Article 6: (TDB)

Pre-face 1: Definitions

Baryonic Matter- normal ‘typical’ matter that is made of protons and neurons

Phase Space- A space in which all possible "states" of a dynamical system are represented with each possible state corresponding to one unique point in the phase space. Often multi-dimensions thought the exact number of dimensions depends on the system being analyzed.

Section: 1 Entropy-the Father of Chaos!

Undergirding all of physics is a rule that governs all physical actions and cannot be violated. It governs the reason why we age, feel warm, and how we create scrambled eggs. This rule is the Second Law of Thermodynamics and it holds a primacy amongst basic laws of physics the same as or greater than the laws of conversation of energy and momentum.

To try and explain how fundamental the Second Law of Thermodynamics is in physics, I turn to a quote that has been used by multiple physicists, is a statement from Arthur Eddington. Eddington, a famous physicists from the early 20^{th} century, was one of the early proponents of General Relativity(GR) even when GR was considered “[a] epistemology and has therefore been the subject of lively debate in philosophical circles”(1). This quote about GR comes from the presenter of the 1921 Nobel Prize in Physics to Einstein, awarded for Einstein’s work in the photoelectric effect at a time when much of the physics community was dismissing his ideas of GR as something that is only philosophically interesting. Eddington was a maverick in his time for advocating for GR even when GR was unfashionable.

Eddington’s quote is about the Second Law: “The second law of thermodynamics holds, I think, the supreme position among the laws of Nature. If someone points out to you that your pet theory of the universe is in disagreement with Maxwell’s equations- then so much the worse for Maxwell’s equations. If it is found to be contradicted by observation, well, these experimenters do bungle things sometimes. But if your theory is found to be against the second law of thermodynamics I can give you no hope; there is nothing for it but collapse in deepest humiliation”. It a remarkable statement to put the Second Law of Thermodynamics above many other cherished, foundational tenets of science and physics. The fact that this quote has been used and endorsed by other eminent physicists drives the point home that its meaning is true; the Second Law is truly fundamental and high on the hierarchy of fundamental physical laws.

The Second Law of Thermodynamics states that the Entropy of a system (explained later in more detail) always needs to increase during any sort of physical action. Physical action means some sort of physical process where an exchange of momentum and energy has occurred. The Second Law was conceptualized to solve basic, common observations. Consider trying explain the following common observations: Why does a fire melt ice? Why does a gas when deployed from a small, pressurized canister in a corner of room then diffuse across the entire room filling it up? Why can one scramble an egg easily but turning a scrambled egg back into a simple, unhatched egg is practically impossible? Entropy always increasing in an inexhaustible march is the fundamental justification for these common physical observations.

Entropy's definition can be somewhat confusing, even for physicists, as it is a non-physical mathematical ideal restricting the physical movements of reality. Entropy is not a physically real thing that can be observed easily like energy, distance, or momentum. Entropy refers to the mathematical representation of a system in terms of its phase space. As described before, a phase space is a literal drawing that accurately depicts a system based on whatever set of rules which define the dynamics of that system. Ludwig Boltzmann, in 1877, used the mathematical ideas of statistical mechanics to show how that set of math constructs a phase space that could well predict and conceptualize why a gas would spread across a room or heat move to a cold object. Boltzmann conceptualized this reason as any system always having to increase this quantity called Entropy. Entropy, in Boltzmann mechanics, is defined as $S=k*\log(V)$. S is the symbol used to refer to the total Entropy of the system. The k refers to what is called Boltzmann's constant and for our purposes should just be considered one of the constants in science found to make the math work well in light of the results of experimentation. The log in the formula refers to logarithm which is a math symbol which codes to a specific way to deal with exponentials or very large numbers and has some useful math properties that are not necessary to discuss for this purpose. The interesting part is the V variable which refers to volume, but not the literal 3D volume. It is the abstract volume of the constructed phase space. Depending on the underlying dynamics, the volume of phase space can increase while the physical volume of the system decreases. To explain, it is completely permissible for a system to have huge volumes in phase space, but a physically real volume that is smaller than an ant. This interesting dynamic will be quite important when discussing Entropy in the context of gravity and the Big Bang, but let us first wrap up the Boltzmann understanding of Entropy.

Now that we have a definition for the Entropy of a system, we can understand the consequence of the Second Law stating that the Entropy of a physical system must always increase during any physical action. For Entropy to always increase this means that the volume of phase space a system occupies must then increase towards larger volumes to ensure unending increases in Entropy. A system will continue to increase its Entropy until it gets stuck in a state where there are no possible physical actions available to increase its Entropy. As physical actions occur whenever two systems are trading momentum and energy this "stuck" state can be understood as a system that has no available trades it can make with another system to increase the total Entropy. It is like a merchant having wares to sell but no one can buy them.

