How in the World are There Many Worlds?

1.0 – Introduction

This paper explores personal identity and persistence through time in the Many Worlds Interpretation (MWI) of quantum mechanics (QM). First, I will motivate the MWI's relevance in the domain of metaphysics. Second, I will define endurantism. Third, I will explain the foundational physics underlying the MWI which entails branching worlds. Finally, I will argue that the *privileged branch view* best captures endurantist judgments about personal identity and persistence through time in the many-worlds framework.

2.0 – Scope

Some of our most successful physical theories have difficulty explaining the dynamics of measurement within QM. This difficulty is popularly known as the measurement problem. Loads of work has been done on this subject in both the physics and philosophy of science literature. The MWI is an increasingly accepted solution to the measurement problem. It is beyond the scope of this paper to compare competing interpretations of QM; nor is it the goal of this paper to convince the audience that the MWI is the *best* of the bunch. Further, for this paper, I adopt endurantism simply for the sake of analysis. Future versions of this work will extend to other theories of persistence through time.

3.0 – Why Bother?

The MWI makes for a unique discussion concerning personal identity and persistence through time. But why should one consider the MWI when exploring these ideas? After all, there are classic fission cases that pump our intuitions about personal identity without requiring background physics.

There are important differences between ordinary fission cases and branching cases. First, many philosophers include no-branching conditions in their accounts of identity to rule out ordinary fission cases in the first place (Walker). However, one must face branching head-on in the MWI since, unlike ordinary fission cases, branching is an objectively real physical consequence rather than a mere possibility. Second, according to the MWI, branching is occurring constantly; this will alter our intuitions about persistence through time as compared to fission cases in which there's typically one split. Lastly, some philosophers, though not all, take the practices necessary for fission cases, such as brain transplants and psychological extraction, as too far-fetched for us to seriously consider. Thus, the MWI is a distinct platform for exploration within the literature on personal identity and persistence through time.

4.0 – Endurantism

There is a puzzle in metaphysics concerning how objects persist through time. One account, known as endurantism, claims that an object persists (or endures) through time if and only if "it is *wholly present* at different times" (Haslanger, 317). Thus, enduring objects have spatial parts but not temporal parts (Hawley, 3). Endurantists hold that an object, O, persists from time t_1 to time t_2 if and only if O is wholly present at both t_1 and t_2 (and presumably in the intervening times) (Haslanger, 318).

5.0 – Many Worlds Mechanics

The MWI is known for its fascinating and rather notorious conclusion that the world as we know it is constantly branching into many worlds. What motivates physicists and philosophers to accept such a seemingly absurd view?

Hugh Everett originally developed his so-called 'pure wave mechanics' during his PhD in the 1950s. Everett took the underlying physics of QM seriously, and, therefore, accepted the theory at face value. He proposed an austere formalism of QM which avoids adding extra machinery to the theory, such as collapse mechanisms and hidden variables. He eventually fleshed out the straightforward interpretation of QM known as the MWI.

For Everett, the underlying mechanics of QM alone provide us with an informationally complete description of the world. The foundation of the MWI is the wavefunction, ψ, which is a fundamental mathematical entity that "gives information only concerning the probabilities of the results of various observations that can be made on the system" (Everett, 3). Each possible outcome of ψ is known as an eigenstate. Each eigenstate, in turn, corresponds to a unique physical value of the system (such as, say, position or momentum). Wavefunctions are defined by their eigenstates, and they are said to be in a *superposition* of all eigenstates. That is, ψ is a linear combination of all its eigenstates *at the same time*.

Wavefunctions evolve with time in a linear and deterministic fashion according to the Schrödinger equation. Everett took these linear dynamics to be a "*complete* as well as accurate description of the time-evolution of every system" (Barrett, 5). Everett extended the validity of the wavefunction mechanics beyond microphysical quantum systems. Macroscopic systems, including observers and measuring devices, are subject to the very same wavefunction mechanics (Everett, 8). One can even consider the wavefunction of the entire universe (Everett, 9). However, as hinted at in section two, the dynamics of the wavefunction change upon measurement or observation. For the MWI, measurement leads to many branching worlds.

