General Fluid Field Theory

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June 29, 2025

Abstract

A general fluid medium governed by Navier–Stokes equations embeds electromagnetism and yields gravity as emergent pressure. This resolves the two-body problem and redefines gravitational and cosmological constants via Dirac's *Large Number Hypothesis*. A hydrodynamic quantum theory also addresses the measurement problem. This unifies all forces through the medium's density sources.

Introduction

The unification for all dynamic properties inside a non-relativistic medium and it's resultant motion may described by,

$$\nabla \cdot \mathbf{V} = Q(\mathbf{x}, t) \tag{1}$$

$$\nabla \cdot \mathbf{W} = 0 \tag{2}$$

$$\frac{\partial \mathbf{V}}{\partial t} = -\nabla \Phi + \mathbf{S} + \frac{1}{\rho(\mathbf{x}, t)} \nabla \cdot \boldsymbol{\tau}(\mathbf{x}, t), \tag{3}$$

$$\frac{\partial \mathbf{W}}{\partial t} = \nabla \times \mathbf{S} + \frac{1}{\rho(\mathbf{x}, t)} \nabla \times (\nabla \cdot \boldsymbol{\tau}(\mathbf{x}, t)), \tag{4}$$

Coupled with the modified continuity equation which models the source of the mediums material properties,

$$\frac{\partial \rho}{\partial t} = -\mathbf{V} \cdot \nabla \rho(\mathbf{x}, t) - \rho(\mathbf{x}, t)\, Q(\mathbf{x}, t) \tag{5}$$

The general fluid field is characterized by its velocity $\mathbf{V}$, it's vorticity $\mathbf{W} = \nabla \times \mathbf{V}$, it's spin $\mathbf{S} = \mathbf{V} \times \mathbf{W}$, and it's stress tensor $\tau(\mathbf{x}, t)$ The energy field Φ represents the fluid's combined potential of the pressure, kinetic energy and stress induced sources, $\rho(\mathbf{x}, t)$ is the density-tensor field; and the divergence term is $Q(\mathbf{x}, t)$.

Derivation of the General Fluid Field Equations

We begin by defining the fundamental quantities describing the fluid. The scope has been theoretically expanded but nonetheless it reduces to down to classical dynamics.

Definition: Density as a Scalar Field.

$$\boldsymbol{\rho}(\mathbf{x},t) = \begin{bmatrix} \rho_m(\mathbf{x},t) \\ m_q\,\rho_q(\mathbf{x},t) \\ \frac{1}{c^2}\,\rho_E(\mathbf{x},t) \\ m_\psi\,\rho_\psi(\mathbf{x},t) \\ \vdots \end{bmatrix}$$

$$\text{where:} \quad \begin{cases} \rho_m = \text{mass density (kg/m}^3) \\ \rho_q = \text{charge density (C/m}^3) \\ \rho_E = \text{energy density (J/m}^3) \\ \rho_\psi = \text{probability density (1/m}^3) \\ m_q = \text{mass per unit charge (kg/C)} \\ m_\psi = \text{quantum mass scale (kg)} \\ c = \text{speed of light (m/s)} \end{cases}$$

Collectively, these can be viewed as components of a scalar density field that fully characterizes the fluid's local state, enabling a unified treatment of mass, charge, energy, and other physical quantities.

Definition: The Stress Tensor.

The **stress tensor** $\boldsymbol{\tau}(\mathbf{x},t)$ is a symmetric rank-2 tensor field that encodes the internal forces per unit area within the fluid medium, generalizing scalar pressure to include anisotropic, viscous, quantum, and other internal stresses.[1] In the *general fluid field framework*, the stress tensor is naturally decomposed into distinct gauge-like components reflecting the multifaceted nature of the fluid's internal dynamics:

[1] [6] The stress tensor is rigorously defined as a second-order tensor field $\boldsymbol{\sigma}$ that maps an oriented surface normal $\mathbf{n}$ to the traction vector $\mathbf{t} = \boldsymbol{\sigma}\mathbf{n}$, encoding internal forces within the continuum. It satisfies the balance of linear momentum $\operatorname{div}\boldsymbol{\sigma} + \rho\mathbf{b} = \rho\dot{\mathbf{v}}$ and is symmetric due to angular momentum balance. For a detailed, coordinate-free, and geometric treatment of the stress tensor and related continuum mechanics principles, see *Marsden and Hughes (1983), Mathematical Foundations of Elasticity*.

$$\boldsymbol{\tau} = \boldsymbol{\tau}_{\text{quantum}} + \boldsymbol{\tau}_{\text{viscous}} + \boldsymbol{\tau}_{\text{non-viscous}} + \cdots,$$

where each component corresponds to a specific physical mechanism:

- $\boldsymbol{\tau}_{\text{quantum}}$ represents quantum-coherent stresses arising from spatial variations in the quantum density field and quantum potential, capturing nonlocal and inherently non-classical effects.
- $\boldsymbol{\tau}_{\text{viscous}}$ accounts for classical viscous stresses generated by fluid deformation rates, shear, and bulk viscosity.
- $\boldsymbol{\tau}_{\text{non-viscous}}$ includes non-dissipative, elastic-like, or other intrinsic stresses not accounted for by viscosity or quantum coherence.

This multi-component tensorial formulation captures the interplay between classical fluid mechanics, quantum effects, and other physical phenomena within a unified tensorial framework.

Navier–Stokes Equation for a Compressible Fluid. We consider the momentum conservation equation for a compressible viscous fluid without external body forces[2]:

$$\frac{\partial \mathbf{V}}{\partial t} + (\mathbf{V} \cdot \nabla)\mathbf{V} = -\frac{1}{\rho(\mathbf{x},t)}\nabla p + \frac{1}{\rho(\mathbf{x},t)}\nabla \cdot \boldsymbol{\tau}(\mathbf{x},t),$$

where,

- $\mathbf{V}(\mathbf{x},t)$ is the fluid velocity field (vector field).
- $p(\mathbf{x},t)$ is the scalar pressure field.
- $\rho(\mathbf{x},t)$ is the fluid density, potentially a scalar density field.
- $\boldsymbol{\tau}(\mathbf{x},t)$ is the viscous stress tensor.

