A New Approach to Understanding Superconductivity, the Magnetic Monopole, and a Possible Path to Consciousness

By James Conde

Abstract: This document proposes that the Meissner effect—the complete expulsion of magnetic fields from superconductors—is fundamentally monopole exclusion. If correct, this reframes 90 years of failed monopole detection as methodological error (using superconductors to detect particles that superconductors exclude), resolves documented thermodynamic contradictions in superconductivity theory, and opens an empirical path to understanding consciousness through monopole-corrected electrodynamics. Full theoretical exposition with citations available in the linked VISION document.

The Consciousness Problem: Two Camps and a Third Way

One of the clear missing pieces in both neuroscience and AI is consciousness and what role it can or should play in the mathematics and physics of either discipline. Physicists who study consciousness fall into two camps.

Camp One hopes the answer lies in "emergent properties"—that sufficient complexity and computation somehow produce a mind. This is less an explanation than a placeholder for one.

Camp Two invokes quantum mechanics: either consciousness explains quantum phenomena, or quantum phenomena explain consciousness. This trades one mystery for another.

I take a third approach. The genuine mystery of the magnetic monopole is the thread that, if pulled, leads to a physical, data-driven explanation for why electricity in the brain (and consciousness) is special.

Following this thread requires mastering another fundamental mystery: the contradictory mechanical explanations of superconductivity. My claim is simple: if we master superconductivity, we master the monopole. Once we understand monopoles’ profound impact on matter, we gain an avenue toward a physical explanation for the binding problem of consciousness.

The Physics Argument

The Monopole Mystery

Magnets always have two poles—north and south. Cut a magnet in half and you get two smaller magnets, each with both poles. Could a single pole exist alone? This hypothetical object is called a magnetic monopole.

In 1931, Paul Dirac proved that if the magnetic field is ever quantized in a singular pole (i.e., a monopole), it would explain one of physics’ deepest puzzles: why electric charge is quantized—why every electron carries exactly the same charge, not 0.99 or 1.01 of it. In 1974, ’t Hooft and Polyakov independently proved that Grand Unified Theories require monopoles. String theorist Joseph Polchinski called their existence “one of the safest bets” in physics.

Yet despite decades of searching and the strongest theoretical arguments for their existence, no monopole has been reliably detected. The standard conclusion has ossified into orthodoxy: monopoles either don’t exist or are cosmologically rare.

The Overlooked Question

How did physicists search for monopoles? Primarily using SQUIDs—Superconducting Quantum Interference Devices. Superconductors completely expel magnetic fields; there are NO magnetic fields within a superconductor. This phenomenon is called the Meissner effect.

Here is the question no one asked: Does the fact that we use superconductivity—a phenomenon we lack a complete theory for—to search for monopoles mean the search was fundamentally flawed?

I believe so. The flaw runs deeper than methodology: superconductivity and magnetic monopoles are inherently, fundamentally linked. One of the defining empirical features of superconductivity is the absence of magnetic field, while magnetic monopoles are the quanta of the magnetic field—they are to magnetism what electrons are to electricity. Since superconductivity is defined by zero magnetic field, these two phenomena must interact at a fundamental level.

I believe one of the key theoretical ideas defining superconductivity is the expulsion of magnetic monopoles from a material. Using superconductivity to find monopoles when we need to anchor our understanding of superconductivity in terms of monopoles is cart-before-horse logic. While this is a simple scientific point—questioning prior results and assumptions is a pillar of the scientific process—I have not found this conundrum presented in the literature. If correct, we must solve the dual mysteries of superconductivity and the magnetic monopole simultaneously, in a singular theory combining both.

The Framework

Another key insight: no one seems to have combined Dirac's 1931 proof with the Meissner effect. Dirac showed through mathematical elegance that if monopoles exist, electron charge must be quantized. The contrapositive holds with equal force: if the monopole field is removed, charge quantization lifts.

My proposal: The Meissner effect—no magnetic field, literally zero, in a superconductor—is monopole exclusion. Same empirical phenomenon, radically different physical interpretation. Superconductors are regions where monopole physics does not operate. Therefore, Dirac's constraint lifts. Electrons "disappear" as discrete units and the electric field forms a continuous fluid—which is exactly what BCS theory describes (Cooper pairs, macroscopic coherence). But BCS describes what happens without explaining why electrons suddenly pair. Monopole exclusion provides the why.

