Shave and a haircut, two bits

The gross misrepresentation of nature as bits of information

James E. Beichler, Ph.D.

Introduction

Recent attempts to reinterpret physics within the computer context of information are no more than a rewrite of an old classic movie with newer and more fashionable language in the script. This method - and it is only an abstraction method to tweak nature for more information - might yield some momentary insights into the processes of nature, but it could never form the basis for a lasting theory of physical reality. The method simply lacks substance. The plot of any movie is based on fundamental substantive unchanging concepts, not the spoken words of information written into the script. The notion that fundamental concepts pass through history unchanged except for the language describing them is well known with examples ranging from Arthur Lovejoy’s ‘unit ideas’ [1] to Gerald Holton’s ‘themata’ [2]. In this newest example, physicists may have changed the names of the characters in the story, but the story remains the same as it has been for several millennia. The issue was originally thought out and settled nearly twenty-four centuries ago when Aristotle based physics on the reality of matter and motion [3] rather than Plato’s ideal mathematical forms [4]. Aristotle observed and classified real objects in nature while Plato conceptualized the real world of sensations and perceptions as no more than ‘shadows on a cave wall’ [5].

In short, the information age has now supplied the ‘emperor’s new clothing’ for the quantum paradigm. Although the notion that reality can be reduced to bits of information is a recent development it is simply not that novel an idea except for the fact that computer concepts have now entered the debate. Computers are electronic gadgets used for the storing, processing and manipulating of bits of information. In this case, intellectuals who do not understand the inner workings of the human mind have taken valid working analogies between the human brain and modern computers too seriously and come to the conclusion that the human brain is merely a wet (computer) processor of information. This point-of-view, no matter how misguided it is, still seems to fit well with past intellectual ideas and even modern physics, especially in the study of quantum physics.

Whether information or some other fashionable term is used, quantum mechanics boils down to the central point that determining physical reality depends on two and no more than two bits of information for any event at any given moment. The main and perhaps the only advantage to the word information is its dynamic neutrality, which offers an easy way of modifying and comparing bits of information to the needs of mathematical abstractions. In the end, the final goal is to reduce all of physical reality to the simplest possible mental (mathematical) abstraction, which would duplicate human perception while completely stripping the subsequent mental interpretation of physical reality of all possible human prejudices. Various scholars who think in terms of ideals rather than practicalities seem to be enamored with this development, which is called mathematical rigor.

Rigor

Throughout history, many scholars have succumbed to the notion that mathematical abstractions are themselves the reality they describe in their overly enthusiastic attempts to reduce physical reality to mental abstractions. This historical undercurrent in the normal advance of science is especially evident through the rigorization process in mathematics. Rigorization is a general movement to purify the discipline by stripping all references to physical reality from which mathematics originally arose and base all of mathematics on a 'rigorous' and purely logical foundation. Any relationship to or dependence upon physical reality was purposely stripped from mathematics during the rigorization process which began in the eighteenth century. Abstract non-physical concepts such as the non-commuting variables that were later adapted for use in quantum mechanics only emerged after the rigorization of mathematics. So mathematical systems based on non-commuting variables may be internally logical, but that neither means nor guarantees that such mathematical relationships are physically viable and/or complete with respect to external physical reality.

In other words, the mathematical concept of non-commuting pairs did not evolve from either strictly physical knowledge or the mental interpretations of real physical processes. Therefore, non-commuting variables should automatically be considered non-physical and purely mathematical by definition. They might prove sufficient to describe specialized subsets of reality, but they do not necessarily describe reality in the whole. In cases where they do describe parts of reality, they are not reality itself but mere mental conveniences created by the human mind. The mere fact that they yield experimental results when applied to the physical world is no absolute guarantee that they alone determine a unique unchallengeable and complete picture of local reality, as assumed in the quantum theory, let alone all of reality. Even then a picture of reality is not itself reality, a mistake most scientists make when they allow their theories to become immutable and unvarying absolute laws of nature. Buddhists have always warned their followers not to mistake the finger pointing at the moon for the moon itself and that warning now needs to be heeded by physicists. Yet it would seem that rigorization has now come to physics under the guise of 'bits of information'.