Using the vector calculus identity,

$$(\mathbf{V} \cdot \nabla)\mathbf{V} = \nabla\left(\frac{|\mathbf{V}|^2}{2}\right) - \mathbf{V} \times (\nabla \times \mathbf{V}),$$

we rewrite the momentum equation as,

$$\frac{\partial \mathbf{V}}{\partial t} = -\nabla\left(\frac{|\mathbf{V}|^2}{2}\right) + \mathbf{V} \times (\nabla \times \mathbf{V}) - \frac{1}{\rho(\mathbf{x},t)}\nabla p + \frac{1}{\rho(\mathbf{x},t)}\nabla \cdot \boldsymbol{\tau}(\mathbf{x},t).$$

[2] [4] See, P. K. Kundu, I. M. Cohen, and D. R. Dowling, *Fluid Mechanics*, 6th Edition, Academic Press, 2015, Chapter 6, for a detailed derivation of the compressible Navier–Stokes equations including viscous stress tensor formulations.

Define the scalar potential,

$$\Phi(\mathbf{x},t) = \frac{1}{\rho(\mathbf{x},t)} \left(p(\mathbf{x},t) + E_k(\mathbf{x},t) \right),$$

where the kinetic energy density is,

$$E_k(\mathbf{x},t) = \frac{1}{2}\rho(\mathbf{x},t)|\mathbf{V}(\mathbf{x},t)|^2.$$

This allows expressing the velocity evolution as,

$$\frac{\partial \mathbf{V}}{\partial t} = -\nabla\Phi + \mathbf{S} + \frac{1}{\rho}\nabla\cdot\boldsymbol{\tau}(\mathbf{x},t),$$

where $\mathbf{S} = \mathbf{V}\times(\nabla\times\mathbf{V})$ represents the vortex force contribution. Therefore the vorticity vector field is,

$$\mathbf{W}(\mathbf{x},t) = \nabla\times\mathbf{V}(\mathbf{x},t).$$

Due to fluid compressibility, the divergence of velocity generally does not vanish,

$$\nabla\cdot\mathbf{V} = Q(\mathbf{x},t),$$

where $Q(\mathbf{x},t)$ is the compressibility or volumetric source term.

This concludes the derivation of the general fluid field equations in the stress-tensor gauge framework, with density treated as a generalized scalar field and the viscous stress tensor explicitly included. The resulting system provides a versatile starting point to explore diverse physical regimes including electromagnetism, gravity, and quantum fields as emergent phenomena from fluid dynamics.

The Material's Properties

The equations of motion of the medium are described by the nature of the medium, the medium's physical nature is the key factor in determining the nature of motion. The determining factors of physical properties of the material depend upon its **stress** and it's **density**, which are subsequently intertwined, and thus gauges are applied to study the motion of our fluid and henceforth everything within in it.

The Density ρ

The density ρ of the medium can vary in both space and time. It is a function governed by the internal flow and volumetric expansion or compression. The evolution of density in a non-homogeneous medium is governed by the continuity equation[3],

$$\frac{\partial\rho}{\partial t} = -\mathbf{V}\cdot\nabla\rho - \rho\, Q(\mathbf{x},t)$$

[3] [4] See P. K. Kundu, I. M. Cohen, and D. R. Dowling, *Fluid Mechanics*, 6th Edition, Academic Press, 2015, Chapter 3, for a detailed treatment of the continuity equation in compressible flows.

where:

- $\mathbf{V}$ is the velocity field,
- $Q(\mathbf{x}, t) = \nabla \cdot \mathbf{V}$ is the divergence of the velocity field (a measure of local expansion or compression),

The Steady-State Solution

To understand the long-term behavior of the medium, we take the limit as time approaches infinity,

$$\lim_{t\to\infty} \frac{\partial \rho}{\partial t} = \lim_{t\to\infty} \left(-\mathbf{V} \cdot \nabla \rho - \rho\, Q(\mathbf{x}, t)\right),$$

this gives the steady-state condition,

$$Q(\mathbf{x}, t) = -\frac{1}{\rho}(\mathbf{V} \cdot \nabla \rho) \tag{6}$$

At steady state, the time derivative of the density vanishes, meaning the system has reached a dynamic equilibrium. Showing that local expansion or compression is exactly balanced by the advection of density in the flow. This condition characterizes how steady-state density distributions are maintained in non-uniform, compressible media.

The Input-State Solution

The evolution of density in a compressible fluid is given by the continuity equation:

$$\frac{\partial \rho}{\partial t} = -\mathbf{V} \cdot \nabla \rho - \rho\, Q(\mathbf{x}, t),$$

where:

- $\rho = \rho(\mathbf{x}, t)$ is the fluid density,
- $\mathbf{V} = \mathbf{V}(\mathbf{x}, t)$ is the velocity field,
- $Q(\mathbf{x}, t) := \nabla \cdot \mathbf{V}$ is the velocity divergence.

To model external mass injection or extraction, we decompose the total density into an initial spatially varying density and a variable incoming mass density:

$$\rho(\mathbf{x}, t) = \rho(\mathbf{x}, 0) + \rho_m(\mathbf{x}, t),$$

where:

- $\rho(\mathbf{x}, 0)$ is the initial density distribution, which may vary with position $\mathbf{x}$,
- $\rho_m(\mathbf{x}, t)$ represents the added or removed mass density due to external input or extraction.

