

THE PHYSICS OF PARADOX

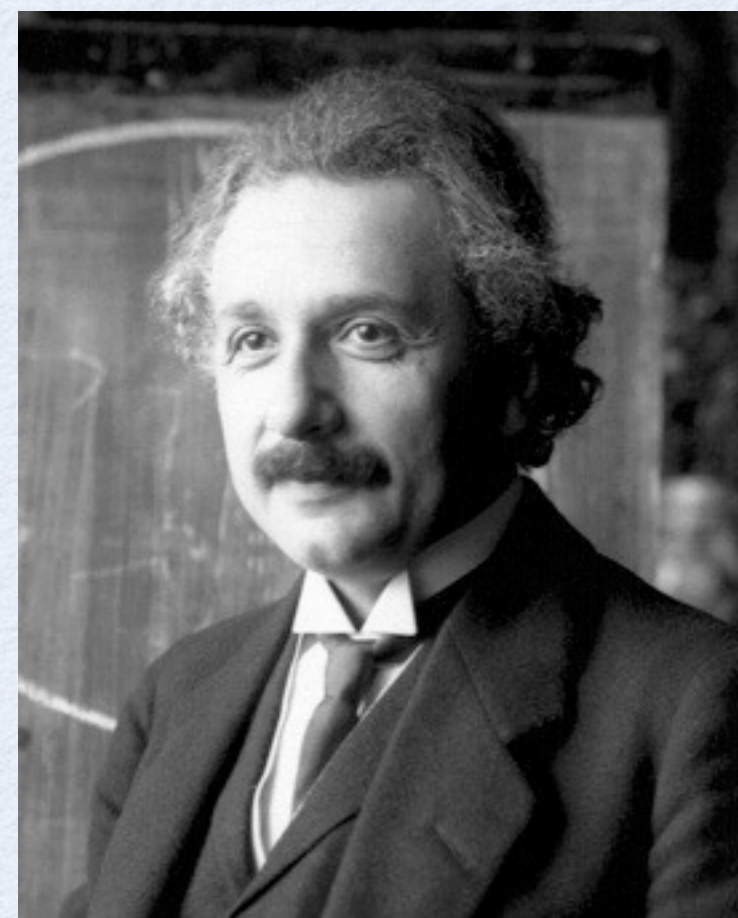
John Ashmead

WHAT IS TIME?



What is time? If no one asks me,
I know. If I wish to explain it to
one that asketh, I know not.
— St. Augustine