The basic premise of the question 'it from bit or bit from it', that the 'things' we perceive as constituting external material reality are really bits of information embedded in a real 'something' that we 'somehow' sense, dates back to earlier scientific revelations in the purely theoretical model of black holes. Intent on describing the simple fact that all science can determine from theory and thus know about black holes inside of the event horizon are the mass, electric charge and angular momentum, John Archibald Wheeler [6] reduced his description of a black hole to the metaphor 'black holes have no hair". This metaphorical description was later elevated in stature as the 'no-hair theorem'. In the 1990s, this statement morphed into a debate whether information in the form of bit pairs could be lost once a piece of matter fell beyond the event horizon. Stephen Hawking [7] had earlier shown that black holes eventually evaporate into nothing. Jacob Bekenstein [8] related this model to thermodynamics by arguing that the entropy of black holes must increase as matter falls into it, implying that information carried into the black holes by particles would eventually disappear from the universe, in violation of the laws of thermodynamics. These theoretical advances pushed the question of whether the universe can lose information or bits of information as matter is sequestered by a black hole to the forefront of cosmological debate. This debate implies, if only weakly, that information is the substratum of physical reality, which seems to fit the needs of mathematical notions of fully rigorizing physics and science as well as mathematics. If this notion is to be believed, then bit pairs of information must be the ultimate definers of physical reality and that takes science back to the non-commuting pairs of variables expressed by the Heisenberg uncertainty relationships. If one can demonstrate that the non-commuting pairs used in quantum mechanics cannot completely determine reality then corresponding bits of information cannot be adequate to describe reality and the 'information is reality' argument (it from bit) would simply collapse.

A good metaphor for this historical progression of ideas comes from the old musical and comedic couplet "shave and a haircut" and its answer "two bits." The basic assumption of the science involved - that information cannot be lost even if the matter carrying that information is lost to the universe - places information at a higher level of fundamentality than even matter itself. In this respect there are advantages to reducing physical reality to bits of information beyond the obvious method of using the hypothesis to tweak nature and literally tease out her innermost and darkest secrets. Information is a dynamically neutral and non-mathematical term (it doesn't interact energetically with physical reality) that is non-varying and non-changing over time and thus a constant 'quantity'. It is also non-contextual, unlike the data upon which the formulation of scientific theories is based. The proposition of an information based universe is thus quite appealing, but then it is also a vastly limited proposition. On the other hand, if information does not already assume pre-knowledge within the physical structure of the universe, then basing science on information is just a very small step short of claiming a universal mind or consciousness in which knowledge in the form of bits of information is preexistent.

Dualities in science and nature

Similar non-commuting concept or word pairs exist throughout nature in a more ubiquitous form called dualities. Throughout nature a number of fundamental non-commuting quantities and qualities form fundamental dualities. They seem to rule our world whether bit and it, discrete and continuous, quantum and relativity, function and form, or ideal and practical. One of the most fundamental of these dualities within science is the distinction between internal and external parts of the physical/material world. This particular duality can be applied at either of two levels of perceived reality: The difference (1) between a person as an individual living organism relative to the external world, *i.e.*, the material 'self', and (2) between the person's non-material mind and all else, *i.e.*, the mental 'self'. These two ways of apportioning reality embody our understanding of the dual notion of 'self'. The mind or mental self is completely internalized in that it is either an epiphenomenon of internal processes or it is a non-material and independent phenomenon that manifests through the brain. Whichever it is, the 'self' is always perceived relative to the external physical world as interpreted by mind through our normal senses. Yet this distinction is really little different from that made during the seventeenth century and known today as Cartesian dualism, *i.e.*, mind and matter, which is still quite influential throughout a great deal of modern scholarly and scientific work, including the notion that information is reality.

So the strictly Cartesian duality of mind and matter is not really that far a jump from the 'bit and it' debate when mind is placed within a modern computer information context. In the

Cartesian context, the argument would be 'mind (bit) from matter (it) or matter (it) from mind (bit)', so it would seem that human science and thought in general has not yet escaped the seventeenth century perspective of the universe, even by using modern computer terminology. In reality, the Cartesian perspective of reality is still current and valid in modern consciousness studies within debates whether mind and consciousness are just inconsequential and accidental epiphenomena or legitimate phenomena independent of the material structures of brain and body. In modern terms, if the human mind can be interpreted as just a sophisticated electronic computer processor of internalized data, then the human mind's interpretation of physical reality might reduce to just a collection of bits of information.

