Diversity from a Fundamental Unity $\odot^{3E}$ and its Projections

Mrittunjoy Guha Majumdar
Indian Institute of Science, Bangalore
(Dated: August 20, 2021)

In this *Letter*, the underlying basis of nature in physical processes is presented to be that of existence, experience and entirety, encapsulated in $\odot$, a fundamental unity from which space-time, causality and all diversified physical phenomena are posited to emerge. The operative element in the emergence is an apparent flux-entity ξ, through which $\odot$ is projected. We see a trade-off between the inherent entangling and equilibriating tendency of $\odot$ and the dissipative nature of ξ, which leads to self-selection in physical systems.

Keywords: Unification, Metaphysics, Information

I. INTRODUCTION

Existence is taken as sacrosanct in any physicalist conception of the Universe, in what is a metaphysical formulation that regards anything that exists as being physical in nature [1]. Existence of entities, concepts and properties are explored in constructibility and mathematics [2, 3], the ideas of observability and physical reality [4, 5] as well as ontological philosophy [6, 7]. We can regard physicalism in terms of exemplification of properties of entities that does not entail presence of conscious beings [8]. The fundamental premise in the causal argument of physicalism is given by the Completeness of Physics (CP), which says that '*every physical event is determined, in so far as it is determined at all, by preceding physical conditions and laws*' [9]. Within this formalism, not everything is taken to be on par, metaphysically: certain elements (such as entities, events or properties) are taken to be more fundamental that others [10]. But what is the fundamental basis of physicalist existence?

The quest for attaining this fundamental basis ties into the quest for finding a unified theory of Physics - a *Theory of Everything* [11–14]. Quantum mechanics brought to the fore the idea of the observer being central to reality [15]. John Archibald Wheeler coined the term of *Participatory Anthropic Principle* [16, 17] and wrote extensively on the '*It from Bit*' theory [18, 19]. The ancient Buddhist doctrine of causality - *Pratītyasamutpadā* (dependent origination) [20], along with the idea of 'relations sans relata' [21] being primary, seem to be coming to the fore, in terms of specific theories of Physics. Recently, the symmetries of fermions and bosons of the Standard Model of particle physics were shown to emerge from multipartite entanglement: beginning with basic chiral left and right states, we can discuss fermions in terms of tripartite maximally entangled classes, while quarks and leptons can be seen to belong to different entanglement classes and bosons are related to symmetry generators [22]. However, this model was mostly restricted to a representation of quantum states in the Standard Model, not quite at the interactions and dynamics.

An insight that we do get from such initiatives is that entanglement is probably fundamental to physical phenomena and existence itself [23, 24]. The entanglement that if we look more closely at the Standard Model, we see that we have 28 bosonic and 90 fermionic degrees of freedom at high temperatures, where all the particles of the Standard Model being present in that regime. The fermions do not contribute as much as bosons, when it comes to energy density, pressure or entropy density, all of which have 28 bosonic and 78.75 fermionic effective degrees of freedom, giving a total of 106.75 effective degrees of freedom [25]. This is because fermions cannot occupy the same state. Each of these degrees of freedom has a certain protected sub-space, which while having the possibility of entangling with other degrees of freedom, remain confined to their own dynamics and evolution. This tendency can be written in terms of group theory and representations [26].

II. REPRESENTATIONS AND $\odot^{3E}$

The fundamental element in the group-theoretic description of nature is the concept of representations [27]. Group representations are automorphisms of vector spaces [28]. Representations can be used to represent (group) elements as invertible matrices so that matrix multiplication can represent the group operation [29]. In Physics, these help describe how the solutions of equations describing a physical system are affected by the symmetry group of the system [30]. Reducibility of representations is key to the basic physical building blocks for a certain physical model describing a system [31]. A subspace V_i of a vector space V that is invariant under group action is known as a subrepresentation. A representation is said to be irreducible (irrep) if the vector space has only two subrepresentations: the vector space itself as well as the zero-dimensional subspace (with the latter being neither irreducible nor reducible), while a representation is reducible if it has a proper subrepresentation of non-zero dimension. Finite group representations can be decomposed into a direct sum of irreps under the assumption that the characteristic of the field does not divide group size [32].

