

Article 7: Super Conductivity and Monopoles

Definitions-

Boson- a subatomic particle, such as a photon, proton or neutron, which has zero or integer spin and follows the statistical description given by S. N. Bose and Einstein. Due to their spin value, it is easy to condense Bosons into each other.

Fermion- any member of a group of subatomic particles having odd half-integral angular momentum (spin 1/2, 3/2), named for the Fermi-Dirac statistics that describe its behavior. It is extremely difficult to condense fermions into each other as opposed to Bosons.

Electron- fundamental unit of the electric field. Has a spin value of $\frac{1}{2}$. Classified as a fermion for their value of spin.

Degrees of Freedom-

In many scientific fields, the **degrees of freedom** of a system is the number of degrees of freedom that may vary independently. For example, a point in the plane has two degrees of freedom for : its position ; a non-infinitesimal object on the plane might have additional degrees of freedoms related to its position.

In , this notion is formalized as the degrees of freedom of a manifold or variety. When degrees of freedom is used instead of dimension, this usually means that the manifold or variety that models the system is only implicitly defined. See:

, number of independent motions that are allowed to the body or, in case of a mechanism made of several bodies, number of possible independent relative motions between the pieces of the mechanism

, a term used in explaining dependence on parameters, or the dimensions of a phase space

, the number of values in the final calculation of a statistic that are free to vary

, the problem of controlling motor movement given abundant degrees of freedom

Introduction

The simple but powerful reason why current thinking in the physics community is that no one has reliably seen a monopole yet results, I believe, from the prevalent practice of using the special physics of superconductivity to detect monopoles, even though, at the same time, there is the lack of a complete theory of what superconductivity is. In other words, scientists were and are using a tool they do not fully comprehend. Thus, their experimental pursuit of using

superconducting rings to detect monopoles was largely doomed from the start. They lacked (and lack today) a competent understanding of what “superconductor” mean in terms of Entropy. This is critical as I will argue that Entropy should be used as the foundational definition of what it means to be in a superconducting state. Once we establish the fundamental relationship between Entropy and superconductivity, it will become clear how to tie together monopoles and superconductors. Once we understand the unique relationship between superconductors and monopoles we can use this relationship to understand the Hard Problem of Consciousness and how we can approach the alignment problem of AI using an enhanced understanding of Consciousness.

Section 1: A Short history of Superconductivity

Superconductivity was first experimentally observed in 1911 when Hieke Karmerlingh Onnes discovered that cooling mercury with liquid helium induced a special property- namely that running an electric current through the mercury did not result in any lost current. He found that once mercury was cooled beneath a temperature, called the critical temperature or T_c , then the mercury exhibited a particular electrical property of having no resistance to an electric current. To be clear, it is not that “no resistance” means there is some resistance but it is so low as to be negligible. A superconductor literally has NO resistance, i.e. 0 or none. Since the cooled mercury exhibited no resistance, this was no ordinary conductor but a “superconductor”.

In classical electrodynamics, running a current through a material will always lose some amount of energy into Entropically unusable heat energy, often called joule heat, from the intrinsic resistance of the material in question. Therefore, a copper wire is not a superconductor because it has some intrinsic resistance which will decrease the energy of any current running through it. To explain using a metaphor, think of a car driving down a road. A bumpy road with tons of potholes will decrease the speed of the car and thus require more gas (i.e. more energy) to maintain speed. Typically, every conductor is a road with at least some potholes and bumps on it. Superconductors are roads with no potholes or imperfections in the road. This results in the first experimental definition of superconductivity: a material is said to be in a superconductive state when it exhibits no resistance to an electric current.

The second main experimental definition of superconductivity is what is called the Meissner effect. The Meissner effect was discovered in 1933 by W. Meissner

and R. Ochsenfeld when they found that within a superconductor the magnetic field is literally 0. To provide additional rationalization of this definition, consider some mercury that was cooled to a temperature beneath its critical temperature to reach a superconducting state. One can then force the mercury out of its superconducting state by applying a strong magnetic field. Thus, the second main definition of a superconductor is the presence of the Meissner effect, i.e. zero magnetic fields.

Given this basic understanding of the key definitions of superconductivity, I can provide some more background of the history of superconductivity. In 1957 BCS theory was proposed to give an exact mathematical definition to explain the phenomena of superconductivity. BCS theory rests on the idea of Cooper Pairs where electrons (fermions with $\frac{1}{2}$ value of spin) team up to become bosons (with integer values of spin) in these Cooper Pairs and thus reduce the resistance of the material to 0 as experimentally found in superconductors. BCS theory was and is regarded as a great achievement of physics for it reproduces the Meissner effect as well as gives specific calculation for the penetration depths of external magnetic fields into a superconducting material. The theory was such a great achievement as to warrant the award the 1972 Nobel Prize in Physics.

