

# Complex analysis of Askaryan Radiation: UHECR and UHE- $\nu$ Reconstruction with Analytic Signals

---

Jordan Hanson

November 9, 2025

Whittier College Department of Physics and Astronomy

## Summary

---

# UHECR and UHE- $\nu$ Reconstruction with Analytic Signals

## 1. Introduction:

- **A fully analytic Askaryan E-field** model in the time-domain [3]
- Based on work begun with Prof. Amy Connolly [2]
- Based on work begun by J. Ralston and R. Buniy [1]
- Advantages: (i) extract UHE- $\nu$  cascade parameters by fitting model to raw voltage traces, (ii) fast and simple, (iii) analytic equations may be embedded as event filter

## 2. UHECR and UHE- $\nu$ identification:

- **A fully analytic Askaryan voltage** model, time-domain [this work]
- Equations for both voltage trace, and envelope of voltage trace
- Verification with NuRadioMC: strong thermal background rejection, signal identification, and (rough)  $\log_{10}(E_\nu)$  estimate

## 3. Correlation with Recent ARA observations of UHECR

# Bibliography

---

# Bibliography



R. V. Buniy and J. P. Ralston.

**Radio detection of high energy particles: Coherence versus multiple scales.**

*Physical Review D*, 65(1), 2001.



J. C. Hanson and A. L. Connolly.

**Complex analysis of askaryan radiation: A fully analytic treatment including the LPM effect and cascade form factor.**

*Astroparticle Physics*, 91:75–89, 2017.



J. C. Hanson and R. Hartig.

**Complex analysis of askaryan radiation: A fully analytic model in the time domain.**

*Physical Review D*, 105(12):123019, 2022.