Subject: Your_manuscript DK13989 Hanson
From: prd@aps.org
Date: 12/10/25, 7:57 PM
To: jhanson2@whittier.edu

Re: DK13989
Complex analysis of Askaryan radiation: UHE- nu identification and reconstruction using the Hilbert envelope of observed signals
by Jordan C. Hanson and Raymond Hartig

Dear Dr. Hanson,

Your manuscript has been reviewed by our referee. Comments for your consideration are included with this communication.

Please use https://authors.aps.org/Submissions/ to resubmit, and include a point-by-point response to all recommendations and concerns, and a summary of the changes made. We only need the PDF file of the manuscript, not the TeX or Word source file or figure files.

It might be helpful to also submit an additional PDF file of the manuscript with the revisions highlighted.

Yours sincerely,

Dr. Panayiotis Tzanavaris (he/him/his)
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Report of the Referee -- DK13989/Hanson

This is a useful follow up to an earlier PRD paper that created a more intuitive understanding of the factors that affect the shape of the time dependent electric field generated by the Askaryan emission. In this paper, they include antenna response and ice attenuation in their analytical formulas to predict the observed waveforms, and therefore of interest to large community of astrophysicists who are involved in high energy neutrino astronomy.

Here are my detailed comments:

On Page 6, please provide reference to “and the dielectric properties of the South Pole”, and do these dielectric properties include attenuation and birefringence? I think the sentence should explicitly say what the dielectric properties describe?

On page 6, what does (3K) refer to ? Please explain the relevance to noiseless data.

Section IV: Application to string of closely spaced dipoles operating to produce coherent signals. Can this procedure also apply to individual dipoles located in a volume of ice? Can it apply to other antenna systems located at the surface such as in RNO-G design? More generally, can the authors comment on the applicability to other antenna styles and configurations and insert those comments into the text?

Section IV: The authors presented a compelling case that the predicted shape of the antenna waveforms from the analytic model agree with NuRadioMC. Do the authors believe similar agreement will be produced by the analytical calculation at higher energies?
Please comment.

Section IV: Does the simulated RF trigger correspond to a trigger rate of 1 Hz? If so, maybe mention that since the rate is assumed in the next paragraph.

Fig 1 and 2: Do the curves correspond to analytical signal amplitude and signal envelope introduced in Section II? If so, can one or more of these symbols be included on the y-axis so it is clear to the reader, or at least mentioned in the Figure caption (if appropriate)?

What is c_ave in Table III, and why is the unit length? I thought it might be x_ave, but 0.85 is not the average of 0.8 and 0.93

Section V: Traditional methods to determine cascade energy rely on the linear relationship between cascade energy and electric field for Askaryan radio emission. In contrast, the method in this section utilizes the logarithmic relationship between cascade energy and square of the duration of the emitted RF pulse, which doubles the error in the measurement of pulse duration. This is not, a priori, a desirable feature. One difficulty is the measurement of the pulse width of the electric field depends on the poorly known measurement of angular deviation from the Cherenkov cone. To make matters worse, the duration of the electric field pulse is only ~10% of the duration of measured pulse from the antenna system, which then requires a very high precision measurement relationship for the antenna response, and high precision measurement of the time dependent waveform.
So it appears that to prove this method can provide a good measurement of cascade energy will require some additional explanation. For example, it would help the reader to know the relative important of sigma_t and the angular difference from the Cherenkov cone in Eqn 5. What is the spread of the expected measurements of true value of sigma_t for a fixed angle from the Cherenkov cone? Then, what is the resolution of the measured sigma_t using waveform shape, again at a fixed angle from the Cherenkov cone? A similar set of suggestions to get a more quantitative estimate of the uncertainty in angle from the Cherenkov cone, and ultimately how good can this measurement get? To get a fractional error in the cascade energy of 50%, what must the error in sigma_t should be? Is this resolution reasonable for a digitized signal assumed in the baseline detector described in this paper? A similar set of questions if sigma_t is known, and delta_theta is unknown.
The answers to the prior questions will help solidify the rationale to include section 5. At the moment, it shows that energy reconstruction by set of dipoles gives an exceedingly poor energy calculation for the cascade (with errors of 2 orders of magnitude, which is practically the entire energy range of the detector). At least for charged current muon neutrino interactions, the energy resolution of the cascade should be better than 50%. Unless the authors have a compelling reason to include the cascade energy calculation, I do not find section 5 of much value and recommend deleting it.

Finally, I think the authors may have missed an opportunity to help the reader understand the utility and benefits of this approach. Though they show that their analytical model agrees with NuRadioMC, what are the reasons to use this work instead of NuRadioMC? Does it greatly speed up the calculations on the computer, and if so, by how much? Can the authors provide a few example applications where this tool would be superior to NuRadioMC? Or are there

specific simulation tasks (perhaps an optimization study of antenna response) where this calculation has advantages? Do the authors think this tool would help to reduce the computation time in the analysis of neutrino signals from strings of closely packed dipoles? Is this work now at the point that it can be included as one of the signal generation tools in NuRadioMC and if so, do the authors recommend that this work be included in NuRadioMC? In summary, what are the benefits of this approach compared to NuRadioMC.

Misspellings: vacuum , just below Equation 3