HYDRODYNAMICS OF PLASMA, VACUUM AND SPACE-TIME

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Abstract

- **Vortons introduced to approximate finite core vortex tubes/filaments and pass through Navier Stocks spontaneous singularities/reconnections without any additional assumptions Ref(1-5,29,50)**
- **Magnetic vortons provide irreducible description of magnetic vortex tubes in plasma with reconnections without any additional assumptions.**
- **Instability of quasi 3D/2D+ vorton collapse provides possible mechanism for explosive universe inflation/first order phase transition.**
- **3D space nature of our universe as a consequence of instability of 3D vortons collapse.**
- **"frisbee like" quasi 3D/2D+ space in galaxies makes "dark matter" not necessary.**
- **Probabilistic interpretation of quantum mechanics as a result of smooth test functions of fluid vacuum modified nonlinear Maxwell equations weak solutions.**
- **Compressibility of space-time and longitudinal space-time waves proposed in new covariant quantum modified general relativity theory Refs.(51-56).**

Key Words: Vortons, solenoid dipole singularities, 3D turbulence, vortex reconnections, inviscid dissipation, instability of 3D vorton collapse, magnetic vortons, universe inflation, 3D physical space, probabilistic interpretation of quantum mechanics, fluid vacuum modified nonlinear Maxwell equations, quantum modified general relativity Qmoger.

SECTION 1: Introduction.

This article explores the basis of several turbulence/hydrodynamics driven physics phenomena: 3D turbulence mechanism of universe inflation, the probabilistic nature of quantum mechanics, magnetic vortons in plasma and quantum modified general relativity all of it based on very fundamental hydrodynamics ideas/results that underpin this work Refs.(1-8,29,47,50):

1. 3D Euler and Navier Stokes equations develop spontaneous singularities based on vorticity self-amplification. Note that the Euler equation requires transformation to weak/integral form to pass through the singularity.
2. Fluid vacuum or plasma is advected by 3D turbulence, and everything is locally subject to the same rate of strain as vorticity Refs.(29,50).
3. There were several interconnected events during exponential space inflation/first order phase transition. First it was instability of quasi 3D vorticity/vortons collapse driving universe expansion (much faster than the speed of light) with vorticity frozen into fabric of space while creating that space. That exponential inflation drove space far beyond causality horizon preserving original causal relationships, thus explaining resulting entanglements Ref(29,47,50).*.

We may assume that exponential inflation with its incredible speed and scale breaks several physics results if not physics laws per se.

*New quantum modified general relativity theory Refs.(51-56) produces remarkable mathematical artefact, appearance of nonzero covariant divergence in Einstein's general relativity equations with space-time vacuum being treated as a superfluid with entanglements and creation/absorption of particles/energy/mass (see section 6) and removing necessity for a Big Bang.

SECTION 2: NAVIER-STOKES SOLUTIONS AND VORTON DYNAMICS.

The 3D Euler equations of incompressible inviscid fluid develop spontaneous singularities on timescales on the order of vortex rotations. Solutions to the 3D Navier-Stokes equations for incompressible viscous flow are smooth for all time, but they bifurcate and are not unique Ref.[6-8,29].
Vorton is the simplest solenoid 3D vortex singularity Refs.[1-5,29]. Finite core vortex tubes may be represented as superposition of vortons Refs.[1- 5]. Experimentally observed topological metamorphoses of vortex structures/reconnections could be seen in numerical vorton simulations without any additional assumptions. Vortons in plasma have magnetic dipole moments. Magnetic vorton tubes reconnect Refs.[3-5,14,29].
The 3D Navier-Stokes equations appear to have spontaneous singularities/reconnections and an inviscid vorton attractor that exhibits inviscid turbulence and dissipation Refs.[1- 5, 10,29] with corresponding Kolmogorov like energy cascade towards small scale.
Original reasons for introduction of vortons were to resolve the most important structures for description of fully developed 3D turbulence, 3D vortex finite core tubes/filaments Ref.(1-5,29), Eq.(1-5) and ability to pass through spontaneous singularities of Navier Stokes equations, which turn out to be bifurcations/branching of solutions/reconnections of vortex filaments/tubes.
Vorton is solenoid dipole 3D vorticity singularity. Velocity field generated by individual vorton.

$$\upsilon_i^{(\alpha)}(t,x) = -\frac{\epsilon_{ijk}\left(x_j - x_j^{(\alpha)}\right)\gamma_k^{(\alpha)}}{4\pi\left|x - x^{(\alpha)}\right|^3}\ , \qquad (1)$$

where ϵ_{ijk} is the unit antisymmetric tensor, and $x_j^{(\alpha)}$ (t) and $\gamma_k^{(\alpha)}$ (t) are the components of position and intensity, respectively, of the vorton labeled α.

