The Perfect First Question.

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"... every it—every particle, every field of force, even the spacetime continuum itself—derives its function, its meaning, its very existence entirely—even if in some contexts indirectly—from the apparatus-elicited answers to yes-or-no questions, binary choices, bits*." ~ John Wheeler*

It is said that famed cosmologist Georges Lemaître, when asked if given the opportunity to have one yes-no question answered by an infallible oracle, first pondered the question of whether the universe had ever been at rest, and in the end relented, "… I think, I would ask the oracle not to give the answer, in order that a subsequent generation would not be deprived of the pleasure of searching for and of finding the solution."[1]

Perhaps most of us think this way—that nature is stingy with her secrets, that whatever there is to learn from our Earthly experience is sparsely allocated and acquired mostly by trial and error. One who spends too much time extolling the benefits of nature's infinite variety and creativity may be regarded as mystic by scientists and hubristic by theologians. And sometimes—as was the case with Monsignor Lemaître —these are the same person. Asking who or what imposes a limit on our knowledge seems to be an almost reflexive question in the face of nature's majesty. Why?—we venture to guess—by considering an infinite nondeterministic variation on the game "20 questions," posed by John Wheeler.[2]

In this variation, the answer is not predetermined—the idea is for a single person to ask yes-no questions of a group of people, until the group is left with but one answer consistent with all the other answers previously given. There is no winner or loser; the game just continues until the participants are bored, or no answer can be imagined that is inconsistent with the one assumed possibility remaining.

One is conditioned to think that winners and losers are inherent in nature, according to the rules of probability. Is that foundationally true? The flaw in this reasoning becomes obvious, in the challenge that many proponents of Bell's theorem as physical law, issue to non-believers: if reality is not probabilistic, they say, then try and win a million dollars from Amazing Randi[3] by psychically communicating at a distance with someone else, with better than 50% random success.[4] The idea that two brains separated in space and sharing an identical time interval, should—if Bell's theorem is not inviolate—communicate with minimal to zero decoherence of information, literally begs the question. For if one thinks reality is a game of "guess what I'm thinking" that one plays against nature when one does physics, one neglects that a better than random result requires an infinite number of questions in an infinite length of time (the problem of bounded rationality, due to Herbert Simon). The consequences of a time interval bounded by *any* finite value, makes the challenge impossible to win, and automatically sets the upper bound of correct guessing to the middle value for each player—exactly as in a 2-player game with equilibrium point, or a coin-toss probability—when the guessing continues for a sufficiently long period of time for sufficient discrete trials of guesses.

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Let us suppose that Wheeler's variation on the parlor game really is unlimited in time. We can only do this in a thought experiment, of course; however, even in a limited -time game of sufficient length, the interval will grow longer and longer between asking a question and receiving an answer, as the oracle(s) process all the possibilities for what the answer is *not*. In the conventional game of 20 questions, the first questions—assuming a rational strategy—are categorically broad and thus quickly answered: Is it animal? Yes. Does it have four legs? Yes. Is it a mammal? And so on. The number of four-legged mammals is eventually pared to one with characteristics that match one and only one predetermined creature. The conventional, deterministic, game assumes a limit of 2^20 or 1,048,576 equally likely information bits at the outset, and good players can usually win within the limit. Excellent players compete to shorten it. Getting Wheeler's "it from bit," though, doesn't assume such a limit at all. Neither does Nature.

It turns out to be Bell loyalists who are the actual determinists, believing that reality is determined by probabilistic measure schemata, by which they assign equally likely outcomes to "… the experiment not done…"[5], and thereby limit the questions that can be asked, to an assumed domain of perfect knowledge.