Given these various factors, it should be evident that analyzing the historical context of the primary dualities with which science has to deal is perhaps the best way to develop an understanding of mistakes modern science has made by attempting to reformat (reformulate) physics in terms of information. Each generation interprets the same dualities within their own unique context, but the overall conceptual relationship between the dualities remains the same. If anything, reformulating physics as a search through nature for information that already exists in nature does no more than point out the modern failure of science to unify the fundamental paradigms of physics - relativity and quantum - while acting as an excuse not to do the hard work and hard thinking necessary to find a way to overcome the differences between the natural non-commuting duality they represent. These are, in turn, reducible to the related incommensurable dualities of discrete and continuous on one hand and indeterminism and determinism on the other. Yet identifying information as the true reality does nothing to mute (or commute) the differences between these and other dualities. In a philosophical sense, identifying the smallest units of reality as bits of information does not really explain anything. Identifying a phenomenon by giving it a label or name does nothing to explain how that phenomenon occurs. For example, entanglement is the name of a specific type of quantum phenomenon, but many people misuse the term entanglement to falsely explain phenomena that go far beyond the quantum meaning of the term. People sometimes mistakenly use such terms as an excuse for their inability to find real physical explanations for specific phenomena. The reality is that these dualities are internal products of the human mind and do not exist in the external world of nature as most scientists and scholars believe.

This practice of imposing unique products of the mind on nature is further confounded by the all too human befuddlement that comes from misunderstanding the notion that if reality is a product of the mind then some form of mind must have created the reality of our universe in the first place, an idea which is anathema to scientific thought. For example, the extreme philosophical interpretation of the quantum idea that 'consciousness collapses the wave packet' is often corrupted into 'only consciousness can (or must) collapse the wave packet to determine reality' instead of just 'consciousness (among other things) can collapse the wave packet to measure reality', which has no scientific or logical foundation. This overly philosophical interpretation is reinforced by the most extreme version of the Copenhagen Interpretation of quantum theory whereby 'consciousness and only consciousness can collapse the wave function to create reality'. This extreme version clearly implies that there is no reality nor can there be any reality before the intervention of consciousness and it is into this philosophical context that mind inserts information into the structure of physical reality.

In other words, some people believe that some form of consciousness must have created physical reality and thus existed before physical reality emerged, and therefore the only reality is consciousness. This erroneous interpretation very nearly expresses the same sentiment as the phrase "it from bit'. Yet there is no evidence that these notions are true and indeed nothing to substantiate them in the least, they are merely philosophical interpretations, beliefs and opinions that seem to persist in the world of science. Unfortunately, they have also grown a life of their own independent of science. These notions are merely products of a mind or minds that cannot understand true physical reality and cannot understand why it cannot understand reality, so that mind creates excuses to fill in the vast emptiness between real true facts by which the human mind perceives and interprets physical reality.

In these cases, the facts stored in mind merely need be identified as information which serves to project that information onto the external physical reality by the mind interpreting physical reality. So the proposition that the physical reality of any individual quantum event from which all of physical reality is established can be reduced to two bits of information is based on a false interpretation of the measurement problem in quantum mechanics. Physical reality cannot and should not be reduced to strings of 0s and 1s streaming down a green screen monitor in the mind of the observer while representing some unspecified mental matrix external to the human mind that seems (and only seems) more real than physical reality itself. This false interpretation is based on the use of non-commuting pairs of physical variables in the Heisenberg uncertainty principle. According to the uncertainty principle, physical reality need only be determined up to a constant multiple of Planck's constant by either the uncertainties in position and momentum or the uncertainties in energy and time. But in these relationships, there lie hidden variables, although a more accurate label would be 'suppressed variables'.

Suppressed variables and reality

Take for example a particle moving at a constant speed in a region of space where no other forces can influence its path. To take a measurement in position, the particle is placed inside an ideal elastic closed (Gaussian) surface so no energy will be lost to the outside world during the measuring process. As the surface shrinks to isolate the position and make the measurement, the particle bounces more and more off of the inner surface of the enclosure. Its energy remains the same although its motion becomes more erratic and the energy density inside the closed surface increases. In the moment before the surface closes in on the particle, which is the physical equivalent of collapsing the particle's wave function, the particle's energy is the same as it has been all along and thus completely certain, supposedly while its energy density has increased. It's erratic movement theoretically approaches infinity according to Zeno's paradox. Until the collapse of the wave function when the surface clamped down on the particle, the uncertainties supposedly describing its reality referred only to position and momentum with no reference to either energy or time according to standard interpretations of quantum mechanics. Yet its energy was constant and thus completely certain. The value placed on the increasing erratic nature of the particle was the only real uncertainty in this measurement and that value is not expressed in the uncertainty principle.

