



The Paradoxes of Time Travel

David Lewis

About Time

- The topology of time
 - Bounded or unbounded: is there a beginning (end) in time?
 - Continuous or discrete?
 - Linear or closed: is there an Eternal Return?
 - Branching or non-branching?
- Some problems
 - Determinism, fatalism and free will
 - Time travel

Lewis' Assumptions

- Enduring things have temporal as well as spatial parts
 - Eternalism vs. Presentism
 - Worm view vs. Stage account
- Personal identity criteria
 - psychological continuity and connectedness
 - causal continuity
- Distinction between external and personal time

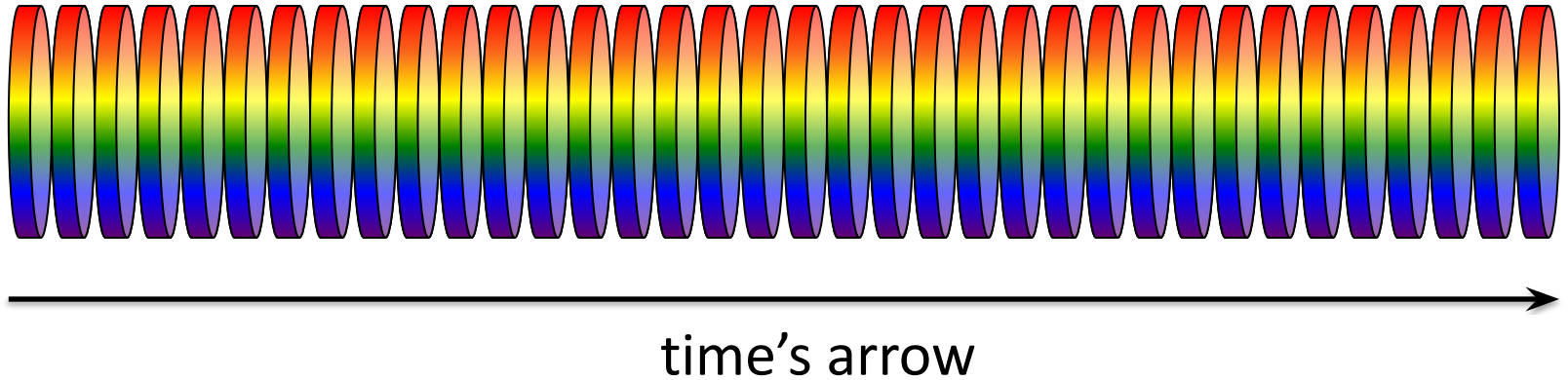
The Four-Dimensional World

- *The world—the time traveler's world, or ours—is a four-dimensional manifold of events.*
- *Time is one dimension of the four, like the spatial dimensions except that...Time remains one-dimensional, since no two time-like dimensions are orthogonal.*
- *Enduring things are timelike streaks: wholes composed of temporal parts, or stages, located at various times and places.*
- *Change is qualitative difference between different stages—different temporal parts—of some enduring thing, just as a “change” in scenery from east to west is a qualitative difference between the eastern and western spatial parts of the landscape.*