The modeling of a physical system relates to identifying a relevant representation for the system, which can help describe its characteristics and dynamics. Given the manner in which the degrees of freedom of physical systems remain within their protected subspaces, we can write a tensor sum of the representations associated with all these degrees of freedom to give us a resultant description of the state of a system. As a result, anything physical that exists can be written as a combination of representations for these distinct degrees of freedom. The representation of an object is present regardless of who or what determines it. If we define observation of a certain physical entity and its description using what is seen to be the most relevant representation as fundamental, one can use this procedural element to propose the underlying basis of existence itself. In this letter, this procedural element is defined as the unit of '*experience*'. Each representation is spanned by a complete set of vector-states, and therefore, these units of experience embody '*entirety*', with each representation associated with a group operation that is usually matrix multiplication when invertible matrices are utilised to define the representations.

III. RESULTS

The ontological premise discussed previously and the concept of units of '*experience*' that embody '*entirety*' can help define a fundamental entity $\odot$, which has been discussed previously. In previous works by *Guha Majumdar et al* [33] and *Josephson* [34], computational backgrounds and synergetic patterns were discussed. In the former, a background $\odot$ field was discussed as the computational background in which fluctuations arise that are 'self-selected'. This letter goes into the manner of undertaking the computation associated with this entity, which is not quite a 'field' but rather a fundamental entity that remains unchanging. This entity is characterised by the ontological premise of '*existence*' itself, besides '*experience*' and '*entirety*'. While the form of all three characteristics can vary, the essence of any of these do not. Anything that exists in nature has the capacity to represent other entities and objects in relateable constructs. For instance, a charged particle can experience the presence of other charged particles with the concept of the electric field, which defines the relevant representation and unit of 'experience'. The representation is complete in itself and does not require any external representation (and associated entity) to define or characterise it. A natural question can be: what is the most fundamental layer of reality that 'experiences'?

In this letter, the answer to this question is posited to be the aforementioned procedural element associated with observation and description using what is seen to be the most relevant representation for doing so, denoted by $\odot$. This is present beyond any instrument of the observation. More importantly, this procedural element of observation and representation has an inherent reflexivity in being able to observe and represent itself. Therefore, not only are objects describable in this manner but so are procedures and processes. In nature, this self-referential nature and self-corrections are visible in gluons, which lead to color confinement, flux-tubes and hadron jets [35–38]. By definition, any irreducible group-theoretic representation has the dual properties of orthonormality and completeness [39], with the procedural element of observation and representation not being constrained by temporality. While the form and dynamics of entities and processes are constrained by time, the essence of their meta-description is not. Also, since properties are associated with entities or processes, there can be no properties associated with the procedural element of observation and representation that informs us of the attributes of processes and entities in the first place. We can therefore write our first primary result,

> **R.1.** $\odot$ *is an unchanging and attributeless fundamental entity that is associated with observation and representation.*

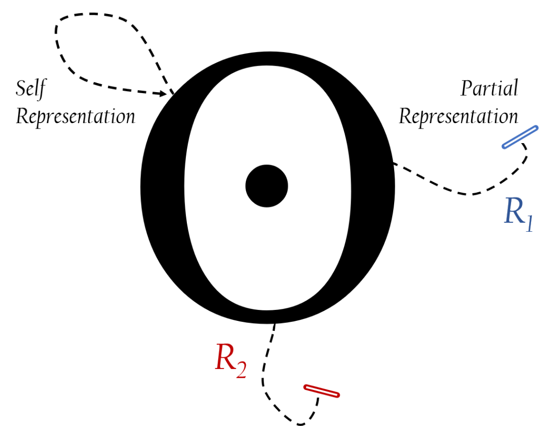

FIG. 1. The self-operation of the $\odot$ entity leads to either a successful self-representation or an unsuccessful partial-representation. In this illustration, we have two partial-representations R_1 and R_2

Any representation of the fundamental entity $\odot$ leads to the emergence of a descriptive structure of itself. If this is a perfect representation of itself, we can call it a self-representation. A self-representation can be represented as the zero-state for all possible degrees of freedom, processes or entities. Since $\odot$ is dimensionless, attributeless and unchanging, a self-representation can be denoted by a singularity - a zero-dimensional matrix. It can also be represented as an infinite-dimensional matrix, spanning all possible derivative degrees of freedom. In actuality, a self-representation of $\odot$ cannot be be even described in terms of degrees of freedom, since it precedes the emergence of any degree of freedom. If the normal operation of this entity is hindered, in the sense of considering errors in the manner in which the observation and representation takes place, we can, in principle, have various incorrect partial-representations, which can be denoted by finite-dimensional matrix representations. This perturbation can be regarded as a fluctuation in $\odot$, although that view is actually incorrect, since $\odot$ has no temporal evolution or dynamics. It is the appearance of a perturbation that we see, which, in turn, is self-selected by entanglement with all other perturbations in the fundamental unity, as we shall be discussing later in the letter. Whenever there is a self-representation, nothing emerges from the background unity while a partial-representation leads to a residual physical particle or force that arises and remains within the fundamental unity $\odot$, till it can be negated by its 'counter-representation' (that can negate the occupancy of the relevant degrees of freedom). For purposes of nomenclature, let us say that the hindrance of the normal operation of $\odot$ can be attributed to a procedural entity ξ.

