A MINIMALLY BOUND CAUSAL FRAMEWORK TO RECONCILE QUANTUM NONDETERMINISM AND RELATIVITY

FRAMEWORK

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October 25, 2024

ABSTRACT

This paper presents an openly conceptual interpretation of the universe that binds quantum nondeterminism to relativity in a strictly causal framework. By deriving intrinsic properties like space, time and causality, this framework offers a coherent way to model fundamental field interactions from any frame of reference, including gravity. An insightful interpretation of electromagnetic radiation and its implications with relativity and time if offered, paving the way to reconciling gravity with the peculiar requirements of the uncertainty principle. A global map of field interactions is outlined, allowing further discussing outstanding quantum and gravitational phenomena from an electromagnetic standpoint.

1 Intrinsic Causality

This conceptual framework is rooted in the idea that the most profound laws of physics should not be imposed, they should rather derive from the nature of the universe itself. Therefore, initial work started by figuring out a mechanistic approach to explain the seemingly all-encompassing causal nature of the world. The simplest idea to approach causality is that everything must either be the cause or the consequence to everything else. While simple, this concept poses the problem of organizing every possible phenomenon.

A simplification opportunity was found by postulating that the tridimensionality of space is not a fundamental property of the universe either. As a result, the three dimensions of space should rather causally derive from something prior. Our human experience is intrinsically bound to space by its electromagnetic (EM) nature. Therefore, a logical starting point was to investigate whether space could result from the manifestation of the electromagnetic field itself.

If we let fundamental electric charges be point like (0D), if we then let the electric field be the straight-line interaction that arises between them (1D), and if we let this interaction result in an orthogonal magnetic field (2D), then perhaps we can stomach to have the electric and magnetic fields consequently output radiation in three dimensions. If so, it would appear that electromagnetic radiation *is* space.

As it turns out, this causal emergence of intrinsic properties offers a profound conceptual opportunity. After all, allowing fundamental charges to be point like (from an electromagnetic standpoint, that is) could logically explain their quantum nature, not to mention their newfound relation to space and, therefore, to gravity. But let's first address space and causality such as we have the following:

$$\begin{aligned} \Delta ... &\rightarrow charge \\ \Delta charge &\rightarrow E_{field} \\ \Delta E_{field} &\rightarrow H_{field} \\ \Delta(E_{field}/H_{field}) &\rightarrow space \\ \Delta space &\rightarrow ... \end{aligned}$$

2 The Emergence of Space and Time

So, what is space? Space is where things are (static) or where they are going (dynamic), space is where kinetic energy propagates and interact. In this framework, the prior interaction of physical manifestations shall cause subsequent dimensions, or fields, to emerge. Therefore, a field is the emerging and correlated energy manifestation of an underlying interaction, from which future effects shall causally restitute or expend the imparted energy. For instance, the energy imparted to the EM field from underlying charges shall be mediated by the laws of electromagnetism. Similarly, if the EM field radiates energy into the **space** field, the imparted energy shall be correspondingly mediated by the kinematic laws of motion.

Of course, fields must also be allowed to interact deterministically if proper composite effects (charge, spin, mass) are to be obtained. For instance, the framework should make it possible to define the position of a punctual electromagnetic change so that the EM and space fields are physically bound. This effect is easily obtained if we consider a non-radiative EM oscillation (i.e. a purely reactive E/H resonance). Thus, a static space field can arise from an oscillating E/H interaction without conveying energy outwards. This is what confers its position to EM manifestations. Then, if this oscillation propagates through the EM field, it shall be bound to its position in space via its defining impedance. Impedance – and therefore instantaneous reactive power – are the mutually interacting properties from which space-bound interactions are mediated in the EM field. Hence, we now have a causally-derived concept for an electromagnetic waveguide.

