Time Travel

Travel

1. **Travel***:* special case of *change*, i.e. change of *place* as opposed to temperature, etc.
2. **Space travel**: between Cambridge at time *t* and Oxford at time *t′*
   from Cambridge *to* Oxford if *t earlier* than *t′*.

Change is a thing's being *G* at *t* and *G´* at *t´*, where *G* and *G´* are incompatible (i.e. such that nothing can be both at the same time, e.g. *hot* and *cold*).

Travel is the special case where *G* and *G´* are spacetime locations (e.g. London and Paris).

Space travel

Object ***o*** travels from *s* at *t* to *s´* at *t´* (*s* and *s´* here are incompatible spatial *locations*, not distances).

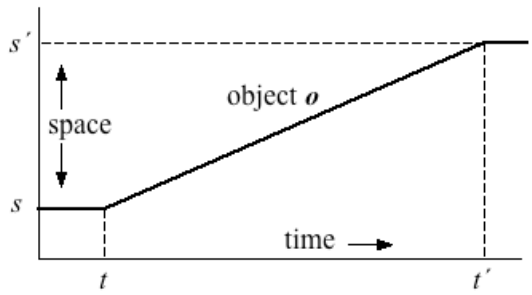

Figure 1

The travel is *from s* and *to s´* because *t* is *earlier* than *t´*, and it can be at *any speed* (in Special Relativity: up to *c*, the speed of light).

Trivial time travel

Object ***o*** 'travels' from *t* at *t* to *t´* at *t´* (*t* and *t´* are incompatible *temporal* locations)

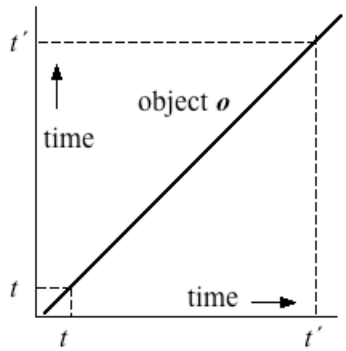

Figure 2

The travel is *from t* and *to t´* because *t* is *earlier* than *t´*; which makes it *trivially* true that we travel *from* the past (tenselessly: from *earlier* times) *to* the future (to *later* times).

Our *speed* of travel into the future is *fixed* at (e.g.) 1 year per year:

– On a *tenseless* view of time, this is a *tautology* (cf. the fact that it takes a mile to go a mile).

– *Tensed* views of time can only make this a tautology if for *t* to be *n* years more past or less future than *t´* is – by definition – for *t* to become present *n* years *earlier* than *t´*.

Calling this 'time travel' makes it trivially true that we travel through time from past to future.

Time passing slowly or quickly

Subjective experience: Time passes *slowly* if (e.g.) a 1 hour talk seems to last *more* than 1 hour; *quickly* if it seems to last *less*.

Objective basis: *internal* and *external* measures of the time interval between two events (e.g. a talk starting and ending) have different values:

Time passes slowly if the internal measure gives the *greater* value: i.e. if an internal (e.g. our biological or psychological) clock goes *fast* as measured by external clocks (e.g. effect of adrenalin produced by sudden stress).

Time passes quickly if the internal measure gives the *smaller* value: i.e. if an internal (e.g. our biological or psychological) clock goes *slow* as measured by external clocks.

Forward time travel

A forward travelling time machine is a device for making time pass quickly

All TARDIS need do to travel forward a year in 10 minutes is to make its internal clocks (and all other processes within it) go *slow* by Earth time. The fact that TARDIS disappears (i.e. has no spatial location) while travelling forward in time is irrelevant (and in fact unhelpful, as it raises the needless question of what makes the TARDIS that disappears identical to the TARDIS that reappears later).