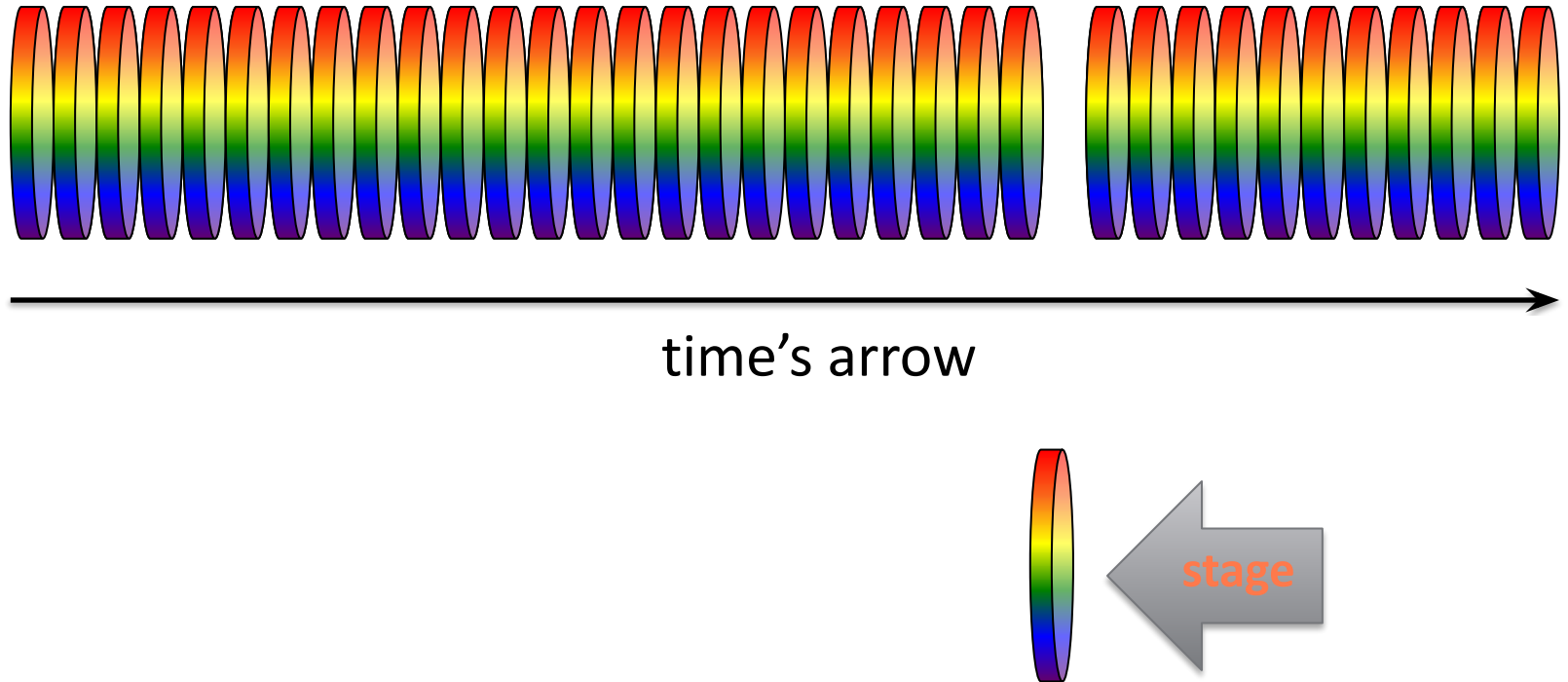
To the 4-d world

Temporal Parts



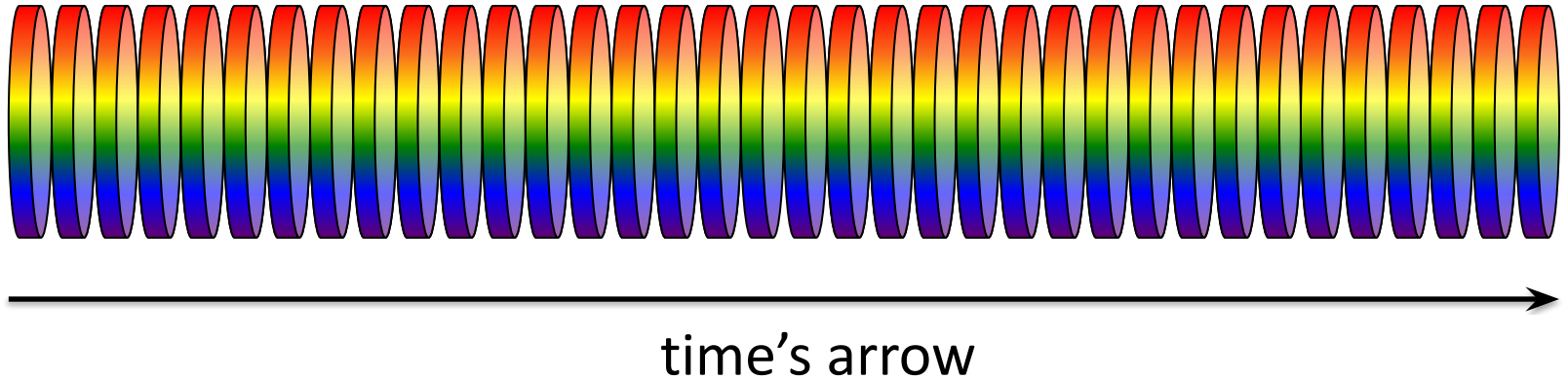
The Worm View (Lewis): enduring things are space-time “worms” composed of temporal (time) parts or *stages*.