By the rules of Wheeler's nondeterministic game, it is impossible that a correct guess can be made without any questions at all—unlike the conventional game, where the answer is predetermined and one can blurt out "platypus" at the start, and possibly win (though the odds are against it). In the nondeterministic game, each individual question *except* the first is constrained by all members of the set of questions previously answered. If it were possible that the first question is answered capriciously, the second can't be, in any case. We will show, however, that the first question *cannot* be answered capriciously (i.e., with a probability of 50% yes or no):

Because there is no limit to the number of questions or time to ask them, rational play predicts a distribution of time intervals, between question and answer, identical to the distribution of prime integers in the prime number theorem:

$$\pi(x) = \frac{x}{\ln x}$$

This means that the probability of finding a prime *x* in a particular interval is approximately equal to an arbitrarily chosen positive integer divided by the natural logarithm of the integer. As *x* increases, the number of primes up to *x* asymptotically approaches unity:

$$\lim_{x \to \infty} \frac{\pi(x)}{x/\ln x} = 1$$

Applying the logarithmic function of a nondeterministic guessing game to the wave function of the universe implies that the answer to the first question is *always* "yes." How do we know that? We know it, for the same reason that the natural number 2 is the only even prime number – the sum of any two arbitrarily chosen positive prime integers (assuming the Goldbach Conjecture is true) is divisible by 2. In other words, because we already know that there is something rather than nothing, the universe gives us an even chance of knowing how nature works before we even have to think about it – like hitting the bull's-eye without firing a shot. Leon Lederman said it best: if the universe is the answer, what's the question?[6]

So, assuming we know nothing else:

Imagine playing an unlimited nondeterministic guessing game with an all-knowing oracle. Knowing that the computer is compelled to answer "yes" to your first question, what will you ask? You don't want to waste it.

There's no profit in asking a question of the form "Is the sky really blue?" that can't be generalized, or loading the dice by asking "Is the universe infinite?" or "Is the universe closed?" We mean, that the perfect first question is something that we not only know to be true, but to which a positive answer implicitly eliminates all theories of the universe we think *might* have been true. Then, because we started with 50% of the knowledge we need, we get another 25% advantage by playing a cooperative game, one that obviates winners and losers. Scott Aaronson explained it precisely and compactly, on his blog "Shtetl-Optimized"[7] during a heated exchange over Joy Christian's topological-framework opposition to Bell's theorem:

"… consider the following game. Two players, Alice and Bob, can agree on a strategy in advance, but from that point forward, are out of communication with each other (and don't share quantum entanglement or anything like that). After they're separated, Alice receives a uniformly-random bit A, and Bob receives another uniformly-random bit B (uncorrelated with A). Their joint goal is for Alice to output a bit X, and Bob to output a bit Y, such that

$X + Y = AB \ (\mathrm{mod}\ 2)$

or equivalently,

X XOR Y = A AND B.

They want to succeed with the largest possible probability.

It's clear that one strategy they can follow is always to output X=Y=0, in which case they'll win 75% of the time (namely, in all the cases except A=B=1).

Furthermore, by enumerating all of Alice and Bob's possible pure strategies and then appealing to convexity, one can check that there's no way for them to win more than 75% of the time: no matter what they do, they'll lose for at least one of the four possible (A,B) pairs. Do you agree with the previous sentence? If so, then you accept the Bell/CHSH inequality, end of story."

One can agree with the strategy. One can agree with the arithmetic. One can agree that Bell/CHSH inequalities are experimentally violated. One is *not* compelled to agree, however, with "the end of the story." Nor even the beginning, as we shall see.

The perfect first question will, like the prime number theorem, imply unity in the limit.

As Aaronson implies, the perfect first question has purportedly already been asked, by John Stewart Bell, over 50 years ago.[8]

$$1 + C(b,c) \geq | C(a,b) - C(a,c |$$

Where a,b,c are particle detector settings and C the correlation of measurement results. The experimental answer ("Does this inequality physically hold?") is famously "No." Bell's Inequality has been violated in numerous experiments, most notably by Alain Aspect.[9] How can that be, when we have allowed that the first answer is compelled to be "Yes?" Contradiction?