Real forward time travel machines

(1) *Hi-tech: very fast round-trip space travel*

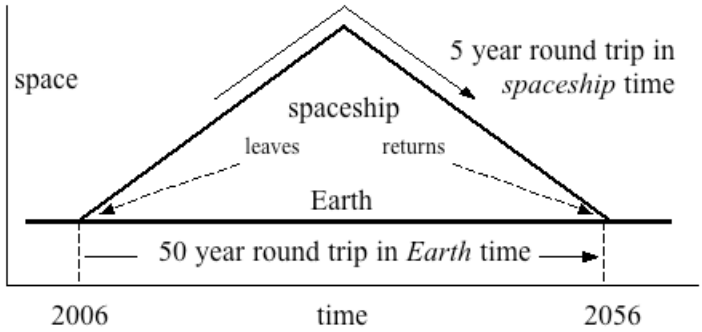

Figure 3

Special Relativity implies that a twin travelling in Figure 3's spaceship would return 45 years *younger* than the stay-at-home twin. This 'Twin's paradox' *isn't* a paradox: in SR this time difference follows from the different temporal lengths of straight and bent paths in spacetime geometry. (The bent path is temporally *shorter* than the straight one because SR treats temporal and spatial components of spacetime distances differently – see Lecture 1.)

Round-trip space travel slows the ageing of everything (that ages at all) equally. To slow it as much as in Figure 3, the spaceship would need to travel nearly as fast as light – impossibly expensive.

(2) *Lo-tech: refrigerators*

These slow down most organic processes, including those of biological ageing and biological clocks by cooling them (lowering the temperature by 10° slows most of the relevant chemical reactions by about 50%. As forward-travelling time machines, refrigerators are far cheaper than space-ships and work just as well for most organisms.

Forward time travel is commonplace and poses no conceptual problems

Backward time travel

If TARDIS travels back 1 year in 10 minutes – call its leaving **e** and its arriving **e′** – then:

(1) **e** *causes* **e′**;
(2) **e′** is *later* than **e** (in TARDIS time) and *earlier* than **e** (in Earth time);
(3) the difference between the two time *distances* between **e** and **e′** doesn't matter: it would still be backward time travel if TARDIS took a year to travel back a year;
(3) what makes this time travel backward in Earth time is the different time *direction* inside TARDIS.

So understood, does backward time travel actually occur; and if not, is it possible?

Does backward time travel occur?

Electrons and positrons [1]

Positrons only differ from electrons in carrying +ve instead of -ve electric charge, so that whereas electrons are *attracted* to fixed +ve charges, positrons are *repelled* by them. This has prompted the idea that positrons are electrons travelling backward in time, which seems to explain why they differ from electrons in this way and no other.

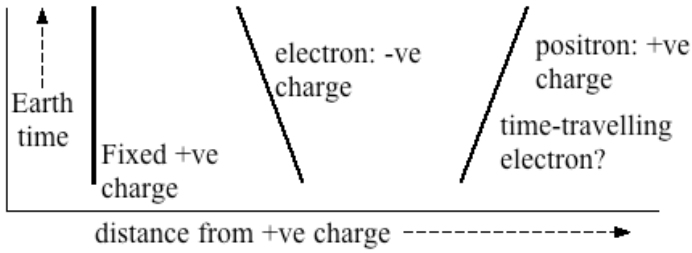

Figure 4

To see what's wrong with this idea, think how a clock made to run backwards (i.e. its hands are made to move *anti*-clockwise) differs from an ordinary clock travelling backward in time.

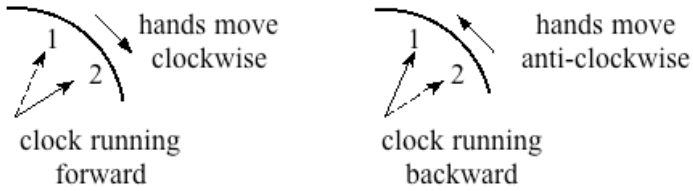

Figure 5

The difference is that the direction of causation in the time-travelling clock would be reversed in outside time (cf. TARDIS). E.g. if we bend the clock's hand just as it passes '2', then in a clock made to run backwards (a) it will be bent as it passes '1' but not as it passes '3', whereas in an ordinary clock travelling back in time (b) it will be bent as it passes '3' but not as it passes '1':

