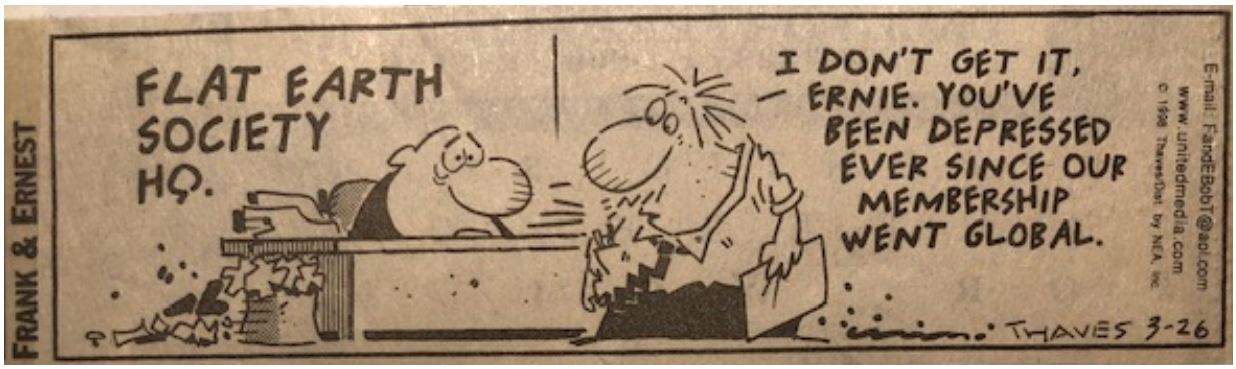
Chapter 8
Quantum Temporal Paradox (QTP)



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Let's take a moment to review the foundations that have been laid in the last few chapters.

1. **Paradigms** – Our world view is a two-edged sword, cutting quickly through the clutter of an information rich environment, but also distorting that data to fit naturally, or in the pathological cases unnaturally, into expected categories. The sign of a full paradigm, when a paradigm shift is called for, is when there remain unsolved fundamental problems that were expected to be easily dispatched. The measurement problem, when and how a quantum system makes the transition to a classical state, is the fundamental unsolved problem of quantum mechanics.
2. **Paradox** – Self-reference has a nasty habit of breaking closure, it seemingly cannot be avoided, and is single-handedly responsible for most of the limit theorems of the last hundred years. The introduction of imaginary truthvalues offers the potential to break this nasty habit, and the fact that they can be formalized as a conjugate basis set to the Boolean truthvalues, is suggestive of their potential power to address unsolved problems in, among other fields, quantum mechanics.
3. **Relativity** – For our purposes we only need to worry about special relativity. Special relativity puts interesting constraints on our models of causality. The fact that spacelike cause and common spacelike cause can be defined, but have never been observed, suggest that due consideration of them might offer fresh insights.
4. **Quantum Mechanics** – Our most successful theory, yet it violates common sense and intuition to such a high degree, that it alone of modern theories suffers from the problem of multiple interpretations. An inherently linear theory, it has long been noted that collapse of a quantum system from a superposition to a definite classical state requires some kind of nonlinearity. Self-reference introduces nonlinearity in a natural way.
5. **Uncertainty** – The uncertainty principle is not actually about the act of measurement disturbing the system under observation. Rather it is the more fundamental concept that measurement bases come in pairs, conjugate pairs, where a pure state in one is in a

maximal superposition in the other. The most shocking, counter-intuitive aspect of this principle is that conjugate bases can have different *units* – momentum is a superposition of position, time is a superposition of energy. It is as if color where a superposition of hardness. You can't make this stuff up, the universe is, indeed, stranger than we can imagine.

6. **Interference** – Interference is the phenomenon where a quantum object can interact with itself in a destructive way. What used to be possible can be cancelled out. Interference seems natural in wave phenomenon, but the wave-particle duality of quantum systems adds perplexing elements. How can a particle take two paths until we look? As long as there is no record of which path, the interference pattern is maintained, but once it is known that one path was not taken, the interference pattern is replaced with a diffraction pattern.
7. **Entanglement** – As bizarre as the quantum mechanics of single objects is, the real shocks come from systems of quantum objects. That entanglement cannot be explained by the only two forms of causality that have an acceptable scientific pedigree is a serious conundrum. That neither timelike nor common cause can explain the correlations of spacelike separated elements of an entangled quantum systems requires denial of either realism or locality. Spacelike causality would be nonlocal, but to restore realism requires it to be relativistically consistent (an unsolved problem) and that there be some kind of cosmic censorship that prohibits temporal paradox. These are high barriers, and Dogma's skepticism is warranted.
8. **QTP** – The hypothesis of Quantum Temporal Paradox is the speculative idea that a quantum system can allow spacelike causality but avoid temporal paradox by collapsing in the basis in which the temporal self-reference is indeterminate. It is an elegant and potentially testable (and thus falsifiable) hypothesis. If true, it would
    a. offer an objective measurement process.
    b. introduce nonlinearity into quantum mechanics naturally, via self-reference.
    c. determine the measurement basis.
    d. explain the randomness of quantum systems.
    e. show how an isolated quantum system could self-collapse.
    f. remove the ambiguous distinction of measurement system vs. quantum system.
    g. implement nonlocality as some form of spacelike causality.
    h. ground quantum nonlocality in relativistically consistent spacelike causes.
    i. permit spacelike causality but prohibit temporal paradox.
    j. resolve the interpretation issue.
    k. offer new technologies with which to manipulate nature.

    The purpose of this book is to explore the scientific viability of this idea.

The major challenge is to refine the hypothesis until it is in a testable form. Basically, this leads to two objectives; address the objections and quantify it until it is experimentally falsifiable.

Before starting the journey, a note to the curious. Some intrepid readers may be wondering where the title of the Discourse came from; what have zombies to do with quantum physics? The answer is a short science fiction story by Robert Heinlein – a time travel story. The creative brilliance of the plot is that the protagonist and antagonist are the same person, just at different moments in their timeline. The son and daughter are the same person, as are the father and mother. The recruiter and the recruit – also the same person. Indeed, they are all the same person. The story concludes with the observational question, "Who are all you zombies?"

The point? The entire story is causally self-consistent, not a paradox in sight.[1]

[1] The science fiction writer cannot resist the temptation to pen a time travel story. The science popularizer cannot resist the temptation to pontificate about quantum physics. In QTP, they are combined – oh, the joy…