Vorticity field of individual vorton. See solenoid dipole field picture fig.(19).

$$\Omega_i^{(\alpha)}(t,x) = \gamma_i^{(\alpha)}\delta\left(r^{(\alpha)}\right) + (4\pi)^{-1}\left(3r_i^{(\alpha)}r_k^{(\alpha)}\gamma_k^{(\alpha)} - \left|r^{(\alpha)}\right|^2\gamma_i^{(\alpha)}\right)\left|r^{(\alpha)}\right|^{-5} \qquad (2)$$

Where $\delta\left(r^{(\alpha)}\right)$ is a δ-function.

Which obviously is non local field.

Vorton intensity change due to interaction with other vortons.

$$\dot{\gamma}_i^{(\alpha)} = \frac{\epsilon_{ijk}}{4\pi}\sum_\beta \left(r_{\alpha\beta}^{-3}\gamma_j^{(\alpha)} - 3r_{\alpha\beta}^{-5}r_j^{(\alpha\beta)}r_m^{(\alpha,\beta)}\gamma_m^{(\alpha)}\right)\gamma_k^{(\beta)}, \quad (3)$$

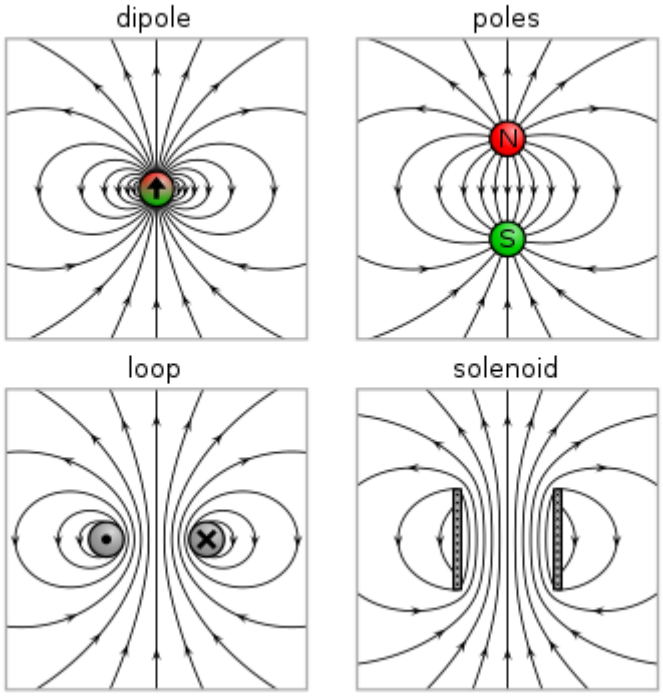
$$\mathbf{r_i^{(\alpha,\beta)}} \equiv \mathbf{x_i^{(\alpha)}} - \mathbf{x_i^{(\beta)}}, \mathbf{r_{\alpha\beta}} \equiv \left|\mathbf{r}^{(\alpha,\beta)}\right|.$$

Vorton position change due to interaction with other vortons.

$$\mathbf{\dot{x}_i^{(\alpha)}} = -\frac{\mathbf{1}}{\mathbf{4\pi}}\boldsymbol{\epsilon}_{\mathbf{ijk}}\sum_{\boldsymbol{\beta}=\mathbf{1}}^{\mathbf{N}}{}' \mathbf{r_{\alpha\beta}^{-1}}\,\mathbf{n_j^{(\alpha,\beta)}}\boldsymbol{\gamma}_{\mathbf{k}}^{(\boldsymbol{\beta})}, \quad \mathbf{(4)}$$

$$\mathbf{r_i^{(\alpha,\beta)}} = \mathbf{x_i^{(\alpha)}} - \mathbf{x_i^{(\beta)}},$$
$$\mathbf{r_{\alpha\beta}} = \left|\mathbf{r}^{(\alpha,\beta)}\right|,$$
$$\mathbf{n_i^{(\alpha,\beta)}} = \mathbf{r_i^{(\alpha,\beta)}}\mathbf{r_{\alpha\beta}^{-1}}$$

Fig.(1,2,19).



