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

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(Dated: February 19, 2026)

The detection

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

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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

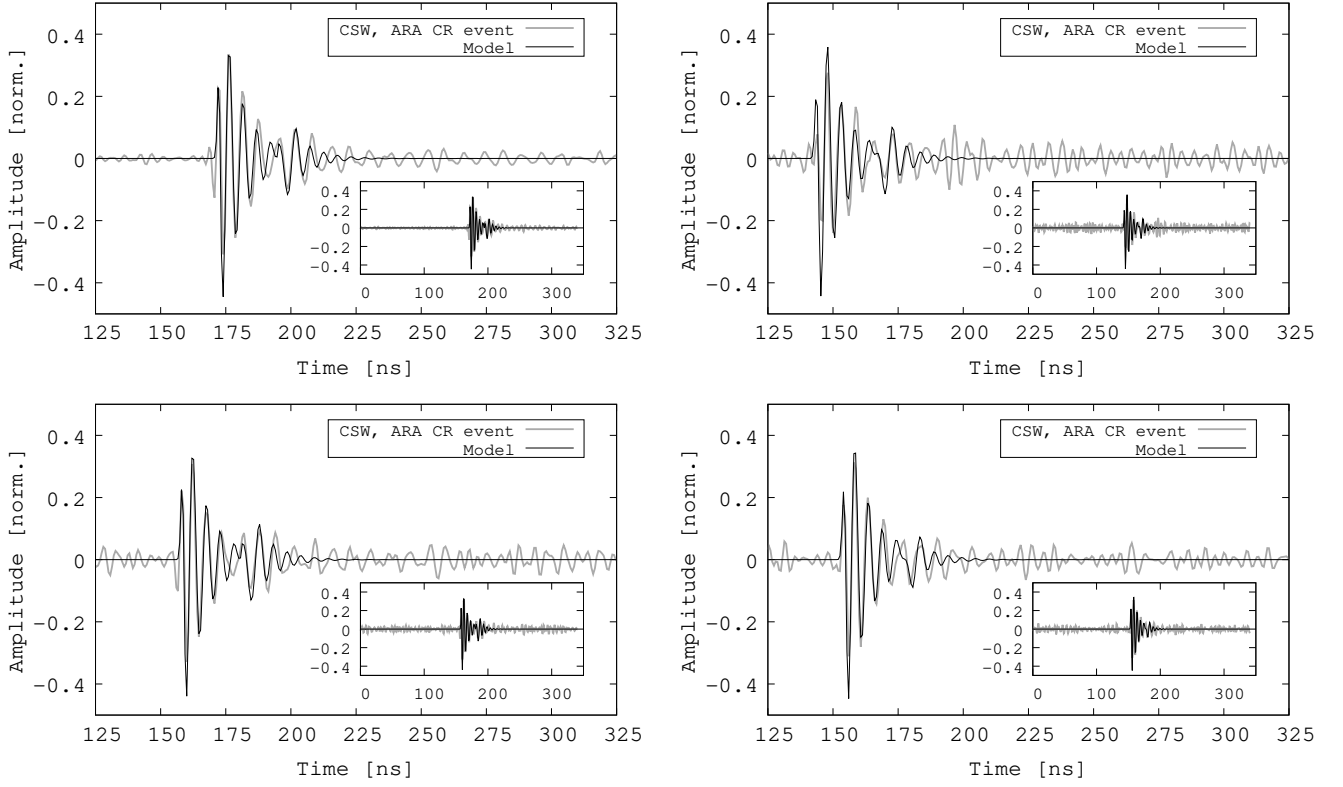Derivation of the $s * r$, maybe the code to do it

