

Beyond the Cookie Cutter Paradigm¹

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What makes it so hard to make sense of quantum mechanics (the theory at the heart of contemporary physics) is the cookie cutter paradigm (a fallacy that is both rooted in our neurophysiological make-up and inherent in the nature of mental consciousness) according to which the world's synchronic multiplicity derives from surfaces that carve up space in the manner of three-dimensional cookie cutters. When liberated from this fallacy, quantum mechanics not only describes the physical world as a manifestation of something very much like the Vedantic Brahman but also describes the process by which this manifestation is effected. It implies that the creative principle to which the physical world owes its existence is supramental rather than mental, in agreement with Sri Aurobindo's ontology.

The “cookie cutter paradigm” (or CCP, for short) is the idea that the multiplicity of the world at any one time rests on surfaces that carve up space in the manner of three-dimensional cookie cutters. This idea seems self-evident. The parts of any material object—including the material world as a whole—are defined by the parts of the space it “occupies”, and the parts of space are defined by delimiting and separating surfaces.

We live in two worlds, at the least. There is the *phenomenal* world—the world as we perceive it,—and then there is the *physical* world—the world as described by present-day physics.

The phenomenal world conforms to the CCP, for two reasons. First, the CCP is hard-wired: The way in which the brain processes visual information guarantees that the result—the phenomenal world—is a world of objects whose shapes are bounding surfaces. Visual representations arise by way of an analysis of the visual field that capitalizes on contrast information. Data arriving from homogeneously colored and evenly lit regions of the visual field do not make it into conscious awareness. Such regions are filled in on the basis of contrast information across their boundaries. (This explains, among other things, why the blind spot goes unperceived whenever it lies in such a region.) Thus the phenomenal world is assembled from boundaries, and its parts are bounded regions of space.

The second reason why the phenomenal world conforms to the CCP lies in the nature of mind, or mental consciousness. This is the deeper reason, for the brain works as it does because the mind works as it does—and not the other way

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round, as we are prone to think. In Sri Aurobindo's words, "the brain is not the creator of thought, but itself the creation, the instrument and here a necessary convenience of the cosmic Mind".²

In the Aurobindonian scheme of things, the world is an evolving manifestation of an ineffable original Reality, Brahman. Mind is the highest creative principle hitherto evolved but not by any means the highest. The original creative principle and dynamic link between Brahman and the world is supermind. The creative action of the supermind is primarily qualitative and infinite and only secondarily quantitative and finite. Mind is the agent of this secondary action—limiting, defining, dividing, individualizing. Here is how Sri Aurobindo describes the characteristic action of mental consciousness:

Mind in its essence is a consciousness which measures, limits, *cuts out* forms of things from the indivisible whole and contains them as if each were a separate integer. Even with what exists only as obvious parts and fractions, mind establishes this fiction of its ordinary commerce that they are things with which it can deal separately and not merely as aspects of a whole.... It is this essential characteristic of Mind which conditions the workings of all its operative powers, whether conception, perception, sensation or the dealings of creative thought. It conceives, perceives, senses things *as if rigidly cut out from a background or a mass* and employs them as fixed units....³

This characteristic action of mental consciousness is the real reason why the phenomenal world conforms to the CCP: Mind conceives, perceives, senses things as if rigidly cut out from a background or a mass.

What about the physical world—the world as described by present-day physics? Interestingly, this does *not* conform to the CCP. If it did, the parts of matter would be defined by the parts of space; the parts of space would be logically prior to the parts of matter; and so they would exist independently of matter. Physical space would be *intrinsically* divided. Moreover, since it is in the nature of mental consciousness to deal with parts as if they were things that exist by themselves, rather than by virtue of some process of division or differentiation, physical space would be *infinitely* divided if it did conform to the mental outlook. The idea that *all* parts of space exist by themselves inevitably leads to idea that space is made up of indivisible parts, or points.

If physical space were intrinsically and infinitely divided, all conceivable spatial distinctions would have an unconditional reality (that is, they would be real for every material object at any time), and one of the following three statements would necessarily be true for any material object M contained in the union of two separate regions A and B:

- (1) M is inside A;
- (2) M is inside B;

² Sri Aurobindo, *The Life Divine*, SABCL Vol. 18, p. 256 (Sri Aurobindo Ashram, Pondicherry, 1970).

³ *Ibid.*, p. 162, italics added.

(3) M has two parts, one inside A and one inside B.

Yet sometimes all three statements are false. This means that physical space cannot be something that is intrinsically and infinitely divided; and it also means that the physical world does not conform to the CCP. An object can be inside the union of A and B without being in A only and without being in B only and without being partly in A and partly in B.

