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INCONSISTENT PHYSICS

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Abstract. A number of works have been devoted to the viability and interest of Inconsistent Mathematics but to this day fewer comparable efforts have been made in the direction of physics. A few physical topics are here described in which the presence of contradictions is indisputable and crying for a different logical treatment. The argument relies on two facts. First, antinomies are not necessarily generated by negation: the conjunction of two opposite statements can generate an antinomy as well. Second, this antinomicity by opposition descends to the level of concepts — terms and relations — which become antinomic when attached to their opposites. Each basic category of thought, for example, is unthinkable and meaningless without being taken in conjunction with its opposite category. They are all necessarily antinomic. Here, indeterminism, nonlocality, and emptiness, in particular, are presented as such eminently antinomic physical concepts.

Keywords: Indeterminism; nonlocality; emptiness.

1. Purpose

Most physicists, including theoretical ones, are essentially pragmatic. They accept any conception that brings verifiable results no matter how strange and even contradictory may appear to traditional ways of thinking. That particles also behave like waves seemed at the beginning of quantum wave mechanics a very odd starting point. Today it is seen as a productive idea that matches the facts. Now, contradictions are of two kinds, one that pertains to statements, and another that applies to terms and relations. "I am lying" is the typical example of a contradictory statement, a sentential antinomy that is both true and false at the same time. But the conjunction of opposite statements, both true, also generate a contradiction, an antinomy in a more general sense. Indeed, a conjoined opposition is a general form of antinomicity. "Less than" and "greater than" are opposite predicates, not necessarily definable one from the other in terms of negation. In an antinomic model of number theory, a can be less than and also greater than b, i.e., $a < b$ and $a > b$ be both true; $((a < b) \,\&\, (a > b))$ is then an antinomy based on just opposition, not on opposite truth values as it is the case with the liar's paradox.

But antinomicity does not limit itself exclusively to statements, concepts can be antinomic as well — terms, and relations. "Being-and-not-being" is an antinomic term, with negation functioning as a term operator. However, negation is not indispensable to generate antinomic terms or relations, opposite concepts which are

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unthinkable each by itself can also generate antinomicity by a term negation. "One" is unthinkable without "many," we have its opposite in mind whenever we think of either: they constitute the antinomic term "one-and-many". So it is the case with "part" and "whole", "identity" and "difference", etc. In fact, every basic category of though, be a term or a relation, has of necessity its opposite as a semantic component. "Vicious circles" — to define or determine the term or relation A using the term or relation B, and then vice versa — are an inescapable antinomic fact of any intellectual beginning. "Particles" and "waves" are opposite terms in physical reality. Their being sewn together into an indivisible complex term, a real, existent "vicious circle", establishes a working way of extracting new properties from nature.

Here we propose to look at three current conceptions of physics which are eminently contradictory, each making of physics an inconsistent discipline that harbors at critical points antinomic ways of thinking about physical reality. They are: Indeterminism, Nonlocality, and Emptiness. Each of these concepts brings with it its own kind of antinomicity. Each is now an inescapable fact of life in quantum physics. But none of these conceptions is absolutely new in human thinking. I shall add examples of their having being asserted long before in contexts other than physics. The nontraditional has been assiduously accepted whenever and wherever it was found to be true and productive.

2. Indeterminism

"Indeterminism" means that the same constellation of causes can create different results. It is an almost universal consequence of quantum mechanics, where the fundamental equation due to Schrödinger determines the probability that, say, an electron be occupying a definite position in space, an essential probability, not a mere statistical estimate of an underlying determinism. In fact, the electron has no definite position, spreading throughout a neighborhood several times larger than the size of the electron, a spread of indeterminate locations. However, the idea of a concealed underlying determinism is not dead. Few support the idea of "hidden variables", variables which would help describe the deep patterns that ultimately govern the physical processes in a thoroughly deterministic way. This idea might be more widely accepted except for the fact that the existence of hidden variables implies nonlocality, an even more startling conception than indeterminism as we shall see.

That indeterminism applied to world and mind is an antinomic concept should be obvious. Absolute indeterminism is tantamount to absolute chaos, and we know that neither world nor mind are absolutely chaotic. Absolute determinism is equivalent to the total absence of novelty, no creative mind, no biological evolution, no

physical uncertainty, all these going against the evidence. Indeterminism can only be conceived usefully as an antinomic conjunction of creativity and causality, each present in every instance with a certain degree. We thought that creativity is what separates life, especially conscious life, from inert nature. Now quantum mechanics has extended creativity to the world of inert nature as well. "At certain moments, nature makes a choice", said Paul Dirac (Cassirer 1966, p.119). Even "creation and annihilation operators" for electrons, positrons, and photons have been introduced to describe their appearances and disappearances.

The notion of creativity has been around from centuries. Enlightenment, the so-called "aha" experience are its most obvious psychological forms. But we must realize that whenever the concepts of indeterminism and essential probability have been seriously advanced they implied a certain degree of creativity whichever the area of discussion was the one being dealt with.

