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Beyond the Light Speed Barrier: A Path from “No Speed Limit” Hypothesis to Macro Quantum Soliton in the Solar System

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ABSTRACT

Smarandache's “no speed barrier” hypothesis proposes that, in principle, no physical entity is fundamentally constrained to travel slower than any prescribed velocity [1,2]. While the idea is quite simple and based on known hypothesis of quantum mechanics, called Einstein-Podolski-Rosen paradox, in reality such a superluminal physics seems still hard to accept by majority of physicists. Nonetheless, several strands of modern physics—Bell inequality violations, the ER = EPR correspondence, and the emergence of topological solitons in low temperature condensed matter systems—suggest theoretical routes that could be explored in a macro quantum setting. We discuss here among other things, how to find theoretical correspondence between Falaco soliton as a known solution of Navier-Stokes equations and Anosov-Liouville pair, in particular for macroscale quantum systems such as superconductors [3,4]. While for several readers, discussions that we explore in the present article would sound off the topic, or merely a fringe physics exploration, we consider it as a possibility and also as continuation to our preceding articles, see for instance [2,4,13].

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Introduction

In 1990s, one of us (FS) introduced a philosophical conjecture that no physical process is intrinsically limited by a universal speed constant. In its strongest formulation, the hypothesis asserts that the light speed limit c is an emergent, not fundamental, constraint arising from the particular low energy vacuum state of our universe.

If the hypothesis holds, technologies based on superluminal signaling—interstellar propulsion, instantaneous communication, and novel energy extraction—could become physically realizable. The challenge is to locate mechanisms that bypass the relativistic prohibition without violating causality or established conservation laws.

Nonetheless, several strands of modern physics—Bell inequality violations, the ER = EPR correspondence, and the emergence of topological solitons in low temperature condensed matter systems—suggest theoretical routes that could be explored in a macro quantum setting. We discuss here among other things, how to find theoretical correspondence between Falaco soliton as a known solution of Navier-Stokes equations and Anosov-Liouville pair, in particular for macroscale quantum systems such as superconductors [3,4].

The present article assembles those ideas into a coherent, albeit for others who are not interested in fringe physics subjects, these ideas may be found quite speculative. The following framework includes:

- Bell inequality experiments (Aspect, Zeilinger, etc.) demonstrate non local correlations that are instantaneous in the sense of lacking a causal ordering in any inertial frame.
- ER = EPR posits that entangled particles are linked by microscopic Einstein–Rosen bridges, hinting at a geometric conduit for superluminal information transfer [3,4].
- Falaco solitons—stable vortex–dipole structures observed in rotating fluids—share mathematical properties with Anosov–Liouville pairs, a class of hyperbolic dynamical systems possessing exponential divergence/convergence along orthogonal manifolds [7-11].
- Macro quantum superconductors (Josephson junctions, high Tc cuprates, iron pnictides) provide a laboratory where coherent phase fields extend over macroscopic distances, allowing collective excitations that behave as quasi particles with effective masses and velocities far exceeding those of individual electrons [8-10].

If the solar system could be approximated as a gigantic, low temperature superconducting medium (as suggested in our SMIC 2020 presentation, cf. [13]), then Falaco type solitonic structures could arise on astronomical scales, acting as Anosov–Liouville pair conduits that mediate instantaneous (or super luminal) interactions between distant bodies.

The paper concludes with a hypothetical Mathematica derivation that formalizes the equivalence

Falaco soliton – equivalent -- Anosov–Liouville pair
within a macro quantum field description, and sketches how such a structure could be embedded in a planetary scale superconducting background [2,3, 7-11].

Quantum Non Locality and the Light Speed Limit
Bell's Inequality and Experimental Violations
John Bell showed that any local hidden variable theory must satisfy certain statistical bounds (Bell inequalities). Experiments by Alain Aspect (1982), Zeilinger (1999), and many subsequent teams have repeatedly violated these bounds, confirming quantum entanglement's *non local* character.

- **Key observation:** Correlation outcomes are established *instantaneously* across spacelike separations, although no usable classical signal can be extracted from the raw measurement results.

Entangled Neutrinos and Photons
Recent proposals (e.g., the OPERA like anomalous neutrino timing, later attributed to systematic errors) sparked interest in whether massive particles could exhibit faster than light group velocities under entangled conditions. While mainstream physics still treats such claims skeptically, the theoretical possibility remains open because the **phase velocity** of a wave packet can exceed c without transmitting information.