Vorton's vorticity field, solenoid dipole. Vorticity and magnetic dipole fields Ref.(1-5,14).
Fig. 19.

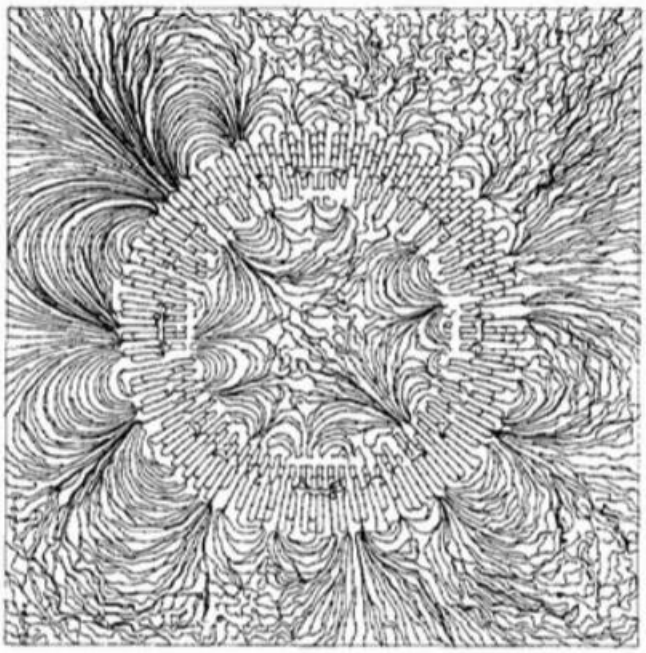


Fig. 1. Distribution of vorticity (vortex lines) in the plane of 80-vorton ring.

Vortex tube clearly seen in a vorton ring. With vortons vorticity cancelling out beyond it Refs.(3-5).

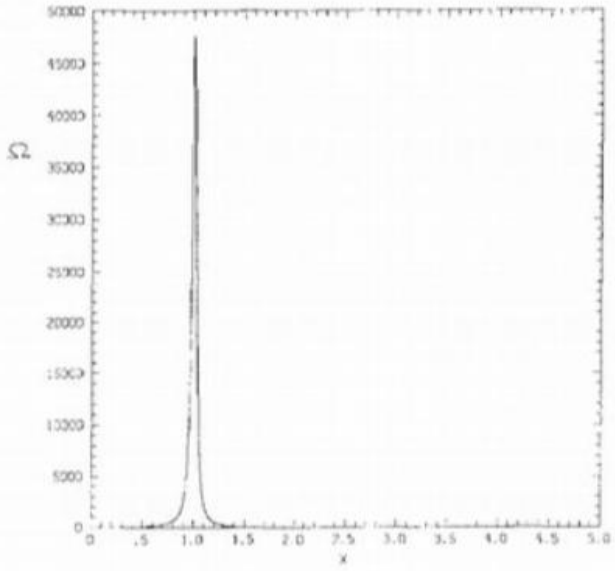


Fig. 2. Cross section of vorticity distribution in 80-vorton ring.

Non zero vorticity around radius of the ring ref.(3-5).

In fact we showed both analytically and numerically that chain of vortons approximates finite core vortex tubes with number of vortons corresponding to Reynolds number at hand Refs.(1-5), Fig.(1,2,19).
Another hope was that by introducing simplest solenoid vortex singularities which are analytically tractable we would be able to pass through some unknown NS "singular events" without any additional assumptions. Those events turn out to be vortex reconnections corresponding to bifurcations and branching of 3D NS solutions Ref.(1-5,29), Fig.(3-18). Both reasons appear to work out despite later vorton critiques, "modifications" and "improvements" Refs.(21-23).
Thus bifurcation and branching of Navier-Stokes solutions Refs.[6-9] can be interpreted as inviscid vorton reconnections Ref.(3-5). Very likely vortons describe dynamics on the Navier-Stokes attractor Ref.[9,29]. From a physical point of view vortons resolve the entire 3D vorticity field, which is superposition of 3D vortex tubes and is the only important aspect for 3D fully developed turbulence dynamics representation. And vortons showed ability to pass through NS "singular events" without any additional assumptions based on vortons inviscid dissipation ability Ref.(3-5,29,50).