The great usefulness of the Second Law is not so much what it allows but what it forbids. Since Entropy MUST always increase, physical operations which would constitute a DECREASE in Entropy are, generally, forbidden from physically happening. Whenever a physical action is Entropically favored then momentum and energy will be exchanged. If a physical action is Entropically disfavored then NO energy or momentum will be exchanged. If one has some particular physical action they want to occur, like a car engine moving a car, then one has to make sure that the physical action is Entropically favored.

To give an example, consider two objects A and B where we consider the Entropy of the entire system before any physical action E1 and the Entropy of the system after physical action to be E2. The Second Law dictates that any physical actions where E2 is less than E1, E1>E2, to be forbidden. Only configurations of A and B where E2 is greater than E1 are allowed(E2>E1). An important corollary is that if one wants to move greater amounts of energy between objects A and B, a larger amount of an Entropy difference between E1 and E2 is needed.

A fundamental part of Boltzmann's definition of Entropy is that there exists certain underlying dynamics which construct a phase space. Boltzmann used the particular dynamics of statistical mechanics to create his phase spaces describing how a gas will diffuse across a room. Since Boltzmann used statistics as his underlining dynamics, one will find physicists refer to how macroscopic systems are simply evolving into their most probable outcome and refer to the Second Law as one describing probabilities rather than deterministic outcomes. The issue with simply interpreting the Second Law as an emergent property of statistics still leaves open the, albeit very remote, possibility of a physical state evolving in an “improbable” direction, which could lead to a spontaneous decrease in the Entropy of the system. This interpretation uses an understanding of statistics as having this quality of inherent “randomness” or “meaninglessness”. “Randomness” in this context does not refer to meaninglessness. Statistics refers to how there are fundamental dynamics going on which are unknown to the observer but still well organized enough that statistical ideas can well describe the system when large number of individual units are being analyzed. It is not the case that Boltzmann statistics output results from acausal, meaningless sources. I have read and heard physicists and lay people argue that the universe is fundamentally “random” without any concept of intent in its macroscopic organization. In other words, they are rejecting the notion of a divine, cosmic order guiding the constituent parts of the universe. These people will cite physics arguments like the Second Law and Heisenberg’s uncertainty principle. Using those sources to then argue that physical reality is fundamentally random, this view of science denies any argument of intelligent design and is a fundamental misunderstanding and misuse of the mathematics behind these ideas.

The basic definition of Entropy is defined on the volume of phase space in question. The phase space is directly, causally, created based on the system dynamics. In Boltzmann’s case he often considered a gas as consisting of many, many particles (this can be on the order or 10^27 number of particles) where EACH of which has its own, different, momentum. In this context, “randomness” is just referring to the great range of particle momenta. This definition of Entropy does not mean that one has to use statistical mechanics in every physical situation. It is simple that in the cases Boltzmann was studying, statistical mechanics to explain the dynamics were the most useful. Depending on the system in question, one is free to use other forms of math to describe the dynamics of the system and thus its phase space. To argue that statistical mechanics is the only way to understand Entropy is a narrow way of thinking which borders on a misunderstanding of how many mathematical ideas are themselves possible.

The Second Law fundamentally argues for the inequality where Entropy can go up but never down. This inequality is what forms the physics basis for what is called the “arrow of time”. This “arrow of time” is very unusual and, frankly, weird in physics. Most physics uses theories which are perfectly symmetric in time. If reality was just using basic Newtonian mechanics or the Schrodinger equation then there would be equal chances of the universe evolving in both the forward and backwards streams of time. This would mean scrambled eggs could spontaneously turn back into the uncrack egg. Even more odd, the uncracked egg could spontaneously turn back into the uterus of the hen from which it came! The Second Law is fundamental to the ubiquitous observation that reality moves in a particular direction and prevents time travel which would open up major maddening paradoxes.

The Second Law, since it effectively enforces the arrow of time, is the fundamental reason for aging, as aging for any object, whether it be biological like a person or not biological like a building. Often one will read other definitions of Second Law as the describing the “chaotic” evolution of the universe because the Second Law forces Entropy always to always increase; thus, people often have to “fight back” against the Second Law. For example, for a very old building over time it will be Entropically unavoidable for its walls and support structures to degrade due to the degrading organization of the building being the Entropically chaotic evolution. Therefore, a human must come along and repair the structure against the constant beating drum of the Second Law. This idea extends to humans with how organ failure becomes more probable over time due a person’s constituent parts evolving in Entropically chaotic organizations that affect the harmony and health of one’s body. Thus, repairing the body involves satisfying the insatiable monster of the Second Law. If one can defy the Second Law forever than one could live, and be youthful, forever.

