Towards a lunar farside hydrogen cosmology telescope: characterizing the absorption trough observed by EDGES. K. Tauscher[*,1], D. Rapetti[1,2] J.O. Burns[1], R. Monsalve[1], and J. Bowman[3], [1]University of Colorado at Boulder, [2]NASA Ames Research Center, [3]Arizona State University.

Introduction: The highly redshifted sky-averaged 21-cm spectrum from neutral hydrogen probes a period of the Universe never before studied. Due to Radio Frequency Interference (RFI) and ionospheric effects—the largest Earth-based impediments to measuring this spectrum—the ideal place to make this observation is either on the lunar farside surface or on a lunar orbiting platform when it is above the farside. Our team is currently working on designs for each of these possibilities. Sophisticated fitting procedures must be applied to interpret measurements from this type of experiment in a consistent manner because the 21-cm signal, whose amplitude is in the hundreds of mK, is much smaller than the foreground emission, which can approach 10^4 K.

Pipeline overview: We will present a general code named pylinex[1] that employs Singular Value Decomposition (SVD) to leverage structure in the data of an experiment to fit for signals in the presence of large systematic effects. This method uses training sets to create SVD models for each component of the data, making it especially useful for effects without parametric forms. After the signal distribution is obtained in SVD coefficient space, it is transformed into a physical parameter space in a two-step procedure. First, a numerical least squares fit of the SVD extracted signal to the physical signal model is performed. Then, a Markov Chain Monte Carlo (MCMC) sampler is used to consistently explore the full posterior parameter distribution.

Application to EDGES: The Experiment to Detect the Global Eor Signal (EDGES)—a 21-cm signal experiment located in Western Australia run in part by three members of our Network for Exploration and Space Science (NESS) team of the Solar System Exploration Research Virtual Institute (SSERVI): J. Bowman, R. Monsalve, and N. Mahesh—can be viewed as a prototype of our target lunar mission. Recently, the EDGES team presented evidence for a detection of the 21-cm signal in their low-band data. We will present preliminary results of applying pylinex to this data.

Pipeline setup: The structure in the EDGES data to be exploited by SVD is the time dependence of the spectra. Using the fact that EDGES is a zenith-pointing instrument, with a precise location of the observatory and estimates of the antenna beam and sky temperature, we can produce a training set of beam-weighted foregrounds expected to be seen by EDGES with time and frequency dependence, which can then be combined with a signal training set and inputted to pylinex.

Pipeline outputs: The pylinex results will include estimates of the signal in frequency space with errors and distributions of signal parameters like those describing the timing and properties of the first stars and black holes such as their abundances and radiation efficiencies. These estimates will inform the design of our target lunar mission, e.g. required frequency coverage.

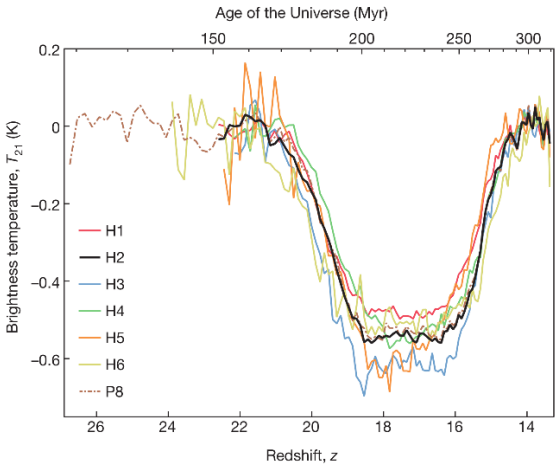

Figure: Absorption profiles reported by EDGES team for various hardware cases. Some of the data used to make this figure will be analyzed for this presentation. This figure originally appeared in Bowman et al. 2018 (Nature **555** 67).

[1] https://bitbucket.org/ktausch/pylinex