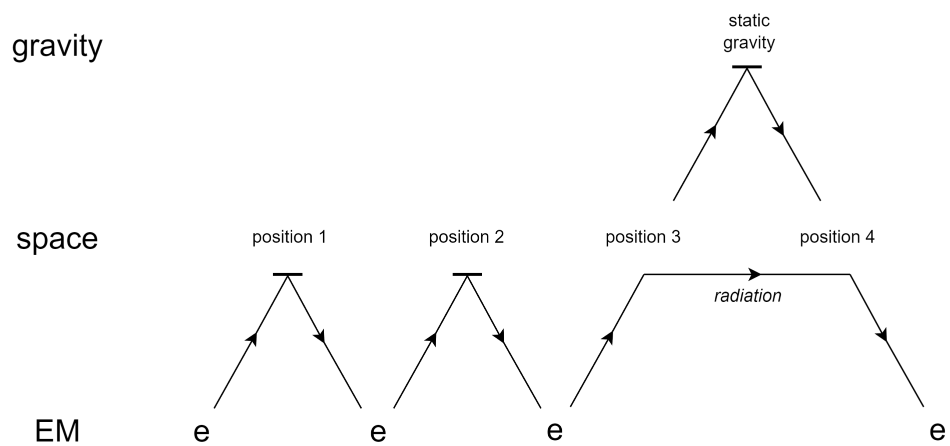

Figure 1: Manifestation of a punctual electromagnetic manifestation 'e' along space.

We shall denote "static" space the position resulting from purely reactive EM power, which resolves space without inducing motion (change) thereof. This static space is analogous to electric monopoles resulting from static charges and shall correspond to underlying electromagnetic structures which have the potential to express motion. In other words, static space is matter at rest. This intuition suggests that (at least some) fields operate in monopole-dipole pairs, allowing us to anticipate the presence of static space and static gravity. In this framework, electromagnetic-space interactions would read as: "the EM field causes space to emerge, and the resulting impedance of space tells the EM field how to propagate". While reminiscent of general relativity and its curved spacetime, it shall be convenient to express such relation without an apparent circular definition.

To rid our interpretation from curved spacetime's mathematical conundrum, it seems necessary to have a proper definition of time. Here, our observational knowledge about the speed of light can be used to make useful predictions. Therefore, in this framework, **speed of light** is the causal propagation of change occurring within the electromagnetic field from a space referential. Similarly, **time** is the causal propagation of change occurring within the space field from a gravity referential. If speed of light changes along with impedance, time changes just as well along with gravity.

$$c = \frac{d(EM)}{d(space)} \qquad and \qquad t = \frac{d(space)}{d(gravity)}$$

Where *d(space)* won't directly correspond to meters or motion per se, it rather implies a *change in motion*, which commands to the subsequent field of gravity (from which the concepts of mass and acceleration naturally derive). Much like a non-radiative EM oscillation resolves space without inducing change thereof, a non-radiative oscillation in space may resolve gravity without inducing change thereof. Therefore, a radiating photon propagating in space shall be bound by static gravity (it will thus bend along gravity in the same way an EM oscillation was previously guided by space), however no time is to be incurred until the photon causes motion by interacting with matter. Long as the photon propagates freely, space incurs no change and therefore time is null (at least with respect to this photon). In the advent a single photon is emitted from – and directly re-absorbed by – the EM field, incurring no change to space either, the photon would still **impart no time**. This is accepted by the uncertainty principle as a virtual photon and corresponds to the middle case the Figure 2. This interpretation predicts that virtual photons are very real indeed event though they happen ‘out of time’. Finally, in Figure 2’s last case (right), the photon does lead to a change in space (inducing a change in motion) therefore time is finally imparted.

