CMB INSTRUMENTATION: DESIGNING AND BUILDING A MILLIMETER WAVE BEAM MAPPER

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OUTLINE

• Why do we care about CMB Research?

• What role does the Simons Observatory play?

• The purpose of a Beam Mapper

• Breaking down the designing and building process

• Looking forward
WHY CMB?

• A probe for the earliest moments in time
• Searching for B-modes as a way to test for gravitational waves
• Measuring properties of the neutrino

Cosmic Microwave Background Seen by Planck (2013), from ESA

Credit: Krauss et al. (2010)

Credit: R. Hurt - Caltech-JPL

Left Gravitational waves due to two black holes. Right: B-Modes versus E- Modes

Credit: Krauss et al. (2010)
SIMONS OBSERVATORY

• Located in the Atacama Desert in Chile

• Breaking ground in early 2018

• New telescopes

• Still in the process of deciding what technology to use
BEAM MAPPING

• My Goal:
  • Characterize optical elements for the Simons Observatory
  • Characterization to be done by mapping the diffraction pattern of a beam of millimeter wavelength light after it interacts with an optical tube.

• Practically speaking:
  • Design and build a mount that can rotate an optical tube in two axes.
THE REQUIREMENTS

• Rotate in two axes as shown to the right

• Accommodate both a 1 meter cubed telescope and a 1 meter long optical tube with a diameter of 60 cm

• Both optical parts would be heavy

• Electronically controlled
The Overall Structure

The final structure had a 6 foot square base and was over 3 feet tall.

- Left: A view of the final structure looking through the cradle towards the lifting BiSlide
- Right: A view from the other end
Rotation Systems

• Two separate systems that enable rotation in the two axes

• Left: A BiSlide on a hinge lifts the frame.
• Right: A second BiSlide laid flat on the table connected to the base frame will rotate the entire structure.
Instrumentation

A lesson in Patience, Perseverance and Planning
FUTURE WORK

• Beam Map Optical Parts!

• Both the optical tubes in question and the scaled telescope have yet to be built, so when they are ready they will need to be characterized using my set up
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