3. Nonlocality

The term "nonlocality" refers nowadays to the way quantum entities influence and are influenced by actions taking place anywhere in the universe — instantaneously. We could say that nonlocality is a form of indeterminism. We clearly distinguish in our minds here from there, this is obvious with our pervading conception of space based on the Cartesian frame of reference. But this frame is an abstraction, nature chooses to brush aside the difference between here and there: it turns out that here is also there and vice versa.

The real character of nonlocality has been verified experimentally (the Alain Aspect experiment), and it is the most egregious phenomenon clamoring to be reconciled with the rest of physical theory. According to nonlocality, the universe functions at some level independently of distance from instant to instant. At that level, the quantum particle **A** functions — has location — on all other particles of the universe. This ubiquity of interactions was already known and accepted as a fact within the scope of a given field of forces. Michael Faraday, who introduced the notion of field in 1844, viewed pieces of matter not only as mutually penetrable, but each atom extending throughout the whole solar system, yet always retaining its own center of force. He compared the interpenetration of two atoms to the coalescence of two distinct waves which, though blended into a single mass, preserve their individuality (Tyndall 1870, pp.151–2). In a field of forces, each local action is felt throughout the field at the same time that the whole distribution of forces of the entire field is felt in every local region. The whole is in each of its parts, *is* part of each of its parts, and each part is everywhere. The same can be said of the physiology of a living organism. Each living organ affects all other organs, but the

influence of organ *A* on organ *B* takes place by "a detour through the whole", to use the wonderfully descriptive expression of Kurt Goldstein's (Goldstein 1963, p.316). But one should add that there are changes that take place in the whole which are not discernable in the part and which mark the difference between physiology and anatomy. This role of the whole as a specially creative organizational instrument is observed also in physics. The physicist Philip Anderson in an article titled "More is Different" makes the point that new properties emerge when parts assemble into a larger whole, properties which were not present in the parts: "At each level of complexity entirely new properties appear" (Anderson 1972, p.393; see also Laughlin 2005, *passim*). It seems natural to assume then that nonlocality, acting by a detour through the whole, brings differences to each quantum entity.

We should remark that nonlocality was asserted of space itself earlier. Alfred North Whitehead stated in 1925 that although volumes can be analyzed into subvolumes and each of the latter be thought of as a multiplicity of points, this is only a product of the abstract imagination. The volumes of space have no independent existence, each is something from the standpoint of every other part of space, and every other part of space is something in relation to it. "Thus if *A* and *B* and *C* are volumes of space, *B* has an aspect from the standpoint of *A*, and so has *C*, and so has the relationship of *B* and *C*. This aspect of *B* from *A* is of the essence of *A*". The aspect of *B* from *A* enters into the composition of *A*. Whitehead adds that he can use Leibniz's language and say that "every volume mirrors in itself every other volume in space" (Whitehead 1967, pp.64–5).

Let me call this last version and all other versions of nonlocality instances of a "principle of multiple location", the principle that portions of space and of many physical and biological entities have location everywhere in their domain of existence beyond the volume each seems to occupy at first sight. This applies to space even if we think of it abstractly as a multiplicity of points, but it applies as well if we think of space as a multiplicity of "lumps" of size no smaller than Planck's length, the minimum possible size for which space makes sense in quantum mechanics. According to this principle, distance is an abstraction, and so ultimately is size.

The principle has been sustained before at various times in history. Anaxagoras said "In everything there is a portion of everything". Then Proclus asserted that some wholes are part of their parts. In Buddhism one finds statements such as "The large and the small can mutually contain each other... Since the very small is very large, Mount Sumeru is contained in a mustard seed; and since the very large is the very small, the ocean is included in a hair" (Chen Kuan, quoted in Chang 1974, p.165). In the Hua Yen School of Buddhism the well-known image of "Indra's pearls has also played a role in pointing out the relativity of size. The image goes as follows: In Indra's heaven there is an infinite net of threads. At each intersection of these threads there is a reflecting pearl on whose surface all other pearls, infinite in number, are

reflected, but not only each other pearl is reflected, so are also all the reflections of other pearls in each reflected pearl, as well as the reflections in each such reflection, and so on ad infinitum. This represents what in the mathematical theory of chaos is called a "fractal", a pattern repeated endlessly in ever-smaller and ever-greater configurations. But even before the notion of fractal was introduced, the geometer Felix Klein discovered in the nineteenth century that "an infinite number of tiles can be fitted into an enclosed finite area, clustering together as they shrink down to infinite depth, [even though] the imagination seems to fail utterly when we try to form a mental image of the result" (Mumford et al. 2002, p.xvi). Hence, since in every part there is room for the entire whole to fit in, it seems natural to conclude that "each object in the world is not merely itself but involves every other object and in fact *is* everything else" (Charles Norton Eliot quoted in Mumford et al. 2002, p.xix, italics in the original).