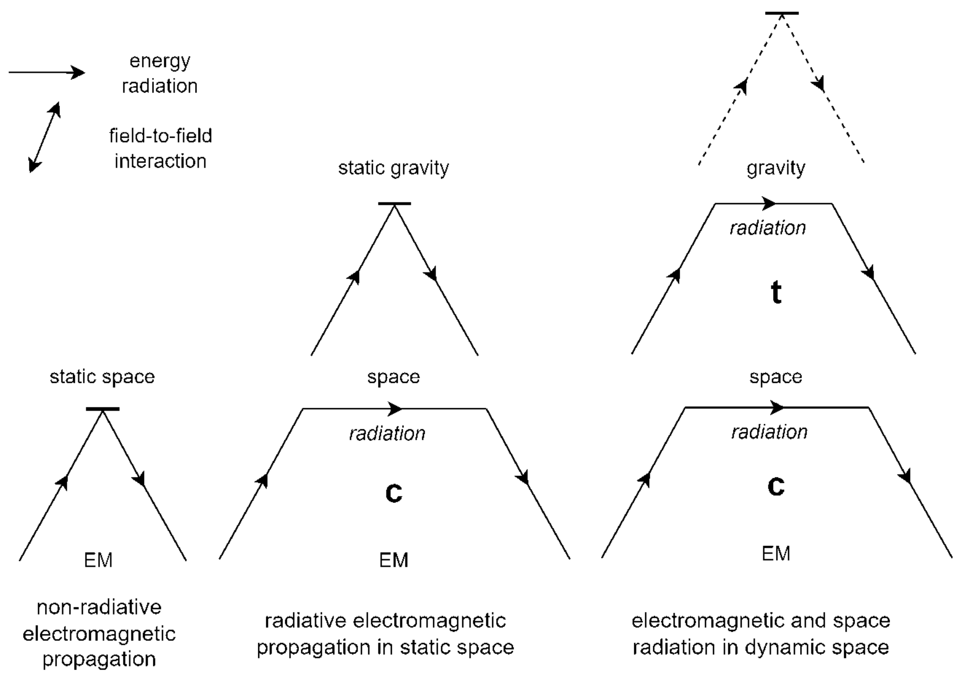

Figure 2: Interactions leading to speed of light and time.

Looking back at the first topology of Figure 2 (left), it could be that virtual particles are characteristic of existing ‘out of time’ (or prior to it), yet it may also suggest that some particles exist prior to the ‘speed of light’, too. This intuition, together with the causal nature of this framework, reinforces the idea that at least two prior interactions are necessary for any field to emerge. As a result, the most precise position of a particle in space must simultaneously originate from two different EM field states. This is oddly reminiscent of quantum superposition and seems a compelling case for quantum mechanics’ nondeterminism (from a space and gravity standpoint, that is). This also provides a comprehensive framework to approach the different relativistic implications of rest, uniform motion and uniform acceleration.

If photon interactions impart time, and if prior fields can also interact ‘out of’ subsequent fields, it makes sense to propose that fundamental particles shall acquire their macroscopic properties as they interact with subsequent fields. Since our measurements mostly always rely on space and time, it is expected that most particles in our experiences will indeed exhibit charge (from the EM field), spin (from the space field) and mass (from the gravity field). However, it may very well be that things like electrons have no rest mass at all (until they get involved in a time-defined interaction). Consequently, should particles contribute to post-gravitational interactions, they could also acquire additional properties, or at least appear to have different flavours.

Allowing fields to causally emerge may lead to the propagation of changes in domains unrelated to space and time. Hence, we shall adopt the following generic definition: propagation is the causal rendition of a difference (change) mutually affecting the constituents of an ensemble throughout successive states, steps or moments. As a starting point, our causal framework can now be summarized with the following logic set:

The electromagnetic field Changes in fundamental charges give rise to – and propagate in – the electric (static) and magnetic (dynamic) fields. The electromagnetic field is where changes in E and H propagate.

The space field In turn, changes in the electromagnetic field correspondingly resolve matter position (static), or brings it into motion (dynamic). The space field is where changes in position (i.e. motion) propagates.

The gravity field Consequently, changes in motion must also be causally transmitted to all of matter. Since the transmission is not instantaneous, mass arises as a measure of impedance due to this finite rate of change. As a result, changes in motion propagate in the emerging field of gravity.

What about particles? A particle shall be the uniform manifestation of a field, where all underlying constituents of that manifestation are locked in an identical state. In other words, particles are a uniform chunk of field that experiences relativity as a whole. Change does not propagate through a particle; their manifestation *is* the change.