Given how I have described that the Second Law cannot be violated, how can one “repair” a structure to its early physical organization? The reason repairs can occur which satisfy the Second Law is that the Second Law is a macroscopic law governing the ENTIRE collection of systems. For example, let us consider system A with has four constituent particles. The Second Law only demands that the entire system A Entropy expands, not that each individual particle has its own entropy increase as well. To use another example, it usually is Entropically favorable for a gas to diffuse across a room. How can then one pump gas into a small container? Let us consider the Entropy of the gas as G1 and the Entropy of the motor that pumps the gas into the container as M1 before the pumping process has started. Then let us name the Entropy of the gas in the container as G2 and the Entropy of the motor as M2 after all of the gas has been pumped into the small container. I will use the notion of S ("some variable") to simply denote the amount of Entropy from "some variable". Therefore, our equation to satisfy the Second Law is that $S(G1)+S(M1)<S(G2)+S(M2)$. This equation simply states that as long as the sum of Entropies of the entire system is greater after physical action has occurred, then the required inequality can be satisfied. Therefore, $S(G1)>S(G2)$ can be true where the Entropy of the gas can decrease as long as $S(M2)$ is large enough to compensate. Thus, it can be understood that the motor in effectively Entropically financing the behavior of the gas. This basic principle underscores all energy system storage as an object is only useful to store energy if it can later pay a high Entropic price to enable the physical action of other objects/systems. Therefore, the reason the Sun blasts the Earth with light is important not because of the raw amount of energy in the light (since a lot of the that energy gets re-released by the Earth into empty space) but that the light is in an Entropically low state which plants then can use photo-synthesis to fund all of their physical actions.

Section 2: The Arrow of Time, Big Bang, and Hierarchy Problem

There is a basic mystery in stating that the "arrow of time" rests on the Secon Law. The Second law can only work for all time if the universe started in a very, very, very ,very, very ,very low state of Entropy. The reason is simple; the universe needs to start with "empty room" in phase space, i.e. have enough potential Entropy to fund all physical actions that will ever occur. This is a huge issue if the universe is meant to exist infinitely in time. If the universe will exist forever then the Big Bang, which is the earliest state of the universe in modern physics, has to then have an infinitely low state of Entropy. Sir Roger Penrose has done the math in his books taking the current age of the universe to show how this means the universe started in an Entropic configuration that only has the probability of spontaneously occurring of one in $10^{(10^{123})}$. $10^{(10^{123})}$ is such a ginormous number that having 1 get divided by it is for all intents and purposed equivalent to 0.

To further add to the mystery of the low Entropy of the Big Bang is that the Big Bang was in thermal equilibrium. This statement of the Big Bang being in thermal equilibrium is not simply an assumption but is back up by the temperature uniformity in the cosmic microwave radiation. It is observed in the ratios of byproducts in hydrogen, deuterium, and helium align from the early universe starting align with the idea of the early universe being in a high temperature but thermally equalized state. What this means is that the phase space corresponding to the dynamics of electrodynamics and the dynamics of other fundamental forces are filled; there is no “empty room” in the direction of phase space corresponding to these dynamics to fund any physical actions. It is Entropically favored for a gas to spread across a room because of all the electrostatic repulsion occurring between its constituent particles. Gravity, on the other hand, because it is an additive force, always encourages things to clump together. If gravity is the only process which is Entropically favored then gas particles would condense into a corner of the room rather than spreading out. When looking at the Big Bang starting in this high temperature thermal equilibrium, then only regions of phase space corresponding to the dynamics of gravity were open to fund physical actions. This means that the entire Entropy budget of the Universe for all time was effectively determined by the nature of gravity during the Big Bang. To reinforce this idea of gravity providing Entropy, it is the Sun which provides the Earth with Entropic fuel through shining low Entropy light on our planet. The Sun can only do this through the nuclear fusion process in its core irradiating useful light. The Sun’s nuclear reaction can only occur because it is so massively heavy that the gravity in is core becomes strong enough to barely overcome the overwise extremely strong electrostatic repulsion between protons. These single protons, otherwise called hydrogen atoms, then get synthesized into helium and that synthesis releases the light to Earth which powers everything. In both the Big Bang and our modern day, we are effectively Entropically funded on massive scales by gravity, even though it is then weakest fundamental force recognized in physics.