Since $\rho(\mathbf{x}, 0)$ is constant in time,

$$\frac{\partial \rho}{\partial t} = \frac{\partial \rho_m}{\partial t},$$

and the spatial gradient decomposes as,

$$\nabla \rho = \nabla \rho(\mathbf{x}, 0) + \nabla \rho_m(\mathbf{x}, t).$$

Substituting into the continuity equation, we have

$$\frac{\partial \rho_m}{\partial t} = -\mathbf{V} \cdot \big(\nabla \rho(\mathbf{x}, 0) + \nabla \rho_m(\mathbf{x}, t)\big) - \big(\rho(\mathbf{x}, 0) + \rho_m(\mathbf{x}, t)\big) Q(\mathbf{x}, t).$$

Rearranging to isolate the velocity divergence yields:

$$\boxed{Q(\mathbf{x}, t) = -\frac{1}{\rho(\mathbf{x}, 0) + \rho_m(\mathbf{x}, t)} \left(\frac{\partial \rho_m}{\partial t} + \mathbf{V} \cdot \nabla \rho(\mathbf{x}, 0) + \mathbf{V} \cdot \nabla \rho_m(\mathbf{x}, t) \right).} \tag{7}$$

This shows that the velocity divergence (the source/sink) $Q(\mathbf{x}, t) := \nabla \cdot \mathbf{V}$ depends explicitly on both the local time rate of change and spatial variation of the incoming mass density $\rho_m(\mathbf{x}, t)$, as well as on the spatial gradient of the initial density distribution $\rho(\mathbf{x}, 0)$, scaled by the initial density. The total instantaneous density at each point can be denoted as

$$\rho_\delta(\mathbf{x}, t) := \rho(\mathbf{x}, 0) + \rho_m(\mathbf{x}, t).$$

- When the advection terms $\mathbf{V} \cdot \nabla \rho(\mathbf{x}, 0)$ and $\mathbf{V} \cdot \nabla \rho_m(\mathbf{x}, t)$ are negligible (e.g., small spatial gradients or slow velocity variations), Eq. (7) reduces to,
$$\nabla \cdot \mathbf{V} \approx -\frac{1}{\rho_\delta(\mathbf{x}, t)} \frac{\partial \rho_m}{\partial t}.$$
- If, further, $\rho_m \ll \rho(\mathbf{x}, 0)$, then $\rho(\mathbf{x}, 0) + \rho_m(\mathbf{x}, t) \approx \rho(\mathbf{x}, 0)$, giving the classical approximation,
$$\nabla \cdot \mathbf{V} \approx -\frac{1}{\rho(\mathbf{x}, 0)} \frac{\partial \rho_m}{\partial t}.$$

Physically, the velocity divergence measures the local volumetric expansion or compression driven by the net injection or removal of mass and its transport. This result connects the macroscopic fluid kinematics (divergence of velocity) directly to the microscopic process of mass injection or removal encoded by the incoming mass density ρ_m.

Other State Solutions

Within the *general fluid field theory* (GFFT), the fluid density $\rho(\mathbf{x}, t)$ evolves according to the continuity equation incorporating an input-state formulation. Due to the generality of this framework, an essentially infinite variety of state solutions exist, describing diverse fluid behaviors beyond any single physical interpretation. These include, but are not limited to:

- **Localized Density Variation Solutions:** Solutions where density changes sharply and locally, modeling phenomena such as fluid jets, shock fronts, or mass injection/extraction regions. These represent transient or steady-state localized structures driven by input mass fluxes $\rho_m(\mathbf{x}, t)$.

- **Branching and Multimodal Density Distributions:** Complex density configurations where the fluid splits into multiple distinct regions or streams, possibly interacting or evolving independently. This can represent mixing flows, turbulence structures, or phase separations.

- **Diffusive and Smoothing Solutions:** Density evolutions where gradients tend to diminish over time due to internal dynamics or external forcing, describing diffusion-like phenomena or relaxation towards equilibrium.

- **Oscillatory and Wave-like Density Solutions:** States exhibiting periodic or wave propagation behaviors in density due to fluid elasticity, compressibility, or external forcing. These solutions capture acoustic waves, surface waves, or other hydrodynamic oscillations.

- **Stochastic or Random Fluctuation Solutions:** Density fields influenced by noise or random inputs $\rho_m(\mathbf{x}, t)$, leading to probabilistic or turbulent states that model environmental disturbances or intrinsic fluid instabilities.

Each of these solution types arises naturally from the flexibility of the input-state continuity equation, with the velocity divergence Q itself linked to time variations and spatial gradients of the input mass density $\rho_m(\mathbf{x}, t)$. This generality underscores GFFT's power as a unifying fluid framework capable of describing a wide range of physical fluid phenomena across scales and contexts. A thorough classification and study of these state solutions constitute a significant topic for future research.

The Stress τ

The stress tensor τ encodes the ability of momentum to diffuse through the fluid medium. It thus relates to the internal dynamics of the medium. The types of stress can either be homogeneous—where stress is distributed evenly—or non-homogeneous—where stress is not evenly distributed—or other reasonable forms.

A homogeneous fluid medium

A homogeneous fluid medium is one in which the medium's parameters—such as density ρ, viscosity μ, and compressibility (the bulk modulus λ)—do not vary with position. That is,

$$\nabla\rho = \nabla\mu = \nabla\lambda = 0,$$

this assumption simplifies the dynamics. First we express the evolution of the velocity field as:

$$\frac{\partial \mathbf{V}}{\partial t} = -\nabla\Phi + \mathbf{S} + \frac{1}{\rho}\nabla\cdot\boldsymbol{\tau}.$$

For a Newtonian fluid, the stress tensor takes the form[4],

$$\boldsymbol{\tau} = \mu\left(\nabla\mathbf{V} + (\nabla\mathbf{V})^T\right) + \lambda(Q(\mathbf{x},t))\mathbf{I}.$$

In a homogeneous Newtonian fluid, because all spatial gradients of medium coefficients vanish, when taking the divergence of $\boldsymbol{\tau}$, only the derivatives of the velocity field remain, yielding:

$$\nabla\cdot\boldsymbol{\tau} = \mu\nabla^2\mathbf{V} + (\lambda+\mu)\nabla(Q(\mathbf{x},t)),$$

this expresses two key mechanisms of viscous interaction:

- Shear diffusion from $\nabla^2\mathbf{V}$, which smooths out transverse velocity gradients.
- Compression from $\nabla Q(\mathbf{x},t)$ smooths out volume changes.
- The shear viscosity is $\nu = \frac{\mu}{\rho}$, and the bulk viscosity is $\frac{\lambda+\mu}{\rho}$.