6.0 – Branching Worlds

In short, branching worlds emerge whenever a measurement or observation occurs. Upon interaction, observers become entangled with the system. This entanglement entails that one world is split into many worlds (Bishop, 28).

Everett was quite liberal in terms of what counts as measurement. He states that any interaction *at all* between the observer and object-system counts as measurement or observation (10). An interaction between the observer and object-system causes all possible eigenstates of ψ to be realized; there is a world generated for each of the eigenstates. The worlds that emerge because of measurement are not a matter of mere metaphysical stipulation (Barrett, 54). Rather, the evolution of the wavefunction through interaction reflects a "continual splitting of the universe into a multitude of mutually unobservable but equally real worlds, in each of which every good measurement has yielded a definite result" (Everett, v). Though modern Everettians apply strict criteria for the reality of a branch by appealing to a process called decoherence, they endorse the familiar conclusion that one world splits into many worlds upon measurement (Maudlin, 176). Thus, the MWI states that one world branches into multiple real worlds upon interaction.

What, then, can be said about the observer's experience of such splitting? As we saw earlier, observers become entangled with the system. This interaction, as described by Everett, transforms the observer from a single defined state into a superposition of states (73). It appears to an observer that any "observation on a system [causes] the system to jump into an eigenstate in a random fashion" (Everett, 70). Each branch corresponds to a single eigenstate; this explains why an observer in each branch records a single definite outcome. All worlds contain a "definite observer state and a definite relative object-system state" (Everett, 10). We should not take this consequence to be mysterious, since the branching is simply a physical consequence of

interaction implied by our straightforward interpretation of QM. First, there are wavefunctions in a superposition of all possible outcomes. Second, observers interact with and, in turn, become entangled with those systems. Finally, there is an actual world generated for each possible outcome which contains all physical things, including the observer and the corresponding outcome of measurement.

7.0 – Betty Brancher

Consider an agent, Betty Brancher, in the MWI framework. Betty is in world w_0 at time t_0. At some later time, t_1, Betty interacts with a quantum system with two possible outcomes. This interaction causes w_0 to split into two worlds, w_1 and w_2, which are spatiotemporally continuous with w_0. What can endurantists say about the 'original' Betty – the Betty in w_0 at t_0? This question is reminiscent of Derik Parfit's discussion of classic fission cases in that there seem to be three initial responses (Parfit, 5). First, the *bye-bye Betty view*, says that Betty does not exist in w_1 or w_2. Second, the *every-branch view*, says that Betty exists in *both* w_1 and w_2. Finally, the *privileged branch view*, says that Betty exists in either w_1 or w_2. I will argue that the privileged branch view is the most plausible.

7.1 – The Bye-Bye Betty View

On the bye-bye Betty view, Betty does not exist on either branch. Betty does not persist through the split in virtue of the fact that she is no longer wholly located in any world at time t_1. Rather, Betty's successors emerge once the split occurs, and each of them is wholly located in w_1 and w_2, respectively.

We can analyze personal identity by invoking both bodily continuity and psychological connectedness as criteria. Betty's successors are surely psychologically connected with Betty

since they have a direct psychological relation to Betty (Parfit, 20). The successors share a unique psychological past with Betty. Since Betty does not persist through branching on this view, it must be the case that the successors fail to satisfy the bodily continuity criteria. Betty (including her body) does not exist at time t_1, so she (and her body) cannot be wholly located on either branch. However, her successors, whose bodies come into existence at t_1, are independently wholly located in their respective worlds. There is no sense in which the body in w_0 at t_0 is continuous with either of the bodies at t_1. Therefore, Betty is not identical to either of her successors since she is not bodily continuous with them. Though this view is consistent, we should not accept it on the following grounds.

First, this view turns out to be not-so-endurantist. Instead, it collapses to an exdurantist view which states that objects persist as stages that exist only momentarily (Haslanger, 318). According to Bryce DeWitt, the universe is constantly splitting; even quantum interactions taking place across the universe cause a split in the universal wavefunction (DeWitt, 33). Thus, agents are only momentarily wholly located. This is incompatible with the endurantist view but compatible with the exdurantist view. Therefore, to endorse the bye-bye Betty view, we must abandon our original endurantist commitments and, instead, embrace exdurantism.