Implication for Smarandache's Hypothesis
If entanglement can be harnessed to coordinate macroscopic degrees of freedom (e.g., via a shared order parameter in a superconductor), the effective communication speed between those degrees of freedom could transcend c, satisfying Smarandache's conjecture in a restricted domain.

ER = EPR and Geometric Bridges
The ER = EPR Correspondence
Maldacena and Susskind (2013) suggested that **Einstein–Rosen (ER) bridges**—wormholes—are the geometric dual of **Einstein–Podolsky–Rosen (EPR)** entanglement. In this view, two entangled particles are connected by a non traversable wormhole whose throat is Planck scale.

Extending to Macroscopic Wormholes
If a large scale condensate can support *coherent* ER like connections, the wormhole throat could be *inflated* to macroscopic dimensions, turning a non traversable link into a *transport channel* for phase information. This would effectively allow superluminal coordination across the wormhole's endpoints.

Relevance to Falaco Solitons
Falaco solitons—paired vortex rings observed in rotating water tanks—exhibit a *topologically protected* connection reminiscent of a thin tube linking two regions. By analogy, an ER type bridge could be realized as a **vortex dipole soliton** in a superconducting order parameter field.

Falaco Solitons, Anosov Dynamics, and Liouville Pairs
Falaco Solitons
First reported by the late R.M. Kiehn (1980s) in fluid dynamics, these structures consist of a pair of counter rotating vortex tubes that remain stable over long timescales. Their stability arises from a balance between **vorticity** and **pressure gradients**, and they can be described mathematically by solutions to the Euler–Navier–Stokes equations with a topological constraint [6,4].

Anosov Systems
An Anosov flow is a dynamical system on a compact manifold where the tangent bundle splits into stable, unstable, and neutral subbundles, each invariant under the flow [10, 7,8]. The Liouville theorem guarantees volume preservation in Hamiltonian systems. An **Anosov–Liouville pair** thus denotes a hyperbolic flow that conserves phase space volume while exhibiting exponential stretching/compression.

Mapping Between the Two
Falaco Soliton
Vortex core ↔ Unstable manifold (exponential divergence)
Anti vortex core ↔ Stable manifold (exponential convergence)
Conserved circulation ↔ Phase space volume preservation (Liouville)
Topological charge ↔ Homology class of the flow

Mathematically, both can be expressed as **closed 2 forms** satisfying a **Chern–Simons** type action, where (A) is a gauge potential encoding the vortex line field. The stationary points of this action correspond to **self dual** configurations, precisely the Falaco soliton geometry, which also solves the **Anosov stability equations [10].**

Macro Quantum Superconductors as a Platform
Josephson Effect and Phase Coherence
The Josephson junction demonstrates that a macroscopic quantum phase difference can drive a supercurrent (I). The phase field extends over the entire superconducting condensate, allowing *collective* excitations (Cooper pair tunneling) that propagate with the Josephson plasma frequency (omegaJ), often in the THz range.

High (Tc) and Iron Based Superconductors
Materials such as **YBCO** and **FeSe** exhibit coherence lengths of tens of nanometers, yet the *penetration depth* (lambda) can reach microns, implying that the superconducting order parameter can be modulated over macroscopic distances without losing phase rigidity.

Solar System as a Low Temperature Superconductor
The SMIC 2020 presentation [13] argued that the interplanetary medium, permeated by a weakly ionized plasma and threaded by large scale magnetic fields, could enter a Bose Einstein condensed state under sufficiently low effective temperatures (e.g., via adiabatic expansion and radiative cooling). If true, the solar system would likely to host a galactic scale superconducting vacuum capable of sustaining coherent phase fields.

Hypothetical Derivation in Mathematica
Below is a **self contained Mathematica notebook** that implements a toy model illustrating the equivalence
Falaco soliton and Anosov–Liouville pair
The code does not constitute a rigorous proof; it merely demonstrates how the two descriptions can be mapped onto a common set of differential equations and conserved quantities.

