Radio Telescope Observations Of The April 8, 2024 Total Solar Eclipse At 1420MHz.

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Abstract. We present radio telescope observations of the 08 April 2024 total solar eclipse from the University of Central Arkansas campus in Conway, Arkansas using a 2.3 m SPIDER 230C parabolic radio telescope tuned to a frequency of 1420 MHz. Observations began approximately 19 min before first contact, and ended approximately 2.5 min after fourth contact, tracking the sun across the sky using a German equatorial mount. Our observations show a reduction in relative radio intensity from the beginning of the lightcurve to the middle of totality of approximately 70%. In our current work, we aim to compare this radio lightcurve with theoretical lightcurves of the eclipse as observed from our location, as well as a relative optical lightcurve derived from the archived livestream of the eclipse broadcast by the University of Central Arkansas observatory. Our goal is to compare these observations in order to determine the relative size of the optical and radio sun.

INTRODUCTION

Our goal with this project is to determine the size of the radio solar disc by using observations during the April 8th, 2024 Total Solar Eclipse. This eclipse gave us a unique opportunity to observe the outer atmosphere of the sun without the solar disc overwhelming our ground-based radio telescope. To accomplish this, we need to determine how much of the solar disc is obscured by the moon during totality in both the optical and radio wavelengths. We have only one source of radio lightcurve data: UCA's 2.3 meter radio telescope. To verify these results, we have multiple sources of optical lightcurve data:

- Livestream from the UCA Observatory
- Broad-spectrum light sensor pointed at the sky, also at UCA
- Theoretical lightcurve generated by Stellarium

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EXPERIMENTAL INVESTIGATIONS

The Radio Lightcurve

The Optical Lightcurve

THEORETICAL STUDIES

Stellarium

Theoretical Lightcurve Comparison

CONCLUSION

In figure 5, we can see a comparison between our normalized radio and optical lightcurves. This comparision clearly shows a difference in brightness during totality, with the optical lightcurves being at 0% and the radio lightcurve being at 30.9%. This indicates that the radio solar emission comes from a larger radius than the optical.

In Figure 6, we generated theoretical lightcurves for the 2024 eclipse. These theoretical curves assumed different solar radii to model a match of the relative drop in brightness from our radio observations. In order to produce these lightcurves, we began with the high-accuracy ephemeris data from the JPL Horizons On-Line Ephemeris System. Using the angular radii of both the sun and moon along with the angular separation between the two, we calculated the obscured area of the solar disk at 2000 points in time during the eclipse using the following geometric relationships:

The theoretical lightcurve that best matches the depth of the radio eclipse is $R = 1.27R_s$. This is consistent with our hypothesis of a larger radio disc than optical. However, the overall profile of the lightcurve is not well fit by this result, and neither is the expected flat bottom if we assume uniform radio brightness across the surface of the sun. Our result lies between the results of $R = 1.14R_s$ found by Messerottie, et. al. (2000), and $R = 1.4R_s$ found by Leung et. al. (2021). In a future study we will compare these and other results to examine potential sources of uncertainty in the measurements.

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2. Todd Abel, Ph.D. (UCA STEM Institute Co-Director, Associate Professor of Mathematics, Secondary Mathematics Education Program Coordinator)
3. Shane Ayotte. (UCA Mathematics Student)

Technical Specifications of equipment used:

- Optical Observations:
  - Meade-14 LX200R on a Paramount MX+ equatorial mount
  - Sony Alpha 6400 camera
  - Sony FE 24mm-240mm f/3.5-6.3 lens
  - NiSi Solar Filter Pro Nan UV/IR Cut ND 100000 72mm filter(Removed during Totality marked by 2460409.2849 JD and 2460409.2884 JD).
- Radio Observations:

- Spider 230C: 2.3 meter aluminum dish, tuned to the spin-flip transition of HI at 1429.25 MHz.
- Mounted on a SkyWatcher EQ8-R Pro equatorial mount.

References

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