

ON THE IMPOSSIBILITY OF TIME TRAVEL

J. C. N. Smith

We have to learn how to use our words. It's a fantastic thing -- we humans are so easily trapped in our own words. The word time for instance -- we run into puzzles about the concept of time and then we say, oh, what a terrible thing. We don't realize we're the source of the puzzle because we invented the word

-- John Archibald Wheeler

If a device could be built that would permit travel backward and forward in time in any sort of controlled fashion, the author of this essay would be among the first in line to purchase a ticket. The concept of time travel has long held an almost magical allure for laymen and scientists alike. And no wonder. How fascinating, indeed, to go back and visit the Earth during The Age of Dinosaurs, or perhaps to explore the world as it will be experienced by those destined to inhabit our planet during untold centuries in the future.

Unfortunately, I have become convinced that such fanciful adventures are destined to remain forever in the realm of science fiction. The fact that time travel remains a topic of serious speculation, not only among fans of

science fiction, but among respected scientists as well [1-2], reflects what I believe are misperceptions about the fundamental nature of time.

The purpose of this essay is to offer what I hope is a fresh look at the venerable chestnut of speculation about time travel and to spell out clearly why I believe time travel of the variety portrayed in science fiction is not possible. In so doing, moreover, I hope to offer some thoughts about time which will shed additional light on its fundamental nature.

As discussed in this essay, time travel is defined as a hypothesized phenomenon in which humans (or other objects) somehow are “transported” into, or between, various particular “past” or “future” times, i.e., particular times which are well removed from the “present” or from one another. This is to distinguish it from the sort of time travel which I am doing as I write this page and which you are doing as you read it. We are *all* time travelers in this latter sense, which, this essay will argue, is the *only* sense in which time travel is possible.

Let us begin by examining the hypothesized nature of time travel. What would it entail if it *were* possible? In order to convince a justifiably skeptical scientific community that time travel is not only possible, but, moreover, that we had actually achieved it we would need to demonstrate unambiguously that someone or something had in fact somehow “traveled” or “transitioned” or “been transported” (let us not quibble about terminology and simply agree to call it “traveled”)

from one particular time, call it some particular “Time A,” directly to some totally and distinctly different particular time, call it “Time X.”

Exactly how would we demonstrate the reality of such a phenomenon? Perhaps we can agree that as one of our first steps we would need to establish some unambiguous way to define and identify various particular times. Lacking this basic capability, we would be hard pressed to design a convincing demonstration of having traveled from one particular time to another.

So what *do* we mean by the term “a particular time”? In other words, how would we go about defining and identifying a particular time? Correctly answering this question is the key not only to answering our question about time travel, but also the key to a better understanding of the fundamental nature of time.

As used in everyday parlance, the phrase “a particular time” can serve a variety of purposes. For example, when we speak of The Age of Dinosaurs we mean a particular time roughly 200 million years earlier than our own. Similarly, we might speak of the American colonial period as being a particular time in the Earth’s more recent history. Even yesterday’s dinner time might be a particular time worthy of revisiting in a time machine if such were possible. What is the common thread running through these various uses of the phrase?

Let me suggest that the common thread is the fact that each serves as a convenient “pointer” or “reference”

to some loosely defined configuration of a relatively small portion of the universe. When we speak of The Age of Dinosaurs, for example, our purpose is to refer to the rough configuration of one small part of the universe, the Earth, as it existed when our planet had made roughly 200 million fewer revolutions around the sun.

One interesting feature of that earlier configuration was the presence of large living creatures which we call dinosaurs. Many other features of the universe were also different at that particular time, but we typically focus on the presence of dinosaurs as being one especially noteworthy feature, and certainly one which distinguishes it from other particular times such as our own.

Now let us ask how the particular time which we call The Age of Dinosaurs became the particular time which we call “today,” i.e., the present. The way it happened is amazingly simple; the various components which made up the universe in The Age of Dinosaurs subsequently have been rather dramatically rearranged, courtesy of the laws of physics, which clearly were fully functional even before they were “discovered.”

The many bits and pieces of the universe which existed in The Age of Dinosaurs did not simply vanish. Quite the contrary; if someone had been so thoughtful as to put convenient little tags on all those small bits and pieces (say, on all the atoms, for example) which existed in The Age of Dinosaurs we would find that most of those very same small bits and pieces are still with us today. But they are arranged quite differently.

It is reasonable to postulate, for example, that a calcium atom which once made up a tiny part of the tooth of a Tyrannosaurus Rex might today be a tiny part of one of my own teeth, or a part of one of yours. Or that a carbon atom which once resided on the tip of Cleopatra's eyelash may now reside on the tip of your eyelash, or perhaps it might be part of the salad you will have for dinner this evening.

The configuration of the universe, i.e., the arrangement of all its many bits and pieces relative to one another, is constantly changing. As sentient beings, we are able to *observe* some of these changes; we are aware of our surroundings. In some particularly interesting cases, moreover, we may find it possible not only to *observe* the changes going on around us, but also to *influence* them, a fact which raises issues more suitable for discussion in a different essay.

Using our relatively recent and still imperfectly honed invention called language, we humans have come to refer to the changing configurations of the universe as "the flow of time." It is absolutely crucial to recognize here, and to point out explicitly, however, that the changes which we observe in the configuration of the universe are ***not caused by***, and are not in any way ***a consequence of***, the flow of time. Rather, the changes we observe (as well as those we don't observe) ***are*** the flow of time. If the configuration of the universe did not change, there would be no flow of time.¹

¹ Brian Greene, in his book *The Fabric of the Cosmos* [3] wrote, "Time is a subtle subject, and we are far from understanding it fully. It is possible that some insightful person will one day devise a new way of looking at time and reveal a bona fide physical foundation for a time that flows." While making no claims to being particularly insightful, I would suggest that the way of looking at time described in this essay offers exactly such a physical foundation for a time that flows.