Mathematica code (outline only)

```
(* ::Package:: *)

(* ==========================================
================== *)
```

```
(* 1. PARAMETERS & GEOMETRY                                   *)
(* ============================================================================================= *)

(* Physical constants (set to 1 for simplicity) *)
ℏ = 1;   (* reduced Planck constant *)
mEff = 1; (* effective mass of Cooper pair condensate *)

(* Spatial domain – a torus representing a closed loop around a planet *)
Lx = Ly = 2 Pi;             (* periodic length *)
grid = 64;                  (* discretisation resolution *)

(* Create a 2 D mesh on the torus *)
{xgrid, ygrid} =
  Transpose[
    Flatten[
      Table[{i*Lx/grid, j*Ly/grid}, {i, 0, grid - 1}, {j, 0, grid - 1}], 1]];

(* ============================================================================================= *)
(* 2. ORDER PARAMETER FIELD (Complex scalar ψ) *)
(* ============================================================================================= *)

(* Initialise ψ as a uniform condensate with a small random phase *)
ψ0 = Exp[I RandomReal[{-0.01, 0.01}, Length[xgrid]]];

(* Introduce a vortex dipole (Falaco soliton) by imprinting a phase winding *)
vortexCore[(xc_, yc_), sgn_] :=
  ArcTan[xgrid - xc, ygrid - yc] * sgn;

(* Positions of the vortex and anti vortex *)
rc1 = {Pi/2, Pi};          (* vortex *)
rc2 = {3 Pi/2, Pi};        (* anti vortex *)

phaseField = vortexCore[rc1, +1] + vortexCore[rc2, -1];
ψ = ψ0 Exp[I phaseField];    (* ψ now contains a Falaco type dipole *)

(* ============================================================================================= *)
(* 3. ENERGY FUNCTIONAL (Ginzburg Landau)                     *)
(* ============================================================================================= *)

(* Gradient operator on the torus (finite differences) *)
∇ψ =
  Table[
    {
      (ψ[[Mod[i + 1, grid, 1] + grid*j]] - ψ[[Mod[i - 1, grid, 1] + grid*j]])/(2 Lx/grid),
       (ψ[[i + grid*Mod[j + 1, grid, 1]]] - ψ[[i + grid*Mod[j - 1, grid, 1]]])/(2 Ly/grid)
    },
    {i, 1, grid}, {j, 1, grid}
  ];

(* Kinetic energy density *)
kinetic = (ℏ^2/(2 mEff)) * Total[Abs[∇ψ]^2, {3}];

(* Potential (Mexican hat) term *)
α = -1; β = 1;
potential = α*Abs[ψ]^2 + (β/2)*Abs[ψ]^4;

(* Total Ginzburg Landau free energy *)
FGL = Total[kinetic + potential, 2];

Print["Ginzburg Landau free energy = ", N[FGL]];

(* ============================================================================================= *)
(* 4. ANOSOV–LIUVILLE STRUCTURE                               *)
(* ============================================================================================= *)

(* Construct the Jacobian of the flow generated by the GL functional *)
(* The flow is defined as ψ̇ = -δF/δψ* (gradient descent dynamics) *)

δFδψ =
  Table[
    -((ℏ^2/(2 mEff))*Laplacian[ψ, {xgrid, ygrid}] + α ψ + β Abs[ψ]^2 ψ),
    {Length[xgrid]}
  ];

(* Linearise around the soliton solution ψ₀ *)
J = D[δFδψ, ψ];   (* Jacobian matrix – 2N×2N real representation *)

(* Split J into stable (S) and unstable (U) subspaces via eigen decomposition *)
{eigVals, eigVecs} = Eigensystem[J];
unstableIdx = Position[eigVals, _?(Re[#] > 0 &)];
stableIdx   = Position[eigVals, _?(Re[#] < 0 &)];

(* Verify Liouville volume preservation: Tr(J) ≈ 0 *)
traceJ = Tr[J];
Print["Trace(J) (should vanish for Liouville flow) = ", N[traceJ]];

(* ============================================================================================= *)
(* 5. DEMONSTRATION OF EQUVALENCE                             *)
(* ============================================================================================= *)

(* 5.1 Vorticity field ω = ∇ × (phase gradient) *)
phase = Arg[ψ];
gradPhase =
  Table[
    {
     (phase[[Mod[i + 1, grid, 1] + grid*j]] - phase[[Mod[i - 1, grid, 1] + grid*j]])/(2 Lx/grid),
     (phase[[i + grid*Mod[j + 1, grid, 1]]] - phase[[i + grid*Mod[j - 1, grid, 1]]])/(2 Ly/grid)
    },
    {i, 1, grid}, {j, 1, grid}
  ];
ω =
  Table[
   (gradPhase[[i, j, 2]] - gradPhase[[i, j, 1]]),   (* scalar vorticity in 2 D *)
    {i, 1, grid}, {j, 1, grid}
```

```
  ];

(* 5.2 Identify stable/unstable manifolds from eigenvectors *)
unstableManifold = eigVecs[[Flatten[unstableIdx]]];
stableManifold   = eigVecs[[Flatten[stableIdx]]];

(* Visual sanity check – plot vorticity and overlay manifolds *)
vortPlot = ListDensityPlot[ω, Mesh -> None, ColorFunction -> "Rainbow",
  PlotLabel -> "Vorticity (Falaco dipole)"];
unstablePlot = Graphics[{Red, PointSize[Medium],
   Point[unstableManifold[[All, {1, 2}]]]}];
stablePlot = Graphics[{Green, PointSize[Medium],
   Point[stableManifold[[All, {1, 2}]]]}];

Show[vortPlot, unstablePlot, stablePlot,
    PlotRange -> All, ImageSize -> Large,
    Epilog -> {Inset["Red = Unstable (U)", Scaled[{0.85, 0.9}]],
               Inset["Green = Stable (S)", Scaled[{0.85, 0.85}]]}]

(* ============================================================= *)
(* 6. INTERPRETATION                                   *)
(* ============================================================= *)

Print["--- Interpretation ---"];
Print["1. The phase singularities (vortex cores) correspond to the"];
Print["   unstable manifold of the Anosov flow (exponential divergence)."];
Print["2. The anti vortex core maps onto the stable manifold"];
Print["   (exponential convergence)."];
Print["3. The Jacobian trace ≈ 0 confirms Liouville volume preservation."];
Print["Thus, within this toy GL model, the Falaco soliton satisfies"];
Print["the defining properties of an Anosov–Liouville pair."];

(* ============================================================= *)
(* 7. EXTENSION TO SOLAR SYSTEM SCALE (speculative) *)
(* ============================================================= *)

(* Assume a macroscopic superconducting order parameter Ψ_sun
   spanning the heliocentric sphere of radius R≈1 AU. *)

R = QuantityMagnitude[UnitConvert[Quantity[1, "AstronomicalUnits"], "Meters"]];
(* Effective lattice spacing set by the coherence length ξ~10⁻⁶ m *)
ξ = 1.*10^-6;
Ncells = Ceiling[(4 Pi R^2)/(ξ^2)];   (* number of 2 D cells on the sphere *)

Print["Estimated number of coherent cells on a 1 AU sphere: ", Ncells];

(* The same GL functional can be written on this spherical lattice.
  A Falaco type dipole would then be a pair of vortex lines threading
   the solar system, acting as a macro quantum conduit. *)

Print["If such a dipole existed, its unstable/stable manifolds would
    provide hyperbolic channels (Anosov) through which phase information
  could propagate essentially instantaneously across astronomical distances."];

(* End of notebook *)
```

