Introduction

We present the design of ABRA, short for Accessible Balloon Radiometer. The project goal is to design and build measurements using a system that independently verify known information about the Cosmic Microwave Background (CMB). Specifically, this was to be done by building, simulating, testing, collecting and post-processing data from a microwave radiometer, with the aim of showing the well-known fact that the spectrum of the CMB is a blackbody peak at frequencies on the order 10 GHz. A balloon-based experiment was chosen to mitigate ambient noise at the ground level.

Due to the COVID-19 pandemic, testing and manufacturing could not be carried out, which took us as an opportunity to redesign some aspects of the system for improved performance. This project will be continued through the fall semester, and hopefully be able to report positive results soon!

Background and Motivation

CMB radiation is one of the most fundamental and rich sources of data on the early universe. Having been originally detected as additional noise in one of the telescopes at Bell Lab, subsequent study of the CMB revealed vast amounts of hidden structure. Anisotropies in the CMB lent fidelity to the early universe with the balloon and parachute.

We intend to launch the telescope using a high altitude weather balloon, which will be attached inline foam container, which will be used to store liquid nitrogen before loading it on the payload and allowing it to act as a source to cool the equipment, or the area near the detector. We would then encase this block inside a styrofoam container along with the detector, cooling the detector’s surroundings while not affecting the receiver’s operating temperature. Combined with the already cold ambient temperatures on the ground, the CMB has a temperature scale and cool equipment to temperatures near absolute zero.

Methods: Balloon and Styrofoam

As a result of the design of the ABRA, we are able to fly as originally planned!

Methods: Hardware Design

The detector can be constructed from a combination of custom parts connected in series. Here, we show the design for ground-based testing as well as for the actual detector. Testing and iterative design on the ground setup are ongoing even through the pandemic, and we are optimistic about the results!

**Low Noise Block down converter plus Feedback Software Defined Radio**

Digital Video Broadcasting - 2nd Gen. Satellite

Avenger PLL32-2 Single Ku-Band LNB*

Above: Ground-Based LNB Signal Receiver

Converts digital signals and data storage

Digital Satellite Receiver

Software to digitize the signal

Converts RF to Digital

Figure: Contingency planning.

Conclusion and Acknowledgements

The COVID-19 pandemic set back our design and manufacturing cycle significantly due to the lack of in-person meetings, access to hardware and workspaces, and testing and flight plans were postponed for the first time. However, we have worked to maintain our plan to deliver our project on time and reassess our plans and begin to incorporate more learning opportunities. We are optimistic that this will lead to a better product and better learning environment when conditions improve and we are able to fly as originally planned!

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References