Questions are more
important than answers.
— Einstein



6 QUESTIONS

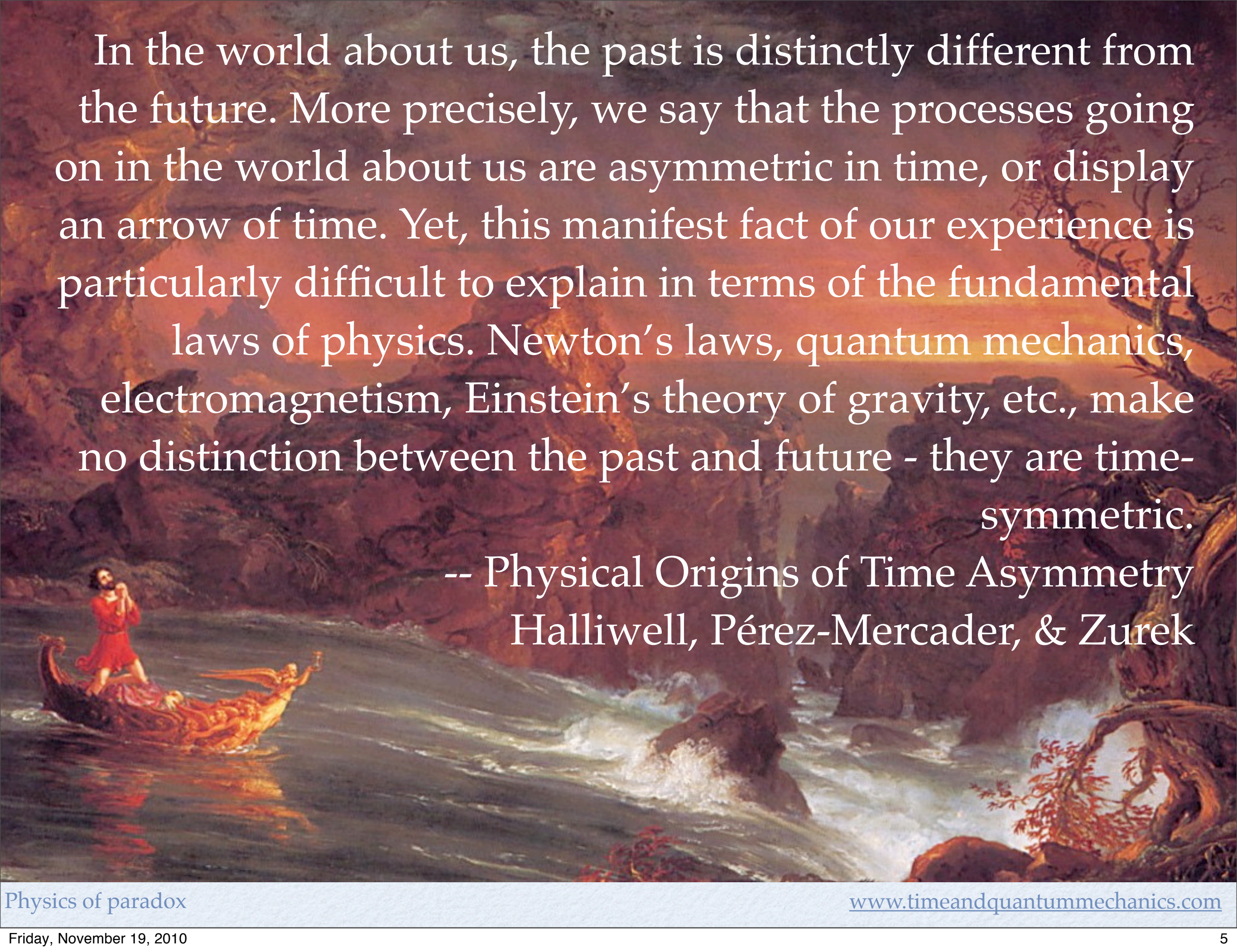


- Why is time a problem?
- What kinds of time are possible?
- Could we travel in time?
- What possible paradoxes might be created by time travel?
- Can we avoid the paradoxes?
- If we can, what would this mean?

WHY IS TIME A PROBLEM?