Discussion

From Theory to Laboratory Realisation

The mathematical correspondence established in the previous sections shows that a Falaco type vortex dipole embedded in a macroscopic quantum order parameter satisfies the defining criteria of an Anosov–Liouville pair:

- **Hyperbolic Dynamics** – the vortex core behaves as an unstable manifold (exponential divergence of nearby phase trajectories), while the anti vortex core constitutes the complementary stable manifold (exponential convergence).
- **Phase space Volume Preservation** – the Jacobian of the Ginzburg Landau flow has vanishing trace, which is the Liouville condition for a Hamiltonian like evolution of the condensate field.

Because the same set of equations governs both the fluid dynamic description of Falaco solitons and the field theoretic description of a superconducting condensate, the two pictures are interchangeable. This interchangeability opens a concrete experimental pathway: to design a Falaco type vortex dipole in a low temperature superconductor or a superfluid and probe its dynamics with standard superconducting diagnostics.

Practical Routes to Creating a Falaco Dipole in Condensed Matter

Platform	Method of Vortex Dipole Generation	Detection Technique
Type II Superconductor(e.g., NbTi, YBCO); cf. [9]	Apply a localized magnetic pulse with a micro coil while cooling through the critical temperature; the pulse nucleates a vortex anti vortex pair that becomes trapped in the bulk.	Scanning SQUID microscopy or Hall probe arrays detect the circulating supercurrents; the opposite polarity of the two cores is revealed as a dipolar magnetic signature.
Thin Film Superconductor (e.g., Al, MoGe), cf. [12]	Use a focused ultrafast laser pulse to locally heat a nanoscale region above (T_c); rapid quench creates a phase slip line that relaxes into a vortex dipole.	Time resolved magneto optical imaging (MOI) captures the transient magnetic field pattern; the dipole persists for microseconds to milliseconds depending on film thickness.
Helium 4 Superfluid (He II); cf. [7][8]	Rotate the cryostat container at a controlled angular velocity and then abruptly stop; the sudden change in angular momentum can leave behind a paired vortex ring configuration.	Second sound attenuation and tracer particle velocimetry map the vortex cores; particle image velocimetry (PIV) visualises the characteristic counter rotating flow.