3 The Relativistic Effect of Heat on Time

If we cool a hypothetical piece of metal, we naturally conceive that it becomes solid. If we keep cooling it, its properties shall further change such as it becomes stiffer. This stiffness also has the effect of increasing the propagation speed of mechanical waves through the metal. Let us now suggest that the metal's heat is the manifestation of space being imparted radiative energy from the EM field. In such case, the material's temperature shall correspond to an induced rate of change in space. By freezing the metal, we impede space changes from manifesting. Doing so, we restrictively put space in a static state. Once completely frozen, the material shall have lost its ability to express relativistic change with regards to itself. Therefore, no single constituent of the metal shall be allowed to 'change' with respect to another. This piece of metal shall therefore behave like a single object, or even perhaps a particle. This would be the manifestation of purely static space. In such a state, electrical propagation 'c' is allowed, yet space incurs no change with respect to 't'. For a piece of metal, that would mean that voltages and currents can be defined in space, but that space cannot impede or extract energy from the electromagnetic field. Superconductors are obtained by inhibiting EM radiation, not imparting a single photon to space, and thus keeping it from experiencing dynamical change. However, supressing the mechanical effects of electrical and magnetic fields may have unexpected consequences.

Since space is not allowed to change within the material itself, it effectively becomes static space, and no individual molecule of this metal can express itself in a different way than its neighbour. Therefore, it must experience gravity as a single point. This resonates with the idea that the metal is not allowed to be deformed, or in other words, it must experience accelerations uniformly. At this point, all of the metal forms a single piece of hypothetical static space and time is no longer allowed to vary amongst that space. This is to say that relativistic kinetical effects can no longer be observed between those molecules, as they experience time as a whole. But what if we shape this metal into a hollow sphere?

Just like for a static charge enclosed in a metal sphere that prevents outside electromagnetic changes from affecting it, an absolute zero metal sphere may have similar effects on space. If we successfully create a sphere through which space (and electromagnetic) change can no longer 'propagate', it is expected that the inside of that sphere would no longer feel outside change (therefore acceleration). Conceptually, that simply means that no vibrations can be transmitted from the outside to the inside of an infinitely rigid sphere. And without space change, time won't tick. That is, it won't tick through the sphere. This creates a discontinuity where the inner volume no longer feels outside gravity and where the (uncorrelated) passage of time is limited to the transformational energy enclosed in its volume. While speculative, such an experiment could yield appreciable scaling effects to aid in validating the predictions of this framework.

4 Relative Motion and Gravity

When the electromagnetic field imparts energy to the space field, resulting in motion (like for an electric motor), we instinctively expect this mechanism to be symmetrical such that motion can be converted back into EM energy as well. However, in our framework, causality is expressed from the EM field upwards, not the other way around. We can however reconcile the a priori observation that motion does induce E/H changes if we consider the flow of power and energy. By using an electric motor, heat (power) is imparted to the space field where energy is stored in the form of motion. However, using the same motor to bring the kinetic energy back into the EM field, power must once more be conveyed outwards in the form of heat as to effectively stop the motion. Of course, the motion of matter does alter the nature of the space where the EM interaction takes place (i.e. its impedance) yet, in both cases, it is the interacting EM field that commands power to the space field, not the opposite. On the other hand, it seems that energy can seamlessly flow back in the causal chain. This is indeed allowed as energy is not a cause in itself, it rather corresponds to a measure change or potential change in a given set of fields. In essence, motion does not cause EM change, motion mediates the possible outcome of underlying EM interactions.

Let us now address gravity in a similar way. Here, we must build upon the concept that gravity arises from a change in the space field and that such change can either be static (motion in free space) of dynamic (kinetic interaction). However, for causality to be preserved, changes in motion must be allowed to propagate through the subsequent field of gravity in order to maintain the relativistic expression of accelerations. Therefore, if a moving object gets hit by a photon, its change in motion shall gradually propagate until the object has been entirely affected. The rate of this propagation shall give rise to the apparent mass (or momentum) of this object. This is analogous to the electromagnetic impedance of space.

