EARTH BASED EVALUATION OF DYNAMIC POLARIMETRY FOR FUTURE GLOBAL 21-CM COSMOLOGY OBSERVATIONS FROM THE MOON. D. Bordenave[1,2], B. Nhan[1,2], R. Bradley[2], and J. Burns[3], [1]University of Virginia, [2]National Radio Astronomy Observatory, [3]University of Colorado, Boulder.

Efforts to the study the Cosmic Dawn, the period when the first luminous sources formed in the early Universe some few hundred million years after the Big Bang, have faced great challenges in instrumentation and observational methods. Observations of this period have focused on the detection of the highly redshifted (30>z>15) 21-cm emission from neutral atomic hydrogen (HI) to probe the ionization and thermal history of the primordial Intergalactic Medium. However, the great challenge affecting both global sky-averaged and interferometric experiments is the removal of the strong synchrotron foreground from galactic and extragalactic sources that is expected to be around 4-5 orders of magnitude greater than the background cosmological 21-cm signal (~10s - 100s of mK). To compound matters, the instruments themselves are difficult to reliably characterize and calibrate at the low frequencies required (<100 MHz) for such observations, most notably the effects of beam chromaticity. Finally, terrestrial radio frequency interference (RFI) and the Earth's ionosphere significantly limit the usable bandwidth of such observations due to the ionospheric cut-off at low frequencies to various allocated communication bands (e.g. FM radio, digital TV). These factors would make observations around the Moon a promising location to block these sources of man-made RFI and to extend our observable window to lower frequencies capable of reaching into the Cosmic Dark Ages at a redshift of (80>z>15) at frequencies below 50 MHz.

To address these challenges, we have continued the development of the Cosmic Twilight Polarimeter (CTP) to evaluate the use of polarimetery for global 21-cm observations. The CTP is a prototype global 21-cm experiment designed to study the combined nature of the signal, foreground, instrument, and environment through polarimerty and physically motivated modeling. Recent experiments have focused on disentangling the spectral and dynamical behavior of the beam-weighted foreground through observations of dynamically induced polarization. This effect, commonly referred to as polarization leakage, is due to the off-boresight projection of foreground sources onto the antenna plane. Simulations of this projection effect have shown that both linear and circular polarization components can be excited from unpolarized but spatially anisotropic source distribution and that this effect is sensitive to both the spectral and spatial features of the sky and antenna beam. Recent theoretical work has also shown that including these polarization signals in SVD based signal extraction methods are expected to improve the constraining power over conventional global 21-cm observations since they provide extra information on the structure found in the sky-antenna system. To evaluate this approach, we conducted observations at Green Bank, WV from November 2019 to March 2020 and have detected both linear and circular polarization signals at 170MHz that are periodic and stable in sidereal time and follow the predicted behavior of our physical simulations. From the lessons learned through this experiment we are developing a new low-frequency CTP that also serves as a testbed for the Dark Ages Polarimetry Pathfinder (DAPPER) spacecraft, a mission that would observe from the radio-quiet far side of the moon using the dynamic polarimetry method we are exploring.