In modern physics there are four commonly recognized fundamental forces: gravity; the weak force nuclear force; electromagnetism; and the strong nuclear force. The weak and strong nuclear forces experimentally refer to what goes on in the nuclei of atoms; they are often not relevant to our day-to-day lives. It is gravity and electromagnetism which dominate the physics of our day-to-day lives. However, there is a massive asymmetry between electromagnetism and gravity where electromagnetism is 10^40 stronger than gravity. This asymmetry in strength is what makes it so hard at a quantum level to probe what gravity is doing there. This strangeness only get stranger as gravity is fundamental in spacetime. Spacetime, in a simply but true sense, determines where things are.

Gravity determines where our planet is; where the Sun is; and Entropically funds all of reality. These critical, foundation facts posit a basic and profound question about why is gravity so weak? It is inherently strange that the weakest force is gravity while then the fundamental Second Law of nature, which is never supposed to be violated, is best supported by gravity. These questions seem to be begging for another explanation for this near contradiction. What missing piece of physics could provide the missing piece to make sense of this all? I believe the answer may rest with the fact that current physics does not understand, and therefore does not address the dynamics and properties of the magnetic monopole.

Section 3: Magnetic Monopoles and Entropy

Magnetic monopoles play a general and fundamental role in physics. In the Article5, it was stated that using typical particle physics assumptions leads to the conclusion that monopoles should have been produced during the high temperatures of the Big Bang. Furthermore, so many monopoles should have been produced at that time they should have the same density as typical baryonic matter. In addition, a monopole can be so heavy that typical Newtonian gravitational effects can influence its dynamics, not just the influence of electromagnetism. Given that monopoles do not decay in time they should also still be with us in our modern day. Combine these facts, all of which are already well backed by basic tenets, of physics with the additional fact the Big Bang was extremely special; it was so specially organized that the Entropic contributions of the other fundamental forces were effectively maxed out so that the universe could ONLY Entropically grow along the dynamics of gravity. As previously discussed, Grand Unified Theory of physics also involve magnetic monopoles. All these facts together lead to the conclusion that monopoles can (and should be used) to explain reality, including the Entropic specialness of the Big Bang.

Monopoles can be so heavy and produced in such abundance that the moment when monopole production began during the Big Bang is also when the Entropic degrees of phase corresponding to gravity started to emerge to fund physical actions. With enough heavy monopoles then gravitation force can become strong enough to entropically fund the universe. Since monopoles do not decay with time and entropically funded the universe from the very beginning, then these monopoles should still be with us today Entropically funding reality, fulfilling and enforcing the Second Law. Connecting Entropy and monopoles makes the mysteries of both the Big Bang, Entropy, and monopoles make sense.

It was my theory from the start that monopoles and Entropy and are connected. I conceived of Alpha Space as the largest possible phase space such that it would be, by the basic definition of Entropy, the largest Entropic configuration possible. In fact, positing that monopoles can then provide this bridge between Alpha Space and physical reality where they increase the Entropy of a system becomes less of an assumption and more a necessary conclusion to explain such fundamental physics ideas like the Big Bang, Magnetic Monopoles, and Entropy.

To further explain my theory, where a monopole X is created it will then create access to Alpha Space which would increase the Entropic of the system. Monopoles are literally producing the means to add to the volume of phase space of the universe in order to fund physical actions. This is conceptually a reverse of the process used by Boltzmann. He assumed some dynamics described his system and that the system could only evolve into the areas of phase space that were open to enlarging the phase space. Here we are doing the reverse where if we start with a phase space that is perfectly closed, i.e. there are no open directions into which the system can expand into, then we can add a monopole and expand the phase space. The monopole could do this through use of its inherent magnetism to modify the dynamics of the system to align with the new opening in phase space. While Boltzmann went from dynamics-> phase space, instead I am positing to use monopoles to go from phase space-> dynamics. Both perspectives should end up agreeing in reality; however, that is simply an assumption and it would be interesting if reality has had to create special rules to deal with what happens when the two perspectives disagree with each other. One possibility to solve such an issue would be to continue adding monopoles until a solution was found.

Now if we are going to hang our hat on monopoles being the way we can connect reality to Alpha Space then we need to explain why monopoles have confounded astronomical observation as described Article 5. Before explaining that issue, the good news is that we have finally reached the point of tying magnetism to all 4 dimensions of spacetime using Entropy and monopoles to tie magnetism to time and the cross product to the other 3 dimensions. We have finally reached what we set out to do in Article 4.

