

Measure CMB with BS antenna

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GPPU Experimental Point (GEP): 4

Goal of Study



1. Measure 21 cm emission line (1.4204GHz at rest frame) from neutral hydrogen in the Galactic disk with radio spectroscopic measurement using hand made antenna and extract information of the Galactic rotation from the line features. Simultaneously, try to measure spectrum feature of the CMB (its shape and possibly temperature).

2. Learn what the following simulators can do and get used to manipulate them. 2-1. CST: Obtain the beam pattern and other optical features of the system which has the comparable size of the wavelength of the EM wave based on Physical Optics. 2-2. GRASP: Obtain the beam pattern of the optical system for which the size of the system is much larger than the wavelength of the EM wave based on Quasi Optics. 2-3. Sonnet: high frequency electromagnetic wave transportation simulation code for 2 dimensional system. 2-4. LightTools: ray tracing simulator for any kind of optical system.

Photo is the measurement system. Up to now, detection of 21 cm line has been confirmed only toward the Cygnus constellation. I pointed the antenna toward Auriga and Orion but failed to detect although some broad band excess emission is seen. The Cygnus is available at early morning (for example 6 -4 AM April) and night (8-6 PM October). So if you are willing to perform observation during the comfortable season, I have to insist you come to university in out of working time. From November to March it is available at around 5 PM to 9 AM. You are able to perform observation during the working time. However, it is very cold and strong wind from the Zao makes you trouble. I strongly recommend you to choose some day during the comfortable season. Whether or not we are able to perform observation depends weather condition. So flexible respond on setting the date is required.

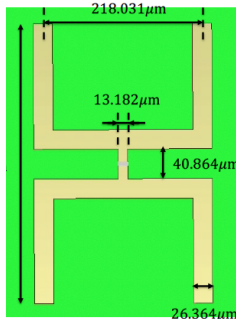
On the simulation, if you are willing to work on your research with some of these simulators, please let me know. You are able to get access right to manipulate them after the course under the condition that you follow the certain rules.

Contents

Measure the sky temperature at 11GHz with BS antenna and possibly measure the CMB temperature.

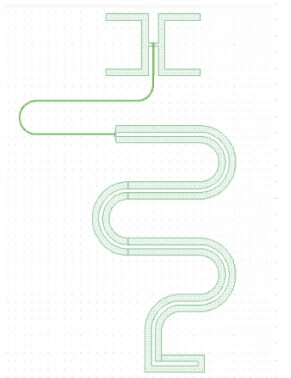


Become able to use one of following simulation methods to treat electromagnetic wave transportation.



2-1. CST: this is powerful tool to simulate the performance of the detector chip antenna. This tool is used to optimize the antenna attached to the detector in microwave region.

2-2. GRASP: This tool is used to obtain the beam pattern of the optical system for which the size of the system is much larger than the wavelength of the EM wave based on Quasi Optics.



2-3. Sonnet: This tool is used to simulate resonance frequency of the designed resonator circuit. Example is kind of superconducting microwave detector MKID.

Textbook and References

[1] In preparation.

Progress Schedule

- ✧ Day 1
Measure the sky temperature with BS antenna on the roof.
- ✧ Day 2
Study how to manipulate one the simulation tools and solve example.
- ✧ Day 3
Apply the code to the advanced problem.
- ✧ Day 4
Apply the code to the advanced problem.

Other Details

Course Period	2023
Place	H26 Physics research building 217 and roof.
Number of Students	1 -2
Evaluation method	Quality of the report and availability of the experiment.

In Addition

CMB measurement system is still in under brushing up stage. Any feedback is welcome.