Opinion and Perspectives

Entanglement, Correlation, Causality and the Analogy of the Dreaming Brain

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Abstract

The problem of entanglement as discussed by Einstein, Podolsky and Rosen (Einstein, 1935) and modified by Bohm is discussed using the analogy of the dreaming brain. A clear distinction must be made between correlations, even those called "spooky action at a distance", and causal events. It is shown that the metabrain model clarifies and helps to resolve the issues.

Key Words: quantum, entanglement, consciousness, correlations, causality

NeuroQuantology 2011; 1: 153-156

Introduction

Consider a particle at rest in some reference frame with zero angular momentum. It decays into two spin 1/2 particles. The decay particles each have spin 1/2 component along some line of direction. We may take one direction along the line as positive and the opposite direction as negative. Because of conservation of angular momentum if the line is along the z axis, and the component of spin for each particle is measured along the z axis, one particle will have z component of spin +1/2 and the other will have spin -1/2. Which particle has z component +1/2 is not predictable.

If the component of spin of each particle is measured along the x axis or along any other direction, one particle will have component of spin in that direction, +1/2, and the other particle will have spin component -1/2. Again, which particle will have spin +1/2 is not predictable. The space-time situation is shown in Figure 1.

Let us suppose that observer A (call him Alex) near particle A measures the spin component of particle A in the z-direction and measures +1/2 and that observer B (call him Bob) near particle B measures the spin component of particle B in the z-direction and measures -/2. Alex and Bob are separated by a space-like separation and cannot communicate with each other.

Alex and Bob then repeat the experiment and measure the spin components again. But this time Alex decides, in the last moment, to measure the spin component of particle A along the x-direction (without telling Bob of the change in direction) and Bob measures the spin component of particle B in the z-direction as before. Alex happens to find particle A with x-component of spin -1/2. Then, as Alex has knowledge of quantum theory he figures that there is a 50% chance that Bob will observe +1/2 along the z-direction and a 50% chance that Bob will observe -1/2 along the z-direction. This is correct; Bob could observe either result. Bob has no way of knowing that Alex has changed direction as no signal or message can travel across a space-like interval. This is due to the fact that no signal or message can travel faster than the speed of light.

If, by chance, Bob had also decided to measure the spin along the x-direction he would have found that particle B had spin component of +1/2 along the x-axis, the opposite of particle A. How did the B particle

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Received Sept 12, 2010. Revised Jan 25, 2011.
Accepted Feb 22, 2011.

"know" that it should have spin +1/2 rather than -1/2? Or, an equally meaningful question, how did particle A "know" to have spin component opposite to particle B? As they are separated by a space-like interval there exist reference frames in which the measurement of particle A precedes the measurement of particle B and other reference frames in which the measurement of particle B precedes the measurement of particle A. Because the time order of the measurements depends on the frame of reference neither result is the cause of the other.

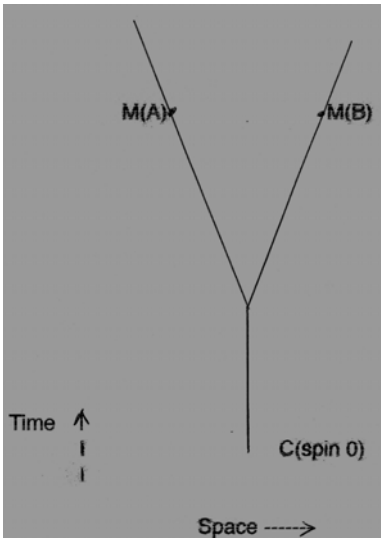

Figure 1. Spin zero particle C decays into spin 1/2 particle A and spin 1/2 particle B. The spin components are measured at M(A) and M(B) respectively. M(A) and M(B) are separated by a space-like interval.

This strange relationship, guaranteeing that if the particles are measured along the same line, the spin components must cancel, no matter what that direction might be, has been called a "spooky action at a distance". The particles can be light years apart and yet the relationship is expected to hold. It is not a causal relationship but it is a non-classical relationship and has puzzled scientists for many years. How can we understand it? Let us change the subject temporarily.

Flipping Coins onto Glass Tables

Let us first consider a simple example, actually oversimplified, to show that the observations of Alex and Bob can be correlated though each observation is unpredictable. This example is designed for the case of looking at the z-components and the x-components. It only works because they are perpendicular. It is not a good example for comparing components in directions which are not perpendicular.

There are two glass tables, Table Z and Table X. Two coins are tossed, one lands on Table Z and the other lands on Table X.

Alex looks down on table Z and sees the head/tail of the coin. He makes a decision based on what he sees, perhaps whether to spin clockwise or counterclockwise. Bob looks from below Table Z and sees the tail/head of the coin and makes a similar decision based on what he sees. Bob cannot see Alex and Alex cannot see Bob and neither knows what the other is doing. Their decisions are correlated and opposite though unpredictable individually. If a coin is observed by neither Alex nor Bob it does not affect anything; it is as if it did not exist.

