Submission to the NASA Astrophysics 30 Year Roadmap Team:

Project Lyman: 11 Gyrs of MIB Evolution

Abstract: The timing and duration of the reionization epoch is crucial to the emergence and evolution of structure in the universe. The relative role played by star-forming galaxies, active galactic nuclei and quasars in contributing to the metagalactic ionizing background (MIB) across cosmic time remains uncertain. Deep quasar counts provide insights into their role, but the potentially crucial contribution from star-formation is highly uncertain due to our poor understanding of the processes that allow ionizing radiation to escape into the intergalactic medium (IGM). The fraction of ionizing photons that escape from star-forming galaxies is a fundamental free parameter used in models to "fine-tune" the timing and duration of the reionization epoch that occurred somewhere between 13.4 and 12.7 Gyrs ago (redshifts between 12 > z > 6). However, direct observation of Lyman continuum (LyC) photons emitted below the rest frame H I ionization edge at 912 Å becomes increasingly improbable at redshifts z > 3, due to the steady increase of intervening Lyman limit systems towards high z.

Thus UV and U-band optical bandpasses provide the only hope for direct, up close and in depth, observations of the types of environment that favor LyC escape. By quantifying the evolution over the past 11 billion years (z <3) of the relationships between LyC escape and local and global parameters such as: metallicity, gas fraction, dust content, star formation history, mass, luminosity, redshift, over-density and quasar proximity, we can provide definitive information on the LyC escape fraction that is so crucial to answering the question of, how did the universe come to be ionized? In the Figure I provide estimates of the ionizing continuum flux emitted by "characteristic" (L^*_{UV}) star-forming galaxies as a function of look back time and escape fraction, finding that at z = 1 (7.6 Gyrs ago) L^*_{UV} galaxies with an escape fraction of 1% have a flux of 10^{-19} ergs cm^{-2} s^{-1} Å^{-1}. This is a challenging flux level to reach, requiring a product of effective area, time and bandpass ~ 2.5 x 10^8 cm^{-2} s^{-1} Å^{-1} at 2000 Å to reach a S/N of 5. Constructing a LyC luminosity function over 11 Gyr is clearly a 30 year project.

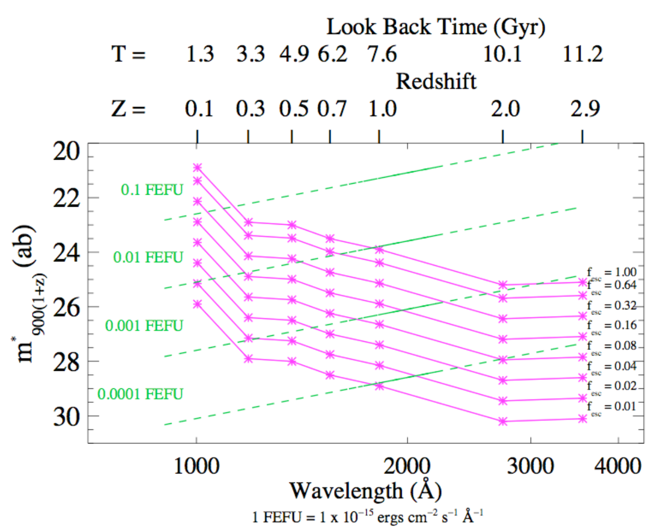

Figure 1 The purple asterisks show the characteristic apparent LyC magnitudes (ab) m∗900(1+z) as a function of look back time, and in redshift and wavelength space, for different escape fractions. Contours of constant flux units are overplotted as green dashes marked in FEFU fractions; the background limit for FUSE.