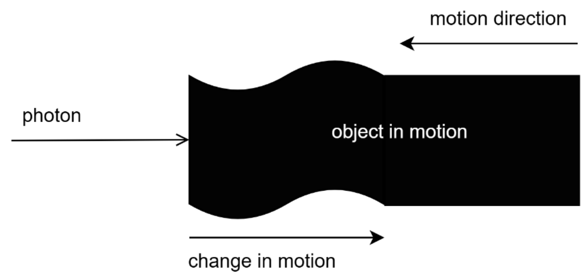

Figure 3: A change in motion, or acceleration, is causally propagated through the object.

At this point, it is not necessary to reason in terms of *length* or *time*. Let us simply establish that motion corresponds to a *change in distance* and that, consequently, a change in motion yields gravitational effects.

$$motion \propto \Delta distance \qquad acceleration \propto \Delta motion \qquad mass \propto \frac{1}{propagation\ rate}$$

Then, let us consider two particles moving about the X-Y plane in Figure 4, where the distance d between them increases as A moves past B. Here, we expect their relative motion to change as distance d goes to d' and to d''. As the distance lengthens, the motion accrues a relative acceleration that **must causally propagate through** the gravity field. In response, the gravity field will **impede this change in motion** such that A can't freely and instantaneously accelerate to A". Indeed, impeding this relative change of motion implies that the straight path between A and A" must now bend around B in order to satisfy the finite propagation rate of the ensemble.

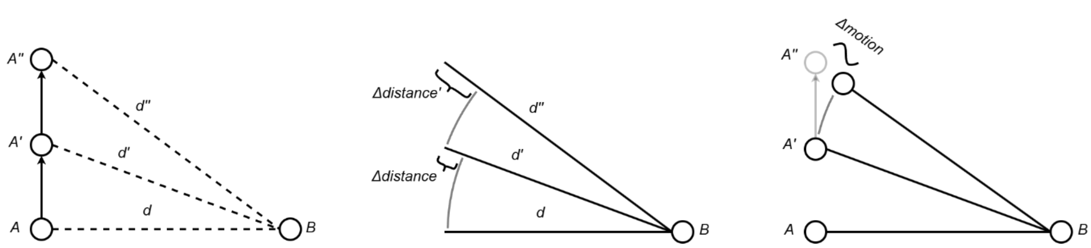

Figure 4: Gravity is the effect resulting from the finite propagation rate of a relative acceleration.

The propagation rate shall depend on the mass of the objects, which is a measure of how gravity opposes relative accelerations. As a result, gravity is not a force nor does it cause motion, its effect is simply rooted in the finite propagation rate of relative accelerations. Or, in relativistic terms, gravity is what guides motion along causal accelerations.