The energy density inside the enclosing surface may have grown very large, but it never became infinite and instead settled to a constant value as the collapse occurred. Yet at the time of collapse, the kinetic energy of the particle disappeared because the enclosure fixed the position of the particle. The energy could only have been absorbed by the enclosure or the particle. Which case is true could not be determined by the uncertainty principle, so it is of no interest regarding uncertainty. In either case, at the moment of collapse of the wave function, when the enclosing surface closed in on the particle, the two different uncertainty relationships became equal to one another.

Before this moment, the motion of the particle was characterized by the uncertainties in position and momentum, purely mental abstractions of the real material situation, but at the moment of 'collapse' (energy exchange) the uncertainties in energy and time were automatically invoked and the two different forms of the uncertainty principle became equal, eliminating any reference to Planck's constant.

$$\Delta x \Delta p \geq \hbar / 2 \leq \Delta E \Delta t \tag{1}$$

$$\Delta x \Delta p = \Delta E \Delta t \tag{2}$$

According to this last equation, when a particle which is specified by two bits of information falls into the black hole, its physical interaction with the event horizon would collapse the wave function creating two new bits of information that are not lost into the black hole. Thus there is no net loss of information in the black hole and the net amount of information in the universe does not decrease. Instead of becoming a basic argument for using bits of information to describe reality, the loss of a particle into the black hole reestablishes the role of classical concepts in physics.

If this new equation is further restricted by the ratio of $(\Delta x/\Delta t) \leq c$, which could be called a certainty principle, the equations defining special relativity are easily derived by noting how the uncertainties involved change relative to one another [9]. Applying this certainty ratio does not imply that the uncertainties yield a real speed, but rather that they are related to a physical constant which defines the physical limits of the space-time continuum. In other words, at the moment when measurement occurs, a 'collapse' of uncertainty reestablishes the relationship between the quantum event and the relative space-time continuum.

Even more physical insight and information can be gained by suppressing the quantum and ignoring the space-time restriction inherent in the certainty principle [10]. According to the energy-work theorem, any uncertainty in energy could be isolated and limited to the distance through which the applied working force acts. Then through substitution a new equation emerges,

$$\Delta x \Delta p = F \Delta x \Delta t \, . \tag{3}$$

Cancelling out the uncertainty in position as well as dividing both sides by the uncertainty in time yields

$$F = \frac{\Delta p}{\Delta t} \, . \tag{4}$$

In the limit where the uncertainties approach the natural limits of physical reality near zero according to the basic theorems of calculus, this equation reduces further to

$$F = \frac{dp}{dt} \quad (5)$$

In this case, there would be no need to invoke Planck's constant because the uncertainties in position and time do not form a non-commuting pair as do position and momentum or time and energy.

Of course, this last equation is none other than the second law of motion as originally stated by Newton. Given this new development, the simple fact that this derivation reinforces the basic idea that the Heisenberg uncertainty relationships do not individually give a complete picture of physical reality has been clearly established. Each of the basic uncertainty relationships that form the fundamental principles of quantum mechanics only gives a partial and thus incomplete picture of physical reality. Reducing reality to discrete bits or information as suggested by the uncertainty principle would thus yield, at best, an incomplete theory of reality. It is only when the two forms of the uncertainty principle are brought together that an observable picture of physical reality emerges from quantum mechanics. Perhaps space and time can be treated separately as independent variables in a rigorous mathematical number system, but they cannot be treated separately in physical reality in the same manner, especially when the changes that occur over the forward movement of time approach their smallest physical measurements in the 'quantum' realm of the microscopic world.