However, BCS theory is only able to explain what are called “conventional superconductors”. In 1986 it was discovered by J. G. Bednorz and K.A. Muller that it was possible to create a superconducting state at a much higher temperature than every previously found material using a cooperate-perovskite ceramic material. For reference, mercury has a critical temperature of 4.2 Kelvin. I will explain the full meaning of what “Kelvin” means later but for now understand that it is simply a unit temperature where 0 Kelvin is supposed to be the theoretical lowest temperature possible. For reference of how cold 4.2 Kelvin is, 72 Fahrenheit is 295 degrees Kelvin. 4.2 Kelvin is equal to -452.11 Fahrenheit. Before 1986 materials had to be cooled to extremely low temperatures to reach superconductivity and it was thought that this “fact” would apply all to materials which can be a superconductor. The 1986 discovery was so profound because it found a critical temperature in the 30 Kelvin range which, under the convention of BCS theory, was supposed to be impossible. Their discovery inspired the creation and search for additional “unconventional” superconducting material which had even higher critical temperatures. These higher critical temperatures are extremely important from an engineering and economic point of view as using liquid helium to cool down a material is expensive. The higher critical

temperature lowers the cost to maintain a material in a superconducting state. The 1986 discovery was so unexpected and unexplained by BCS theory that they got the Nobel Prize in Physics the very next year.

In our modern day, materials have been found to exhibit superconducting properties with critical temperatures of 250 Kelvin but with the huge caveat that the material was also under 170 gigapascals of pressure. For reference, the amount of pressure that we humans experience from the atmosphere of the Earth is defined as 1 atmospheric pressure or 1 atm. 170 gigapascals is equivalent to 1.68×10^6 atm or over a million times the pressure of Earth's atmosphere. BCS theory has continued to be unable to predict and explain the presence of these additional superconductors and there is no widely accepted theory for what is going on in these "unconventional" superconductors. This lack of theoretical understanding creates a big hole in the argument that scientists can or should be using superconductors to search for monopoles.

At a basic level, since (1) of the main experimental definitions of superconductivity is the Meissner effect where there are 0 magnetic fields and (2) magnetic monopoles are the special quanta particles of the magnetic field, then to create a theory about superconductivity without reference to magnetic monopoles, I believe, was and is doomed to be a fundamentally flawed one. BCS theory was formulated without using or referencing monopoles. I believe the historical reason for this is that the papers by 't Hooft and Polyakov which seems to have convinced the physics community that they needed to find monopoles came out in 1974, two years after BCS theory had been given the Nobel prize in Physics and 17 years after BCS theory was first published. Furthermore, the Cabrera measurement was made in 1982 and the Preskill review article I used for reference in Article 5 was created in 1984. Therefore, a lot of these monopole searches using superconductors effectively concluded in reporting no monopoles before the 1986 discovery. Furthermore, it is not the case that the 1986 discovery led to the creation of the true theory of superconductivity which completely supplanted BCS theory. BCS theory still works for "conventional" superconductors. It is not as simple as to throw out BCS theory, especially since there is not a good successor theory to replace it. Consider that that today, 38 years from 1986, there is still no widely accepted theory well describing superconductivity in all cases. In fact, it is such hotly debated topic with experts in the field not knowing what the right answer will be that a fraudster can pass peer review in prestigious journal saying he has evidence of a new, never seen

before “unconventional” superconductor (Citation). Even when it is not fraud, the whole media hype around the LK-99 being a possible “new” discovery and then it being found not to be one is a consequence of lacking a good theory of superconductivity. If there existed a better understanding of what constitutes superconductivity then it would be much easier to refute, confirm, understand, and lessen the enormous media hype around these experimental results.

These facts paint a picture that makes it very hard to argue that previous studies using superconductors to search for monopoles gave trustworthy results. The modern-day misunderstanding of superconductivity shows how the prior experiments looking for monopoles failed to find any. The experiments and studies searching for monopoles using superconductors were finished or winding down before evidence started to come out pointing out problems with BCS theory. Based on my reading of the consequences of those experiments, it seems that a lot of scientists moved from trying to find monopoles to explaining why they could not find any. Inflation theory’s “fix” to the monopole problem then provided an easy way out for theorists and that is why scientists came to trust the result that monopoles are either extremely rare or just do not exist.

Section 2: Understanding Superconductivity from Monopole-Entropy Perspective

In the physical theory I am arguing for monopoles are in large abundance and provide definition to the Entropy of any physical system through the monopoles’ intrinsic relationship to Alpha Space. From that basis, the phenomena of superconductivity can be considered from that point of view rather than the prior approach based on BCS theory seeks to figure out the conditions for when electrons would form Cooper Pairs.

