Why time travel is possible, but time machines are not

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Abstract

According to existing physics, it is possible to have time travel of the sort that does not involve physical transport of the traveller's body, but which nevertheless permits some sort of interaction with the past. This can be achieved by a combination of retarded and advanced electromagnetic radiation, say. Clearly, the real world is not time symmetric, and the electromagnetic radiation we observe is mostly[1] retarded, so our ability to interact with the past, or to anticipate the future (in a direct [perceptual] and non-inferential way), would be very limited.

But, how does one rule out the empirical existence of small amounts of advanced radiation? Clearly, the way to do this is to determine the empirical consequences of this state of affairs, and compare these with observations. What are these empirical consequences? Determining the detailed empirical consequences requires the solution of a mathematical problem that has only recently begun to be solved in the physics literature.[2] However, one empirical consequence is clear: if small amounts of advanced radiation exist, we must observe events that are spontaneous, in the sense of being inexplicable even from precise knowledge of the entire past (causally inexplicable).[3]

This analysis is quite general, and makes no use of any property specific to electromagnetic radiation. That is, any sort of interaction propagating from future to past would imply the existence of spontaneous events. The empirical existence of spontaneous events can hardly be ruled out: the existence

and operation of living beings itself very likely involves such spontaneous events. (If, on the other hand, it were to be supposed that living beings are completely causally explicable, according to existing physics, for example, then there is little justification left for believing in that physics!)

A machine, however, to slightly modify the inadequate OED definition, is "a combination of parts, moving mechanically, in obedience to a rule". Knowing those rules, the behaviour of a machine can be controlled. From H. G. Wells to Kip Thorne,[4] various machines have been suggested for time travel. But if a machine (any sort of machine, not necessarily one which uses wormholes) is used for time travel, one would be able to control the production of spontaneous events by rule. *Where* would this control reside? In the absence of a causal explanation, spontaneous events cannot be controlled from the past. On the other hand, retarded interactions are there, irrespective of time travel, and in the presence of retarded interactions, a purely teleological explanation (i.e. an explanation of past from precise knowledge of the entire future) is also impossible. Hence, spontaneous events cannot be controlled from the future either. Counter-examples show that, in general, control is impossible over an interval of time, even if *both* past and future data are prescribed outside that interval. Therefore time machines are impossible, since time travel implies the occurrence of spontaneous events that cannot be mechanically controlled from either past or future or both.

A second argument for the impossibility of time machines is the following. It can be shown that retarded interactions result in increase of entropy (loss of information) towards the future, while advanced interactions result in increase of entropy towards the past, which is the same thing as *decrease* of entropy towards the future. If order is naturally defined as the negative of entropy, advanced interactions are associated with an increase of order (with increasing time). Therefore, time travel implies the existence of spontaneous events that create order or decrease entropy.

Now, the occurrence of occasional spontaneous events which decrease entropy does not conflict with the second law of thermodynamics. However, with a time *machine*, one could *mechanically* decrease entropy, hence decrease it by an arbitrarily large amount. Hence, a time machine (any sort of time machine) is a perpetual motion machine, and is hence impossible.

Notes

[1]Estimated, using the incorrect Wheeler-Feynman theory, advanced radiation in the universe was put at less than 1 part in 10^9 by R. B. Partridge, *Nature*, **244**, 1973, pp. 263–65.

[2]The mathematical problem is the solution of mixed-type functional differential equations. An account of how to solve these equations was given in the paper "Simulating a tilt in the arrow of time", *Seminar on Some Aspects of Theoretical Physics*, Indian Statistical Institute, Calcutta, 14-15 May 1996. For the first numerical solutions of retarded functional differential equations of electrodynamics, along those lines, in a realistic physical context, see, C. K. Raju, "The Electrodynamic 2-body Problem and the Origin of Quantum Mechanics", *Found. Phys.* **34**(6), June 2004, pp. 937–62.

[3]For more details, see my article, `http://philsci-archive.pitt.edu/archive/00002416/01/Time_Travel_and_the_Reality_of_Spontaneity.pdf`. For the full background, see *Time: Towards a Consistent Theory*, Kluwer, 1994, and for a non-technical account, see "Time Travel", chp. 7 in *The Eleven Pictures of Time*, Sage, 2003.

[4]K. S. Thorne, *Black Holes and Time Warps*, Norton, New York, 1994; M. S. Morris, K. S. Thorne, and U. Yurtserver, *Phys. Rev. Lett.* **61** (1988) 1446; S. -W. Kim and K.S. Thorne, *Phys. Rev.* **D 44** (1991) 4735-37.