It appears that in our nondeterministic game, there exists *either* no perfect first question *or* no deterministic first answer. The first answer, however, *has* to be deterministically positive; i.e., for the same reason that the positivity condition imposed by the prime number theorem perfectly corresponds to what we know: information received by *every* measurement is oriented *toward* the observer, never in the direction opposite the observer. The mathematics of Bell's theorem is indifferent to that physical fact—the experimental answer is compelled to be "no," because of a hidden assumption that the space of measurement is nonorientable—that nothing else besides the *observer's* choice orients the measure. We will question this assumption of an observer-created reality, with the consequence that if it is false, Bell's theorem has no physical counterpart to its mathematical outcome.

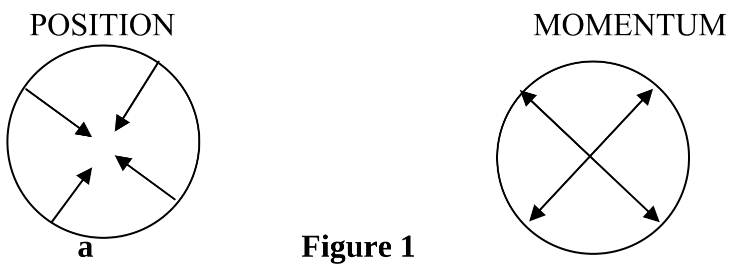
The source is everywhere.

No matter how we arrange an experiment to account for particle detection, the result excludes the middle value, because the source of measurement values always *originates* from a middle value.

This condition gives the illusion of nonlocality, seeming to impart causality at a distance.

Think of it this way: Imagine standing on the seashore, waves rolling in and out. Then imagine that this ocean is a Poincare′ disc. You would see that there is no point of origin from where you observe on the rim of the disc. So you wonder what it would be like to be "inside" the rim, and you walk into the waves, continuing on for an arbitrarily long distance (our ocean is apparently very shallow). Nothing changes. So you decide to walk in a different direction—no matter which way you orient yourself, however, the wave appears to grow vanishingly small at the horizon of the rim—and you might feel a bit of panic to find that now you can't even get back to the rim! The horizon is never any closer than it was when you started. What happened to the beach!? Nothing. The beach was never there.

Nonlocality assumes such a "beach," an arbitrarily chosen local point of origin. The illusion that an observer occupies a locally fixed point equidistant from the horizon in every direction is equivalent to the uncertainty principle—i.e., on a nonorientable manifold, local measures always originate from a middle value, so an infinitely accurate knowledge of position implies infinitely inaccurate knowledge of momentum and vice versa, because momentum is measured relative to a local fixed point, while a position measurement is relative to nonlocal fixed points on the horizon (fig 1):



a **Figure 1**

What we have to keep in mind, is that the boundary conditions for each of these independent measures are incompatible as well as arbitrary. Position is measured by convergence of a minimum fixed two lines, generated by 2 sets of 4 antipodal cardinal points (in 2 dimensions) from a continuous range of point values on the horizon; momentum is measured by infinitely orientable divergence from one chosen fixed point toward the horizon. Physically, there are no absolutely accurate simultaneous measures; we compromise between converging and diverging metrics to get arbitrary accuracy for each discrete measurement value in one time interval. Quantum mechanical measurement values are averaged for that time interval.

However:

The real function – the continuous wave – is not a probability function. Referring back to our analogy, there is zero probability that an observer ever occupied any point (the "beach") on the horizon. In mathematical terms, all measurement functions are nondegenerate near the horizon; the observer will only encounter the same self-similar patterns in the same fixed relations. There is no real center, no real boundary.

One then sees that measurement is a *function* of orientation in this center-less, boundary-less sea of fluctuating waves. And because the observer's orientation is compelled to be in the direction of observation, we see that the direction from the arbitrary middle value is always toward the singularity of the horizon. In other words, the *information* that the observer receives from the wave function is *independent* of the direction of the wave—regardless of whether the wave is incoming or receding (blue shifted or red shifted), the information is always *incoming*.

No prize for second place.