Resolving the compression from the source term inside the potential, the equation becomes the classical Navier-Stokes equation:

$$\frac{\partial \mathbf{V}}{\partial t} = -\nabla\Phi + \mathbf{S} + \nu\nabla^2\mathbf{V},$$

The internal forces that arise from gradients in motion are purely a consequence of deformation; the fluid dynamics arise purely from interactions between momentum, vorticity, and pressure-like effects—not from any position-dependent medium variations.

A non-homogeneous fluid medium

In contrast to a homogeneous fluid medium, a *non-homogeneous* fluid medium is spatially dependent; this spatial dependence must be accounted for in the evolution of the velocity field. The general medium equation is,

$$\frac{\partial \mathbf{V}}{\partial t} = -\nabla\Phi + \mathbf{S} + \frac{1}{\rho(\mathbf{x},t)}\nabla\cdot\boldsymbol{\tau}(\mathbf{x},t),$$

[4] [4] See, P. K. Kundu, I. M. Cohen, and D. R. Dowling, *Fluid Mechanics*, 6th Edition, Academic Press, 2015, Chapter 6, for a detailed derivation of the compressible Navier–Stokes equations including viscous stress tensor formulations.

here, the viscous stress tensor $\boldsymbol{\tau}$ may now depend on position, not only through gradients of velocity, but also through spatially varying viscosity[5]:

$$\boldsymbol{\tau} = \mu(\mathbf{x}) \left(\nabla \mathbf{V} + (\nabla \mathbf{V})^T \right) + \lambda(\mathbf{x})(Q(\mathbf{x}, t))\mathbf{I},$$

this introduces additional complexity into the dynamics. Notably, when taking the divergence of $\boldsymbol{\tau}$, the spatial derivatives will now act on both the velocity gradients and the variable coefficients:

$$\nabla \cdot \boldsymbol{\tau} = \nabla \mu(\mathbf{x}) \cdot \left(\nabla \mathbf{V} + (\nabla \mathbf{V})^T \right) + \mu(\mathbf{x}) \nabla^2 \mathbf{V} + \nabla \left[\lambda(\mathbf{x})(Q(\mathbf{x}, t)) \right].$$

This introduces terms representing the medium's inhomogeneities.

Miscellaneous fluid media

Beyond classical Newtonian fluids, the stress tensor $\boldsymbol{\tau}$ can be generalized to describe a wide variety of fluid media with more complex internal structures or interactions. These include, but are not limited to[6]:

- **Non-Newtonian fluids**, where the stress depends nonlinearly on velocity gradients or includes memory effects.
- **Anisotropic fluids**, in which the viscosity and compressibility vary directionally, often modeled by tensor-valued coefficients $\mu_{ij}(\mathbf{x}, t)$, $\lambda_{ij}(\mathbf{x}, t)$.
- **Quantum fluids**, where the stress tensor incorporates quantum mechanical effects such as superfluidity, phase coherence, and quantized vortices. In such media, $\boldsymbol{\tau}$ can include additional terms derived from quantum stress tensors or quantum potentials, reflecting internal quantum stresses beyond classical viscosity.
- **Viscoelastic media**, where fluid exhibits both viscous and elastic responses, typically modeled by constitutive relations with time-dependent or strain-dependent stresses.

In these generalized fluid media, the form of $\boldsymbol{\tau}$ must be derived or postulated based on the specific physical phenomena involved. The resulting equations of motion extend beyond the classical Navier-Stokes framework, often requiring computational analysis, advanced mathematical tools, or other physical interpretations.

[5] [1] See, R. B. Bird, W. E. Stewart, and E. N. Lightfoot, *Transport Phenomena*, 2nd Edition, Wiley, 2007, Chapter 3, for treatment of position-dependent viscosity effects in fluid stress tensors.

[6] [3] See, R. J. Donnelly, *Quantized Vortices in Helium II*, Cambridge University Press, 1991, for quantum fluids and related stress tensor formulations.

The Material Propagation c

Within the framework of *general fluid field theory*, the speed of propagation of disturbances in media arises naturally from the intrinsic fluid properties such as density and compressibility. We begin by considering the key variables of the fluid dynamics:

- The fluid velocity field: $\mathbf{V}(\mathbf{x}, t)$,
- The compressibility or divergence of velocity: $Q(\mathbf{x}, t) = \nabla \cdot \mathbf{V}$,
- The scalar potential related to pressure and kinetic energy:

$$\Phi = \frac{1}{\rho}(p + E_k),$$

  where ρ is the mass density and $E_k = \frac{1}{2}\rho|\mathbf{V}|^2$ is the kinetic energy density.

Assuming small perturbations and neglecting kinetic energy, we approximate the scalar potential as,

$$\Phi \approx \frac{p}{\rho}.$$

From the evolution equation of the fluid velocity, taking the divergence and assuming no source terms and negligible viscous stresses, we obtain,

$$\frac{\partial Q}{\partial t} \approx -\nabla^2 \Phi.$$

Relating pressure fluctuations to density fluctuations via the fluid compressibility ϵ, we have,

$$\delta p = \frac{1}{\epsilon\rho}\delta\rho,$$

where ρ is the equilibrium mass density. The fluid continuity equation links divergence of velocity to the time derivative of density perturbations, yielding the input-state solution,

$$Q = \nabla \cdot \mathbf{V} \approx -\frac{1}{\rho}\frac{\partial \delta\rho}{\partial t}.$$

Taking the time derivative yields,

$$\frac{\partial Q}{\partial t} \approx -\frac{1}{\rho}\frac{\partial^2 \delta\rho}{\partial t^2}.$$

Combining these relations, we substitute Φ and rewrite the equation for density perturbations:

$$-\frac{1}{\rho_0}\frac{\partial^2 \delta\rho}{\partial t^2} = -\nabla^2\left(\frac{1}{\epsilon\rho^2}\delta\rho\right).$$

Multiplying both sides by $-\rho$ and assuming constant fluid parameters leads to the classical wave equation,

$$\frac{\partial^2 \delta\rho}{\partial t^2} = \frac{1}{\epsilon\rho}\nabla^2 \delta\rho.$$