> **R.2.** *The incorrect operation of the observational and representative aspect of $\odot$ leads to its partial-representations.*

Each of these partial-representations arise and remain as projections within $\odot$. These projections are what arise as physical particles, equipped with a certain tensorial state that encapsulates information of the various degrees of freedom that are relevant. The partial-representation are inherently $\odot$, albeit either different in size of the representation or the elements it contains. A partial-representation is what can be regarded as an incorrect 'awareness', which. A Spin(11,3)-based partial-representation can support a Grand Unified Theory based on Spin(10) and gravity based on the group Spin(1,3) [40]. Each of the partial representations themselves are equipped with the capacity to undergo self-representation or partial-representation. When a partial representation itself undergoes a partial representation operation, we find an erroneous replication of the original structure, usually in lower dimensions. This is what is seen as symmetry-breaking, when a larger symmetry group undergoes a breaking of its inherent symmetry.

> **R.3.** *Symmetry breaking and divergence of fundamental forces in nature are due to partial representations of $\odot$.*

Going by the proposed model, the movement from Spin(11,3) to either Spin(10) or Spin(1,3) groups is proposed to be a byproduct of the partial representation of Spin(11,3) at an early stage of the Universe.

Any object in nature inherently has the capacity to operate as $\odot$, albeit only upto limited degrees of freedom possessed by the object. It can only 'observe and represent' other objects or relate to processes that connect to the degrees of freedom that the object possesses. An electron, for instance, can only feel other electrically charged objects or exchange photons. It cannot undertake color-based interactions, as gluons and quarks can. To put it into mathematical terms, if we represent an initial state of two particles as $|A_1, A_2\rangle$, we can regard their interaction as the simultaneous 'observation and representation' of each other, which can be denoted by a function f, thereby giving

$$|A_1, A_2\rangle \to |A_1, f_2(A_1)\rangle + |f_1(A_2), A_2\rangle$$

Instead of the separable state initially, we see that we obtain a non-separable state. Given this universal tendency to 'observe and represent', entanglement and correlations seem to be a natural tendency, in nature. This may be a reason for the occurrence of increasing entropy and the arrow of time in the Universe [41]. Recently, it was discovered that objects can reach equilibrium, or a uniform energy distribution state, within a fairly long amount of time by undergoing quantum entanglement with their surroundings, thereby implying that the stability and equilibrium in nature is also due to the inherent nature of $\odot$ [42].

IV. CONCLUSION

In this paper, we have posited the triadic formulation of a fundamental unity $\odot$ that has the capacity to 'observe and represent'. In doing so, it can have self- or partial-representations that give rise to the various different kinds of mathematical structures that underly the physical systems and forces of nature.

V. ACKNOWLEDGEMENTS

I would like to thank Prof. Brian Josephson for our insightful discussions that helped in shaping this letter.

[1] J. Schaffer, The internal relatedness of all things, Mind **119**, 341 (2010).

[2] C. S. Chihara, *Constructibility and mathematical existence* (Oxford University Press, 1990).

