark gaps") in Ly-a forests even at z<5.5. These long dark gaps could be the last remaining neutral islands in the IGM at the end of a highly inhomogeneous reionization process. If confirmed, it will have profound impact on the physics of reionization. We propose for joint JWST and Keck observations to study galaxy properties around two lowest-redshift long dark gaps known detected quasar absorption spectra at z=5.3. NIRCam/WFSS will measure the H-a redshift of ~230 galaxies (~75 in dark gap regions) and joint Keck observations will probe Ly-a emission from detected galaxies.

If long dark gaps are indeed neutral islands, we expect a significant lower Ly-a visibility, and a large Ly-a/Ha velocity offset, among JWST-detected H-a emitters in the dark gap regions due to saturated IGM absorption. We will also characterize the galaxy density field around long dark gaps. This joint program will allow us to directly test the ultra-late reionization model and to place robust constraints on the topology of reionization and the nature of inhomogeneous reionization.