This identifies the speed of propagation of density perturbations in the fluid as,

$$\boxed{c = \frac{1}{\sqrt{\epsilon\rho}},}$$

where c is the fundamental propagation speed emerging from the fluid density ρ_0 and compressibility ϵ. Thus, in GFFT, the universal speed limit—such as the speed of light—is fundamentally a fluid velocity determined by the intrinsic density and compressibility properties of the underlying fluid.[7]

The Electromagnetic Phenomena

Maxwell originally viewed electric and magnetic fields not as abstract entities but as real stresses and motions in a continuous fluid-like ether[8]. Though the ether concept was abandoned, *general fluid field theory* generalizes this by treating electromagnetic fields as emergent features of any fluid's internal stresses, velocities, vorticities, and compression. Thus, whether in quantum fluids, plasmas, or the space-fluid, electromagnetism appears as a mechanical response of the fluid, restoring Maxwell's fields as real descriptors of fluid motion and structure.

Describing Electromagnetism

Electromagnetism emerges naturally from fluid dynamics when interpreted through the velocity field $\mathbf{V}(\mathbf{x}, t)$ and scalar potential $\Phi(\mathbf{x}, t)$ of a compressible, vortical medium. In this interpretation, the speed of propagation c, the permittivity ε_0, and the permeability μ_0 all arise from intrinsic fluid properties. We define the electric and magnetic fields as:

$$\mathbf{E} := -\frac{\partial \mathbf{V}}{\partial t} - \nabla\Phi, \qquad \mathbf{B} := \mathbf{W} = \nabla \times \mathbf{V}.$$

These expressions reveal that:

- The magnetic field $\mathbf{B}$ corresponds to the fluid's vorticity $\mathbf{W}$.
- The electric field $\mathbf{E}$ represents the local acceleration of the fluid and gradient of the potential.

[7] [4] See, P. K. Kundu, I. M. Cohen, and D. R. Dowling, *Fluid Mechanics*, 6th Edition, Academic Press, 2015, Chapter 6, for the classical derivation of wave propagation speed in compressible fluids.

[8] [7] J. C. Maxwell, "On Physical Lines of Force," *Philosophical Magazine*, vol. 21, 1861, pp. 161–175, 281–291.

Starting from the fundamental relations which can be derived from the explicit definitions of the electromagnetic vector fields,

$$\nabla \cdot \mathbf{B} = 0, \tag{8}$$

$$\nabla \cdot \mathbf{E} = \frac{\partial Q(\mathbf{x}, t)}{\partial t} - \nabla^2 \Phi, \tag{9}$$

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}, \tag{10}$$

$$\nabla \times \mathbf{B} = \nabla Q(\mathbf{x}, t) - \nabla^2 \mathbf{V}, \tag{11}$$

By using the Lorenz gauge condition, we relate the divergence of the velocity field directly to the time derivative of the scalar potential scaled by the propagation speed c.

$$\nabla \cdot \mathbf{V} = Q(\mathbf{x}, t) = -\frac{1}{c^2} \frac{\partial \Phi}{\partial t},$$

This establishes that the fluid velocity responds instantaneously to changes in the potential energy caused by variations in charge or mass distribution. Physically, this means the field adjusts locally without delay, while disturbances then propagate through the medium as waves traveling at speed c. Thus, the field dynamically "knows" about changes and reconfigures itself in a way that preserves causality, ensuring information and energy propagate at a finite, physically meaningful speed.[9]

The Two-Body Problem

The two body problem is contextualized in the framework of fluid dynamics, such as two moving sinks in a fluid will produce the observed effect of gravity.

Density Sink Model

Mass is treated as a time-dependent density sink, i.e., a localized loss of background fluid density, from the input-state solution,

$$\nabla \cdot \mathbf{V} = Q(\mathbf{x}, t) = -\frac{1}{\rho_0} \frac{\partial \rho_m(\mathbf{x}, t)}{\partial t},$$

where ρ_0 is the initial fluid density at point $\mathbf{x}$ at the start of injection, and $\rho_m(\mathbf{x}, t)$ is the spatial mass-density field.

[9] Explicit derivation of Maxwell's equations have been omitted, though they can be easily derived from the definitions.

Pointlike Density Sinks

For two pointlike bodies at positions $\mathbf{x}_1(t)$ and $\mathbf{x}_2(t)$ with time-dependent mass injection rates $\dot{m}_1(t)$ and $\dot{m}_2(t)$, we define:

$$\frac{\partial \rho_m(\mathbf{x},t)}{\partial t} = -\dot{m}_1(t)\,\delta(\mathbf{x}-\mathbf{x}_1(t)) - \dot{m}_2(t)\,\delta(\mathbf{x}-\mathbf{x}_2(t)),$$

so that:

$$\nabla\cdot\mathbf{V} = Q(\mathbf{x},t) = \frac{1}{\rho_0}\left[\dot{m}_1(t)\,\delta(\mathbf{x}-\mathbf{x}_1(t)) + \dot{m}_2(t)\,\delta(\mathbf{x}-\mathbf{x}_2(t))\right].$$

Potential from Density Sources

Assuming irrotational and inviscid flow, the divergence of the velocity field $\mathbf{V}$ is related to a scalar potential Φ by,

$$\frac{\partial}{\partial t}(\nabla\cdot\mathbf{V}) = \frac{\partial Q}{\partial t} = -\nabla^2\Phi.$$

This Poisson equation for Φ can be written as,

$$\nabla^2\Phi = -\frac{\partial Q(\mathbf{x},t)}{\partial t} = -\frac{1}{\rho_0}\left[\ddot{m}_1\,\delta(\mathbf{x}-\mathbf{x}_1(t)) + \ddot{m}_2\,\delta(\mathbf{x}-\mathbf{x}_2(t))\right],$$

where ρ_0 is a reference density, and $\ddot{m}_i$ denote the second time derivatives of the source masses at positions $\mathbf{x}_i(t)$. We define the effective gravitational permittivity ε_g as,

$$\varepsilon_g := \rho_0 T^2,$$

where T^2 is an effective characteristic time acceleration parameter[10]

$$\nabla^2\Phi = \frac{1}{\varepsilon_g}\left[m_1\,\delta(\mathbf{x}-\mathbf{x}_1) + m_2\,\delta(\mathbf{x}-\mathbf{x}_2)\right].$$

