



Extended Abstract

SYMMETRY AND INFORMATION: BROTHERS IN ARMS

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1. Introduction. Rationale

The description of this Session included many goals or questions, of which I discuss two here: 1) what do we consider physical information? 2) What are the roles of different appearances of symmetries in taking a stand on these questions? In a recent paper [1], based on a contribution I made to an Essay Contest on the subject, I discussed whether information or energy was more fundamental in the universe [2]. My answer (which did not win a prize), published elsewhere [3], was that energy was definitely more primitive than information as bits, but that energy and information as difference in energy emerged together from an unknown substrate, perhaps the quantum vacuum. Subsequently, energy and information always accompany one another. They follow the extension of logic to real processes or systems that I have called Logic in Reality (LIR) [4]. LIR is grounded in the dualistic properties of energy and applies to the evolution of complex processes at biological, cognitive and social levels of reality.

A direct relationship between energy and information has been established by Gerhard Luhn in his Causal-Compositional Concept (CCC) of information [5]. In this conception, the first change of state of any kind in the universe resulted in a non-uniform energy-density distribution, thus a new form. From this follows a Compositionality Principle that states if that there are fundamental processes in the Universe (the 2nd Law of Thermodynamics; the Pauli Exclusion Principle) and that they interact at all, this principle was itself new irreducible information or a basic principle of the universe, the basis for all subsequent processes of the emergence of form and structure. The new form thus results in a further unequal distribution of energy, and the meaning or content of this new form are the activities which this non-equilibrium distribution of energy induces, which appear as new laws. The universe appears to operate in such a way as to increase the number of new states or laws, that is, information.

Unlike standard bivalent and multi-valent linguistic logics and their mathematical equivalents, LIR is not topic-neutral but founds an ethics. It is therefore relevant to the development of an information commons in which information is a carrier of value, even at the lowest level as in the concept of Luciano Floridi [6]. Accordingly, theories which support or add credibility to the dialectical physical approach of my logical system *ipso facto* also support its application in the ethical domain.

2. Symmetry-Forming (In the beginning . . .)

The key postulate of LIR is that any element of an energetic process A is always accompanied, logically and functionally, by its opposite or contradiction non-A but only to the extent that when A is predominately actual (or present or active), non-A is always predominantly potential, alternately and reciprocally, without either ever going to the ideal limit of 0 or 1. The mid-point of equal actuality or potentiality is one of maximum opposition from which new entities may emerge at higher levels of reality or complexity.

Is it appropriate, then, to consider the relation between Symmetry and Asymmetry, defined as the absence of Symmetry, as an abstract one, or is there is real tension or energy exchange between the parts of a system displaying symmetries in a real temporal (energetic) sequence? One of the corollaries of the LIR system is that it is not necessary that these two issues be completely disjunct, unless we are discussing purely formal or abstract geometric Symmetry.

My proposal for discussion is that indeed Symmetry ‘was’ more fundamental, but it was so in a state of the universe about which we can only speculate. Assuming it is meaningful to ascribe Symmetry to what as far as we know now was an *undifferentiated* entity of some kind, singularity or not, one could then say that the ‘first’ Symmetry-Breaking was the emergence of particle-fields as we know them. We thus have a picture of Asymmetry as being ontologically secondary to Symmetry in our world. Energy, information, Asymmetry and *difference* all emerged together from an unknown substrate, making the difference that *really* made a difference! Symmetry then re-emerged (was actualized) when the universe ‘cooled down’, and the Asymmetry that was potentialized was re-actualized in the evolution of real processes associated with the appearance of mass.

Roger Penrose has developed a Conformal Cyclic Cosmology [7] which describes the possibility of smooth movement from an ‘old’, diffuse universe to a ‘new’ condensed one *via* a singularity. Matching of the disparate physical dimensions is possible due to conformal invariance, but as one moves to the new state, the Symmetry of fields corresponding to conformal invariance may not be true in a quantum context, as new rest mass begins to appear. This supports a speculation that the singularity, which does not have to be of infinitesimal size in this theory, possesses spherical symmetry which is then broken before the new symmetries appear.

3. Symmetry, Anti-Symmetry and Asymmetry

Like information, Symmetry is a complex metaconcept with both ontological and epistemological references to phenomena. Following Darvas, I will consider that Asymmetry is the conjunction of Symmetry and Anti-Symmetry. In particle physics, some particles will be characterized by symmetric wave functions (bosons) and others, for example fermions, by anti-symmetric wave functions. The most primitive example of Anti-Symmetry is in the wave functions of fermions

(electrons) as expressed in the Pauli Exclusion Principle. Since this principle is ultimate ground of all real physical difference and the formation of complex chemical structures, one can say that our existence, let alone information, depends on that of Anti-Symmetry.

According to the ontological viewpoint, symmetries are a substantial part of the physical world, their theories representing properties (capacities for action) existing in nature or characterizing its structure. The epistemological aspect of symmetries is related to our ignorance of laws of nature; we use Symmetry principles to search for and hopefully discover them. Brading and Castellani [8] concede that aspects of Symmetry may be used to support either an ontological or an epistemological account, but I feel the emphasis given here is incorrect. Rather than focusing and/or trying to opt for one or the other, one might consider a picture in which both are partly correct, as suggested by Logic in Reality.