SECTION 3: MAGNETIC VORTONS

The vorticity field of a vorton is identical in structure to the magnetic field of a magnetic dipole Fig.(19). In fact, in a turbulent plasma every vorton becomes magnetic due to the rotation of electrically charged plasma. So magnetic vortons interact both as a vorticity and magnetic dipoles Eq.(3,4,7).
Formula for force F between 2 magnetic dipoles **m1** and **m2** Ref.(14).

(7)

$$\mathrm{F} = \frac{3\mu_0}{4\pi|\mathrm{r}|^4}\{(\hat{\mathrm{r}} \times \mathrm{m}_1) \times \mathrm{m}_2 + (\hat{\mathrm{r}} \times \mathrm{m}_2) \times \mathrm{m}_1 - 2\hat{\mathrm{r}}(\mathrm{m}_1 \cdot \mathrm{m}_2) + 5\hat{\mathrm{r}}[(\hat{\mathrm{r}} \times \mathrm{m}_1) \cdot (\hat{\mathrm{r}} \times \mathrm{m}_2)]\},$$

where $\boldsymbol{\mu_0}$ is the magnetic constant**, $\hat{\mathbf{r}}$** is a unit vector parallel to the line joining the centers of the two dipoles, and $|\mathrm{r}|$ is the distance between the centers of $\mathbf{m_1}$ and $\mathbf{m_2}$.
Also, the magnetic amplitude and the vorticity amplitude will remain in a constant ratio, as they are stretched by the same fluid strain field. Formulas Eq.(3,4,7) describe the evolution of the magnetic vorton amplitude and their dipole-dipole interaction; note that there is no self-amplification of magnetic dipole momentum through magnetic interactions since the Maxwell equations are linear Ref.[14].
In section (3) we saw that chains of vortons provide an approximation of finite-core vortex tubes. Similarly, chains of magnetic dipoles provide an approximation of finite core magnetic flux tubes, as may be observed in the Sun or in nuclear fusion experiments. Inviscid dissipation associated with reconnection of magnetic vorton tubes may be the energy source for the very high temperatures on the surface of the Sun.
Our vorton horseshoe numerical experiments show reconnection and the expulsion of vortex rings, see Figs. [1,4,5].

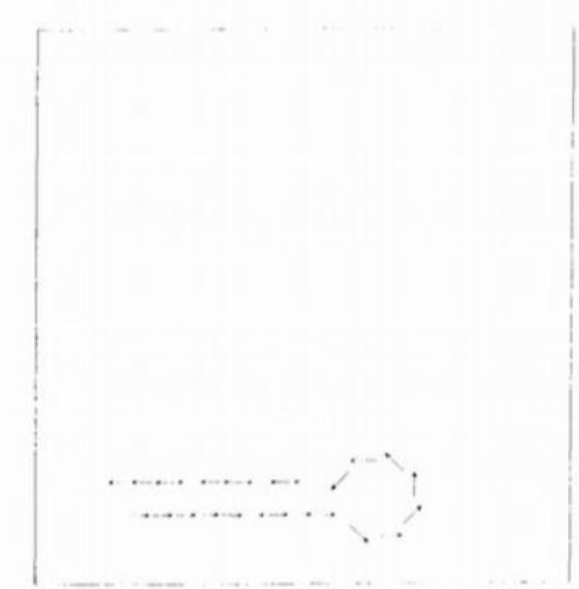


Fig. 7.

Fig. 8.

Perturbed horseshoe vortex and it expelling vortex ring ref.(3-5).

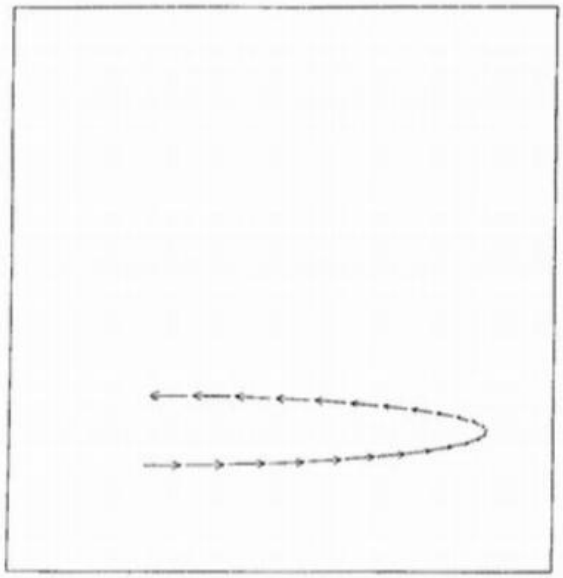


Fig. 9.