Temporal Parts



The Worm View (Lewis): enduring things are space-time “worms” composed of temporal parts of stages.

Temporal Parts



- *Change is qualitative difference between different stages—different temporal parts—of some enduring thing, just as a ‘change’ in scenery from east to west is a qualitative difference between eastern and western spatial parts of the landscape*
- Cambridge Changes: changes in relational or extrinsic properties, e.g. Xantippe’s being widowed.

Varieties of Time Travel

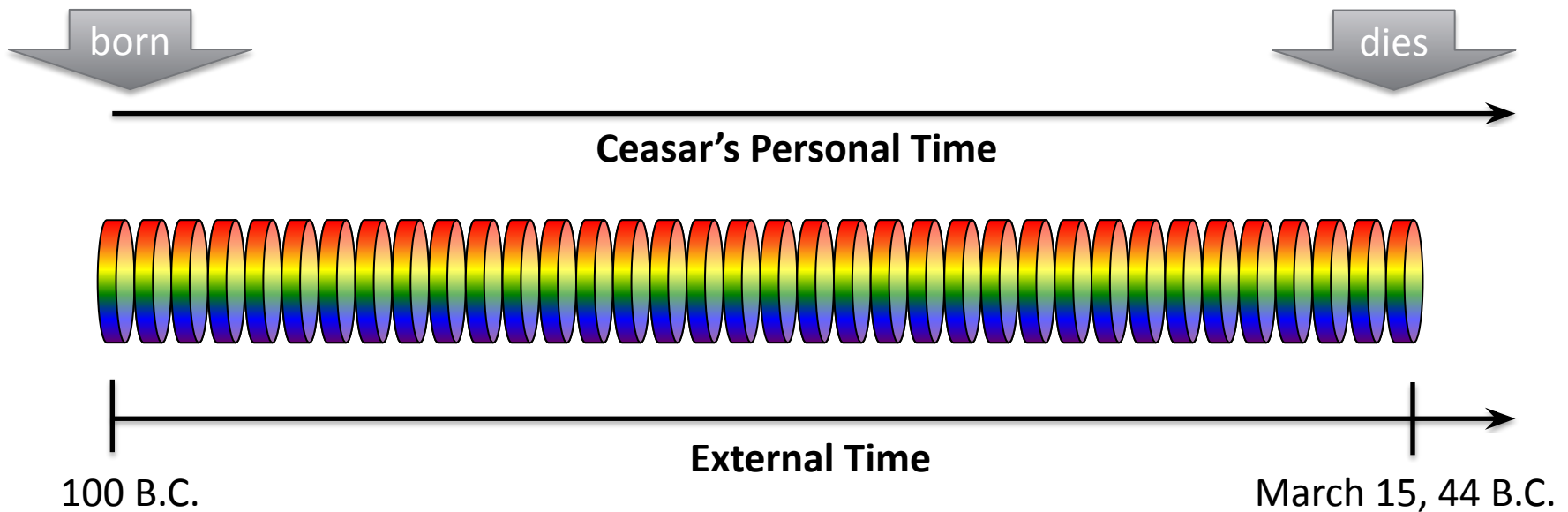
What is time travel?

[T]he time elapsed from departure to arrival (positive, or perhaps zero) is the duration of the journey. But... [for] a time traveler, the separation in time between departure and arrival does not equal the duration of his journey.

- **Back to the Future:** time travel to the past and back
- **Around to the Past:** travel around a closed time-like curve
- **Forward to the Future:** time travel to the future

Personal Time

[H]ow it could be that the same two events were separated by two unequal amounts of time? ... I reply by distinguishing time itself, external time as I shall also call it, from the personal time of a particular time traveler: roughly, that which is measured by his wristwatch.