The solution for Φ is then,

$$\Phi(\mathbf{x},t) = -\frac{1}{4\pi\varepsilon_g}\left(\frac{m_1}{|\mathbf{x}-\mathbf{x}_1|} + \frac{m_2}{|\mathbf{x}-\mathbf{x}_2|}\right).$$

Finally, define the compressibility strength constant as,

$$G := \frac{1}{4\pi\varepsilon_g}.$$

[10]The factor T^2 in $\varepsilon_g = \rho_0\,T^2$ compensates for the cosmic scaling of mass density ρ_0. Since ρ_0 scales roughly as $M(T)/L(T)^3$ with $L(T)\sim T$, including T^2 ensures ε_g has the correct physical units and grows appropriately to maintain dimensional consistency across cosmic time.

Dimensional Consistency of G via Dirac's Large Number Hypothesis

Starting from the fundamental wave relation in the cosmic fluid,

$$c^2 = \frac{1}{\varepsilon_0 \rho},$$

with gravitational compressibility,

$$\varepsilon_g = \varepsilon_0 = \frac{1}{4\pi G}.$$

Rearranging[11],

$$\boxed{G = \frac{\rho c^2}{4\pi}.}$$

Let's write the dimensions explicitly:

$$[G] = \frac{L^3}{MT^2}, \quad [\rho_0] = \frac{M}{L^3}, \quad [c] = \frac{L}{T}.$$

Substituting into G,

$$[\mathrm{RHS}] = [\rho_0][c]^2 = \frac{M}{L^3} \cdot \frac{L^2}{T^2} = \frac{M}{LT^2},$$

which does **not match** $[G] = \frac{L^3}{MT^2}$.

Resolution via Dirac's Large Number Hypothesis (LNH)

Assume that the characteristic cosmic mass density ρ_0 evolves with cosmic time T and gravitational constant G according to:

$$\rho_0(T) = \frac{1}{G(T)\,T^2}.$$

Check dimensions on the right-hand side:

$$[\rho_0] = \frac{1}{[G][T]^2} = \frac{1}{\frac{L^3}{MT^2} \cdot T^2} = \frac{M}{L^3},$$

which correctly yields mass density units. Now substitute into the expression for G:

$$G = \frac{\rho_0 c^2}{4\pi} = \frac{c^2}{4\pi} \cdot \frac{1}{GT^2}.$$

Multiply both sides by G:

$$G^2 = \frac{c^2}{4\pi T^2} \quad \Rightarrow \quad G = \frac{c}{\sqrt{4\pi}\,T} \sim \frac{c}{T}.$$

[11] The resultant dependency on the density of space could explain the phenomena of dark matter.

Thus, G must scale inversely with cosmic time T, and consequently:

$$\rho_0(T) \sim \frac{1}{GT^2} \sim \frac{T}{c} \cdot \frac{1}{T^2} = \frac{1}{cT}.$$

This confirms that dimensional consistency is restored if both G and ρ_0 are treated as time-dependent quantities. The cosmic fluid picture thereby necessitates a dynamic gravitational coupling, consistent with Dirac's LNH. The "gravitational constant" emerges not as a fixed parameter, but as an effective property of the evolving fluid medium.[12]

Fluid-Mediated Motion of the Density Sinks

Each particle moves along streamlines of the fluid velocity field, which itself derives from the gradient of the potential:

$$\frac{d\mathbf{x}_i}{dt} = \mathbf{V}(\mathbf{x}_i, t) = -\nabla\Phi(\mathbf{x}_i, t), \quad i = 1, 2.$$

Therefore, the equations of motion for the two-body system become:

$$\begin{aligned} \frac{d\mathbf{x}_1}{dt} &= -Gm_2 \frac{\mathbf{x}_1 - \mathbf{x}_2}{|\mathbf{x}_1 - \mathbf{x}_2|^3}, \\ \frac{d\mathbf{x}_2}{dt} &= -Gm_1 \frac{\mathbf{x}_2 - \mathbf{x}_1}{|\mathbf{x}_2 - \mathbf{x}_1|^3}. \end{aligned}$$

Newtonian Gravity from Fluid Compressibility

This formulation derives Newtonian gravitational attraction from fluid compressibility sourced by slow-moving point-like density sinks. The full system is governed by the equations:

$$\begin{aligned} Q(\mathbf{x}, t) &= -\frac{1}{\rho_0} \frac{\partial \rho_m}{\partial t}, \\ \frac{\partial \mathbf{V}}{\partial t} &= -\nabla\Phi, \end{aligned}$$

where

- $Q(\mathbf{x}, t)$ is the fluid compressibility (divergence of velocity),

[12] Dirac's Large Number Hypothesis proposes that the gravitational constant G varies with cosmic time as $G \sim 1/T$, suggesting that so-called constants may actually reflect evolving properties of the universe. In our model, this variation is captured by defining an effective gravitational permittivity $\varepsilon_g := \rho_0 T^2$. While this resolves dimensional inconsistency in our fluid framework, it also hints at a deeper issue: the fundamental units of mass, length, and time—and by extension all derived quantities—may scale with the state of the universe. Dirac's insight opened this possibility, but a complete treatment requires a reexamination of dimensional analysis and unit definitions on cosmological scales. That ambitious task lies beyond our present scope. For now, we maintain self-consistency by absorbing cosmic scaling into ρ_0 and ε_g, leaving open the broader challenge for future study.

- ρ_0 is the initial background mass density,
- $\rho_m(\mathbf{x}, t)$ is the mass density source (or sink),
- $\mathbf{V}(\mathbf{x}, t)$ is the fluid velocity field,
- $\Phi(\mathbf{x}, t)$ is the scalar potential field analogous to gravitational potential.