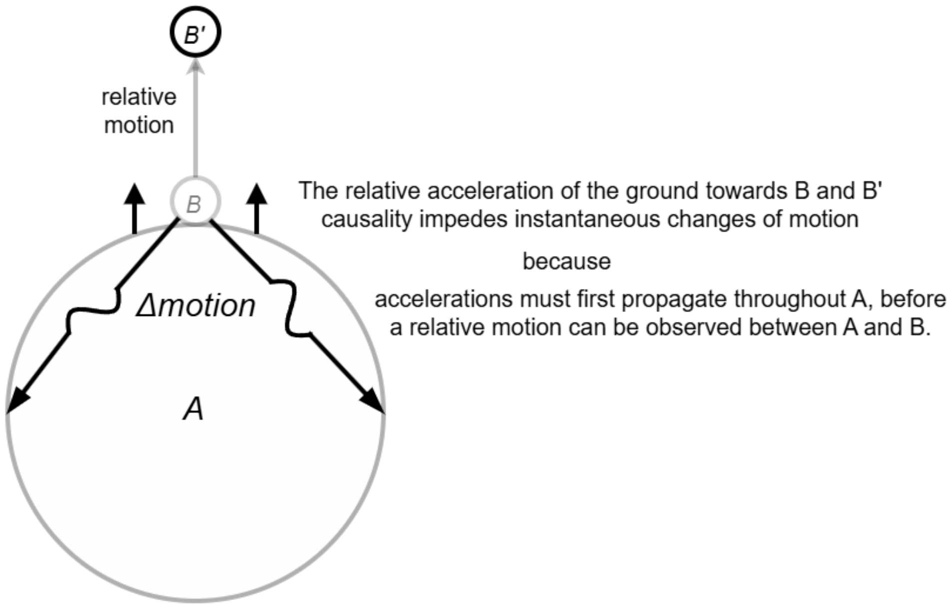

Figure 5: A relative change in motion is not observable until the acceleration has propagated throughout the bodies.

If gravity does not induce motion, yet affects its outcome; and if motion does not cause electromagnetic changes, yet affects their outcome, it is compelling to suggest that performing electromagnetic measurements on an antecedant quantum system does not cause fundamental change either, yet it would however affect the outcome of the underlying interaction.

5 Discussion

Including all the above concepts together in a single picture is not trivial, but even a simple rendition allows making interesting predictions. For instance, the figure below suggests that emerging fields may yield energy transformations well above gravity (i.e.: jerk, named after the derivative of acceleration). Instinctively, jerk could well fit the gravity-interacting portion of postulated dark matter and dark energy. However, part of the inferable dark may also come from the other end of the graph.

Despite for the simplistically undefined fundamental field shown in Figure 6, the rest was laid out symmetrically as a starting point. However, there may exist useful analogues to reinforce the idea that the EM, space and gravity fields do manifest themselves in a mechanistically similar way. For instance, during an electrical short-circuit, the electric field collapses, the magnetic field becomes infinite, resulting in an intense current that turns the available energy into heat (EM radiation) at the short. Conversely, the gravitational collapse of black holes may be a similar type of event if we propose that it causes static space to collapse (position no longer being properly defined), their dynamic space (motion) becomes infinite, resulting in intense space radiation. If so, it seems that a black hole may be the apparent manifestation of energy leaving space as it is entirely radiated out into the subsequent field of gravity.

Armed with those ideas, we can openly speculate about outstanding properties of physics. Namely, we can infer the possible reason behind the quantized nature of fundamental particles, the reason why fermions won't share identical atomic states as well as the mechanism preventing electrons from collapsing onto their atom's nucleus. By initially proposing that the tridimensionality of space is a successive buildup of dimensions obtained through antecedent field interactions, we inferred that charges are point like particles (from the emerging standpoint of the EM field, that is).

Therefore, the apparent quantized nature of particles may elegantly stem from their point-like dimensionality. On the other hand, the case for the electron's discrete energy levels may be rooted in the eventual one-dimensionality of the electric field. Or, perhaps, this one-dimensionality would better be depicted as a 1+ degree of freedom with respect to 0D particles, which would allow fundamental charges to still have intricate antecedent interactions of their own, but in a way the EM field can't fully resolve. As they interact, particles shall however cause electromagnetic variations, giving rise to a corresponding space field. Therefore, it may well be that nothing really prevents fermions from sharing the same state, but rather that a distinct space position unavoidably emerges for every one of them. In those conditions, the reason why electrons would not collapse onto their atom's nucleus could be explained if they take part in a non-radiative oscillation under the E/H fields along with their nucleus. Such a purely resonant state amounts to no radiation, therefore equilibrium is attained rather than radiation.

