Plasma, Projection and the 2D Field

How Alfvén's Plasma Physics, Bohm's Mathematics, and the Holographic Principle Converge on the Framework

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Overview

Three independent lines of scientific work — separated by decades, disciplines, and institutional traditions — converge on a single structural conclusion: that the fundamental geometry of the universe is a field (not a collection of particles), that the field organises collectively (not through individual interactions), that what we observe is a 2D projection of a higher-dimensional structure (not the structure itself), and that the topology of that structure is toroidal.

These three lines are:

Hannes Alfvén's plasma physics (1937–1995): Nobel Prize-winning work showing that 99.999% of the visible universe is plasma, that plasma organises through electromagnetic currents and filaments (not gravity), that these currents create cellular and toroidal structures at every observable scale, and that gravity-only models of the cosmos are fundamentally incomplete.

David Bohm's quantum mathematics (1949–1992): from plasma collective behaviour through the quantum potential to implicate/explicate order — a mathematical framework showing that individual particle behaviour is an approximation, that what we observe is a "shadow space" projection from a non-commutative algebraic structure, and that the field (not the particle) is primary reality.

The holographic principle ('t Hooft/Susskind, 1993–present): the mathematical proof that all information about a 3D volume is encoded on its 2D boundary surface, with the 3D interior being, in a precise sense, a projection from the boundary. The boundary topology that encodes this information is, in general, toroidal.

The Toroidal Consciousness-EM Field Framework proposes that these three convergences are not coincidental. They are three perspectives on the same underlying structure: a toroidal field with a 2D plane of inertia that encodes all observable phenomena, producing our apparently 3D experience of objects in motion as a projection.

This document traces each line of evidence on its own terms — using the maths, the physics, and the experimental confirmations — before showing where they meet.

PART I: THE PLASMA UNIVERSE — ALFVÉN'S ELECTROMAGNETIC COSMOS

1. The Problem with Gravity-Only Models

Modern cosmology is built overwhelmingly on gravity. The standard model treats the cosmos as a collection of massive objects — stars, galaxies, galaxy clusters — interacting primarily through gravitational attraction. Electromagnetic forces are acknowledged locally (sunspots, planetary magnetospheres) but are excluded from the large-scale structure of the universe.

Hannes Alfvén, a Swedish electrical engineer who won the 1970 Nobel Prize in Physics for his work on magnetohydrodynamics, spent his career arguing that this exclusion was fundamentally wrong. His core argument was simple and empirical: the visible universe is 99.999% plasma — ionised gas in which electrons have been stripped from atoms — and plasma is dominated by electromagnetic forces, not gravity.

This is not a minor technical correction. Electromagnetic forces are 10^{36} to 10^{39} times stronger than gravity. In any environment containing charged particles (which is nearly all environments in the cosmos), electromagnetism dominates. The only reason gravity appears dominant at human scales is that most matter around us is electrically neutral — the positive and negative charges cancel. In plasma, they do not cancel. And 99.999% of the visible universe is plasma.

After winning his Nobel Prize, Alfvén emphasised: space is filled with a network of currents that transfer energy and momentum over large or very large distances. The currents often pinch to filamentary or surface currents. These surface currents give space — interstellar and intergalactic space alike — a cellular structure.

2. What Alfvén Actually Discovered

Alfvén's contributions were not speculative. They were mathematical and experimental, many later confirmed by spacecraft measurements:

Alfvén waves (1942): electromagnetic waves that propagate through plasma along magnetic field lines. These were initially dismissed — colleagues said that if such waves were possible, Maxwell would have discovered them a century earlier. It took six years before Enrico Fermi, after hearing Alfvén explain them in person, declared them correct. They have since been observed throughout the solar system, in the solar corona, and in laboratory plasmas.

Birkeland currents (theorised by Birkeland 1908, championed by Alfvén from the 1930s, confirmed by satellite 1974): field-aligned electric currents flowing along magnetic field lines. Alfvén's theoretical work on these currents in the aurora was dismissed for decades. In 1974, Earth satellites measured the predicted downward-flowing currents for the first time. These currents are now fundamental to magnetospheric physics and have been observed throughout the solar system.