4. Emptiness

According to present physical cosmology what is perceived as empty space has density, therefore mass, spontaneous activity, and structure. For Frank Wilczek, "it is the primary reality of which matter is a secondary manifestation" (Wilczek 2008, p.73). He called this empty space "the grid", an important effective factor in the mechanics of the subatomic world. In his words: The grid is "the entity that we perceive as empty space. Our deepest physical theories reveal it it to be highly structured; indeed, it appears as the primary ingredient of reality" (2008, p.231). This is the empty space of quantum mechanics. In relativity theory there is a different view. The empty space of relativity hosts matter and energy which in return induce a curvature of space. This relativistic curved space is one in which parallels do not exist, all lines intersect. In turn, this curved space determines all by itself the motion of objects: gravity and movement are both governed by space. Hence, also in relativity theory empty space is not unmitigated nothingness; having been curved by matter and energy, space becomes a factor in determining the dynamics of the world, causing the way bodies move in the universe and along which lines. Let us emphasize: according to relativity, gravitation is the warps and curves of space-time.

In any case, both the quantum and the relativistic conceptions of emptiness are antinomic. In both cases, the emptiness of emptiness is a matter of degree. In both conceptions, emptiness acts and functions as something, and anything that acts and functions as something is something to a degree.

The Middle-Way School of Buddhism sustains that at the bottom of reality there is only emptiness, that reality itself is empty, but although it asserts that emptiness is not something, it also claims that emptiness is not unmitigated nothingness. We are

then in the presence of an antinomic concept not much different in this form from the emptiness of physics. Given that the emptiness of the Middle Way is meant not to be something at the same time that it is also meant not to be nothing, how can it be conceived and perceived? Could a method of indefinite semantic purification do? A kind of "negative theology"? Here the problem is that such method is also used to reach not an ultimate void of sorts but an absolute being like Vedanta's Brahman. How to distinguish a formless emptiness from a formless Brahman? The Middle Way ultimate position is that words should be set aside and call for a direct enlightenment to grasp that absolute emptiness which even if it is not something it is also not nothing. Remarkably, the words that brought about the perplexing antinomy of emptiness are to be cast away as illegitimate instruments of any clarification. An inconsistent behavior to be sure. As to the process of indefinite elimination, nothing can guarantee in advance what the outcome will be. The famous chemist Robert Boyle invented the vacuum pump with which he pulled the air out of a bottle. He claimed to have obtained in this way a small space of nothing, a true vacuum, contradicting Descartes and Leibniz who had asserted before that an absolute vacuum does not exist. But it was Thomas Hobbes who arguing against Boyle asserted that it could never be said that the vacuum pump would be able to remove everything out of the bottle.

5. A Final Remark

In the three inconsistent concepts we have briefly described the notion of degree was mentioned. Physical indeterminism owes its antinomicity to the fact of being a conjugation of a degree of creativity with a degree of causality. Nonlocality is antinomic in that it conjugates a degree of simple location (without which we would lack a handle to apprehend the world) with a degree of multiple location, whose reality we live and sense constantly. As for emptiness, it is of course true to a degree to say that Boyle's bottle is empty, but it is not completely true to say that it is fully empty. Degrees of truth and falsity are the centerpiece of "Fuzzy Logic" and "Fuzzy Mathematics", both having proved to be eminently successful in systematizing and applying conceptions that humanity has held obscurely from time immemorial. Now, Lofti Zadeh has distinguished between degrees of possibility and degrees of probability. Useful as both concepts are, they may suggest that the degrees in antinomic conceptions are necessarily mere potentialities, covering up what ultimately is due to incomplete information. This is far from being the case. The degrees we have referred to are not mere potentialities, they are actual characteristics of thought and of the reality we try to comprehend and describe. Degrees are real degrees of gradual properties and gradual relations, existing aspects of existing entities; there is nothing

potential in this way of conceiving degrees even when we must approximate them through subjective evaluations. Thus, for the emptiness of the Buddhist Middle Way to make sense we must conclude that it is empty to a degree and to another degree it is also something. It could not possibly have all the transcendental powers attributed to it if it were, above everything, a true void.

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Resumo. Um certo número de trabalhos foi dedicado à viabilidade e interesse da matemática inconsistente, mas até hoje poucos esforços comparáveis foram feitos no que diz respeito à física. Alguns poucos tópicos de física são aqui descritos no qual a presença de contradições é indisputável e clama por um tratamento lógico diferenciado. O argumento baseia-se em dois fatos. Primeiro, antinomias não são necessariamente geradas por negação: a conjunção de dois enunciados opostos pode igualmente gerar uma antinomia. Segundo, essa antinomicidade por oposição desce ao nível dos conceitos — termos e relações — que se tornam antinômicos quando ligados a seus opostos. Cada categoria básica do pensamento, por exemplo, é impensável e sem significado se não tomada em conjunção com sua categoria oposta. Todas elas são necessariamente antinômicas. Aqui, indeterminismo, não localidade e vazio, em particular, são apresentados como conceitos físicos eminentemente antinômicos.

Palavras-chave: Indeterminismo; não localidade; vazio.