Fig. 10.

Unperturbed horseshoe vortex and it expelling vortex ring Refs.(3-5,29).

These resemble the magnetic vortices that produce magnetic storms on Earth and disrupts magnetic confinement in plasma fusion experiments Ref.[16,17,29,50].
Appearance of magnetic vortons could be also understood based of equations for plasma turbulence similar to fluid modified Maxwell Equations with viscous dissipation added in fluid plasma advection equation (5.7) and resulting singularities of Navier Stokes less pronounced than in case of Euler equations (singularities here are branching/bifurcations of NS solutions/reconnections). Notice that electromagnetism/plasma coupling constant equals 1 here (see section 5 for all related equations).

SECTION 4: INSTABILITY OF VORTON COLLAPSE, UNIVERSE INFLATION AND "DARK MATTER"

As we saw in articles Refs.[3-5,29] the system of 3 slightly non-parallel vortons almost perpendicular to 3 vortons plane (approximating 2D vortex dynamics) can start to collapse toward a point. Just before that collapse, however, 3D vorton self-amplification commences and leads to explosive vortons amplitudes and distances growth.

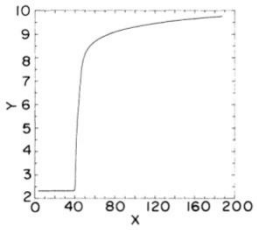


Fig.21

Jump in vorticity during 3 vorton collapse, LOG VORTICITY INTENSITY! against time Refs.(2,3,29). We have the same explosive grows in distances between vortons leading to space explosive inflationary grows and FIRST ORDER PHASE TRANSITION of vacuum compact dimensions to our quasi 3D world Refs.(2,3,29,50).

This could be a "turbulence" mechanism for the inflationary initial stage of the Universe expansion Refs.[15,29].
More precisely, imagine that the Universe starts as a point singularity fluctuation, and becomes a 2D or 3D turbulent fluid with gravity. In the 2D case gravity will collapse the Universe back to a singularity. However in 3D or quasi-3D/2D+* the vorton amplitudes and distances increase exponentially at the last stage of collapse, see Fig.(21) in Refs.[3-5,29].
This may explain why our world is 3 dimensional!
A quasi 3D frisbee-like world has 2 fully-developed dimensions and 1 short dimension; it might better be described as 2D+ or "frisbee-like".
In 2D+ frisbee-like space the Universe may be slightly less complex, and have slightly more chances to fluctuate from the original singularity than a fully 3D Universe. And once gravitational collapse explodes in quasi 3D universe it will never get to any more complex spaces. Also quasi 3D/2D+ space may more naturally lead to explosive growth permitting closer vortons approach before 3D stretching and self amplification kicks in an explosive fashion.
However in 2D+/quasi 3D gravitational force decays proportionally to 1/r at a distances from the center of galaxy much larger than the short dimension, instead of 1/r^2 as in 3D.
A universe with two-plus dimensional structure could provide an alternative to "dark matter" as an explanation for anomalous rotation curves in galaxies. It has been observed in the edges of frisbee-like galaxies that star velocities do not depend on distance from the center. Explicitly, setting centripetal acceleration v^2/r equal to gravitational acceleration Constant*M/r, we deduce that v must be constant in such a situation. This is a necessary condition for galactic disk stability Refs.[12,29].

*2D+ universe space before inflation could be imagined as two commuting dimensions and third compact one non commuting with first two. In this case initially 2D vortex collapse will become locally 3D at the last moment due to generalized uncertainty principle GUP fluctuations Ref.(46). And explosive vortons self amplification/expansion/space inflation will start at the point of collapse.