The two-slit experiment with electrons is a case in point. The existence of interference fringes tells us that each electron goes through the two slits *without* going through the left slit, and *without* going through the right slit, and *without* being divided into parts that go through different slits.

The possibility of this strange behavior rests on the fact that physical space is not something that is intrinsically divided. Spatial distinctions have a *contingent* reality. The distinction we make between two regions of space is real for certain objects at certain times and is nonexistent for other objects or at other times. If an actual event indicates the slit taken by an electron, the distinction we make between the regions defined by the slits is real for the electron, and the electron goes through the indicated slit. On the other hand, if there isn't any actual event from which the slit taken by the electron can be inferred, that distinction has no reality for the electron, and this is why the electron can and does go through the two slits without going through either slit in particular and without being divided by its passage through the slits.

The fundamental physical theory that correctly describes, among other things, the strange behavior of electrons in two-slit experiments, is quantum mechanics. It is common knowledge that the interpretation of quantum mechanics is controversial, to say the least. Most physicists, tired of discussions of interpretational issues, take an instrumentalist stance. For them, quantum mechanics concerns statistical regularities in the behavior of measuring instruments, and any attempt to go beyond the "brute facts", to give an account of how it is that the statistical regularities predicted by quantum mechanics come out the way they do, is idle metaphysics. This attitude appears justified by the bizarre views held by those who purport to give such an account. (One of the least bizarre of those views is the popular misconception that quantum mechanics involves the consciousness of observers in some essential way.)

As I see it, the root of the problem is the CCP, or the nature of mental consciousness, or the way our brains deal with visual information and visual imagery. (There is mounting evidence that the same neural processes are involved in the production of both visual percepts and visual images.) We are mentally as well as neurophysiologically disposed to interpret the mathematical formalism of quantum mechanics along lines laid down by the CCP, but this simply doesn't work; for the CCP makes us treat spatial distinctions as real *per se*, as having an *absolute* reality, whereas quantum mechanics tells us how spatial distinctions *arise*, and this cannot be understood without acknowledging their *contingent* reality, and thus without going beyond the CCP.

The contingent reality of spatial distinctions has far-reaching consequences for the spatial aspect of the physical world and for the shapes of the things it contains. Let us now try to conceive of the spatial aspect of the physical world and of the shapes of material objects in agreement with quantum mechanics and in defiance of the CCP.

Space first. Physical space, as distinct from phenomenal space, is a system of spatial relations between material objects. For “spatial relations” you may substitute “relative positions” (that is, positions of material objects relative to other material objects). Where physical space is concerned, there is no such thing as “empty space”. Space is not a separate constituent of the world like an empty container but a system of relations between the world’s material constituents. If there are no material objects, there are no spatial relations, and without spatial relations, there is no space.⁴

The shapes of things next. While the position of a material object M consists in its *external* spatial relations, the form of M consists in its *internal* spatial relations. (The external spatial relations of M are those between M and such objects as have no material constituents in common with M. The internal spatial relations of M are those between M’s own material constituents.) Two extreme cases are of special interest. First, if M is the entire physical world, there are no spatial relations *external* to M. Hence the physical world as a whole lacks a position, which makes good sense. Second, if M is a fundamental particle—a quark or a lepton like the electron,—there are no spatial relations *internal* to M. Therefore a fundamental particle lacks a form. The basic constituents of matter are formless.

If the physical world were created along the lines laid down by the CCP, the shapes of things would be bounding surfaces, and matter would be an extended stuff bounded by surfaces. A material object would have as many parts as the space it occupies, and an object without parts—a noncomposite object like the electron—would be a bit of stuff with the form of a point.

In reality, as described by quantum mechanics, there is no extended stuff bounded by surfaces, and there are no bits of stuff with pointlike forms. A generic material object owes both its spatial extension and its form to its internal spatial relations, rather than to some extended stuff capable of being bounded by a surface. And a fundamental particle is neither extended nor does it have a form. If you nonetheless want to think of it as a bit of stuff, be prepared that this bit of

⁴ The ordinary, substantival view of space not only is inconsistent with quantum mechanics but also leads to an inconsistent attribution of two contradictory properties to the same thing, space: continuity and discreteness. We have learned to gloss over this inconsistency by a clever use of ambiguous terminology. The relational view of space required by quantum mechanics gets rid of this inconsistency, for it attributes continuity and discreteness to different things: While continuity is a qualitative property of every spatial relation, discreteness—not the discreteness of a so-called “continuous set” but a countable discreteness—is a property of the entire system of spatial relations. The synchronic multiplicity of the physical world therefore is countable. It is, depending on whether you prefer to think in terms of substances or in terms of relations, either the multiplicity of material objects that exist at any one time or the multiplicity of their spatial relations.