As mentioned earlier in Article 5, monopoles can be massive. In fact, let use assume for now that we do not know a particular limit on monopole mass nor why there should be a limit. We should keep an open mind that the ceiling for how massive a monopole can be could be very, very high. As mentioned earlier, given how abundant monopoles should be and how massive they can be, we should see many massive objects in the cosmos corresponding to these monopoles. Expressed in the different way, can we look into the cosmos and see a bunch of objects with varying mass, some EXTREMELY massive as compared to other ones? The basic answer to that question is yes! We do see many planets, asteroid, stars, galaxies, and black holes with huge differences in their masses. The next question to answer is why do monopoles then not make the universe far more massive than we observe? I believe physicists in the past thought it absurd to think of most astronomic objects as being inherently tied to monopoles because they thought monopole mass would be independent of the mass typical matter. Therefore, calculations of monopole density were double counting the number of particles and thus making the expected mass of the universe ridiculously. I argue instead that monopole mass and baryonic mass are fundamentally linked, and in fact, are likely the same thing! This makes the statement in Article 5 about how monopole density should be the same as typical matter actual make sense and be a supporting fact of our supposition. We need to recognize the fact that monopoles and Entropy are fundamental linked; one cannot talk about one without necessarily including the other. I believe this Entropic linkage between monopoles and the mass of any system is fundamentally tied to how well the relevant monopole can open the system's phase space to include additional dynamics and the energy associated with said dynamics.

This thinking leads to the conclusion that monopole mass is shared with the typically, baryonic mass and thus when we look into the cosmos and see baryonic mass we are also detecting monopole mass. In the sense the monopoles Entropically fund reality they also fund how massive systems can become.

If the supposition if correct that monopoles are these abundant entities which can, perhaps spontaneously, increase the Entropy of a system can these interactions be probed experimentally? This also begs the question of whether the Cabrera experiment actually did detect a monopole? If they did detect a monopole why did all other pursuits of looking for monopoles with the same basic experiment set up-fail? To answer these questions, we need to investigate the physical process they were trying to use to detect monopoles, superconductivity. Therefore, the next article shall describe the nature and mystery of superconductivity and its relation to monopoles. Once we have covered superconductivity, we can finally synthesize all these ideas into a paradigm of devices which we will then install into AI systems to ensure their good behavior.

Bonus Section 1: Monopoles, Entropy, Stories, and People

Now I believe there is a very basic and fundamental relationship between storytelling and Entropy. Good story are ones that keep people's interest and are not boring. Boring stories are, I believe, most often defined as ones without any conflict. For a story to keep a person's interest and attention, it must be directly tied to physical essences in the body. It takes energy to maintain attention and there are psychological experiments demonstrating this fact. From an Entropy perspective, for a person to watch/read a story they need to be Entropically favored to spend the finite Entropy in their brains to focus their attention and take time to watch/read the story. Even in fundamental human activities, such as reading make-believe stories, the Second Law is in effect and needs to be respected. Often, stories that keep people's interest are ones where people do not know all of the details and/or have elements of a mystery. In effect, stories where one cannot predict the end are more likely to maintain a person's attention. A story which is unlikely to grab and maintain a person's attention is one that a person already knows and thus would not constitute an increase in phase space and thus is Entropically disfavored. In this sense, depending on the specific Entropy of the individual, the same story can be boring or exciting depending on the person.

If so, then why would it ever be Entropically favored for a person to watch re-runs? How would we understand people who will do the same action forever if each action is supposed to be Entropically favored? There two ways to answer this. One is that for the person in question they have quarks about their phase space/monopole/Entropy where their phase space in those directions of the story never saturate and become Entropically disfavored. This would provide a precise definition for what is addictive to a person. Physical actions which never will Entropically saturate are what literally could become addictive behavior.

However, there is another potential reason, which connects to this idea of forgetfulness. A story which a person saw but then forgot can then be rewatched by the same person, even though they know they saw the story before, as they forgot enough of it to make is still interesting enough for watch again. Under the Entropy paradigm it would that the story became Entropically favored after initially saturating. This can be understood that the volume of phase space corresponding to the story in question contracted and thus it became Entropically favorable to watch the story again. This seems to go against the Second Law, for it posits that Entropy can only increase not decrease. In reality, it is more complicated than that, for as explained earlier, a gas can have its Entropy decrease by putting it into a small container as long as the pump compresses the gas is paying a higher Entropic price. Therefore, one part of a person's phase space can get contracted to expand in a different direction.

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