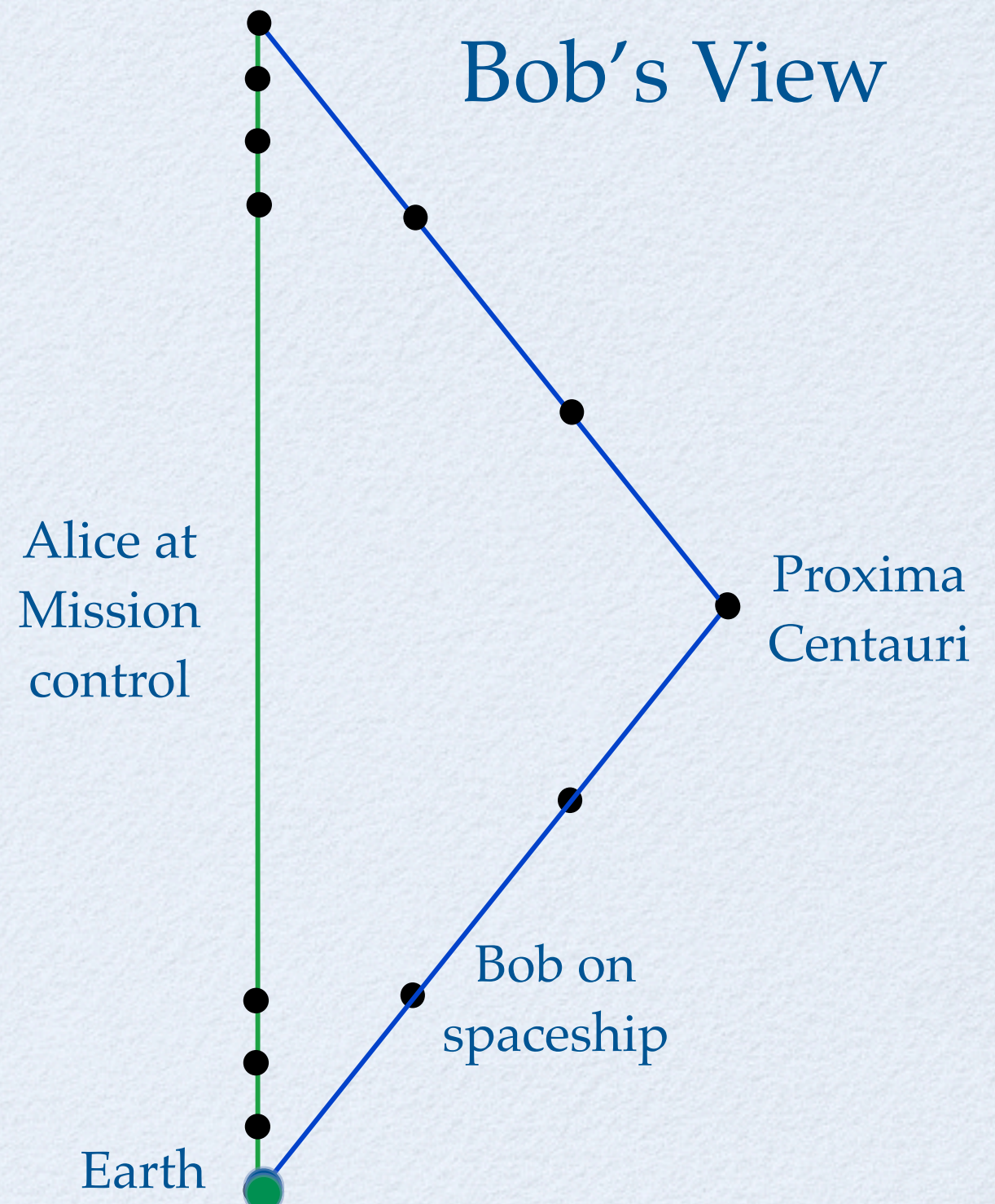
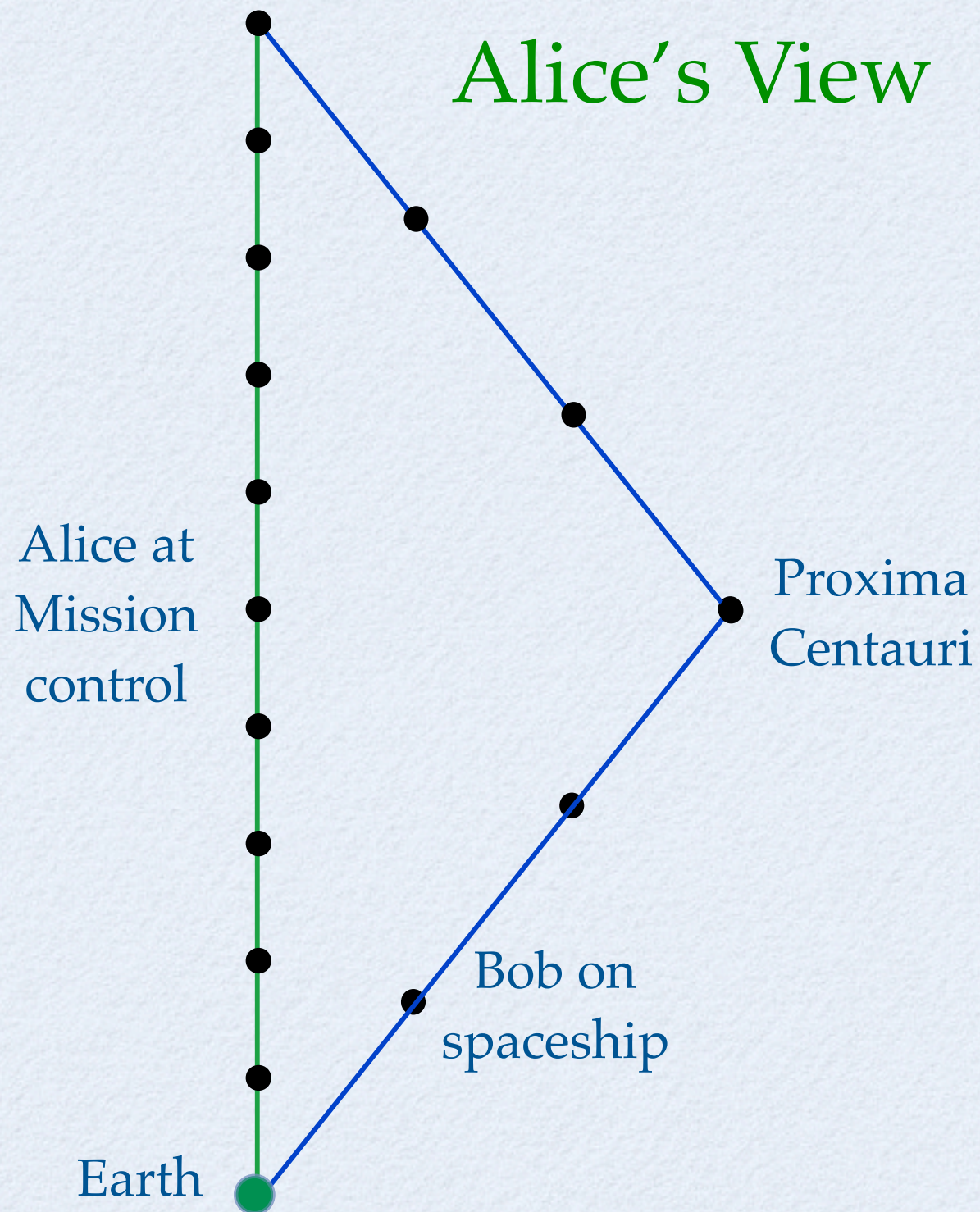
- At our level time goes one way, but laws of physics seem to go both ways
- In relativity, time is dynamic
- But in quantum mechanics, time is boring

A painting of a river with a figure in a red dress on a boat and a winged figure in the water. The scene is set in a dramatic, rocky landscape with a sunset or sunrise sky. The text is overlaid on the upper half of the image.