As with information, also, the mind moves back and forth between the aspect of Symmetry which is primarily active or actualized and the other, as above, alternately and reciprocally. Brading and Castellani state that many physical phenomena can be explained as direct or indirect consequences of 1) Symmetry *principles*, with an explanatory role based in a hierarchy of physical theories, or 2) Symmetry *arguments*, used especially in the area of Symmetry-Breaking (Cf. Section 4).

4. Symmetry-Breaking

Symmetry-Breaking was first explicitly studied in physics to explain the physical occurrence of the phenomena on the basis of the Symmetry-Asymmetry of the situation. Explicit Symmetry-Breaking is a well-studied process in quantum mechanics, for example in parity. Spontaneous Symmetry-Breaking (SSB) will be discussed in another paper in this Conference, but SSB gives a way of understanding the complexity of nature without renouncing fundamental symmetries – or Symmetry as fundamental? In [8], the questions are asked why we should prefer symmetric to asymmetric fundamental laws, in other words, why assume that an observed Asymmetry requires a cause – asymmetric initial conditions or any form of Symmetry-Breaking? In SSB [8] the symmetry of the ‘cause’ is not lost, but is preserved in the totality of the outcomes (the ‘effect’). This apparent partial overlap between cause and effect should be a signal that the concepts of cause and effect themselves may follow some interactive pattern in their evolution. Following Lupasco, I have suggested [4] a contradictorial picture of cause-effects that applies at both the physical and theoretical levels. Among the classical examples of Symmetry cited in [8] are situations or processes, such as rest - motion which may display a certain Symmetry. Breaking of this Symmetry cannot happen without a cause, that is, no Asymmetry can arise spontaneously. This position, not unsurprisingly, is that of the anti-realist van Fraassen and it begs the question of the origin of any ‘first’ Symmetries and of their breaking. I see the sole of the existence of the Symmetry – Asymmetry pair as a further exemplification of the underlying duality of the universe.

As to *why* asymmetric fundamental laws are preferred and Asymmetry, as it is created in real thermodynamic systems gets much less attention than Symmetry except as a negation, according to Lupasco, Symmetry has the properties of an *identity* and people like identities. This is an inevitable logical consequence of our existence as biological – read mortal – entities. Similarly, Lupasco saw all 20th Century science as a search for invariants, to the exclusion of their opposites. This may be human but it is not good science. It is often said that the physical world appears asymmetric to us, but that that

does not necessarily mean that Asymmetry belongs to the fundamental laws of nature. Perhaps, but it does not mean that Asymmetry may *not*, especially if it can be seen as operating dually with Symmetry. In this perspective, the discussion of the Symmetries in particles and Einsteinian space-time Symmetry become *a posteriori*. Once Symmetry is in hand so to speak, it can or must be broken for the universe to evolve.

5. Symmetry and Information

I find the subject of Symmetry in relation to Information extremely interesting in principle. However, the mathematically knowledgeable authority on information, Mark Burgin, makes no reference to Symmetry in his major compendium, *Theory of Information* [9]. Other authors, for example Terrence Deacon [10], stress the *Asymmetry* of the thermodynamic changes involved in or which constitute information.

Today, does it make sense to talk about Symmetry principles applied to information and complex cognitive processes, such as this Conference? I think not, basically because the concept adds no new information, no new laws in Luhn's terms, that are not already explicitly present or the consequence of the same emergent cognitive processes involved in other subjects. The cognitive process involved in my finding symmetrical patterns esthetic is not itself symmetrical, and if it is termed asymmetrical, then every process is asymmetrical and the term becomes vacuous. Use of the phrase 'symmetrical behavior', similarly, would force Symmetry to have a purely semiotic meaning as a classification of the epistemological similarities between processes that has no further ontological purport.

What remains to be explored, however, is the nature of the information present in complex systems that display both Symmetry and Anti-Symmetry. From this point of view, one may imagine that additional 'non-classical' information is encoded as a consequence of the joint presence of entities whose form is congruent (the Yin-Yang picture) but whose reference is to an opposition between them as instantiating conflicting properties. This is another expression of the fundamentality of the dualist Principle of Dynamic Opposition in Logic in Reality. I wish to assure the reader, however, that nothing mystical intended here about the information that is encoded and decoded by the observer. The information in the encoding is present as a pattern of physical potentialities and its decoding results in a pattern of physical cognitive changes – 'meaning-as-process'.

6. Conclusion

Information and Symmetry/Anti-Symmetry are brothers-in-arms, 'born' together with energy when our world became our world, but their relative roles have changed. Today, Information is hard at work, while Symmetry/Anti-Symmetry has retired to a somewhat more scientific and esthetic life. We now know that Symmetry must be taken into account in science, *e.g.*, in any attempt to make meaningful statements about the emergent dynamics of our world at the fundamental level of quantum and non-quantum physics. Symmetry or the absence of it in biological structures is an important component of discussions on how they emerge, evolve and function.

The concept of Symmetry, which should be understood as Symmetry-Asymmetry and Symmetry/Anti-Symmetry, however, does support a scientific picture of the underlying duality of the

universe. As mentioned, I have shown elsewhere that the related Principle of Dynamic Opposition provides a non-transcendental grounding for ethics. The question, then, is how to best express the importance of Symmetry studies for the Information Society as well as Information Science. Given their difficulty, how can Symmetry principles contribute to the achievement of a new common informational good? I would be happy to learn.

References and Notes

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