In this model, the sinks of mass density produce compressibility Q which drives the velocity field $\mathbf{V}$, leading to acceleration described by $-\nabla\Phi$, which recovers Newtonian gravitational dynamics as an emergent fluid phenomenon. The fluid flow thus mediates interaction between bodies without the need for a gravitational field per se; instead, all dynamics emerge from density-based modifications of the fluid's compressibility.

Quantum Mechanics within the General Fluid Field Framework

In *general fluid field theory*, spacetime is modeled as a continuous fluid medium whose internal stresses give rise to classical and quantum phenomena. Quantum mechanics emerges naturally when the fluid's intrinsic quantum coherence is expressed via a dedicated quantum stress tensor acting on the fluid density.

Quantum Density and Wavefunction Representation

The fundamental scalar field encoding quantum behavior is the quantum density $\rho(\mathbf{x}, t)$, representing the probability density of the fluid's quantum state. It is defined as the squared modulus of a complex-valued wavefunction $\psi(\mathbf{x}, t)$:

$$\rho(\mathbf{x}, t) = |\psi(\mathbf{x}, t)|^2.$$

Using the Madelung hydrodynamic representation[13], the wavefunction can be expressed as,

$$\psi(\mathbf{x}, t) = \sqrt{\rho(\mathbf{x}, t)}\, e^{iS(\mathbf{x},t)/\hbar},$$

where the phase $S(\mathbf{x}, t)$ relates to the fluid velocity field by

$$\mathbf{V}(\mathbf{x}, t) = \frac{1}{m}\nabla S(\mathbf{x}, t).$$

Thus, the quantum density ρ and phase S completely characterize the fluid's quantum state and dynamics.

[13] [5] E. Madelung, *Quantentheorie in hydrodynamischer Form*, Zeitschrift für Physik, 40, 322–326 (1926).

Derivation of the Quantum Stress Tensor

We postulate a symmetric, traceless quantum stress tensor $\boldsymbol{\tau}_{\text{quantum}}$ to model internal quantum pressure arising from spatial variations in density. Following Takabayasi[14], this tensor is given by

$$\boldsymbol{\tau}_{\text{quantum}} = -\frac{\hbar^2}{4m^2}\left[\nabla \otimes \left(\frac{\nabla\rho}{\rho}\right) + \left(\nabla \otimes \left(\frac{\nabla\rho}{\rho}\right)\right)^{\top} - \mathbf{I}\,\nabla \cdot \left(\frac{\nabla\rho}{\rho}\right)\right],$$

where $\mathbf{I}$ is the identity tensor and $\otimes$ denotes the tensor (outer) product. Taking the divergence and dividing by ρ yields the quantum force density,

$$\frac{1}{\rho}\nabla \cdot \boldsymbol{\tau}_{\text{quantum}} = -\nabla\Phi_q,$$

where,

$$\Phi_q = -\frac{\hbar^2}{2m^2}\frac{\nabla^2\sqrt{\rho}}{\sqrt{\rho}}$$

is the Bohm quantum potential[15], representing a conservative quantum force that suppresses density gradients.

Quantum Fluid Evolution Equation and Derivation of the Schrödinger Equation

In GFFT, the evolution of a quantum-like compressible fluid with internal coherence is governed by a modified Euler equation with both classical and quantum potentials:

$$\frac{\partial\mathbf{V}}{\partial t} + (\mathbf{V}\cdot\nabla)\mathbf{V} = -\nabla\left(\frac{p}{\rho} + \Phi_q\right),$$

where:

- $\mathbf{V}$ is the velocity field,
- p/ρ represents the classical pressure potential,
- Φ_q is the quantum potential defined by,

$$\Phi_q := -\frac{\hbar^2}{2m^2}\frac{\nabla^2\sqrt{\rho}}{\sqrt{\rho}}.$$

We now assume that the velocity field is irrotational and can be written as the gradient of a scalar function $S(\mathbf{x}, t)$ via the Madelung representation:

$$\mathbf{V} = \frac{1}{m}\nabla S.$$

[14] [8] T. Takabayasi, "On the Formulation of Quantum Mechanics Associated with Classical Pictures," *Progress of Theoretical Physics*, vol. 8, no. 2, pp. 143–182, 1952.

[15] [2] D. Bohm, "A Suggested Interpretation of the Quantum Theory in Terms of 'Hidden' Variables I," *Physical Review*, vol. 85, no. 2, pp. 166–179, 1952.

Substituting into the velocity evolution equation and using the identity

$$(\mathbf{V} \cdot \nabla)\mathbf{V} = \nabla \left(\frac{|\mathbf{V}|^2}{2} \right) \quad \text{for irrotational flow,}$$

we obtain:

$$\frac{\partial}{\partial t} \left(\frac{1}{m} \nabla S \right) + \nabla \left(\frac{1}{2m^2} |\nabla S|^2 \right) = -\nabla \left(\frac{p}{\rho} + \Phi_q \right).$$

Multiplying both sides by m, integrating spatially, and simplifying:

$$\frac{\partial S}{\partial t} + \frac{1}{2m} |\nabla S|^2 + m\frac{p}{\rho} + m\Phi_q = 0.$$

This is the quantum Hamilton-Jacobi equation, now derived from a fluid with both pressure and quantum stress terms. Meanwhile, the mass continuity equation is:

$$\frac{\partial \rho}{\partial t} + \nabla \cdot \left(\rho \frac{\nabla S}{m} \right) = 0.$$

Define the complex wavefunction via the Madelung transform:

$$\psi(\mathbf{x}, t) := \sqrt{\rho(\mathbf{x}, t)}\, e^{iS(\mathbf{x},t)/\hbar}.$$

We now compute the time and spatial derivatives of ψ. The time derivative gives:

$$i\hbar \frac{\partial \psi}{\partial t} = \left(i\hbar \frac{1}{2\sqrt{\rho}} \frac{\partial \rho}{\partial t} - \frac{\partial S}{\partial t} \sqrt{\rho} \right) e^{iS/\hbar}.$$

