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LST-binned investigations of the EDGES lowband data with the new open source EDGES-analysis pipeline

Nivedita Mahesh*(1), Steven Murray(1), Judd Bowman(1), Alan Rogers(2), Raul Monsalve(3)
(1) School of Earth and Space Exploration, Arizona State University, Tempe, Arizona, USA
(2) Haystack Observatory, Massachusetts Institute of Technology, Westford, Massachusetts, USA
(3) Berkeley Space Sciences Laboratory, University of California, Berkeley, USA

We report the investigation results of variations of the EDGES low-band data with Local Sidereal Time (LST). In this work, we build on the original validation tests we reported in [1]. We extend our analysis of the data as a function of local sidereal time (LST). We previously only showed the absorption amplitude fits to individual LST bins assuming the same center, width and, flatness. In this work, we individually fit for all the parameters of the absorption feature for each LST bin. Using the polychord nested sampler, our preliminary results of the best-fit parameters for the absorption signal are well within 1σ values reported in [1] with the additional confirmation that it is constant over time within the systematics of the instrument. This test is useful as it can disfavor beam artifacts that might have created the reported feature and helps confirm the "global" nature of the reported detection. Next, we furthered the LST binned analysis to simultaneously fit for independent foreground models and the same cosmic model across the multiple LST bins. This enables us to utilize the foreground angular structure better to help separate it from the 21-cm signal model. Initial results from this analysis successfully retrieved physical estimates for the foregrounds and estimates of the cosmic signal consistent with previously findings but with improved error bars. We plan to implement this analysis strategy of simultaneously fitting multiple bins of data to test for various systemics reported in [2] and [3]. I will present the most recent results from this effort.

For this work, the complete processing and analysis on the collected field data is done using the new public EDGES data analysis pipeline. The pipeline is intended to accompany planned EDGES-3 data releases to provide a modular and fully traceable analysis path. Implemented in Python, the pipeline contains independent software modules for each of the data-processing steps, such as calibration, filtering, modeling, gridding, averaging, data binning, and model fitting. At each stage, the output data formats contain all of the metadata from processing steps used to get to that point for traceability. This ensures transparency in the various parameter choices such as calibration data files used along with their fitting terms, types of filtering methods and its associated parameters, foreground modeling functions and its parameters, frequency and time bin sizes. All of this enables easy testing of the effects of those parameter choices on the analyzed data, at each processing stage. The modules for the open source pipeline are implemented in several repositories available at github.com/edges-collab. In this talk, I will provide the overview of the pipeline structure and functionality in addition to results of the validation testing of the pipeline using tests similar to those employed in [1].

References

[1] Bowman, J. D., Rogers, A. E. E., Monsalve, R. A., Mozdzen, T. J., and Mahesh, N., “An absorption profile centred at 78 megahertz in the sky-averaged spectrum”, *Nature*, vol. 555, no. 7694, pp. 67–70, 2018. doi:10.1038/nature25792.

[2] Sims, P. H. and Pober, J. C., “Testing for calibration systematics in the EDGES low-band data using Bayesian model selection”, *Monthly Notices of the Royal Astronomical Society*, vol. 492, no. 1, pp. 22–38, 2020. doi:10.1093/mnras/stz3388.

[3] Singh, S. and Subrahmanyan, R., "The Redshifted 21 cm Signal in the EDGES Low-band Spectrum", *The Astrophysical Journal*, vol. 880, no. 1, pp. 26, 2019. doi:10.3847/1538-4357/ab2879.