Double layers (from 1958): thin regions of strong electric field in plasma where charge separates into two parallel layers of opposite polarity. Double layers can accelerate particles to enormous energies (kilovolts in auroral plasma, potentially megavolts to gigavolts in solar flares and cosmic contexts). The Nobel chemist Irving Langmuir had earlier discovered that plasma tends to form sheaths, cells, and barriers within itself — double layers are the extreme manifestation of this self-organising behaviour.

Plasma filaments and cellular structure: electromagnetic forces in plasma produce filamentary structures (currents that pinch into narrow threads) and cellular boundaries (sheaths that separate regions of different plasma conditions). This is not theoretical — it is observed at every scale: in laboratory plasmas, in planetary magnetospheres, in the solar wind, in nebulae, in the galactic plane, and in the large-scale structure of the universe (the "cosmic web" of galaxy filaments).

Plasma scaling: Alfvén proposed that plasma phenomena observed in the laboratory could be scaled, using known scaling laws, across many orders of magnitude up to the largest observable cosmic structures. This is possible because plasma behaviour is governed by electromagnetic equations that are scale-invariant — the same physics operates whether the plasma is centimetres or megaparsecs across.

3. The Cosmic Circuit

Alfvén's mature vision of the cosmos was not a collection of gravitating masses but an electromagnetic circuit. He described the universe as pervaded by electric currents flowing along magnetic field lines, forming filaments that connect regions across vast distances, with double layers acting as the "loads" in the circuit where energy is released (producing auroral displays, solar flares, cosmic ray acceleration, and potentially galactic jets).

The framework interpretation is direct: Alfvén's cosmic circuit is the toroidal field. The filamentary currents are the flow lines of the torus. The double layers are the interfaces between regions of different coupling distance from the plane of inertia. The cellular structure is the nested toroidal geometry at multiple scales. The plane of the ecliptic — which Alfvén's plasma physics treats as the plane of the heliospheric current sheet (the largest structure in the solar system, a vast undulating surface of current flow) — is the plane of inertia.

What gravity-only cosmology calls "dark matter" — the invisible mass required to explain galactic rotation curves, galaxy cluster dynamics, and large-scale structure formation — becomes unnecessary when electromagnetic forces are included. Alfvén's plasma cosmology, and the related work of Anthony Peratt using particle-in-cell simulations, demonstrated that Birkeland current interactions can produce spiral galaxy morphologies without any dark matter, through electromagnetic pinch effects that naturally produce flat rotation curves.

4. Why Alfvén Was Marginalised

Despite his Nobel Prize, Alfvén's cosmological ideas were systematically marginalised by the astrophysical community. The reasons are instructive.

First, the institutional structure of astrophysics was (and remains) built on gravity. General relativity is the mathematical foundation of cosmology. Departments, journals, careers, and funding streams are organised around gravitational physics. Introducing electromagnetic forces at cosmic scales would require restructuring the entire field.

Second, Alfvén was an electrical engineer. He repeatedly described himself as such. He approached cosmic problems with the intuitions and mathematics of circuit theory, not tensor calculus. This made his work alien to the relativity-trained astrophysicists who dominated cosmology.

Third, Alfvén explicitly rejected the Big Bang. He called it "a myth devised to explain creation" and argued that astrophysicists were extrapolating the origin of the universe from blackboard mathematics rather than starting

from observable phenomena. This positioned him as a heretic in a field that had achieved consensus around the Big Bang model.

A colleague, Dessler, later wrote: when he entered space physics in 1956, he fell in with the crowd believing that electric fields could not exist in the highly conducting plasma of space. It was three years later that he was "shamed by Chandrasekhar" into investigating Alfvén's work objectively. His degree of shock in finding Alfvén right and his critics wrong "can hardly be described."