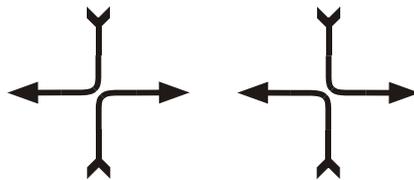
stuff does not exist in space. Physical space is the totality of spatial relations that exist between formless particles. It contains, in the set-theoretic sense of “containment”, the forms of all things that have forms—for forms are sets of spatial relations,—but it does not contain material objects over and above their forms; *a fortiori* it does not contain formless objects. Instead, physical space exists *between* the fundamental particles, inasmuch as it is constituted and spanned by their spatial relations.

So much for the formal aspect of the physical world. To bring out its substantial aspect, I will discuss another experiment, a two-particle collision. Initially we have two incoming particles, one heading northward and one heading southward, and after the collision we have, per assumption, two outgoing particles, one heading eastward and one heading westward.

To make sense of what happens in this experiment, you need to know that in the quantum world there are no causal links. What takes their place is statistical correlations. The mathematical formalism of quantum mechanics is an algorithm for calculating the corresponding probabilities. The calculation of quantum-mechanical probabilities is subject to what we may call the *principle of the contingent reality of mental distinctions*. This says that if a process can be conceived as following several different routes or alternatives, the probability of the process depends on whether there is a fact of the matter about the alternative taken by the process. If there is such a fact of the matter, the probability of the process is the sum of the probabilities of the alternatives. In this case the process actually follows a particular alternative, and the only reason why we assign to it a probability is that we do not know or care which one it follows.

On the other hand, if there isn’t any such fact of the matter, the probability of the process is *not* the sum of the probabilities of the alternatives, and this forbids us to assume that the process nonetheless follows a particular alternative. Instead, the process follows them all, but indistinguishably, in the sense that the distinction we make between the alternatives is a distinction that Nature does not make.

One example of this kind of situation is the two-slit experiment, where the distinction between “electron goes through the left slit” and “electron goes through the right slit” is a distinction that Nature does not make. Another example is our collision experiment. Here the first alternative is that the outgoing particle heading westward is the same as the incoming particle heading southward (in which case the outgoing particle heading eastward is the same as the incoming particle heading northward), and the second alternative is that the outgoing particle heading westward is the same as the incoming particle heading northward (in which case the outgoing particle heading eastward is the same as the incoming particle heading southward).



If the two particles are of different types—say, a proton and a neutron,—there is a fact of the matter about the alternative taken—if the outgoing particle heading westward is of the same type as the incoming particle heading *southward*, the first alternative has taken place, and if the outgoing particle heading westward is of the same type as the incoming particle heading *northward*, the second alternative has taken place. On the other hand, if the two particles are of the same type (and also lack such distinguishing properties as antiparallel spins), there isn't any fact of the matter about the alternative taken. In this case the outgoing particle heading westward is neither the same as nor different from either of the incoming particles. It is indistinguishably both of them, for the distinction we make between the two alternatives corresponds to nothing in the physical world.

This distinction is based on the idea that the two particles are re-identifiable. The possibility of re-identification may exist for two reasons, either because the two particles possess distinguishing properties or because they are distinct substances to which proper names can be permanently attached. In reality the possibility of re-identification does not exist, and this means that at the time of collision the two particles lack distinguishing properties and are not distinct substances either.

What we are confronted with here is another instance of the inconsistency of quantum mechanics with the CCP. If things are conceived “as if rigidly cut out from a background or a mass”, they occupy different regions of space at all times; there always is a fact of the matter that warrants their distinctness. This makes it possible to conceive of them as distinct substances, in conformity with the mind's pluralistic outlook. But Nature does not conform to this outlook. Two particles of the same type are not distinct substances. If the particles in our collision experiment were distinct substances, the probability for scattering at right angles could not be contingent on the existence of a fact of the matter about the alternative taken.

The consequences are literally *mind-boggling*: If we consider particles of the same type, and if we consider them by themselves, out of relation to each other, we must consider them identical not just in the weak sense of exact similarity but in the strong sense of *numerical identity*. (Identical twins are genetically identical in the weak sense. The evening star and the morning star are identical in the strong sense.)