SECTION 5. FLUID VACUUM MODIFIED NONLINEAR MAXWELL EQUATIONS

The wave functions of elementary particles are often interpreted as probability amplitudes. When they take the form of Gaussian distributions for isolated particle, they look very much like test functions for generalized solutions of unknown nonlinear equations.
Maxwell equations are linear and we don't expect any spontaneous singularities there starting with smooth initial conditions and thus no singular solutions expected there.
However if by analogy to previous chapter we assume original vacuum to be very dense and fluid we may modify Maxwell equations for fields and charges to be advected, frozen in fluid vacuum.
Thus we have following modified electromagnetism equations,

$$\nabla \cdot \overline{E} = \frac{\rho}{\varepsilon_0} \qquad (5.1)$$

$$\nabla \cdot \overline{B} = 0 \qquad (5.2)$$

$$\nabla \times \overline{E} = -\frac{d\overline{B}}{dt} \qquad (5.3)$$

$$\nabla \times \overline{B} = \mu_0 \left(\bar{j} + \varepsilon_0 \frac{d\overline{E}}{dt}\right) \quad (5.4)$$

$$\frac{d\rho}{dt} = 0 \quad (5.5)$$

$$\frac{d\bar{j}}{dt} = 0 \quad (5.6)$$

$$\frac{d\overline{V}}{dt} = -\nabla\left[\frac{\propto}{2}\left(\varepsilon_0 E^2 + \frac{B^2}{\mu_0}\right) + \frac{g^2}{8\pi G}\right] \quad (5.7)$$

$$\nabla \cdot \overline{V} = 0 \qquad (5.8)$$

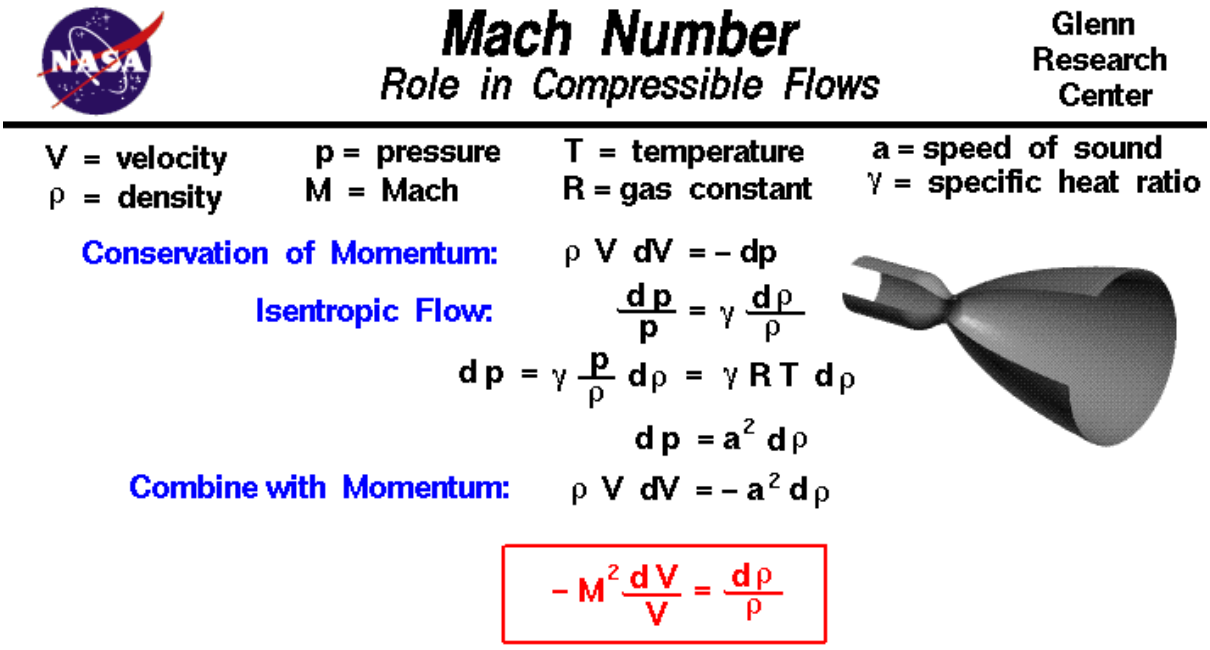
Where in original Maxwell equations we substituted total/advective derivatives Refs. (37,29) instead of partial time derivatives and all the fields and charges are frozen in vacuum fluid and being advected.
Vacuum itself satisfies incompressible Euler equation Refs.(37,29) (only transverse waves propagate there). And Euler equation (5.7) represents in right hand side gradient of energy density/dynamic pressure Refs.(36,37) of electromagnetic and gravity fields. And alpha is electromagnetism/vacuum coupling constant (around 1/173), which originally could have been closer to 1.