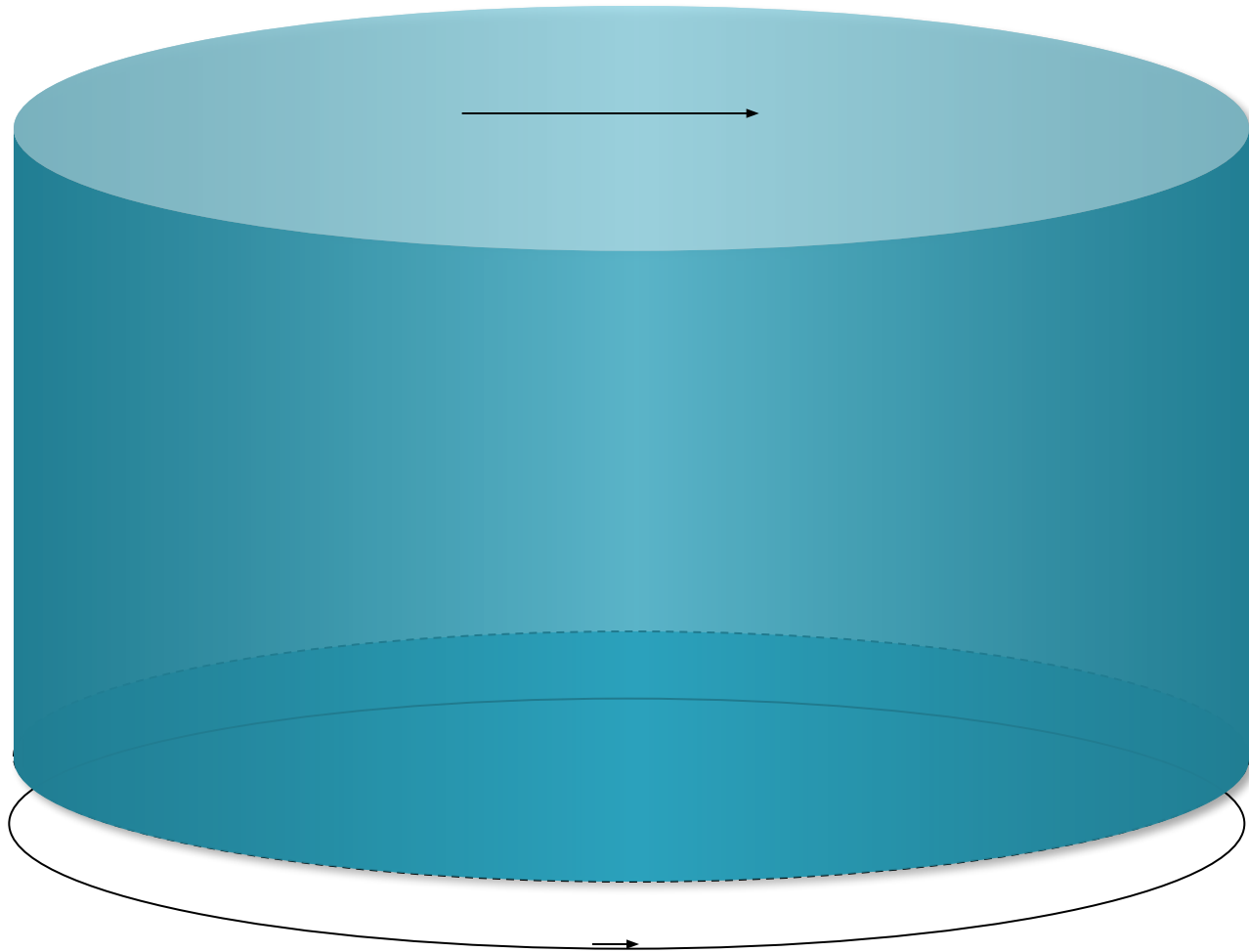


Forward to the Future

- We're always traveling to the future, but the duration of our journey in *personal time* is the same as the elapse from the beginning to the end in *external time*.
- In Forward to the Future Time Travel the elapse of time from the beginning to the end of the time-traveler's journey in external time is greater than the duration of his journey in personal time.
- So the time traveller can land in the remote future without aging significantly.

