Complex Analysis of Askaryan Radiation: UHECR Reconstruction with Askaryan Radio Array

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The detection

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I. INTRODUCTION

1. Define UHECRs
2. Brief summary of radio detection of UHECRs
   - Geomagnetic effect
   - Askaryan effect
3. Why Askaryan effect can dominate UHECR signals in ARA
   - Cite recent paper
   - When cascade interacts directly with ice
   - Do models exist for this? Likely not
   - Gives us a measurement of the E-field
4. This paper is organized as follows...

II. UNITS, DEFINITIONS, AND CONVENTIONS

1. Define $s(t)$, and parameters E_0 and σ_t
2. Define $r(t)$, and parameters f_0 and γ
3. Define convolution $s * r$
4. Define cross-correlation $d \star x$
5. Define CSW

III. THE ASKARYAN RADIO ARRAY

1. Detector diagram of ARA
2. Event diagram of UHECR interaction
3. Cite recent detection of UHECR events
4. Calibration of f_0 from data itself
5. Calibration of γ from data itself

IV. RECONSTRUCTION ANALYSIS

1. Waveform reconstruction
   - Present graphs and tabulated results for CSWs by event
   - Present graphs and tabulated results for subsets of channels by event
2. E-field calculations
   - E-field of UHECRs from CSWs
   - E-field of UHECRs from channel subset CSWs

V. CONCLUSION

What did we learn? How to reconstruct the E-field, and the product $\sigma_t \propto a\Delta\theta$ tells us about the event geometry and energy

Appendix A: The appendix

Derivation of the $s * r$, maybe the code to do it

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