2nd URSI AT-RASC, Gran Canaria, 28 May – 1 June 2018

Spaced-based Extraction of the Global 21-cm Spectrum

David Rapetti*[1,2], Jack O. Burns[1], Keith Tauscher[1], Richard Bradley[3], Bang Nhan[1,3], and Eric Switzer[4]
for the DARE collaboration
(1) The University of Colorado, Boulder, CO, 80309, e-mail: David.Rapetti@colorado.edu; Jack.Burns@colorado.edu; Keith.Tauscher@colorado.edu; Bang.Nhan@colorado.edu
(2) NASA Ames Research Center, Moffett Field, CA, 94035
(3) National Radio Astronomy Observatory, Charlottesville, VA, 22903; e-mail: rbradley@nrao.edu
(4) NASA Goddard Space Flight Center, Greenbelt, MD, 20771; e-mail: eric.r.switzer@nasa.gov

The hyperfine 21-cm line of neutral hydrogen is expected to be a powerful probe of Cosmic Dawn, when the first stars, galaxies and black holes ignited. The Dark Ages Radio Explorer (DARE) is a mission concept for observations of the sky-averaged 21-cm spectrum to be placed in a low-altitude lunar orbit, performing at night-time while on the farside of the Moon to avoid terrestrial radio frequency interference, ionospheric corruption, and solar radio emissions. Using realistic characterizations of the DARE's instrument (beam and receiver) to carry out 40-120 MHz ($10<z<35$) spectral observations, in Burns et al. (2017) we demonstrate the ability of our strategy to measure the global 21-cm signal at the precision required to distinguish between physical models of the early Universe. In particular, we are able to clearly separate two key, representative models, one with primordial Population II stars (richer in metals) and another containing also Population III stars (metal-poor).

To extract the global 21-cm signal from bright foregrounds plus instrumental systematics we utilize a pattern recognition technique that optimizes the differences between them to allow for a clean separation. While the redshifted 21-cm spectrum has a distinct spectral structure, and is spatially uniform and unpolarized, the foregrounds are spectrally featureless, spatially varying, and polarized. We model the foreground, instrument, and 21-cm signal with eigenmodes calculated via Singular Value Decomposition (SVD) and use a Markov Chain Monte Carlo (MCMC) algorithm to constrain the parameter space of their coefficients, and thus the spectrum. We also present results on astrophysical parameters that could be constrained in the presence of large foregrounds using DARE.

1. J. O. Burns, R. Bradley, K. Tauscher, S. Furlanetto, J. Mirocha, R. Monsalve, D. Rapetti, W. Purcell, D. Newell, D. Draper, R. MacDowall, J. Bowman, B. Nhan, E. J. Wollack, A. Fialkov, D. Jones, J. C. Kasper, A. Loeb, A. Datta, J. Pritchard, E. Switzer, M. Bicay, "A Space-based Observational Strategy for Characterizing the First Stars and Galaxies Using the Redshifted 21 cm Global Spectrum", *Astrophysical Journal*, **844**, 33, 2017, doi: 10.3847/1538-4357/aa77f4.