LETS TRY IT!

Around to the Past



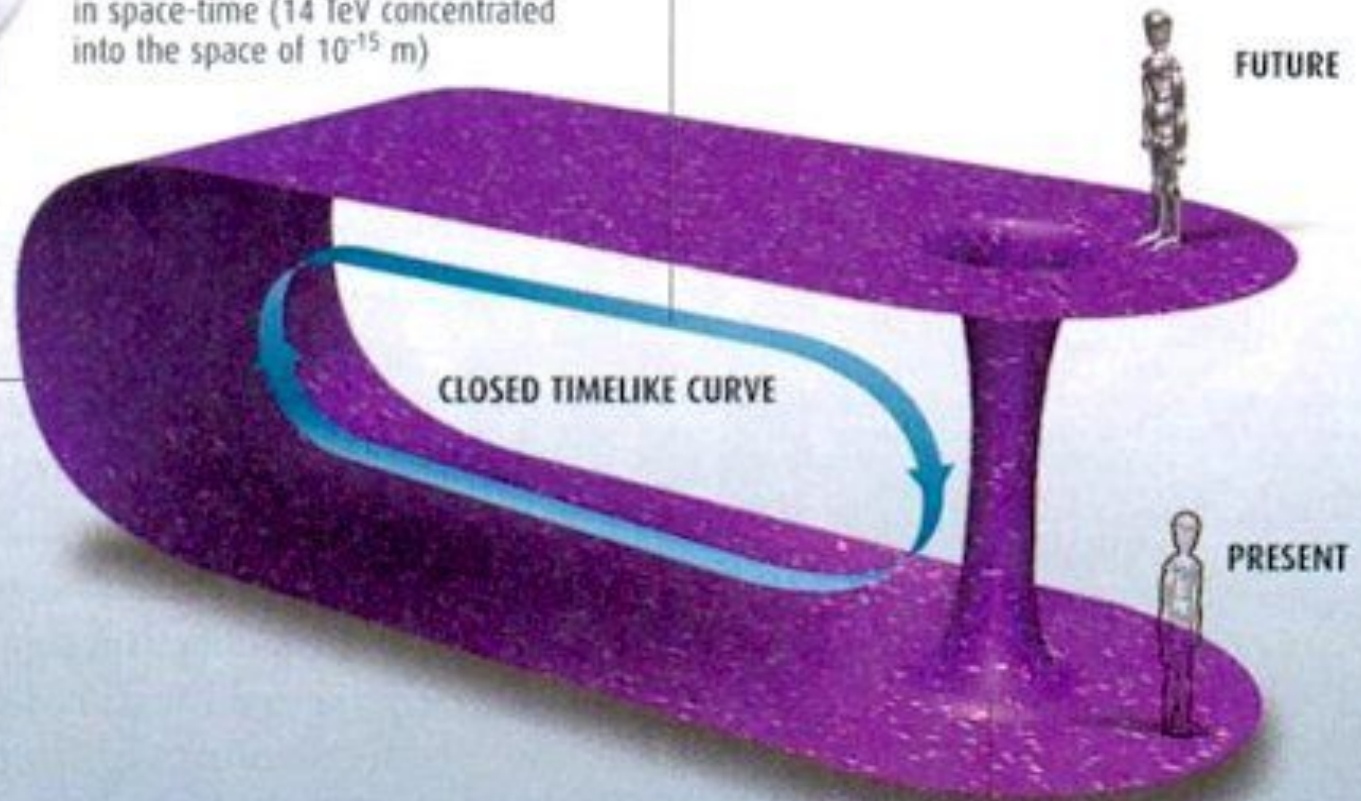
Through the Wormhole



Colliding gravitational waves from accelerated protons rip a wormhole in space-time (14 TeV concentrated into the space of 10^{-15} m)

The wormhole helps form a closed timelike curve, which allows particles to flow into the past, or from the future to the present

SPACE-TIME



Dark energy might keep wormhole open, and could even make it wide enough for a person