[3] S. Shapiro, *Philosophy of mathematics: Structure and ontology* (Oxford University Press on Demand, 1997).
[4] M. Omelianovsky, On the principle of observability in modern physics, Foundations of Physics **2**, 223 (1972).
[5] S. Kak, Observability and computability in physics, Quantum Matter **3**, 172 (2014).
[6] M. Bunge, *Treatise on basic philosophy: Ontology I: the furniture of the world*, Vol. 3 (Springer Science & Business Media, 1977).
[7] M. Bunge, *Treatise on basic philosophy: Ontology II: A world of systems*, Vol. 4 (Springer Science & Business Media, 2012).
[8] B. P. Göcke, What is physicalism?, Ratio **22**, 291 (2009).
[9] B. Montero and D. Papineau, A defence of the via negativa argument for physicalism, Analysis **65**, 233 (2005).
[10] K. Bennett, Global supervenience and dependence 1, Philosophy and Phenomenological Research **68**, 501 (2004).
[11] T. Maudlin, On the unification of physics, The Journal of Philosophy **93**, 129 (1996).
[12] P. S. Wesson, Clue to the unification of gravitation and particle physics, Physical Review D **23**, 1730 (1981).
[13] D. Z. Freedman and P. Van Nieuwenhuizen, Supergravity and the unification of the laws of physics, Scientific American **238**, 126 (1978).
[14] J. E. Beichler, The point of unification in theoretical physics, 20th Natural Philosophy Alliance Proceedings , 9 (2014).
[15] A. Shimony, Role of the observer in quantum theory, American Journal of Physics **31**, 755 (1963).
[16] J. A. Wheeler and W. H. Zurek, *Quantum theory and measurement*, Vol. 53 (Princeton University Press, 2014).
[17] A. Nesteruk, A “participatory universe” of ja wheeler as an intentional correlate of embodied subjects and an example of purposiveness in physics, Journal of Siberian Federal University-Humanities and Social Sciences **3**, 415 (2013).
[18] J. A. Wheeler, Toward “it from bit”, Quantum Coherence , 281 (1992).
[19] J. A. Wheeler, *Information, physics, quantum: The search for links* (CRC Press, 2018).
[20] G. L. Sopa, The special theory of pratītyasamutpāda: the cycle of dependent origination, Journal of the International Association of Buddhist Studies , 105 (1986).
[21] A. Yaghmaie, On the problem of relation without relata, Journal of Philosophical Investigations **14**, 404 (2021).
[22] P. Mulders, Emergent symmetries of the standard model, Physics Letters B **787**, 193 (2018).
[23] R. Horodecki, P. Horodecki, M. Horodecki, and K. Horodecki, Quantum entanglement, Reviews of modern physics **81**, 865 (2009).
[24] M. B. Plenio and S. S. Virmani, An introduction to entanglement theory, Quantum information and coherence , 173 (2014).
[25] L. Husdal, On effective degrees of freedom in the early universe, Galaxies **4**, 78 (2016).
[26] W. R. Scott, *Group theory* (Courier Corporation, 2012).
[27] J. Ping, F. Wang, and J.-q. Chen, *Group representation theory for physicists* (World Scientific Publishing Company, 2002).
[28] D. Bump, *Automorphic forms and representations*, 55 (Cambridge university press, 1998).
[29] D. E. Littlewood, *The theory of group characters and matrix representations of groups*, Vol. 357 (American Mathematical Soc., 1977).
[30] J. Elliott and P. Dawber, *Symmetry in Physics, Volume 1 and 2* (Macmillan, 1979).
[31] W. Ludwig and C. Falter, *Symmetries in physics: group theory applied to physical problems*, Vol. 64 (Springer Science & Business Media, 2012).
[32] D. Passman, It’s essentially maschke’s theorem, The Rocky Mountain Journal of Mathematics **13**, 37 (1983).
[33] M. Guha Majumdar, Unified field: How self-selected fluctuations can underlie reality, Researchgate , 1 (2020).
[34] B. D. Josephson, Beyond the’theory of everything’paradigm: synergetic patterns and the order of the natural world, Philpapers , 1 (2021).
[35] D. E. Kharzeev and E. M. Levin, Color confinement and screening in the θ vacuum of qcd, Physical review letters **114**, 242001 (2015).
[36] A. R. Swift and J. L. R. Marrero, Color confinement and the quantum-chromodynamic vacuum, Physical Review D **29**, 1823 (1984).
[37] H. Suganuma, S. Sasaki, and H. Toki, Color confinement, quark pair creation and dynamical chiral-symmetry breaking in the dual ginzburg-landau theory, Nuclear Physics B **435**, 207 (1995).
[38] T. Hansson, K. Johnson, and C. Peterson, Quantum-chromodynamic vacuum as a glueball condensate, Physical Review D **26**, 2069 (1982).
[39] W.-K. Tung, *Group theory in physics*, Vol. 1 (World Scientific, 1985).
[40] A. G. Lisi and J. O. Weatherall, A geometric theory of everything, Scientific American **303**, 54 (2010).
[41] S. Lloyd, *Black Holes, Demons and the Loss of Coherence: How complex systems get information, and what they do with it*, Ph.D. thesis, Rockefeller University (1988).
[42] N. Linden, S. Popescu, A. J. Short, and A. Winter, Quantum mechanical evolution towards thermal equilibrium, Physical Review E **79**, 061103 (2009).