There have evidently been 'hidden variables' in the quantum uncertainty relationships all along in spite of all arguments to the contrary made by quantum philosophers. They were always in the background, but 'hidden' until they were invoked by the Heisenberg uncertainty principle at the moment of collapse. Any reference to time is missing from or suppressed in the relationship between the uncertainties in position and momentum and any reference to space (location) is missing or suppressed in the uncertainty relationship between energy and time. Time and space, respectively, are the 'hidden variables' in the Heisenberg uncertainty principle, or better yet the 'suppressed variables', yet there is obviously an unsuspected 'suppressed variable' in the classical view of space-time, and that is Planck's constant. The same mistake was made in classical Greek philosophy by Zeno's paradoxes. Zeno assumed the reality of motion to prove that the assumption leads to paradoxical results, logically proving that motion is impossible. But he also assumed that motion was equivalent to either changes in position or time without reference to the other in his logical examples (ancient gedanken experiments), both of which are untrue. Quite simply, Zeno unwittingly lied and his paradoxes are worthless in reality. Yet they held up the advance of science for more than a millennium and a half and still influence physical thought today. Although more complicated, the same is true with the two forms of the Heisenberg uncertainty principle which form the basis for assuming bit pairs of information are more fundamental than the matter and motion which they describe.

When space and time are reunited as space-time, Zeno's paradoxes evaporate and Planck's constant is successfully suppressed. Therefore Planck's constant, which does not normally appear in either Newtonian or relativistic physics, must always be hidden or suppressed in the background of classical physics as the binding constant for space and time. The quantum uncertainty upon which indeterminism is based only emerges from the scientific attempt to artificially separate space and time during the measurement process, which is an abstract mathematical procedure since space and time cannot be separated in reality. Under these circumstances, information does not disappear into the black hole because the information only exists in the mind of a hypothetical observer. The debate between 'it from bit or bit from it' may just as well be restated as 'does science tell nature what to do or does nature tell science what to think?' The answer is obvious: It from bit is impossible.

Conclusion

Contrary to what quantum theory seems to say, measurements do not naturally occur independently in space or time, but rather dependently and simultaneously in (Newtonian) space and time or (Einsteinian) space-time. Every quantum measurement is an artificially isolated event with no reference to either of the interacting objects' past history or future course. Einstein's famous EPR argument [11] challenged this very interpretation of the measurement problem, but has never been clearly confirmed or denied. However, scientists still successfully develop experiments to try and force reality to divulge its innermost workings by measuring small pieces of physical reality based on either space (uncertainty in position) and a surrogate of time (uncertainty in momentum) or (uncertainty in) time and a surrogate of space (uncertainty in energy), but not without invoking quantum restrictions in the form of Planck's constant by the artificial and unnatural unbinding of space and time. By the same token scientists can tease new information from nature in gedanken experiments by treating nature as if reality is no more than information, but this does not mean that reality is no more than bits of information. In the end, bits of information only arise in the mind as measurements or observations of 'it', not the other way around.

The present goal of physics in the minds of many physicists and scientists is at least finding a way that the quantum and relativity can live in harmony if not outright unification. That goal can only be accomplished if the question of whether mind creates reality or reality creates mind is answered. But given the Copenhagen Interpretation of the Heisenberg uncertainty principle, if information is truly a more fundamental quantity in nature than matter, such that information exists in nature independent of the mind or is somehow stored in the space-time continuum (or quantum substratum), then this impasse is unimportant and of no consequence to physics, rendering unification much easier because physics would be reduced to the context in which information is unfolded or otherwise pried from nature.

However, science cannot just shove information into an equation and expect material reality to be pumped out. The newly proposed information picture of reality does not account for, or perhaps it just ignores, the basic substantiality of the natural world. Many physicists and cosmologists believe that the final theory or TOE (theory of everything) will consist of a single equation (the factory creating reality) and a single matching physical constant (the regulator that determines our particular experienced reality). This view represents the rigorized 'bit' way of thinking. This view is wrong. Perhaps all of reality can eventually be reduced to a single equation, but if it ever is then some single substantial thing, which can be represented by one or more physical constants, must accompany the equation. That single substantial thing could only be a single continuous potential field. This field cannot be just a mathematical construct or abstraction. It must be real and substantial (Aristotle's plenum or Einstein's unified field) so the theoretical equation developed in the minds of scientists to describe physical reality can duplicate how nature generates both matter and the physical reality that the mind interprets, even if that mind wishes to interpret, or rather misinterpret physical reality as bits of information. So bits of information, or data points if you wish, only emerge at the end of the story through the measurement and interpretation conducted at the suggestion of mind and consciousness. Science should leave the ultimate reality of bits of information to Bugs Bunny, who would probably just say "shave and a haircut - two bits". "That's all folks".

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