STEVEN SPIELBERG PRESENTS



BACK TO THE FUTURE

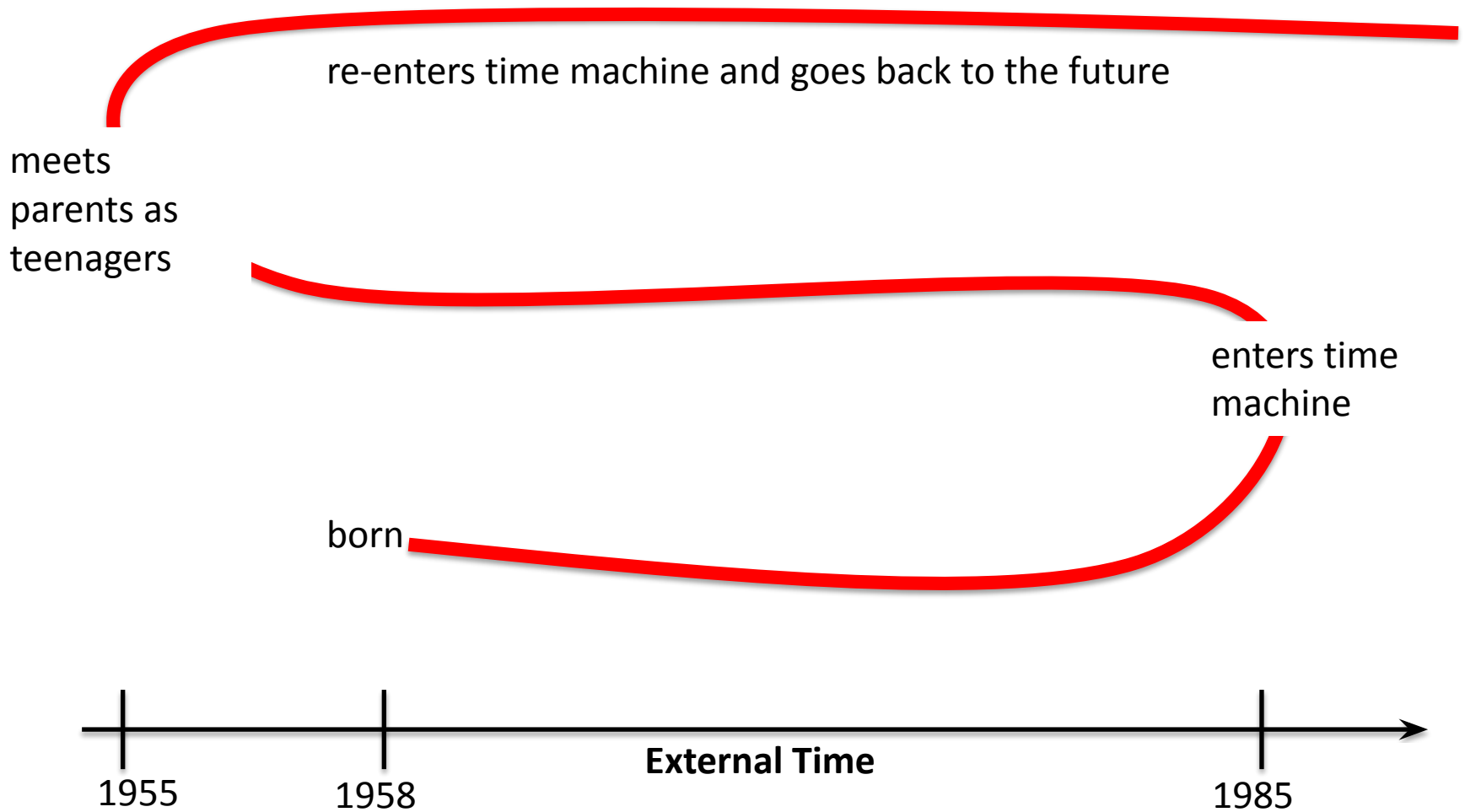
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A ROBERT ZEMECKIS FILM



Traveling to the Past

Marty McFly's Personal Time



Could you meet your past self?