The Laplacian is:

$$\nabla^2 \psi = \left[\nabla^2 \sqrt{\rho} - \frac{1}{\hbar^2} (\nabla S)^2 \sqrt{\rho} + \frac{i}{\hbar} \left(2\nabla \sqrt{\rho} \cdot \nabla S + \sqrt{\rho} \nabla^2 S \right) \right] e^{iS/\hbar}.$$

Combining these into the standard Schrödinger equation form:

$$i\hbar \frac{\partial \psi}{\partial t} = -\frac{\hbar^2}{2m} \nabla^2 \psi + V\psi,$$

and substituting $V = m\frac{p}{\rho}$, we recover the full linear Schrödinger equation from fluid principles:

$$i\hbar \frac{\partial \psi}{\partial t} = -\frac{\hbar^2}{2m} \nabla^2 \psi + m\frac{p}{\rho} \psi.$$

This derivation shows that quantum dynamics, including coherence and internal stress, arises as a natural consequence of the generalized compressible fluid with both pressure and quantum potential. The Schrödinger equation emerges directly from classical-like fluid field dynamics when the wavefunction is reinterpreted as a structured complex density. In GFFT, quantum mechanics is not fundamental but a special case of nonlinear fluid field behavior.

Resolution of the Measurement Problem

Within GFFT, suppose measurement is modeled as an external disturbance that injects or extracts fluid density $\rho_m(\mathbf{x}, t)$ at a localized region of space. The resulting velocity divergence, derived from the continuity equation[16], is given by:

$$Q(\mathbf{x}, t) = -\frac{1}{\rho(\mathbf{x}, 0) + \rho_m} \left(\frac{\partial \rho_m}{\partial t} + \mathbf{V} \cdot \nabla \rho(\mathbf{x}, 0) + \mathbf{V} \cdot \nabla \rho_m(\mathbf{x}, t) \right).$$

Suppose the measurement acts instantaneously at a spacetime point $(\mathbf{x}_0, t_0)$, extracting information and collapsing the state. Then the incoming mass density can be approximated as a sharply peaked function:

$$\rho_m(\mathbf{x}, t) \approx -\rho(\mathbf{x}, 0)\, \delta(\mathbf{x} - \mathbf{x}_0) \Theta(t - t_0),$$

where δ is the Dirac delta function and Θ is the Heaviside step function. Its time derivative is,

$$\frac{\partial \rho_m}{\partial t} \approx -\rho(\mathbf{x}, 0)\, \delta(\mathbf{x} - \mathbf{x}_0)\, \delta(t - t_0),$$

leading to a divergent compression in the velocity field:

$$\nabla \cdot \mathbf{V}(\mathbf{x}, t) \approx +\frac{\delta(t - t_0)\, \delta(\mathbf{x} - \mathbf{x}_0)}{\rho_\delta(\mathbf{x}, t)}.$$

This sudden positive divergence implies rapid volumetric contraction of the fluid around the point $\mathbf{x}_0$, dynamically suppressing the density elsewhere. The total density evolves as,

$$\frac{\partial \rho}{\partial t} \approx -\rho \nabla \cdot \mathbf{V} \approx -\delta(t - t_0)\, \delta(\mathbf{x} - \mathbf{x}_0),$$

driving $\rho(\mathbf{x}, t)$ toward a localized spike:

$$\rho(\mathbf{x}, t > t_0) \to \delta(\mathbf{x} - \mathbf{x}_0),$$

which corresponds to the classical collapse of the wavefunction onto a definite measurement outcome.

In this framework, wavefunction collapse is not postulated but dynamically induced by a measurement-triggered divergence in the velocity field. The Born rule is preserved statistically, since the likelihood of collapse at $\mathbf{x}_0$ is proportional to the initial density $\rho(\mathbf{x}_0, 0)$, in accordance with

$$P(\mathbf{x}_0) = \int_{\mathcal{R}} \rho(\mathbf{x}, 0)\, d^3x,$$

[16] The source term $\rho_m(x, t)$ in the continuity equation provides a general mechanism through which various interpretations of measurement—ranging from decoherence to dynamical collapse—can be modeled. GFFT identifies this term with a real, physical perturbation of the underlying fluid density.

where $\mathcal{R}$ is a region centered at $\mathbf{x}_0$. Measurement is therefore reinterpreted as a nonlinear fluid instability driving coherent quantum states to collapse under externally induced compression, without violating the unitary structure of the underlying fluid evolution.

Change Notes For Second Version

- **Removed the black hole singularity,** although the result was interesting it is not in the scope for this general treatise.
- **Removed all relativistic mechanics,** I am hoping for there to be a paper in the future (named *Special Fluid Field Theory*) to deal with the treatise of relativistic fluids and hence obtaining Einsteins field equation's without postulating that mass-energy interactions.
- **Removed the dark forces analysis,** again, although highly valuable and interesting, it remains out of scope for this treatise and is better accompanied with data analysis.
- **Removed the appendix** to make the paper easier to read.
- **General reformulation of the paper.** Firstly, the paper has been refurnished as a whole, the unification of forces has been introduced through the **density** and **stress** tensors which accompanied the derivation of the *general fluid field equations.* The gravitational section was refined, removing relativistic motion and including a dimensionally accurate formulation of the two-body problem along with Newtons gravitational constant (with the help of Dirac's LNH to resolve the dimensional inconsistency). The electromagnetic section was reduced - Maxwell's equation are generally treated as self-evidently arising from the definition of the electromagnetic vector fields of the fluid, and finally the quantum mechanical section has been refined to show it's derivation and applicability.
- **I removed the grandiose conclusion,** the quotes listed in the conclusion are of much interest with respect to the treatise but I thought ought to keep this treatise purely scientific.
- **Future work** includes, as above, and also: conciliating the observation-problem within the context of GFFT, uncovering deeper insights about the cosmological constants and there relationship with the observable universe and expanding the scope of definitions of the density and stress tensors to explore unknown fluids and there resultant phenomena, and of all; due to the nature of theoretical study, that there may still remain some inconsistencies which will need to be addressed by revision of the paper.

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