We have determined at this point, that although the perfect first question has not been asked, we have deduced in the meantime that Bell's inequality is the perfect *second* question—how so?—because knowing that *something* exists logically implies the existence of something else (for the same reason that the integer 2 is the first prime—X + Y = AB *mod* 2 as Scott Aaronson noted, just as any two arbitrarily chosen odd primes generate $a \equiv b(\bmod 2)$, which begs the question of how many relations two things can share at the same time. Bell's answer is: only one, equal and opposite. The answer applies to points in space absent of time, and flat Euclidean space at that, so that of the 4 possibilities for the space-centered observer of fig. 1a, only one at a time can be realized locally. Correlating results of two observers, A & B, doesn't improve the odds; because of the continuous range of values converging on an observer from the horizon, one can expect no better than random correlation of values between A & B at discrete times of measurement. As we have seen, while the odds improve for cooperative measurement events, the idea of random distribution of results does not change. Reality, says quantum mechanics, is inherently probabilistic and observer-created. To see that this statement is true, imagine a continually spinning roulette wheel with only two possible repeating discrete values, 0 and 1. The wheel is hidden from our view, except for a window through which we can see only one value when the wheel stops. When we open the window and look, it immediately shuts. If we saw 0, all the unseen values of the wheel are 1; if we saw 1, all the other values are 0. As long as the wheel is spinning and no value chosen, the 0s and 1s are in superposition, neither "here" nor "there." When one value is chosen to be "here" (local) all the other values are "there" (nonlocal), quantum entangled with our local choice. Therefore, as Bell's theorem concludes, no measurement schema can be both local and realistic.

If one does not question this idea of an observer-created reality, one is convinced that free will—in the choice of measurement direction— randomly determines the outcome of measurement events. However, if—as shown—information is only received by an observer from a single direction, there is (Gertrude Stein agrees) no "there" there. One may freely choose a *coordinate system*, yet those arbitrarily chosen coordinates are independent of information concerning the observer's measured physical properties (such as position and momentum) – why?

The remarkable deduction is that information always *originates from a point at infinity, regardless of the orientation of the observer.*

In other words, physical measurement—which is based on local events whose causality is known, in measuring interactions bounded by arbitrarily chosen coordinate frames—has a constant relation to a metaphysical coordinate-free causality. A metaphysically real result is not mystical; it is a direct consequence of denying physical reality to the arbitrarily chosen coordinates that imply nonlocality. One recalls that prior to Descartes, all geometry was done with compass and straightedge—all "here" and no "there." Only with the development of analytical geometry were we able to identify relations between numerically distant points and a local coordinate system. Even when causality is restricted to events within the limit of relativity, the point at infinity does not have to be physical to be causal, which explains the Wheeler delayed choice result in classical terms[10]: In classical physics, the time parameter is reversible, so symmetry demands that points of history hypothetically originating beyond the horizon contain future events (represented in relativity theory as the divide between photons and the hypothetical tachyons). Even though classically, we know that Schrödinger's wave equation simultaneously applies both backward and forward in time, we conventionally consider the forward (advanced) solution to be unphysical—lying in the future—so we assign physical value only to the backward (retarded) solution, because "backward" is the only direction is which we can observe, i.e., receive information.