After instability/inflation/First order phase transition of vorton collapse created quasi 3D space out of original curled/compact vacuum dimensions we could observe that 3D Euler equation with vorticity develops spontaneous vortex like singularities Refs.(6-8) due to nonlinear stretching/self amplification on time scale of vortex rotation. Also above nonlinear Maxwell equations transform into weak/integral form Ref.(32) with corresponding smooth test functions. As a consequence electromagnetic field and charges also become singular being subject to the same rate of strain as vorticity and being frozen into vacuum fluid.
As a final result we have singular/generalised solutions/"particles" with vorticity/spin and singular electric charge or electromagnetic field and with smooth test function distribution which squared could be interpreted as a probability density function.
Charged singularities with vorticity/angular momentum/spin and spatially distributed according to test function develop magnetic moment.
Here we have possible explanation of quantum mechanics properties of elementary particles. More details of actual elementary particles parameters are connected to influence of remaining compact vacuum dimensions with corresponding symmetries and entanglements and discrete nature of vacuum at the Planck scale.

SECTION 6: HYDRODYNAMICS OF SPACE-TIME,QUANTUM MODIFIED GENERAL RELATIVITY.

Original physics explanations in Refs.(51-56) for derivation of Qmoger theory are not very straightforward/compelling. On the other hand original derivation of Maxwell equations was based on some farfetched mechanical models. So as in many other cases equations turn out to be "smarter " than their original inventors.
Here is possible physics behind those quantum modified general relativity equations Refs.(51-56).
We may start with noticing that universe exponential inflation happened at faster than the speed of light (superluminal speed). And original compact vacuum degrees of freedom got expanded into our space/universe beyond causal horizon, thus creating entanglements.
In fact any entanglements (or even possible wormholes EP=EPR Ref.(56)) create possibilities for superluminal propagation of disturbances.
And there are two interpretations of relativity principles. First, that superluminal propagation of disturbances is impossible. And second, possible, being Lorentz invariant.
And Qmoger theory is fully covariant including newly added covariant divergence of space-time Refs.(51-56).
With superluminal/supercausal propagation of space-time disturbances we have longitudinal/ "compression" space-time waves (not of space itself, where only transverse waves are possible). Longitudinal waves mean compressibility of space-time and appearance of sources/sinks and creation/absorption of mass/energy and thus removing singularity of those equations and necessity for Big Bang. Still this theory is only viable in dimensions 3+1 Refs.(51-55) and only explanation of appearance of our 3D space/universe is aforementioned instability of 3D vorton collapse/inflation.
And this theory means that universe appears to be open thermodynamic system and energy and mass are not preserved, unlike in original general relativity Ref.(35). Longitudinal waves of space-time predicted there could be experimentally detected Ref.(54).
New entanglements entropy based general relativity modification theory Ref.(57) logically should provide the way to calibrate coefficient at the new additive covariant divergence

term in Qmoger quantum modified general relativity equations. Somewhat similar paper on sources/sinks like singularities of space time and creation/absorption of mass/energy just appeared Ref.(58).
Introducing light speed related Mach number M for longitudinal/compression space-time waves and for isentropic (constant rate of quantum entanglements) flows we have below formula Ref.(60). In case of universe expanding with Hubble constant rate H we have as a result of equation below decay of mass/energy vacuum density at exp(-M^2H^3t) rate.



SECTION 7. CONCLUSSIONS AND DISCUSSION

Instability/"inflation" of vorton collapse in quasi 3D space is proposed as an explanation of aspects of the origin of the Universe and phenomena attributed to "dark matter" Refs.(29,39,50,59). Magnetic vortons provide dynamics of combined vortex and magnetic tubes in plasma including reconnections.
In terms of cosmology results vorton system provides unique self amplification explosive nonlinear mechanism to explain early universe inflation/first order phase transition and current accelerated expansion with extra bonus of purely dimensional explanation of dark matter without need for dark matter detection efforts. Also it explains results of MOND gravity theory, based on space dimensional structure, which similarly implicitly assumes 1/R gravity force in galaxies far from the center. And First order phase transition/inflation of original compact vacuum space to our quasi 3D physical space during universe explosive expansion leads to fluid vacuum induced appearance of spontaneous singularities in

electromagnetism and transition to weak/integral formulation of equations which in turn explains appearance of elementary particles and their probabilistic distribution based on test function of generalized/weak solutions of fluid vacuum modified nonlinear Maxwell Equations. Plus hydrodynamics of quantum space-time introduces new covariant divergence term into original Einstein's general relativity equations, thus removing singularity of those equations and necessity of Big Bang.

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