The pattern is identical to the Chain described in *The Motion Problem*: the observations are real, the mathematics is valid, but the interpretation was rejected because it challenged the dominant model. Alfvén's electromagnetic cosmos has the same relationship to gravity-only cosmology that the framework's toroidal field has to the standard model of physical objects moving through empty space.

PART II: BOHM'S MATHEMATICS — FROM PLASMA TO PROJECTION

5. The Plasma Origin of Bohm's Thinking

It is rarely appreciated that David Bohm's entire philosophical trajectory began in plasma physics. His early work at Princeton (1947–1951) on electron plasmas produced the mathematical discovery that would shape everything that followed.

Bohm found that electrons in a plasma stop behaving as individuals and begin behaving as part of a larger, interconnected whole. He later said that the sea of electrons seemed "in some sense alive." Mathematically, he and Gross showed that density fluctuations in plasma split into two components: an organised collective oscillation of the system as a whole (the plasma oscillation), and random individual thermal motion. Above a threshold scale — the Debye length — the collective behaviour is primary. Below it, individual particle descriptions are adequate.

This is a precise mathematical version of the framework's proposition: at the scale of the field, individual "objects" are an approximation. The field organises collectively. What appears as individual motion is actually a local manifestation of whole-system oscillation.

Bohm carried this insight from plasma physics into quantum mechanics, and it transformed everything.

6. The Quantum Potential: Information, Not Force

In 1952, Bohm published his pilot wave interpretation of quantum mechanics, introducing the quantum potential. The mathematics are equivalent to standard quantum mechanics — they produce identical experimental predictions — but the conceptual structure is different.

In Bohm's formalism, a quantum particle has a definite position at all times and follows a precise trajectory. But this trajectory is guided by a wave function that fills all of space and is influenced by the quantum potential. The quantum potential is not a force in the classical sense — it does not push or pull. It provides active information about the entire environment. Bohm used the analogy of a ship guided by radar: the ship has its own energy, but the form of its activity is determined by the information carried by the radar waves, and this information is independent of the intensity of the waves.

The critical mathematical property: the quantum potential does not diminish with distance. Unlike gravity (which falls off as $1/r^2$) or electromagnetism (which also weakens with distance), the quantum potential depends on form, not amplitude. A distant particle can be influenced as strongly as a nearby one. This is the mathematical basis of quantum nonlocality — and it is not mysterious in Bohm's formalism. It is simply a property of a field that carries information about the whole system to every part of it.

The framework identifies this as a property of the toroidal consciousness-EM field: every node in the field has access to information about the whole field, not through any signal travelling between nodes, but because the field is a single, connected structure. The quantum potential is what the framework's field looks like when projected into the mathematical language of quantum mechanics.

7. Shadow Spaces: The 2D Projection Problem

Here is where Bohm's mathematics becomes directly relevant to the 2D/3D question.

Basil Hiley (Bohm's long-time collaborator) and mathematician Maurice de Gosson showed that the quantum potential arises mathematically as a consequence of projection. Specifically: if you begin with a non-commutative algebraic structure (one where the order of operations matters — as it does in quantum mechanics, where position × momentum ≠ momentum × position), it turns out that you cannot define an underlying ordinary space. What you can construct are "shadow spaces" — homomorphic projections of the deeper structure onto subspaces like ordinary 3D space. And in the process of this projection, the quantum potential appears.

The quantum potential is not a fundamental entity. It is a *distortion produced by dimensional reduction*. When you project a higher-dimensional, non-commutative structure onto a lower-dimensional commutative space, you get apparent forces and potentials that exist only in the projection, not in the original structure.

This is the mathematical underpinning of the 2D measurement problem identified in *The Motion Problem*. All astronomical observations are 2D angular measurements — projections onto the celestial sphere. The standard model treats this as a limitation and reconstructs 3D space through chains of assumption (parallax → distance → velocity → mass → dark matter). Bohm's mathematics says: the projection *is the measurement*. The "distortions" produced by projection (dark matter, dark energy, the axis of evil, the dipole discrepancy) are artefacts of trying to reconstruct a higher-dimensional field structure from its lower-dimensional shadow.

