Time Travel

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1 Introduction

I chose this part of the "Paradoxes" lecture because I have the most experience and interest in this topic. Time travel is present in many science fiction series (which I am a fan of) and each one of them explains it differently. The best example in my opinion is "Window of Opportunity" - Episode 6 of Season 4 of Stargate SG-1. They have a consistent picture of the timeline and it is a hell of a lot of fun. I will refer to this episode at the end of this essay to examine a more developed example of time travel to get some experience with the topic.

2 Back to the Future

This movie is very clearly inconsistent as stated by Rayo. The two interpretations, the one using super time and the one using the world-travel interpretation, are essentially the same to me. The additional dimension, the "super time", did not seem very time-like to me. It is more like a fifth dimension which separates the different timelines. Those timelines can also be interpreted as different worlds. So with super time, the multiverse can be portrayed.

At the end of this section I think that there is a second problem. Marty travels forward in time to the good world where George is happy. Rayo points out that he never returns to the sad world where he originally came from, and his family is still miserable there. But if Marty travels back to the present of the good world, there would be two Martys. The Marty which belongs to the good world would be born and raised normally. Then, in 1985, a second one would appear. So where did the original Marty of this world go? This fact is also just ignored in the movie.

3 The Toy Model

This model shows an intuitive way to look at a wormhole. Especially the legitimacy of creating additional particles looping through the wormhole is displayed. So two additional particles can be created and prevent Particle A from entering the wormhole region (Rayo, Figure 4.8).

Thinking about this, another problem occured to me: conservation of energy. Particle A collides once with particle B. But particle B and C collide an infinite amount of times in their reference frame. On a second thought though, conservation of energy is not included in the two laws of the toy model. And it is anyway not fulfilled if moving particles can be created in a loop. The notion that the particles B and C are not "caused" by particle A was a bit confusing to me. But I can accept it that they are not caused within the model, but particle A causes us to make particles B and C.

I had quite some problems on the two conceptions of a physical law: what will happen and what must happen. So I try to apply the conceptions to the Toy Model. The conception on what will happen tells us that if particles A, B and C are on the paths as depicted in Figure 4.8 in Rayo. They bounce off each other and there is no paradox. The conception on what must happen tells us that A must not be on a paradoxical path. So A causes the particles B and C, and A has no freedom when it approaches the edge of the wormhole region.

I think that an additional law could resolve the problem in this scenario, that a particle cannot interact with itself. Sadly, this law would cause the Toy Model to be no more analogous to the grandfather paradox. But maybe for every time travel scenario, there would be an elegant law to resolve a problem.

4 The Grandfather Paradox

In this section, Rayo only explains how we can avoid a paradox, not what happens if he shoots his grandfather. We would need a second world, like in "Back to the Future", which makes it the same problem, so it is not worth talking about it. The Toy Model prepares us for the first argument, where everything happens in a way, that no paradox occurs. And it really does not mean that Bruno does not have a free will. He is in a position to make his shot, but maybe decides otherwise. There is another example where the first argument prevents a paradox in a story where the characters have free will. In Harry Potter: The Prisoner of Azkaban. No physical or magical law prevents the characters to cause a time travel paradox, but it just happens that there is no paradox. The second argument involving the powerful enemy or a physical law which prevents Bruno to kill his grandfather is really not applicable in this story. It has to be set up beforehand. A nice example is "Window of Opportunity" (see later).

5 Window of Opportunity

"Window of Opportunity" is an episode of the Stargate: SG-1 series. In this series, the US Airforce finds an thousands of years old giant ring, the Stargate. It was built by an old, vanished, technologically developed alien civilization, called the "Ancients". They use the Stargate to travel to other Stargates distributed throughout the Milky Way in seconds. This is more or less the setup for many fantastic and funny adventures of the SG-1 team, consisting of Colonel Jack

O'Neill, Major Samantha Carter, Dr. Daniel Jackson and Teal'c. In my opinion, the best episode is "Window of Opportunity", which is (kind of) about time travel.