Let us take the two experimental definitions of superconductivity as correct where 1) electrical currents can move through superconducting regions without losing energy and 2) the Meissner Effect where magnetic fields in the same region are 0. These two definitions, I believe, to be different descriptions of the same thing; if there any magnetic fields, no matter how small, there should of course be some resistance in the material because the magnetic fields would cause electrons to veer off course and not reach their destination. Thereby, the amount of energy leaving the material into the intended destination would be lower than the energy which entered.

What does 0 magnetic fields mean? Well, what does 0 mean? 0 should not be interpreted to be nothing; that is incorrect. Instead, 0 should be defined to be

what happens when one takes X and subtracts X from itself i.e. $X-X=0$. Therefore, 0 magnetic fields means that, from the perspective of the quanta of the magnetic field magnetic monopoles no monopole is able to contribute any strength to the magnetic field inside of a superconductor. This means that if the superconductor is near N number of monopoles then none of the N monopoles are able to contribute any strength to the magnetic field. What this means is that the effect of those monopoles and their associated magnetic fields to influence the physical world has already have been normalized or zeroed out. Thus reaching a superconductivity state can be understood as creating the conditions where the monopole field is 0 in strength in a specific region/material.

The influence of monopoles getting zeroed out combines interestingly with the idea that monopoles directly add Entropy to a system. Considering Entropy by itself for a second, we can ask what is the physical state of matter in which there exists no possible avenues (in more technical terms degrees of freedom) for a system to undergo physical actions which would be permissible under the Second Law? In other words, what happens to matter when the Entropy phase-space well dries up and this issue where any additional physical action would have to violate the Second Law? I believe this saturation of the Entropic phase space is what also fundamentally defines superconductivity. To saturate phase space means there is not more “empty” room in the phase space perspective to fund physical actions.

When combined, these ideas of a zeroed out magnetic field, together with the saturation of Entropy (which is another form of “zeroing” out) together with the belief that monopoles and phase space by themselves have direct causal connections, then this leads to the understanding of superconductivity as a state of matter in which the matter/system has reached Entropic saturation. A superconducting material has no more phase space available at that time to comply with the Second Law.

I should explain how Entropic saturation, while strongly correlated with lower temperatures does not absolutely mean lower temperatures in all cases, as may be an expectation from many readers. The basic definition of temperature in terms of Kelvin comes from this idea of considering the thermal expansion of an “ideal” gas. However, we are considering the contribution of the magnetic fields of monopoles to the phase space of a material and not an “ideal” gas. I consider monopoles as well as Entropy and the Second Law to be more fundamentally important physical paradigms than the behavior of an “ideal” gas. I am arguing

that superconductivity can theoretically occur at any “temperature” for it is not the definition of an “ideal” gas that matters, but rather how close the system is to saturating in phase space. Using my argument, it makes sense how in general, that is a correlation between reducing a system’s temperature and how well it can conduct, as generally, cooling a material requires moving a material towards Entropic saturation. However, my definition then also makes sense of high temperature, unconventional superconductors as rationalizing them to be closer to their Entropic saturation than a simple temperature measurement makes clear. As a corroborating fact, the abrupt nature of superconducting transitions makes intuitive sense when understanding them from the Entropic phase space definition. The definition of superconductivity as the state of a physical system that has reached the limits or walls of its phase space where it is completely filled is an ALL or nothing definition. If true, it will also be true that if even there still exists a very small amount of phase space unfilled then the material will not be in a superconducting state.

This new definition of superconductivity makes clear why a superconductor would have no resistance when its phase space is filled. The core idea behind Entropy and the Second Law is that it takes Entropy to fund physical actions. Therefore, a system where its phase space is filled cannot fund any physical actions including absorbing the energy from an electric current running through it. Typical wires absorb energy from current and then release that energy as joule heat (which is why computers heat up) thus exhibiting resistance from an electric current. A wire can only do this for as long as the absorption process to produce joule heat is Entropically favored as demanded by the Second Law. It is then a logical extension that if the absorption process becomes Entropically disfavored then the wire cannot take energy from the current. Thereby, the wire would have no resistance.

The question remains that if we posit that a superconductor is in a saturated state of Entropy how can it gain any more Entropy to comply with the Second Law? Given my definition for superconductivity, why would perturbing a superconductor with magnetic fields cause it to lose its ability to superconduct? Why do superconductors always need cooling systems to maintain superconductivity? If the entire universe was one big superconductor would the universe become eternally frozen because no physical action could occur? All these questions can be answered through taking into account the generation of new monopoles. As I have previously argued, monopoles increase the Entropy of

a physical system. Adding a new monopole into physical reality will then expand phase space to Entropically fund additional physical action. This process of monopole generation is how we can understand why superconductors do not break the Second Law and explain experimental results.