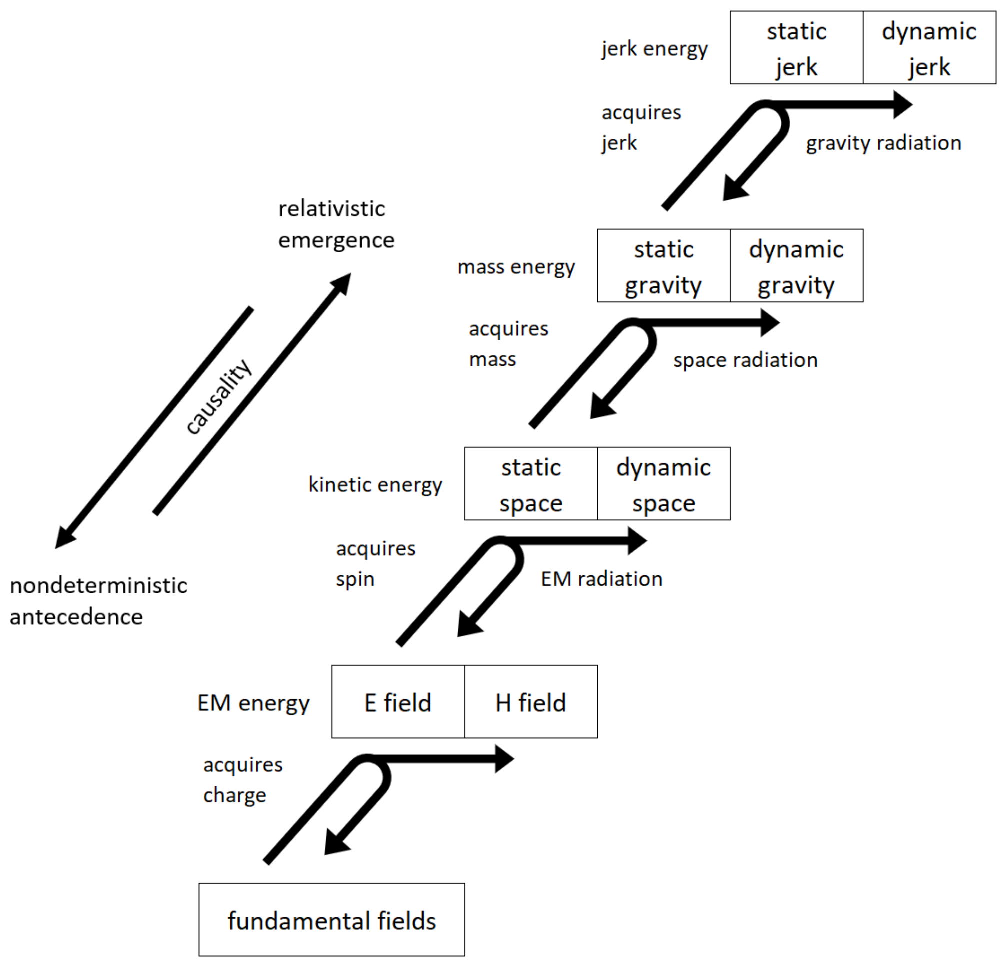

Figure 6: Map of causal field interactions.

Finally, it seems appropriate to ask how did the (observable part of the) universe begin? In the case of our minimally bound causal framework, the onset seems to derive from the initial interaction of fundamental fields. In turn, this would cause the EM field to spontaneously emerge. Upon the first incredible EM radiation event that this would cause, space would burst out of existence. Matter would then (and only then) start to exhibit kinematic properties as gravity would subsequently establish itself. This seems consequent with the global concept of the Big Bang. However, we may not infer that the Big Bang is the start of the universe, for that a multitude of antecedent fields could have existed and interacted prior to the emergence of our observable space.

6 Conclusion

While this framework is not a thorough mathematical demonstration of any sort, its merit is found in the intuitive simplicity with which it provides a causal instalment from which first principles naturally derive. The concept of field emergence seems appropriate to describe the composite nature of quantum manifestations. It also provides straightforward reconciliation avenues to bind fundamental interactions with gravity and time. Should the symmetry between the electromagnetic, space and gravity fields be confirmed, this model could simplify our approach to relativity and perhaps extend it to other fields as needed. At any point, describing physics in absolute terms may inherently force an imprecise frame of reference upon us. On the other hand, if rewriting physics in causal terms can be daunting, one may find solace in that its apparent laws could well unravel as being the simple derivative relations and constants that emerge along the way.

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