In this episode, the SG-1 team visits a planet named P4X-639. They arrive at an ancient abandoned altar in the middle of a desert. An archaeologist named Malakai examines the altar which will turn out to be a time machine. After a short conversation, the machine gets activated and hits the Stargate with a lightning strike. O'Neill an Teal'C try to intervene, but are also hit by the lightning. After this, they find themselves at the breakfast table of the stargate center on earth. They are exactly in the same position as they were in the beginning of the day. As if someone had turned back time for 10 hours. But only Teal'C and O'Neill remember what has happened on the P4X-639, and everyone else is unaware of the incident. This timeloop of 10 hours happens again and again, regardless if they are on P4X-639 or not. Teal'C and O'Neill are able to influence everything normally, but ultimately it does not have an effect on their environment, because every time the changes are turned back. In the end they find out that Malakai used the machine to give himself time to research how to turn back time for a few years, to see his dead wife again. They tell him that he traps billions of people in a time loop and convince him to give up and turn off the machine.

I think that this kind of time travel is a quite consistent one. As I mentioned, this is "kind of" time travel in my interpretation. Technically, time progresses normally, but all changes of the last 10 hours get reverted, with the exception of Teal'Cs, O'Neills and Malakais thoughts. In the end of the episode they get a message from allied aliens who tell them that they could not contact them or connect to their Stargate for the last three months. So if you compare this with "Back to the Future", this is more like "turning back" time, than time travelling.

5.1 The powerful enemy

In context of Rayo's book, the time machine itself represents the powerful enemy, which prevents Susan to enter her train to Alaska in section 4.4.2. Whatever the SG-1 team does, it gets reverted. First they nearly go crazy from the countless repetitions (Figure 1).

But they find their ways around this enemy. Teal'C and O'Neill find out how to tell their team members that they are trapped in a time loop without being labelled as crazy and learn to decipher the ancient texts which describe the time machine. After some time, Teal'C and O'Neill also recognize the advantage of their actions having no effect on the outcome: They also have no consequences. So they decide to use some loops as well deserved leisure time (Figure 2) without facing any consequences from their actions. This powerful enemy prevents any kind of paradox - at least none that I can think of. Maybe a spaceship which enters the vicinity of the time machine from outside would be a problem. The time machine creates a "sub-space bubble" where it reverts time. What happens if you enter it from outside? Can you enter it? The easy solution would be that

Figure 1: Jack O'Neill on the verge of loosing his shit.

it is protected by an in-penetrable barrier. This example shows the convenience of ancient alien technology as the powerful enemy.

5.2 A "real" time machine?

Now in "Window of Opportunity", only a small part of the universe is affected by this time machine. This makes a definition of the "real" time quite easy, as we have a reference time from the alien allies. But if the time machine would affect the whole universe, it would no longer be distinguishable from a time machine a la "Back to the Future" when going back in time. You would just have to add the physical transport of your body and revert everything else (of course no problem with alien technology). But with a time machine which is "turning back" time, no paradoxes (that I can think of) can occur. The old world does not exist anymore. Everything gets turned back an then develops according to the normal physical laws.

Going forward is anyway just like waiting. The only problem, if you travel physically through time, is that at some point you would exist twice. This is not really a paradox, but more an effect of the time machine. This problem is also ignored in "Back to the Future" when considering the world travel interpretation. Anyway, for me this kind of time travel is the most robust for me. But it needs some kind of a powerful enemy which is properly set up in this case.

Figure 2: Jack O'Neill and Teal'C playing golf through the billion dollar, heavily regulated Stargate.

6 Conclusion

It was fun to revisit this section of Rayo's book and also to incorporate my favorite episode in this essay. It was interesting that there are essentially only two arguments to avoid paradoxes: the convenient story that the paradox is just not happening, and the powerful enemy. The scenarios with the powerful enemy are more appealing to me because they are more robust and don't have to ignore what would happen if a character made a different decision.