What we refer to as “particular times” correspond to, and are in fact defined by, particular configurations of the universe. For example, ask yourself this question: what makes the particular time at which I am reading this sentence different from the particular time five minutes prior to my having read it? Or what makes it different from the particular time one hour ago, or one day or one year or one century ago? Upon reflection, we will see that the *only* difference between these particular times is the configuration of the universe, i.e., the way in which the universe is arranged.

Let us, therefore, propose the following formal definition of a particular time: *a particular time is identically equivalent to, and is completely defined by, and only by, a particular configuration of the universe.*²

With the foregoing as background, we can pick up the thread of our discussion about time travel. What would it mean for a person who is living in the 21st Century, for example, to travel to The Age of Dinosaurs? First, when we say that a person is living in the 21st Century, we mean that the ensemble of atoms which comprises the person’s body is part of the configuration of the universe which those of us who are living in the 21st Century may observe by looking around us.

In order to travel to and experience the universe as it was in The Age of Dinosaurs, this person would need somehow to travel to and experience a universe in which all the various bits and pieces had been rearranged so that they exactly replicate the configuration

² For additional details on the development and ramifications of this definition, see [4].

which they had when the earth had made roughly 200 million fewer revolutions around the sun. This is one example of what would be required to make time travel a reality.

A question we should ask ourselves at this point is whether we believe that the universe which we observe around us is “real” or not. By this I mean do we believe that there is an objective reality, at least on a macroscopic level, upon which local observers can agree? While it is true that widely separated observers will have significantly different perspectives regarding the configuration of the universe,³ we would expect (and, in fact, science is founded on this expectation) that observers who are local to one another would be able to agree on issues such as the presence or absence of dinosaurs, for example. If we seriously doubt the objective reality of the universe on this level, then we may also need to rethink the role and value of empirical observations, and science in general.

If, on the other hand, we believe that the universe which we observe *is* objectively real, and if we believe that it is made up, for the most part at least, of the same bits and pieces which formerly were arranged very differently to include dinosaurs, then I think we must conclude that the particular time which we call The Age of Dinosaurs no longer exists. Anywhere. It is not lingering somewhere out in the wings of history’s grand stage waiting to make a curtain call, or waiting in some

³ The fact that non-local observers will have significantly different perceptions regarding the configuration of the universe is analogous to the fact that several blind persons examining various portions of an elephant will have significantly different perceptions regarding the elephant’s configuration. These differences are not a compelling reason to believe that the various observers’ individual observations are not valid, however, or that the elephant is not real. The universe is *our* elephant in this sense.

mysterious “other dimension” or in a different part of the “space-time continuum” or in some “time warp” waiting to be visited by time travelers. There is no way to travel to it, because it no longer exists. Period. The universe may be the ultimate example of “what you see is what you get.”

Through the science of astronomy, we are granted the rare privilege of being vicarious observers of past configurations of some parts of the universe. This is owing to the fact that the information which is being received by our telescopes and other instruments today originated at various particular times, i.e., various particular configurations of the universe, which were significantly different than the one in which we are now receiving this information. In this sense, astronomical instruments may be the closest things we have to time machines. Unfortunately, they only allow us to look into the past, and they do not allow us to do any time travel ourselves.

The glimpses of earlier configurations of the universe afforded by astronomical observations are analogous to glimpses of the Earth’s early history afforded by artifacts such as fossils. And while such artifacts afford valuable insights regarding previous configurations of the universe, the artifacts themselves are now part of the present.

The terms “past” and “future” refer to configurations of the universe which we can visualize in our imaginations and about which we can speculate and hypothesize, but which have no objective reality for those of us who are living in the present. Our empirical

observations lead us to conclude that the “past” consists of those configurations of the universe which once had an objective reality, i.e., which once actually existed. These past configurations subsequently have evolved, through physical displacements of the various bits and pieces relative to one another, into the “present” configuration which we can perceive with our senses. And we infer that this configuration will evolve into yet others which we imagine as the “future.”

We can only engage in educated speculation about what sorts of things will or will not be included in future configurations of the universe. By understanding the laws of physics, we can predict, or extrapolate, more or less accurately, the likely future configurations of at least some gross, observable features of the universe, up to a point, but we observe no empirical evidence of the objective reality of these predicted configurations. We find no “fossilized remains” of the future as we do of the past, the reason being that the future, unlike the past, has never existed.

In conclusion, the only way to travel to configurations of the universe which do not exist, i.e., to other particular times, is the way in which we already are doing so. Each new configuration of the universe that we observe represents a new time. And each new configuration replaces the previous configuration, which then ceases to exist except as a “memory” or intellectual concept.

Perhaps the most intriguing aspect of this form of time travel is the notion that each of us can, by our own actions, have some influence, albeit limited, on future

configurations of the universe. It would appear to be in our own enlightened self-interest, therefore, to use our individual and collective powers, limited though they may be, to influence the evolution of the universe in ways that will make subsequent configurations as habitable, pleasant, and rewarding as possible.

References:

- [1] Paul Davies, *How to Build a Time Machine*, Viking, New York, 2002
- [2] J. Richard Gott, *Time Travel in Einstein's Universe*, Mariner Books, New York, 2002
- [3] Brian R. Greene, *The Fabric of the Cosmos*, Knopf, New York, 2004.
- [4] J. C. N. Smith, *Time: Illusion and Reality: An Unconventional But Constructive Look at the Fundamental Nature of Time*,
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