Omar Iskandarani
Vinkenstraat 86A
9713 TK Groningen
The Netherlands

December 25, 2025

Editors
Foundations of Physics

Dear Editor,

I am pleased to submit the manuscript *Relational Time-of-Arrival as a Covariant Field Observable: From Event Currents to a Continuum Clock Limit* for consideration as a Research Article in *Foundations of Physics*.

The status of time observables in quantum theory remains conceptually unsettled. Pauli-type arguments obstruct the existence of a self-adjoint time operator conjugate to energy, while relativistic quantum field theory lacks a universal, observer-independent notion of arrival time. In this manuscript, I propose a complementary approach: time-of-arrival (TOA) is formulated as a *relational field observable*, constructed from two conserved structures—a matter flux through a detector world-tube and an event current whose coarse-grained limit defines a physical clock field governed by an effective field theory.

The construction is manifestly covariant and avoids operator-based difficulties by never postulating a universal time operator. Discrete event counts and smooth clock readings emerge as ultraviolet and infrared descriptions of the same underlying structure. In a worked $(1+1)$-dimensional example, the TOA distribution is obtained explicitly as a convolution of the matter flux with clock correlations, yielding a calculable arrival-time broadening and an exponential suppression *envelope* for early-arrival contributions set by the clock-sector mass scale.

What is new and potentially of interest.

- Time-of-arrival is defined directly at the field-theoretic level as a relational functional of conserved currents and a physical clock, independent of detector microphysics up to geometry and flux.
- Discrete event-count clocks and continuum clock fields are unified through an explicit UV–IR coarse-graining, making time an emergent infrared observable rather than a fundamental operator.
- The clock sector carries its own effective dynamics, whose correlators enter TOA statistics and fix observable broadening and suppression scales.
- A complete $(1+1)$D worked example demonstrates explicitly how clock fluctuations modify semiclassical arrival times.

Falsifiability and predictive content. Given a measured flux profile $\mathcal{F}(t)$ and a clock variance σ_τ^2, the TOA distribution is fixed by a convolution formula and predicts an excess variance beyond wavepacket dispersion. While local clock readouts produce Gaussian one-point tails, spacelike clock correlations impose an exponential suppression envelope governed by the clock mass scale μ_τ, yielding a concrete and testable bound. At sufficiently high temporal resolution, discrete event-count clocks additionally predict renewal-type deviations that vanish under coarse-graining.

I believe this manuscript aligns well with *Foundations of Physics* in its emphasis on conceptual clarity, explicit assumptions, and physically interpretable structures, while remaining close to standard quantum field-theoretic tools.

A timestamped preprint is available on Zenodo DOI: 10.5281/zenodo.18050157. The submission is original, not under consideration elsewhere, and involves no external funding or conflicts of interest.

Thank you for your time and consideration.

Sincerely,

Omar Iskandarani
Independent Researcher, Groningen,
The Netherlands
ORCID: 0009-0006-1686-3961
Email: info@omariskandarani.com