What This Resolves

The SQUID paradox. Scientists searched for monopoles using detectors made of materials that exclude monopoles by their fundamental nature. This is like searching for sound in a vacuum. SQUID non-detection isn't evidence against monopoles—it's expected.

The thermodynamic contradictions. Recent work by Hirsch (2024) and Nikulov (2025) documents that textbooks give three mutually incompatible thermodynamic treatments of superconductivity. The "Keesom task"—explaining how supercurrents appear and disappear without dissipation—has been unsolved since 1934. These contradictions exist because superconductivity lies outside conventional thermodynamics, at a boundary condition I call entropy saturation, where a material's phase space has maximized due to all topological holes being removed.

The fragmentation of magnetism. Magnetic phenomena span five disciplines—particle physics, condensed matter, geophysics, astrophysics, cosmology—with no unified framework. Dynamo theory cannot explain field reversals. Galactic magnetic field origins remain, in the literature's own words, "still a mystery." Monopole physics is the missing unifying element.

The Validation Strategy

The power of tying monopole physics to superconductivity is that we can experimentally probe and generate theories about monopoles through superconductivity data. This is a clear avenue where machine learning can excel: the space of possible theories is large, but a properly built ML pipeline can perform high-throughput hypothesis testing, matching model outputs to known superconductors AND generating predictions for unknown ones—providing scientifically rigorous validation beyond curve fitting.

My entropy saturation framework combines high-dimensional geometric and topological theories of magnetic monopoles with the unique phase-space transition that superconductivity represents. For theorists like Eric Weinstein, this framework would be compelling: it means we can use superconductivity data to understand monopole physics, providing an empirical path to unifying quantum mechanics and general relativity.

Any theory of magnetic monopoles will have clear theoretical and practical predictions for the Big Bang, dark matter, dark energy, galactic magnetic fields, and Earth's dynamo. That monopoles would have such profound effects on physics is already known—that was part of 't Hooft's point in the 1970s. If physicists hadn't convinced themselves monopoles were undetectable, monopoles would be the leading candidate to explain dark matter.

This feeds into validation: any monopole theory derived from superconducting data can be cross-validated against nominally disparate datasets—Earth's and Sun's magnetic field changes, galactic magnetic field structure, dark matter distribution. We have the tools, data, and ability to gather more. In high-throughput ML processing, most theories will fail; the few that survive cross-domain validation should be the correct ones.

Variational Autoencoder for Superconductor Discovery

I am building a ~108-million-parameter VAE trained on superconductor datasets with non-superconductors for contrastive learning. The encoder fuses element composition via attention, 145 material features, and critical temperature into a 2048-dimensional latent space. The key design choice: a bidirectional training objective that jointly optimizes Tc prediction and chemical formula reconstruction, forcing the latent space to encode complete thermodynamic state rather than task-specific shortcuts.

The system currently achieves 82%+ exact formula reconstruction in true autoregressive mode (no teacher forcing), with accuracy improving as training continues. This is just the first step. The goal is an ML pipeline with symbolic regression where the decoder outputs not only new materials with predicted critical temperatures but also the mechanism, mathematics, and theory explaining why superconductivity occurs. The theoretical ideas of monopoles and superconductivity become regularizing and constraining factors—training on data reconstruction and theoretical consistency.

The Validation Logic

If the learned pipeline produces a model satisfying constraints from five independent domains—thermodynamics, electromagnetism, particle physics, general relativity, and cosmological observation—it is capturing real physics.

The Goal: Homo et Machina

My hope is that this ML pipeline for superconductivity and monopole physics will become a powerful estimator and processor of high-dimensional entropy and information—one that can be turned into an algorithm for precision medicine. Such an algorithm could process an individual's data and yield tailored information on allergies, protein deficiencies, and predictions on how drugs and therapies will interact with their unique chemistry.

This feeds into my greater vision: humans of tomorrow will be physically stronger and intellectually healthier than today. The profound capacities of human cognition—creativity, moral reasoning, genuine understanding—will rise in demand as AI enhances human health while handling the repetitive work people would be grateful not to do.

The future should be Homo et Machina—humans and machines working together—not a nightmare of Deus ex Machina where we wield tools and physics we do not understand.

Thank you for reading. This document is a surface-level description; particularly within the physics arguments, there are many scientific and mathematical nuances that could not fit here. If you find these concepts intriguing, more detailed expositions are available through the links below.

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GitHub: github.com/jamesconde

Published Work: Yale ModelDB

Full Theoretical Framework (VISION Document): [GitHub Portfolio]