What is necessary for something to be *two* things is either the existence of distinguishing substances or the existence of distinguishing properties, and particles of the same type, considered out of relation to each other, lack both. (The properties by which such particles could be distinguished are relational; they do not exist when the particles are considered out of relation to each other.) This

strong identity is not confined to particles of the same type. Since particles of one type can be converted into particles of another type, the property of belonging to a particular type of particle is an accidental or contingent property, rather than a constitutional one. Therefore even particles of different types are *intrinsically* identical in the strong sense of numerical identity.

We must accept that being one thing, or many things, or identical things, or different things is not something that has an absolute meaning. These are *relative* notions. Two particles can be one thing in one sense, two identical things in another sense, and two different things in yet another sense. Considered in themselves, all fundamental particles are the same thing. Because of the spatial relations that exist between this thing and itself, they are also many things. A multiplicity of relations implies at least the appearance—Shankara would say the illusion—of a multiplicity of relata. Because intrinsically the relata are the same thing, they are many identical things. And if they possess distinguishing properties, they are also different things.

So what is this one thing X that all fundamental particles intrinsically are? We will have the answer if we resolve the following apparent contradiction. A fundamental particle has no form. And considered out of relation to other particles, it has no position, it has neither energy nor momentum, it has neither mass nor charge nor spin, for all these properties only characterize how it behaves in relation to other particles; they tell us nothing about what a particle intrinsically is. In itself, therefore, a fundamental particle is nothing—nada. Call this Statement 1. Statement 2 is the assertion that intrinsically all fundamental particles are identically the same thing X.

These two statements are contradictory only in appearance, for Statement 2 (“intrinsically all fundamental particles are X”) refers to *existing* particles—the actual ingredients of the physical world at any one time,—while Statement 1 (“in itself a fundamental particle is nothing”) is about the *concept* of a fundamental particle. By considering *existing* particles out of relation to each other, Statement 2 divests them of all properties but their existence. Statement 1 further divests them of their existence in the physical world. The fact that in this case nothing remains, reveals that the only intrinsic characterization of an existing fundamental particle is to say: It exists. Therefore that one thing X which all particles intrinsically are, is *existence pure and simple*. Since this is one of the possible characterizations of the Vedantic Brahman, the identification X=Brahman seems justified.

It might be instructive to contrast the traditional concept of instantiation with that instantiation of Brahman to which the fundamental particles owe their existence. Traditionally, instantiation runs parallel to predication: What gets instantiated is a predicable universal, a secondary substance in Aristotle’s terminology, and the resulting instance is an impredicable individual, a primary substance. On this view, what is responsible for the instantiation is something that is present in the individual but absent from the universal. This view conforms to the mind’s inborn tendency of conceiving of individuals as existing by themselves,

rather than by virtue of a process of division or differentiation: Primary substance serves the dual purpose of individuating the universal and of bestowing an independent physical reality on the individual.

The instantiation of Brahman that gives rise to the fundamental particles of matter is something else altogether. To create an instance of Brahman, nothing material or substantial needs to be added to Brahman. There is nothing present in a fundamental particle that is absent from Brahman. Nor can whatever it is that instantiates Brahman exist in advance of the instantiation. In advance of the instantiation of pure existence there is only pure existence. Only Brahman can instantiate Brahman, and this only by entering into relations with itself. This is the only way that respects the proper logical dependencies: The instances of Brahman exist because the instantiating relations exist; the instantiating relations exist because Brahman has entered into relations with itself; and Brahman exists because it is Brahman.

According to Sri Aurobindo, the world is a manifestation of Brahman. Quantum mechanics tells us how this manifestation is effected. The existence of the physical world is supported by a spatial differentiation of Brahman. By entering into spatial relations with itself, Brahman acquires the aspect of a multiplicity of formless particles. Along with the particles, physical space and forms come into existence, for physical space is the totality of existing spatial relations, and forms are particular sets of such relations.

Again, since what exists at either end of each spatial relation is Brahman, spatial relations are *internal* to Brahman. Fundamental particles, recall, do not exist in space. Instead, space is a web of relations spun *between* fundamental particles. Add to this the fact that intrinsically all fundamental particles are Brahman, and you arrive at the conclusion that space is internal to Brahman. The physical world is both constituted by Brahman and suspended within Brahman, in full accord with Sri Aurobindo's philosophy of Brahman.

The manifestation of a world calls for another differentiation of Brahman, a temporal differentiation. This is effected by change, for time and change are coimplicates: A timeless world cannot change, and a changeless world is temporally undifferentiated and therefore timeless.