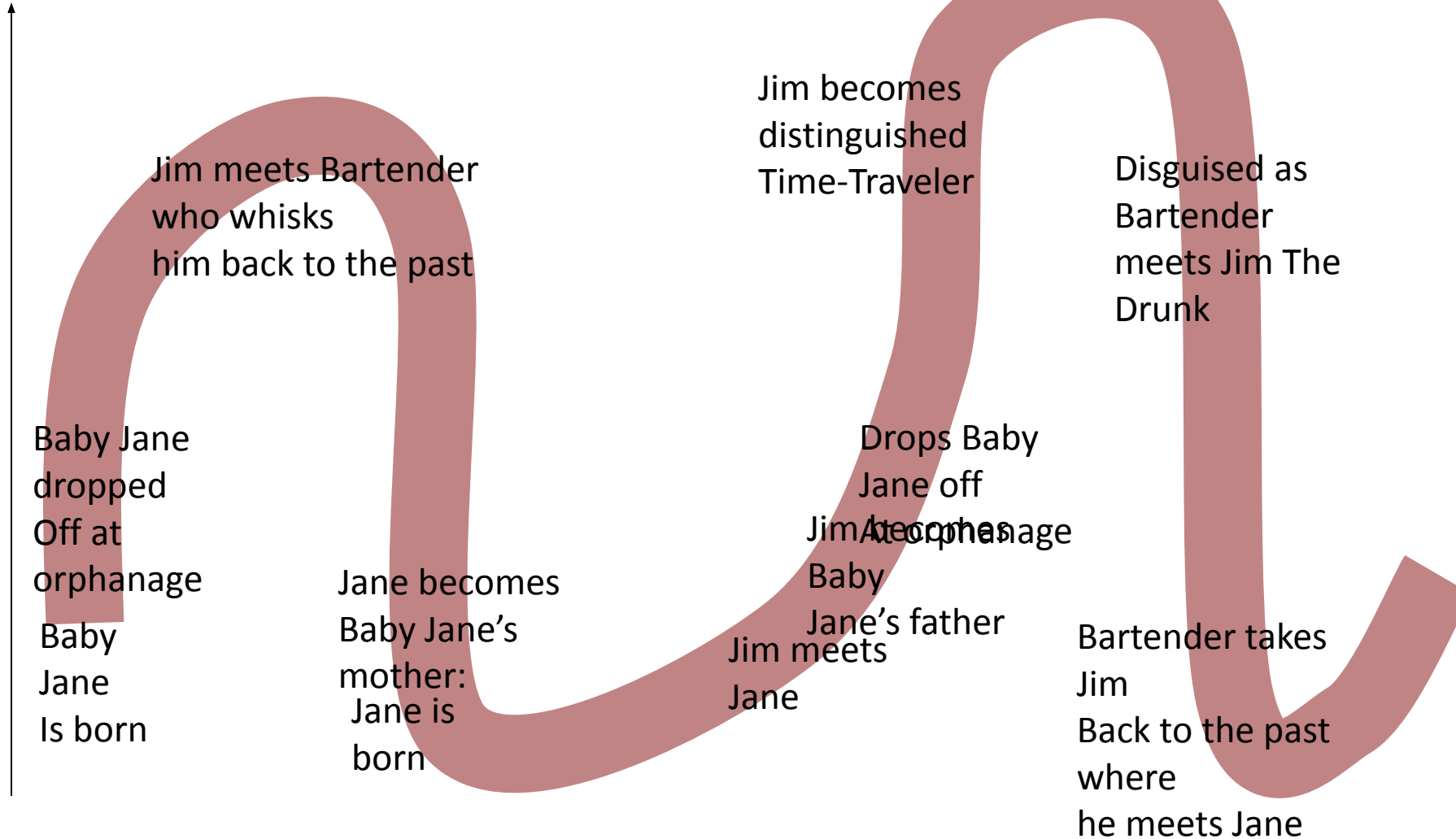
The man who was his own mother*

“Jane” is left at an orphanage as a foundling. When “Jane” is a teenager, she falls in love with a drifter, who abandons her but leaves her pregnant. Then disaster strikes. She almost dies giving birth to a baby girl, who is then mysteriously kidnapped. The doctors find that Jane is bleeding badly, but, oddly enough, has both sex organs. So, to save her life, the doctors convert “Jane” to “Jim.”