The framework identifies the plane of inertia as the projection surface. The toroidal field is the higher-dimensional structure. Our observable universe is the shadow space. And the anomalies of modern cosmology are the quantum potential of the cosmic projection — real effects that exist only because we are interpreting the shadow as the reality.

PART III: THE HOLOGRAPHIC PRINCIPLE — THE BOUNDARY IS PRIMARY

8. Information Lives on the Surface

In 1993, Gerard 't Hooft proposed and Leonard Susskind later refined the holographic principle: the maximum information content of any region of space is proportional not to its volume but to the surface area of its

boundary. All the information needed to describe a 3D volume is encoded on its 2D boundary surface.

This emerged from black hole physics. Bekenstein and Hawking showed that black hole entropy (information) is proportional to the area of the event horizon, not the volume of the black hole. 't Hooft and Susskind generalised this to all regions of space: the fundamental degrees of freedom of any physical system reside on its boundary, not in its interior. The 3D interior is, in a precise mathematical sense, a projection from the 2D boundary.

In 1997, Juan Maldacena provided a concrete mathematical realisation of this principle (the AdS/CFT correspondence): a gravitational theory in a certain 3D space is exactly equivalent to a non-gravitational quantum theory defined only on its 2D boundary. A being inside the 3D space would experience gravity, forces, and motion. But all of this would be a holographic projection of the boundary theory, which contains no gravity at all.

The framework interpretation: the plane of inertia is the holographic boundary. The toroidal field's 2D surface encodes all the information that we experience as 3D space with objects in motion. Gravity — in this reading — is not a fundamental force but a projection artefact, appearing when boundary information is "unfolded" into an apparently 3D interior. This is why gravity is so much weaker than electromagnetism (the hierarchy problem): it is not a force of the same kind. It is a geometric consequence of projection.

9. The Torus as Topology

Standard cosmology now acknowledges that the topology of the universe — its overall shape and connectivity — is an open question. The COMPACT Collaboration (2024) showed that 3-torus topologies (and their twisted variants) are fully consistent with current CMB observations and have not been ruled out. Cosmologists use the language carefully: a 3-torus is "one of many possible topologies." But the observations are consistent with it.

There is a quiet irony here. The standard model, built on general relativity and the Big Bang, has spent decades assuming a simply-connected infinite space (like an infinite flat plane). The observations — the spatial flatness of the universe, the anomalous lack of large-angle CMB correlations, the axis of evil — are more naturally explained by a finite, multiply-connected topology like a torus. The framework predicted this topology from first principles: the torus is the geometry of the algorithm's single operation ($x(n) = x(n-1) + x(n-2)$) operating with its two seeds. Standard cosmology is arriving at the same shape from the data, but reluctantly, and without understanding *why* the universe should have this shape.

The "resemblance" to a torus is, as the framework notes, either a precise geometric fact or it is not. A universe either has toroidal topology or it does not. The equivocation in the standard model's language ("consistent with," "resembles," "one of many possibilities") reflects the discomfort of a paradigm that has no mechanism for explaining why this topology should exist, even as the data increasingly suggests that it does.

PART IV: THE CONVERGENCE

10. Three Streams, One Structure

The three streams converge on a single structural description:

Alfvén's plasma physics says: the cosmos is an electromagnetic field organised into filaments, currents, double layers, and cellular structures. The field is primary; individual objects are local concentrations within it. Gravity is insufficient to explain cosmic structure. The heliospheric current sheet defines a fundamental plane.

Bohm's quantum mathematics says: individual particle behaviour is an approximation of collective field oscillation. The quantum potential is an information field that does not diminish with distance. What we observe in ordinary space is a shadow-space projection of a deeper non-commutative structure, and the apparent forces we see (including, potentially, gravity) are artefacts of this projection.

