19 August 2025 ·
Qeios

Peer Review

Review of: "Field Dynamics in a Unified Differential Forms Framework: From Field Strength Tensor to Compressible Flow, Navier-Stokes Equations, and Vorticity Dynamics"

Jakob Leck[1]

1. Independent researcher

The abstract, introduction, and conclusion should both be tightened up and expanded. What is the purpose of the article? What new ideas or material are presented? What is already known? More references and comparison to existing literature would be beneficial. For example (not necessarily, not exclusively...) how much of this formalism is already present in standard textbooks like Misner, Thorne, Wheeler, or Truesdell's Non-Linear Field Theories of Mechanics? (And it seems the author got the same feedback for his own article from last year that is referenced as No. 7. I would regard any article with suspicion that only quotes fewer than ten references, making exceptions for some exotic topics...). Somewhere between 20 and 60 seems to be a usual standard—but, of course, choose your references purposefully.)

The above is my first and most important concern; depending on the outcome, one can judge whether the present article is indeed quite interesting or unnecessary.

Some minor remarks:

- There are a few imprecise statements at the beginning of the introduction (or perhaps the wording just is not ideal).
    - "a field should be viewed as a collection of massive particles." No. What about classical electromagnetism? Temperature fields?

doi.org/10.32388/H8YJKR

- "In reality, all physical fields exhibit some degree of compressibility." Again, what about electromagnetism? I have never heard anyone talk about a compressible electric field.
- "Disturbances in the field propagate at finite wave speeds, such as electromagnetic waves traveling through space at the speed of light." This does not seem to be the case generally. Far below in the text, you mention the limit of infinite propagation speeds. Models of diffusion spring to mind... (And I say: "models of," of course the propagation happens with finite speed in this case as well.) And of course, electrodynamics is a comparison where life is much easier, where indeed the speed of light introduces a barrier that cannot be crossed, while in fluid dynamics, you may have to deal with supersonic phenomena.

- I only skimmed through the mathematics (I am not in top shape geometry-wise after working as a software dev for some time now...). I did not find any flaws, just some remarks:
  - Some equations seemed redundant or unnecessarily spelled out, e.g., 41 or 49. This may be a matter of taste and does not necessarily require changes.
  - Eq. 45 looks like a highly unusual metric (I am hesitant to say "wrong" given limited experience...). AFAIK, (-1,1,1,1) would be the standard form in Minkowski space-time, and if you indeed require the Lorentz factor in the metric, you should maybe comment on why and how this works.
  - In Eq. 26, 33, 73, and others: I think you should not start using the old u,v,w convention for velocity when everywhere else in the article you use notation consistent with v_x, v_y, v_z.
- I think it may be important in general to comment on the use of the four-vector formalism and Lorentz factors versus this being a text on non-relativistic physics!
- The text block around Eqns 53 and 54 did not make sense to me. Starting with "The fluid is at a stagnation state; the flow velocity is zero relative to the lab frame," which sounds like the description of a state with \vec{v}=0 everywhere, the discussion turns to the propagation of small disturbances (non-zero v!). Is this about linearized equations and needs improvements in wording?
- The interpretation below Eq. 59 sounds like a bit of a stretch, if not wrong. Especially "It reveals that the particle moves along a helical (spiral) path." Or maybe this is good intuition to have about the equations and requires a more careful choice of words, or illustration with examples?

Declarations

Potential competing interests: No potential competing interests to declare.

doi.org/10.32388/H8YJKR