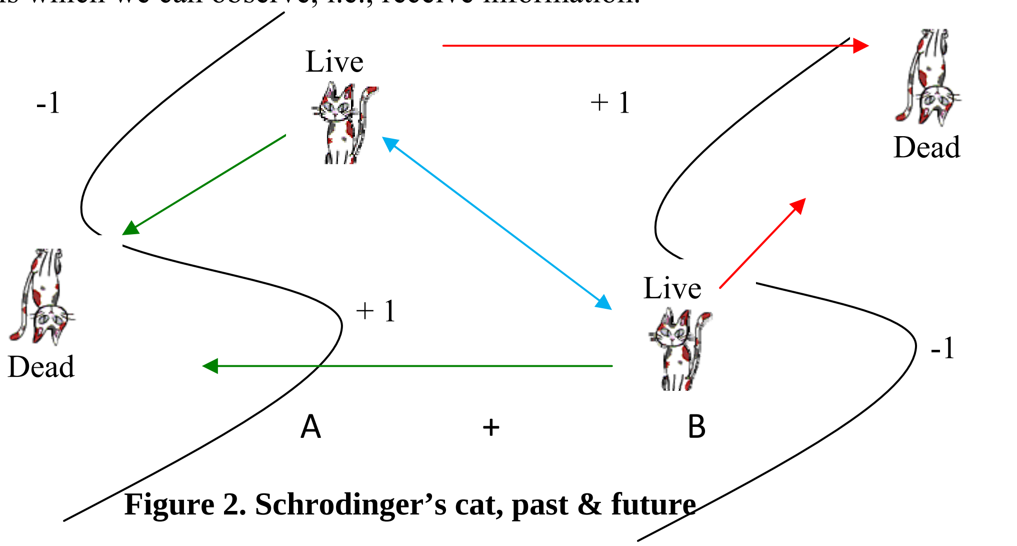


Figure 2. Schrodinger's cat, past & future

Something one never hears about Schrödinger's cat (at least, I haven't) is that the thought experiment always begins with the assumption of a live cat, never a dead cat. Now of course, one can say that the cat in superposition is neither alive nor dead, and one doesn't know which state until one looks – yet that makes no sense experimentally, because one has to prepare an experiment in one state or the other. Even a thought experiment, to be valid, must be do-able in principle. A rational person doesn't expect a cat to rise from the dead—the direction of observation from live to dead isn't just intuitive; it's consistent with what we know of thermodynamics. A & B in fig. 2 refer to observers of the cat in their respective frames of reference—both have access to identical solutions of the wave equation; at any moment of observation the live cat in one's present may also lie in the present of a future observer (blue double-arrow line), while each observes in but a single direction which though oppositely oriented is toward the same singularity.

One will note that the arrows of fig. 2 are oriented the same as the arrows of fig. 1a/2a. Position is represented by convergence, momentum by divergence. The critical difference is that there is no boundary between the live cat(s) in both present and future. Because this is a relativistic model and there is no privileged coordinate frame, the "dead" state remains continuous with the range of values of the "live" state of negative entropy, the former being a closed system (toward equilibrium), the latter an open system (nonequilibrium state[11]). In a measurement function continuous from an initial condition, it is therefore possible in principle to match element for element past to future whether the system is open or closed, because the trajectory of a nonequilibrium state is unitary (fig. 3).

One cat, two cats, live cat, dead cat. (Apologies, Dr. Seuss.)

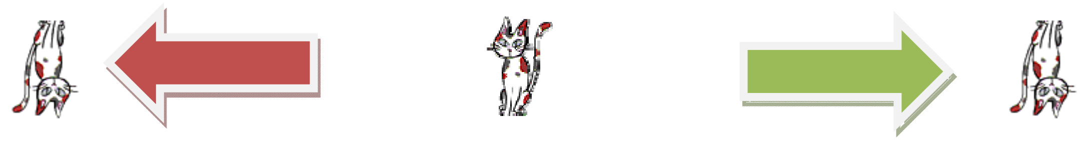


Fig 3. Unitarity.

In mathematical language, figure 3 is quantum mechanical unitarity: $\langle \Psi | \Psi \rangle = 1$
There aren't two dead cats for any measure continuous from the live cat state in any one time interval. Nor does the same cat die twice. For one observation, there is either a live cat, or not—if alive, we say that the wave functions of the two possibilities are correlated (rather than entangled); if dead, we say that the wave function of the future observer has decohered. The "future observer" though, is on a continuum with the past—so we are compelled to accept the noncollapsing model of Hugh Everett[12] without imposing a probability measure (Stephen Hawking is purported to have said that Everett's many worlds hypothesis is trivially true; we agree, whether he actually said it or not)—for if one allows that the result of any discrete observation (live or dead) by the Copenhagen interpretation is a collapse of the wavefunction, one neglects that the physical property of momentum is orientable (vectorized) while the property of position is not.

