Review of: "Hamiltonian, Lagrangian, Dynamics and Singularity of the Compressible Fluid Flow"

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Potential competing interests: No potential competing interests to declare and this article suits to scope of your journal

Reviewer(s)' Comments to Author

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Title: **Hamiltonian, Lagrangian, Dynamics and Singularity of the Compressible Fluid**

Flow

This is a potentially interesting paper that addresses an important problem of the above title. The article describes the behavior of waves in compressible fluids and how this behavior varies between different reference frames. This paper is a pioneering attempt to focus on the Hamiltonian and dynamics of the compressible fluid flow with a finite wave propagation speed. It elaborates on the dynamics and Hamiltonian formulation of compressible fluid flow with a finite wave propagation speed, contrasting it with incompressible fluid flow. Here I have observed the following key points :

1. In incompressible fluids, the wave propagation speed is infinitely great or undefined, but

The wave propagation speed is finite in compressible fluids.

2. There is no wave function to describe dynamic behavior in incompressible fluids.
3. In compressible fluids, the dynamics are better understood by examining the center-of-

linear-momentum (CoM) frame and the laboratory (Lab) frame.

4. The CoM frame reveals the relationship between potential energy, pressure, and

volumetric energy density (Hamiltonian).

5. Emphasizes the equivalence between mass density and volumetric potential energy density.
6. The Hamiltonian represents the total internal energy in a closed, reversible adiabatic system.
7. When the flow velocity exceeds the wave speed, the Lorentz and expansion factors become imaginary numbers in the supersonic flow regime. This leads to unique expressions for the Hamiltonian, kinetic energy, and potential energy.
8. Incompressible fluids have zero compressibility, leading to instantaneous propagation of disturbances.
9. Potential energy density is solely a function of position, and no wave function describes the dynamic behavior, unlike compressible fluids.

10. The conservation of momentum in the Euler coordinate system is derived. Also, a singularity exists for compressible fluids when the flow velocity equals the wave speed, resulting in infinitely great mass and energy densities.
11. The literature survey can be expanded by adding some relevant recent literature on incompressible fluids for the enrichment of the paper:

a) https://doi.org/10.1080/17455030.2021.1912436

b) https://doi.org/10.37934/arfmts.75.2.110

c) https://doi.org/10.2478/ijame-2018-0033

d) https://doi.org/10.1007/978-981-16-5952-2_21

e) https://doi.org/10.1515/nleng-2018-0031

f) https://doi.org/10.1142/S0217979223503095

g) https://doi.org/10.1080/17455030.2023.2169783

h) doi:10.1088/1742-6596/1849/1/012019

The overall view, this paper explores the implications of using the CoM frame for understanding the relationship between various energy forms in compressible fluids and highlights the distinct behaviors exhibited at different flow velocities, particularly at the transonic point where singularities occur. The dynamic equations and the Hamiltonian formulation are tailored to account for the finite wave propagation speed in compressible fluids, providing a more comprehensive understanding of their behavior compared to incompressible fluids. Therefore, I **recommend** this paper for publication in your esteemed journal of "***QEIOS***".