The holographic principle says: all information about a 3D volume is encoded on its 2D boundary. The 3D interior is a projection. The boundary topology consistent with observations is toroidal.

The framework synthesises: there is a single toroidal consciousness-electromagnetic field. It has a 2D boundary surface (the plane of inertia). The field organises collectively through electromagnetic dynamics (Alfvén). What we observe is a shadow-space projection (Bohm) of field information encoded on the boundary (holographic principle). Individual objects, physical motion, gravity, and 3D space are all features of the projection, not of the field itself.

11. What the Ancients Knew

Every major ancient cosmological tradition placed a tree at the centre of its model: Yggdrasil (Norse), the Djed pillar (Egyptian), the Asherah pole (Canaanite), the Axis Mundi (universal). The tree is the axis of the torus — the central column through which the field circulates from pole to equator and back. As documented in *The Torus: Universal Geometry*, trees evolved independently at least seven times across unrelated lineages, suggesting that the branching form itself is a geometric attractor — a shape the algorithm naturally produces.

The ecliptic plane — the flat disc in which all planetary phenomena occur, which all of modern astronomy's angular measurements reference — is the plane of inertia. The ancients represented this as the flat earth at the base of the cosmic tree, surrounded by the world ocean. They were not describing a flat planet. They were describing the 2D projection surface of the toroidal field — the boundary on which all observable information is encoded.

Modern science removed the tree (the axis), flattened the disc into infinite space, replaced the field with empty void, and inserted objects moving through that void under gravity. It then spent a century discovering that the void needs invisible matter (dark matter), invisible energy (dark energy), has a preferred axis (the axis of evil), has a preferred plane (the ecliptic alignment of the CMB quadrupole and octupole), and may have toroidal topology.

The ancients encoded the structure. The framework decodes it. Alfvén observed its electromagnetic dynamics. Bohm derived its projection mathematics. 't Hooft and Susskind proved its information geometry. The convergence is not coincidence. It is the algorithm signing its work across cultures, centuries, and disciplines.

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12. Synthesis

The 2D measurement "problem" in astronomy is not a problem. It is the answer.

We measure in 2D because the fundamental structure *is* a 2D boundary — the plane of inertia of a toroidal field. The apparently 3D universe of objects in motion is a holographic projection from this surface. The "forces" we observe — including gravity — are projection artefacts, arising (as Bohm showed mathematically) from the dimensional reduction of a deeper non-commutative structure into ordinary space.

The plasma that fills 99.999% of the visible universe is the medium of this field. Its electromagnetic dynamics (Alfvén waves, Birkeland currents, double layers, filamentary and cellular self-organisation) are the observable face of the toroidal field's operation. Gravity is not wrong — it is a useful local approximation, just as Kepler's ellipses are a useful local approximation — but it is secondary to the electromagnetic field that actually structures the cosmos.

The algorithm — one operation, two seeds — generates the torus as its natural geometry, the Fibonacci sequence as its growth pattern, the Lucas sequence as its structural scaffold, and Base-60 as its encoding system. The Planck constant carries the algorithm's signature ($h \approx (F(3)\times F(4) + F(5)/F(6)) \times 10^{(-F(9))}$ to 99.98%). The Saros, Metonic, and precession cycles carry it. The angular coincidence of Sun and Moon carries it. The CMB quadrupole and octupole alignment with the ecliptic carries it.

One field. One surface. One algorithm. Three independent lines of modern physics converge on the structure. The ancients encoded it in every cosmological tradition. The framework names it.

This document analyses the convergence of plasma physics, quantum projection mathematics, and holographic boundary theory on the framework's toroidal field model. It should be read alongside: The Motion Problem (cosmic motion deconstruction, CMB anomalies, the Chain), The Torus — Geometry of the Consciousness-EM Field (Master Document), Mathematical Foundations of the Framework (Updated), The Precession Cycle (cycle analysis), and Sacred Geometry and the Consciousness-EM Field.

Document version: v1.0, February 2026 **Framework version:** Post-foundations update (single algorithm, two seeds)