We are left to conclude that correlated elemental wave functions represent simultaneous particle properties of position and momentum; one of these point particle pairs, however, is positioned at infinity, though it doesn't matter which one. A normalized measure, as represented in quantum unitarity, can *only* refer to a *local* result, assigning no value to nonlocality. Nonlocality in Bell/CHSH does not differentiate intervals of time; we know, however, that there is at least one interval of time in every measurement continuous from an initial condition, by which the trajectory could have differed from that measured, in a bounded length of time. Computer scientist Leslie Lamport discovered it nearly 30 years ago, though "Buridan's Principle" was published only in April 2012.[13] *"A discrete decision based upon an input having a continuous range of values cannot be made within a bounded length of time."*

Figure 3, showing three representations of the state of one cat does not imply three cats, or even the same cat at three different times of observation. Figure 3 implies that a live cat in a nonequilibrium state is on continuous path toward equilibrium on one of two reversible trajectories. In other words, the orientability of the cat's trajectory implies, though both trajectories lead to a singular result, that each trajectory is reversible *in principle*, i.e., classical—that *relativity on the microscale reduces to random motion*; i.e., there is no absolute rest state (and by extension, no boundary between quantum and classical domains). David Hestenes has used this quantum property of *zitterbewegung* to profit by connecting it with his method of space-time algebra, thereby uniting elements of classical relativity with quantum mechanics[14] on the small scale, as Hawking did on the large scale. More recently, Lawrence Krauss[15] has ably explained that the quantum vacuum is unstable—which supports a point at infinity in every measure of a local event— for if it were otherwise, quantum pairs could not even *be* oriented and therefore not correlated ("No observation in any experiment was ever made except in some direction" ~ Joy Christian[16]). By Hawking's "no hair" theorem,[17] the fundamental black hole properties of mass and charge can be precisely and simultaneously defined, scale-free, with mass oriented toward the center (position) and charge oriented toward the event horizon (momentum)—because as Buridan's principle implies, one encounters a local singularity in *every* measurement continuous from an initial condition, without regard to scale. Angular momentum, at both the cosmic extreme or the microscale extreme, corresponds to a "dead cat," lying always in the future of an unstable vacuum—a wavelike future middle value that is, relativistically speaking, simultaneously in some discrete observer's past, some other's future (even if they are the same observer).

If Joy Christian[18] is right (the author is on record in the conviction that he is) the properties of physical existence that give us the illusion of quantum entanglement are topological: orientability and initial condition. One notes that the Euclidean space R^3 differs from the topological space S^3 by one point at infinity, and therefore the hidden variable of a locally real measure is the handedness of the universe—the choice that nature makes, independent of the observer—because only nature has access to a continuous range of values on the horizon, by which only she knows whether any choice a time-limited observer makes at the moment of measurement belongs to the left hand or the right hand hemisphere. In other words, we deduce, if nature does not have free will (or as Einstein put it, "Did God have a choice in creating the world?") it would be impossible that any physical observer, human or not, has a choice in observing it, and we would have to dismiss Bell's theorem from the start. The answer to Einstein's question is "yes."

Bell loyalists are challenged to explain how they can possibly prove that the mathematics of Bell's theorem—based on a nonconstructive proof assuming a nonorientable domain of equally likely outcomes—is independent of the experiment that validates it. If not, it *cannot* be complete, and therefore cannot be foundational.

Oh, and this is the perfect first question: ***Am I alive?*** If the answer is yes, no theory of "dead matter" (i.e., based on equilibrium thermodynamics in a nonorientable space) can explain what an evolving, conscious universe[19] [20] [21] knows at the start—without having to explain itself—and before we even begin to try and explain it ourselves.

For Candy, in appreciation of our connections past & future

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