FIG. 1: UHECRs, by ID: (top left) 1915-26288, (top right) 1957-13330, (bottom left) 2171-31805, (bottom right) 2250-20189.
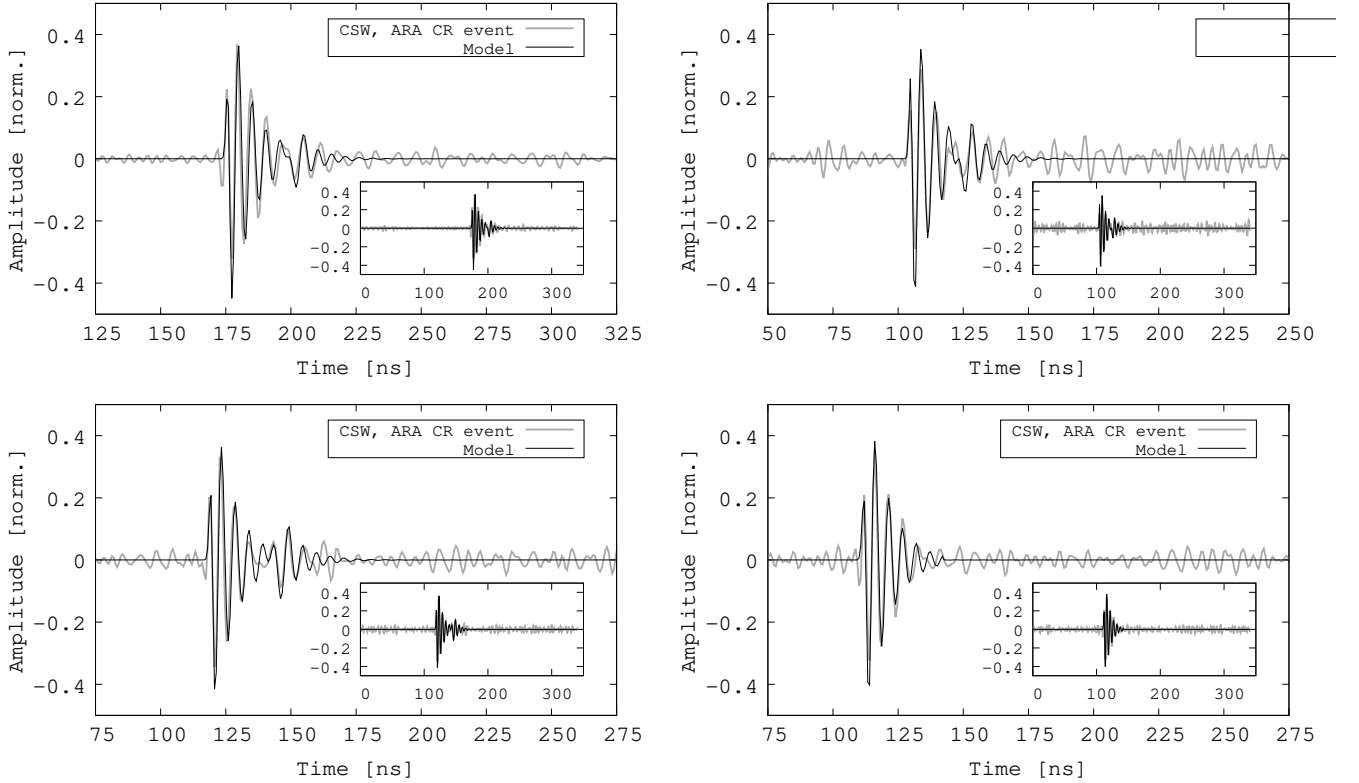

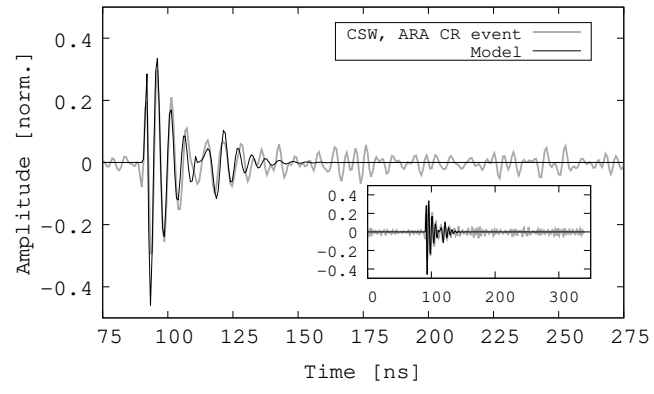FIG. 2: UHECRs, by ID: (top left) 2352-85489, (top right) 2375-17342, (bottom left) 2529-09767, (bottom right) 2716-58611.

FIG. 3: UHECRs, by ID: 3352-89556