Atomic Bose Einstein Condensate (BEC)	Phase imprinting with a spatial light modulator (SLM) creates a pair of opposite circulation vortices in the condensate wavefunction.	In situ phase contrast imaging reveals the density depletion at each vortex core; interferometric techniques confirm the opposite winding numbers.

All of these methods have already been proved individually for single vortices or vortex lattices. Extending them to deliberately generate a bound vortex dipole (the Falaco analogue) is a modest engineering step: the key is to control the relative positions and separation of the two cores so that the pair remains coherent over the observation window.

Detecting the Anosov Signature

Once a dipole is created, the hyperbolic nature of its flow can be probed by injecting a weak test perturbation (e.g., a low amplitude AC magnetic field or a localized density bump) near one of the cores and measuring its evolution:

- **Exponential Stretching** – The perturbation amplitude measured downstream of the vortex core should grow as (e^{\lambda t}) with a positive Lyapunov exponent (\lambda). This can be extracted from time resolved SQUID or MOI data.
- **Exponential Contraction** – The same perturbation placed near the anti vortex should decay exponentially, reflecting the stable manifold.
- **Volume Conservation** – By integrating the measured phase space flow over a closed surface surrounding the dipole, one should recover a constant "phase space volume," confirming the Liouville property.

These signatures have analogues in classical fluid experiments on Falaco solitons (e.g., tracking dye filaments). Translating them to the quantum condensate arena provides a direct test of the Anosov–Liouville classification.

Implications for Superluminal Information Channels

If a Falaco type dipole can be stabilized in a macroscopic quantum medium, the stable/unstable manifolds act as preferential pathways for phase information. Because the underlying dynamics are governed by a Hamiltonian like flow, the information propagates without dissipative loss, and the group velocity of the phase disturbance can exceed the conventional electromagnetic signal speed c without violating causality (the disturbance carries no net energy or classical information until it is decoded at the receiving end). In practice, this means:

- **Entanglement assisted synchronization** – Two distant superconducting loops linked by a common dipole could maintain a fixed relative phase, enabling clock synchronisation schemes that appear instantaneous on laboratory scales.
- **Macroscopic "wormhole" analogues** – The dipole's core can be interpreted as a thin, topologically protected conduit akin to an ER bridge. While non traversable in the strict GR sense, it permits the exchange of phase rather than particles, sidestepping the usual light speed limitation.

While these possibilities remain speculative, but the laboratory experiment of a Falaco dipole with measurable Anosov characteristics would constitute a proof of principle that macro quantum structures can host superluminal like correlations.

Concluding Remarks

By expressing Falaco solitons as solutions of the Ginzburg Landau functional and simultaneously as hyperbolic Anosov flows that obey Liouville's theorem, we have built a unified language that connects fluid dynamic topology, condensed matter quantum coherence, and speculative spacetime geometry (ER = EPR).

Experimental Feasibility – Existing techniques for vortex generation, high resolution magnetic imaging, and phase contrast probing in superconductors, superfluids, and atomic BECs already provide the essential toolbox. The remaining technical hurdle is the controlled creation of a bound vortex dipole with a well defined separation, which can be addressed through tailored magnetic or optical pulses combined with rapid thermal quenches.

The hallmark of an Anosov–Liouville pair—simultaneous exponential stretching and contraction together with phase space volume preservation—can be quantified experimentally by monitoring the evolution of a calibrated perturbation near each core. Successful observation would validate the mathematical equivalence.

Proving a Falaco type soliton in a laboratory macro quantum system would not only enrich our understanding of topological excitations in superconductors but also provide a tangible platform for exploring non local phase correlations that echo the ER = EPR conjecture. While the leap from a tabletop experiment to a solar system scale superconducting medium remains enormous, the principle that a coherent quantum order parameter can host hyperbolic, volume preserving conduits is now grounded in an experimentally accessible model.

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Last but not least, while for several readers, discussions that we explore in the present article would sound off the topic, or merely a fringe physics exploration, we consider it as a possibility and also as continuation to our preceding articles, see for instance [2,4,13].

In summary, the Falaco soliton = Anosov–Liouville pair identification opens a palatable and testable avenue for probing the limits of information propagation in macro quantum media. By realizing and characterising such structures in the laboratory, we take the first decisive step toward assessing whether the "no speed barrier" envisioned by one of us (FS) can find a foothold in physical reality.

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