To clarify about the monopole generation process, it is not a process by which any random monopole can be added to reality once a material is in a superconducting state. The addition of the new monopole needs to be able to produce a magnetic field which will break the Meissner effect and effectively “heat” up the superconductor out of its superconducting state. We need to keep in mind that a superconductor has to, by the definition of the Meissner effect, zero out all the already present monopoles influencing it. What the cooling mechanism does for a superconductor is zero out all of these magnetic influences. To add strength to the magnetic field means that the “new” monopole needs to interact with the monopoles already present in such a way as to add strength to the magnetic field. Monopoles that interact with already present monopoles without adding to the magnetic field would not generate a discernable result and in a sense are equivalent to the monopoles already present. The main point is that monopoles already present constrain the types of monopoles which influence reality. Similarly, the monopoles already present in the physical world are the reason why vast parts of Alpha Space do not observably interact with our physical world. Put another way, rocks do not exhibit feeling or emotion because the monopoles already influencing the rock prevent any connecting type of conscious possibility.

We have actually come full circle from our Article 4 supposition of $\text{Space}(X,Y,Z) \neq$ “esoteric ideal”. We can extend this supposition to be more clear and include more physics. Let us now replace $\text{Space}(X,Y,Z)$ with the monopoles linking to the regions of Alpha Space that represent the fundamental mathematics and meaning of Einstein’s General relativity. Therefore, let us use EGR to denote “Einstein’s General relativity” and that the monopoles which implement EGR into reality enforce compliance by all other monopoles in the physical world with EGR. The beautiful and powerful fact of superconductivity is that a material to enter into a superconductor state requires the material has satisfied the shielding effects of monopoles in our universe that normally prevent the formation of addition monopoles. Once the shielding has “gone away” through Entropic saturation, there will be an immediate inclusion of a new monopole tying itself to reality which then increases the Entropy of the superconductor

and heats it up. For a basic physics note, current is an organized flow of electrons while “heating up” a material also changes the flow of electrons i.e. creates a current but the current is not uniform and noisy. This heat/current then gets absorbed by the cooling mechanism and carried away from the superconductor. Thus the persistent current from superconductor (and other metals) can be understood as the effect from new monopole influencing reality. This persistent current will become an important fact when understanding any engineering with the Brain. A separate article will be written to detail and discuss this relationship but it is highly technical and we do not need to go in-depth into that subject now.

The spontaneous addition of monopoles is fundamental to the basic heating of the entire universe. Without new monopoles entering our universe the universe would freeze. New monopoles add Entropy to the universe and thus prevent it from Entropically saturation and freezing. If we lived in a universe without new monopoles to add additional Entropy to reality then we would never need a constant, consistent cooling mechanism for superconductors. Superconductivity would instead be considered the “stuck” state of matter where it becomes permanently inert to anything else. It would be impossible to perturb the superconductor to stop superconducting. Spontaneous monopole generation means that our Universe will never freeze but also that a cooling mechanism is always needed to absorb the impact of the new monopoles in order to maintain the superconducting state.

Conclusion: Monopoles + Superconductivity= How to have an Original Thought

The deep relationship between Monopoles and Alpha Space provides a mechanism on which we can explain where people can get creative original ideas, as well as experience psychosis. What Entropy and superconductivity provide are the physical conditions of how and when monopoles/Alpha Space intersect with our universe and our brains. We can use this process to gain information from Alpha Space that would otherwise be inaccessible to us if we simply relied on information restricted to our universe. Once we get a material, or portion of the brain, into a superconducting state the persistent current caused by the new monopoles will deposit into reality an electric current tied with intrinsic meaning/information via a nexus with Alpha Space. To be clear I am not arguing that the information given will always be clear, consistent, or relevant to the question/task at end. I expect that a lot of the information deposited by these new monopoles will be quite noisy and require that the

superconducting material and cooling mechanism are iteratively “tuned” to decrease the noisy, useless information in favor of good, relevant information.

The main thrust and purpose of this argument is that I believe there is a good, physics inspired path to understand why monopole-based electrodynamics can produce effects in the brain can which create people with the sometimes strange, amazing behavior we observe. Understanding how this unique, special interaction in electricity can produce conscious feelings in people will lead to the understanding of when an AI algorithm has gone rogue or malevolent. Armed with that knowledge we can better protect against harmful AI and create the boundaries to foster good, useful and trustworthy AI.