Suppose Alex decides to look at Table X instead of Table Z. He makes his decision on how to spin depending on the coin which lands on Table X. Table Z is now totally irrelevant to Alex. Bob's results remain unchanged. Bob has no way of knowing that Alex has changed his (Alex's) table. But now suppose that Bob, by chance, decides to look at the underside of Table X instead of Table Z. Again his results will be correlated and opposite to Alex's results. Neither Alex nor Bob can look at more than one table at a time. We see that this simple example mimics the special case of entanglement when the two possible component directions are perpendicular.

The crucial problem for EPR is the great space-like separation between the correlated measurements of the two particles, in sharp contrast to the proximity of one side of a coin with the opposite side of the coin in our oversimplified example. This is an issue we must resolve.

Siamese Twins

Siamese twins are twins who are biologically joined at birth. Through some problem in the development of the fetuses they never separated. Let us consider two Siamese twins joined at the brain. Thus they share some brain cells but also have individual brain cells. Let us name the twins Alex and Bob. Typical cells in Alex's portion of the compound brain are called A cells and typical cells in Bob's portion of the compound brain are called B cells and cells that are shared in common by Alex and Bob are called C cells. Alex and Bob have separate consciousnesses but may share certain memories, personality traits and desires. Their desires may be correlated. Some of the C cells may be control cells. When they influence some A cells, causing Alex to be hungry for an apple they may simultaneously influence some B cells causing Bob to desire a banana. That is, they produce a correlation between the experiences of Alex and Bob.

If, however, Alex wishes to communicate with Bob (or vice versa), he may have to use the external world outside of the brain. He may write a note or he may speak to Bob. If Alex speaks to Bob the signal from the mouth with which Alex speaks travels to the ear with which Bob hears at a speed no faster than the speed of sound in air. It is influenced by the physics of the world outside of the brain. This is different from the physics of communication within the brain such as from some "control" cells C to cells A and/or B.

The Metabrain and Observed Reality: An Analogy with the Dreaming Brain

In previous articles by this author various aspects of quantum theory have been derived from an analogy with a dreaming brain. The "dream" is our ordinary observed reality in space-time and the "brain" is the unobserved "metabrain" (Schumann, 2010; 2009; 2007; 1997; 1991). In this section I attempt to "derive" characteristics of EPR entanglement from this model.

Many sections of the metabrain correspond to separate conscious beings though there will also be sections which the various conscious beings have in common. In their "dream-reality" Alex and Bob may on occasion be in the same room. They will then share similar experiences and observations related to their common location. Thus there must be "nerves" in the metabrain connecting Alex's section to Bob's section. Their "dreams" will partially overlap. The laws of physics in their "dreams" will be the same.

In an ordinary brain a common memory may influence different parts of a brain. For example, if you remember an opera you saw years ago, this might trigger both the sight of a tenor singing his aria and the sound of the melody of the aria. The visual part of the brain is located in a different section than the audio part and thus different parts are stimulated. Suppose that the corpus collosum of a person's brain has been cut but there are still nerve connections between the right and left hemisphere. Two consciousnesses have been produced but with many common memories and personality traits. Thus the experiences of the two consciousnesses will be correlated by memories of the past. This situation has been studied by Roger Sperry, Michael Gazzaniga and others (Sperry, 1968).

We have previously argued (Schumann, 2000) that "currents" in the metabrain correspond to quantum probability amplitudes and that when a current triggers a "synapse" ("neurotransmitters" conduct a signal across the "synapse") this corresponds to a conscious experience. The entanglement situation has been described by the mathematics of the quantum probability amplitudes. That has not been the problem. The problem has been in finding an intuitive model which makes the space-like correlations seem reasonable. The metabrain model serves that purpose.

The sections of the metabrain which the various conscious beings have in common may simultaneously influence the experiences of those consciousnesses and thus produce correlations in those experiences. This may occur though in the "dreams" of those consciousnesses they have the experience of being very far apart in the space-time of the dreams (which they partially share). Those correlated experiences may involve large space-like separations. The physics of the unobserved metabrain is very different from the physics of the shared observed "dream-reality" of the conscious personalities brought about by the metabrain, just as the physics of the Siamese twin brain(s) is different from the physics of the world outside that brain.

Next we must discuss causality.

Imagine that one consciousness, Alex, has the experience within his "dream", of signaling to another consciousness, Bob. Later, perhaps much later, Bob has the experience within his dream of receiving a signal from Alex. The two dreams partially overlap and they "share" the same space-time. The signal, within that dream space-time must travel no faster than the speed of light and the interval between sending the signal and receiving it must be time-like or light-like. The laws of physics are observed within the dream space-time. What happens within the metabrain is not observed.

The correlation conducted within the metabrain is clearly very different from any causal signals sent in the observed dream-reality experienced by Alex and Bob. If, in that dream-reality, Alex and Bob are separated by a space-like interval, no signal can be sent from one to the other within that interval. There is no reason to talk of "spook-like action at a distance". The correlations are not paradoxical.

Conclusion

The goal has been to bring the strange behavior of quantum physics into an intuitive model. Previous articles have "tamed" a number of these quantum characteristics; this article has attempted to bring the very important Einstein-Podolsky-Rosen problem of entanglement into the "cage" of the metabrain model.

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