In my opinion, the quintessential message of quantum mechanics is that there are limits to both the spatial and the temporal differentiation of Brahman. The physical world is only finitely differentiated. This too conflicts with the CCP, inasmuch as the latter implies a world that is infinitely differentiated both spacewise and timewise. This conflict is what makes it so hard for us mentally conscious being to make sense of quantum mechanics. Quantum mechanics tells us how and to what extent the world is spatially and temporally differentiated. As long as our thinking adheres to the CCP and we assume, accordingly, that the world is infinitely differentiated to begin with, we cannot but fail to get the message.

In an infinitely differentiated world, spatial relations are determinate quantities; they possess definite values. In a finitely differentiated world, spatial

relations are indeterminate quantities; they possess fuzzy values. The proper conceptualization of indefiniteness requires the use of statistical concepts, and this is why quantum mechanics is formally a statistical theory. But why is the world only finitely differentiated? Why do spatial relations have fuzzy values? The answer is that, for all we know, this is the only consistent way to “fluff out matter”, to create finite-sized material objects using a finite number of particles, or to manifest finite forms using a finite number of spatial relations. What makes material objects occupy finite volumes of space is the fuzziness of their internal spatial relations. If you are Brahman, and you want to create spatially extended objects by entering into countably many spatial relations, you have no choice but to let these relations have fuzzy values.

A slightly more general way of giving quantum mechanics in a nutshell is to say that there are limits to the objective reality of mental distinctions. Recall Sri Aurobindo’s characterization of mind. Mind is the agent of division, of differentiation. When it is employed by supermind, the original creative principle, mind is used judiciously. The mind’s tendency to divide *ad infinitum* is checked. But when mind is separated in its self-awareness from its supramental parent and left to run wild, as it is in us, it not only divides *ad infinitum* but also fails to recognize itself as the instrument of the division. It takes the resulting multiplicity for the original truth or fact. That is why mental consciousness is inherently reductionistic, atomistic, and therefore materialistic.

By conforming to the mental way of conceiving things, classical physics is conducive to a materialistic way of thinking. When taught without proper corrective, it instills a materialistic outlook. As physics is ordinarily taught, such a corrective is never given. Quantum mechanics is introduced with a materialistic world view already firmly in place, and with apologies for its failure to make sense. Let me give you an example. In classical physics mass is quantity of matter. As long as you have a quantity of matter, you have a materialistic world view, no matter what other ideas you may entertain. When quantum physics is introduced, mass is rarely redefined. But the meaning of mass in quantum physics is totally different. The mass of a fundamental particle is essentially a universal unit of time. Its function is to provide a standard for the measurement of distances and durations. It has nothing to do with the quantification of matter. In a world governed by quantum mechanics, there is no quantifiable matter. You can count particles, but you can’t measure them. A particle isn’t so and so much matter.

According to quantum mechanics, the original truth or fact is unity, rather than multiplicity. Multiplicity is contingent and emergent. Quantum physics thus is the opposite of materialistic, which is something for which I don’t have a satisfactory word. Quantum mechanics describes a world that is created top-down, by a process of differentiation, rather than bottom-up, by a process of aggregation. And in doing so it reveals that the creative principle to which the physical world owes its existence is supramental rather than mental, for supermind, characteristically, proceeds from the One to the Many by differentiation or

particularization, while mind proceeds from the Many to at best a semblance of unity by aggregation.

There is yet another differentiation of Brahman, its differentiation into subjects and objects. Sri Aurobindo endorses the Vedantic characterization of Brahman as being at once pure existence, or Sat, and pure consciousness, or Chit. We may characterize Brahman as an intrinsically indeterminate existence with the power to determine itself, or we may characterize it as an intrinsically contentless consciousness with the power to give itself content. There is a supreme way of being, or of being conscious, to which these two characterizations are equally adequate. Up there there isn't any difference between Brahman qua existence and Brahman qua consciousness. (Hence there also isn't any difference between ontology and psychology.) The differentiation of Brahman into subjects and objects arises as a result of another individuation or instantiation of Brahman, one that gives rise not to a multiplicity of formless particles but to a multiplicity of conscious beings. But this is a different story. I mention it here in order to indicate how this story connects with the story I told you today. On the one hand Brahman is, indistinguishably, pure existence and pure consciousness. On the other hand, each fundamental particle is Brahman. Therefore each fundamental particle is, indistinguishably, a pure existence and a pure consciousness. I suppose this brings the mystery of how anything material can be conscious into the realm of solvable problems.