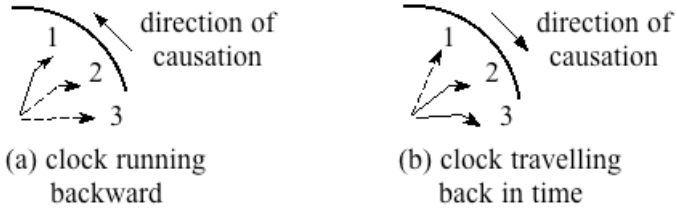

Figure 6

Applying this causal test to positrons shows that they are *not* electrons travelling backward in time, since forces applied to positrons change their trajectories at *later* Earth times, not at *earlier* ones.

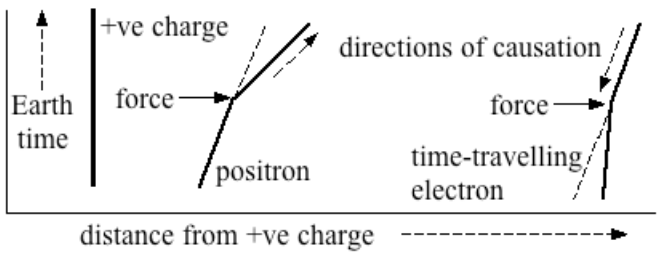

Figure 7

Similarly for all other apparent actual cases of backward time travel that I know of: none of them passes this causal test.

[1] Mellor, *Real Time II*, ch. 11.1.

Is backward time travel possible?

Spurious objection: *'Backward time travel would change the past, which is impossible.'*

E.g. stories where, to avoid affecting the future (too much), time-travellers only kill dinosaurs that an earlier reconnaissance has shown dying naturally shortly afterwards.

Bad defence: 'Time machines take us to a *different* past.' This is just a way of *not* taking us to *our* past. If we *will* travel into our past, then we *have* travelled into it, and the dinosaur story contains a contradiction (the dinosaur is both shot and dies naturally).

Right defence: In the sense in which *changing* our actual past is impossible, so is changing our actual future. We might still be able to *affect* the past, just as we can affect the future, by causing it to differ from what it *would* have been had the cause not occurred. [2] Backward time travel tales needn't contain contradictions (see e.g. the tale at the end of *Harry Potter and the Prisoner of Azkaban*).

Bugs or features?

(1) *'Backward time travel could put one thing in two places at once'*

If TARDIS is made in 2030, used in 2050 to travel back to 2040 and left unused for ten years, then from 2040 to 2050 TARDIS is in two places at once. *Verdict*: Feature: *not obviously impossible*. [3]

(2) *'Backward time travel means that artefacts need never be made'*

If TARDIS arrives in 1950, is put into the Science Museum, taken out in 2050 and used to travel back to 1950, where it's put into the Science Museum … then it's never *made*. *Verdict*: Feature. [4]

(3) *'Backward time travel lets you make the travel impossible'*

E.g. by killing your younger self before you travel.

Reply: Backward time travel is possible because you *needn't* (e.g.) kill you younger self. [5]

Rejoinder: [6] (a) What anything can do at any time *t* doesn't depend on how it got there.

(b) Your younger self is alive at *t* and could be killed then.

(c) So if you could travel back to *t* you could kill your younger self.

(d) But your travelling back to *t* entails that you *don't* kill your younger self.

(e) So you couldn't *both* travel back to *t and* kill your younger self.

(f) So you couldn't travel back to *t*.

(g) *All* backward time travel makes *something* both possible and impossible.

(h) So all backward time travel is impossible.

Verdict: Fatal bug …

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[2] Dummett, M. 1964. 'Bringing about the past', in Le Poidevin and Macbeath, eds, *The Philosophy of Time*, ch. VII.

[3] Mellor, 'Time travel', pp. 60–1.

[4] Mellor, 'Time travel', pp. 61–2.

[5] Lewis, 'The paradoxes of time travel'.

[6] Mellor, *Real Time II*, ch. 12.1; 'Time travel' pp. 62–64.