And then . . .

“Jim” subsequently becomes a roaring drunk, until he meets a friendly bartender (actually a time traveler in disguise) who whisks “Jim” back way into the past. “Jim” meets a beautiful teenage girl, accidentally gets her pregnant with a baby girl. Out of guilt, he kidnaps the baby girl and drops her off at the orphanage. Later, “Jim” joins the time travelers corps, leads a distinguished life, and has one last dream: to disguise himself as a bartender to meet a certain drunk named “Jim” in the past...

The Man Who Was His Own Mother



Causation and the 'Arrow of Time'



(External) time goes in only one direction.

- On one account the direction of time just *is* the direction of causation: from past to future.
- **BUT** if BTF time travel is possible then it is possible for later events to cause earlier events
 - Note: Given the for personal identity, events that occur to stages later in external time must cause events that occur to stages that are earlier in external time.
- Is the 'backward causation' (required for BTF time travel) possible? And if so how?

Could you kill your baby-self?



Uh-oh!



Can Tim kill his grandfather?

It *seems* that he can...

*Tim...has what it takes.
Conditions are perfect in
every way: the best rifle
money could buy,
Grandfather an easy target
only twenty yards away...Tim
is as much able to kill
grandfather as anyone ever is
to kill anyone.*



A duplicate of Tim could...

Suppose that down the street another sniper, Tom, lurks waiting for another victim, Grandfather's partner. Tom is not a time traveler, but otherwise he is just like Tim.



...but it looks like Tim can't!

Grandfather begat Father in 1922 and Father begat Tim in 1949. Relative to these facts Tim cannot kill Grandfather.



What I can do, relative to one set of facts, I cannot do relative to another more inclusive, set

[F]acts about my larynx and nervous system are compossible with my speaking Finnish. But don't take me along to Helsinki as your interpreter.



Tim can't kill Grandfather

Tim's killing Grandfather that day in 1921 is compossible...with all the facts of the sorts we would ordinarily count as relevant in saying what someone can do...Relative to these facts, Tim can kill Grandfather. But his killing Grandfather is not compossible with another, more inclusive set of facts...[including] the simple fact that Grandfather was not killed.



Tom can't kill Grandfather's partner

Exactly the same goes for Tom's parallel failure. For Tom to kill Grandfather's partner also is compossible with all facts of the sorts we ordinarily count as relevant, but not compossible with a larger set including, for instance, the fact that the intended victim lived until 1934.



Fatalism

The thesis that whatever will happen in the future is already unavoidable, i.e. that no one is able to prevent it from occurring.

- (1) There exist now propositions about everything that might happen in the future.
- (2) Every proposition is either true or else false
- (3) If (1) and (2), then there exists now a set of true propositions that, taken together, correctly predict everything that will happen in the future.
- (4) If there exists now a set of true propositions that, taken together, correctly predict everything that will happen in the future, then whatever will happen in the future is already unavoidable.
- (5) Therefore, whatever will happen in the future is already unavoidable.

Lewis' objection to Fatalism

- *I am not going to vote Republican next fall. The fatalist argues that, strange to say, I not only won't but can't; for my voting Republican is not compossible with the fact that it was true already in the year 1548 that I was not going to vote Republican 428 years later.*
- *My rejoinder is that this is a fact, sure enough; however, it is an irrelevant fact about the future masquerading as a relevant fact about the past, and so should be left out of account in saying what, in any ordinary sense, I can do.*
- Compare the sense in which I 'can't' not raise my arm if that is what I in fact do, with the senses in which I can't wiggle my ears, or fly, or buy a 2 million dollar house, or vote in the UK...or any of the other can't we ordinarily care about.

que será, será
:: whatever will be, will be



- There are true propositions about the future
- *Given* the facts about the future that make them true we can't 'change the future'
- But when we worry about what we can or can't do, we aren't concerned about future facts and so shouldn't be worried about an irrelevant fact about the future "masquerading as a fact about the past."