Second, this view does not capture experience or our judgments about the future since we are led to conclude that agents do not persist through any branching. Thus, by the time you have finished reading this sentence, you – the person who began reading this sentence – no longer exist. The consequence of this view is that it severely diminishes our typical forward-looking attitudes. We ought to prefer a different view that better captures our intuitions about our own identity and persistence. Therefore, as an endurantist, one should reject the bye-bye Betty view.

7.2 – The Every-Branch View

Alternatively, an endurantist can endorse the every-branch view, which says that Betty exists in both resulting branches. That is, Betty persists through the split in virtue of the fact that Betty is wholly located in both w_1 and w_2.

The criterion of psychological connectedness is satisfied since Betty's psychology is retained, so to speak, *in-house*. The bodily continuity criterion is also satisfied since the wholly located body in w_1 and the wholly located body in w_2 are identical to the wholly located body in w_0. That is, the same body in w_0 became multiply wholly located in two separate branches. We should not accept the every-branch view on the following grounds.

First, this approach faces an issue concerning numerical identity. It posits that the single body wholly located in w_0 is, post-split, multiply wholly located in both w_1 and w_2. How is it that a single wholly located body in one world becomes two identical wholly located bodies, each in spatially distinct worlds? It does not appear that the endurantist can reconcile the every-branch view in any commonsensical way.

Second, the every-branch view is inconsistent with the underlying physics of the MWI. In this case, Betty will obtain *all* possible outcomes upon measurement since *she* exists in both branches. As described in section six, however, each branch contains a single definite observer who records a single unique outcome. In this view, Betty is a single observer who records two unique outcomes. This is analogous to Betty flipping a coin once and recording that the outcome was both heads and tails. Thus, the every-branch view produces counterintuitive results that are inconsistent with the MWI. Therefore, one should reject the every-branch view.

7.3 – The Privileged Branch View

Lastly, an endurantist can hold that Betty exists in either w_1 or w_2. That is, Betty persists through the split in virtue of the fact that Betty is wholly located in only one branch while her counterpart is wholly located in the other. The branch that Betty ends up on, then, is the *privileged branch*.

As in the every-branch view, Betty's psychology from t_0 to t_1 is retained in-house. Betty's counterpart, on the other branch, is psychologically connected to Betty. Thus, both Betty and her counterpart satisfy the psychological criterion of identity. However, only the body in the privileged branch satisfies the bodily continuity criteria. Betty, wholly located in w_0 at t_0 is identical to the wholly located body in the privileged branch at time t_1. More specifically, the body wholly located on the privileged branch at t_1 *is the same body* that existed in w_0 at t_0. Betty's counterpart, however, is not identical to Betty because the counterpart's body is nonexistent until t_1; there is no shared bodily past between Betty and her counterpart. Ultimately, there is only one body that existed both before and after the split, and it is Betty's body. Therefore, the counterpart is not identical to Betty. One should accept the privileged branching view on the following grounds.

First, it captures our experience and judgments concerning persistence through time. Our forward-looking attitudes are not undermined since this view holds that agents persist through constant branching. Further, one need not abandon their endurantist commitments since agents are wholly located at different times rather than mere moments.

Second, this view does not face a numerical identity issue. There exists one wholly located person in w_0 at t_0, which, after branching, is identical to the wholly located person in the privileged branch. The counterpart, wholly located in the opposite branch at t_1, is not identical to Betty. Thus, we can plausibly maintain a one-to-one identity relation.

Finally, the privileged branch view is most consistent with the underlying mechanics of the MWI. Once the split happens, Betty is a single definite observer wholly located on the privileged branch. Betty will record a single unique outcome. Betty's counterpart is a *different* (i.e., non-identical) single definite observer wholly located on the other branch. The counterpart will record a unique outcome. Therefore, one should accept the privileged branch view as it is the most attractive of the responses regarding Betty's identity and persistence through time.

8.0 – Conclusion

This paper aimed to analyze what metaphysical implications a branching universe has on personal identity and persistence through time. After explaining the underlying mechanics of the MWI, I offered three possible endurantist responses to the question of Betty's identity and persistence in the many-worlds framework. I argued that endurantists should reject both the bye-bye Betty view and the every-branch view. Finally, I argued that the privileged branch view is the best of the bunch.

[Word Count: 2478]

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