In the world about us, the past is distinctly different from the future. More precisely, we say that the processes going on in the world about us are asymmetric in time, or display an arrow of time. Yet, this manifest fact of our experience is particularly difficult to explain in terms of the fundamental laws of physics. Newton's laws, quantum mechanics, electromagnetism, Einstein's theory of gravity, etc., make no distinction between the past and future - they are time-symmetric.

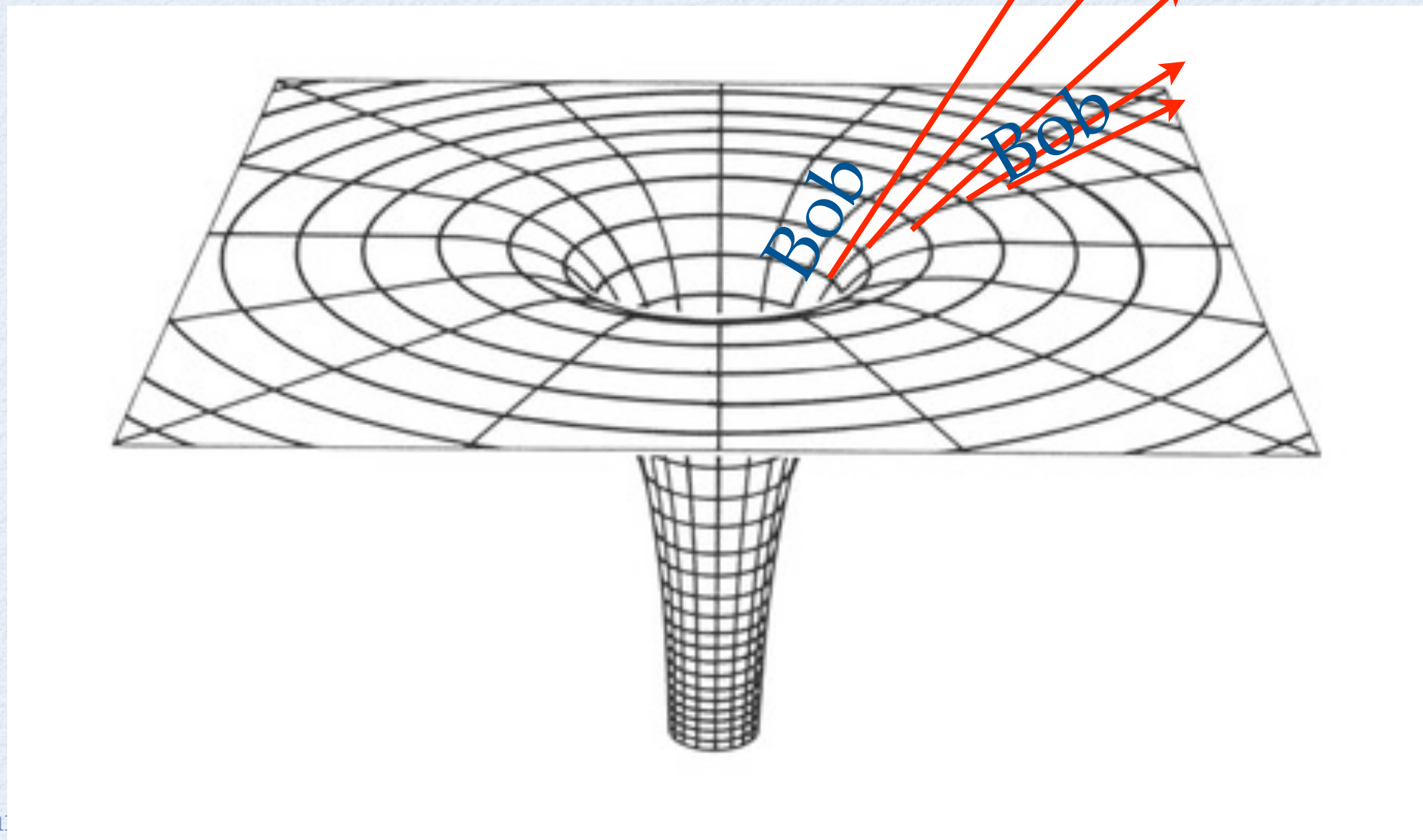
-- Physical Origins of Time Asymmetry
Halliwell, Pérez-Mercader, & Zurek

THE TWIN PARADOX

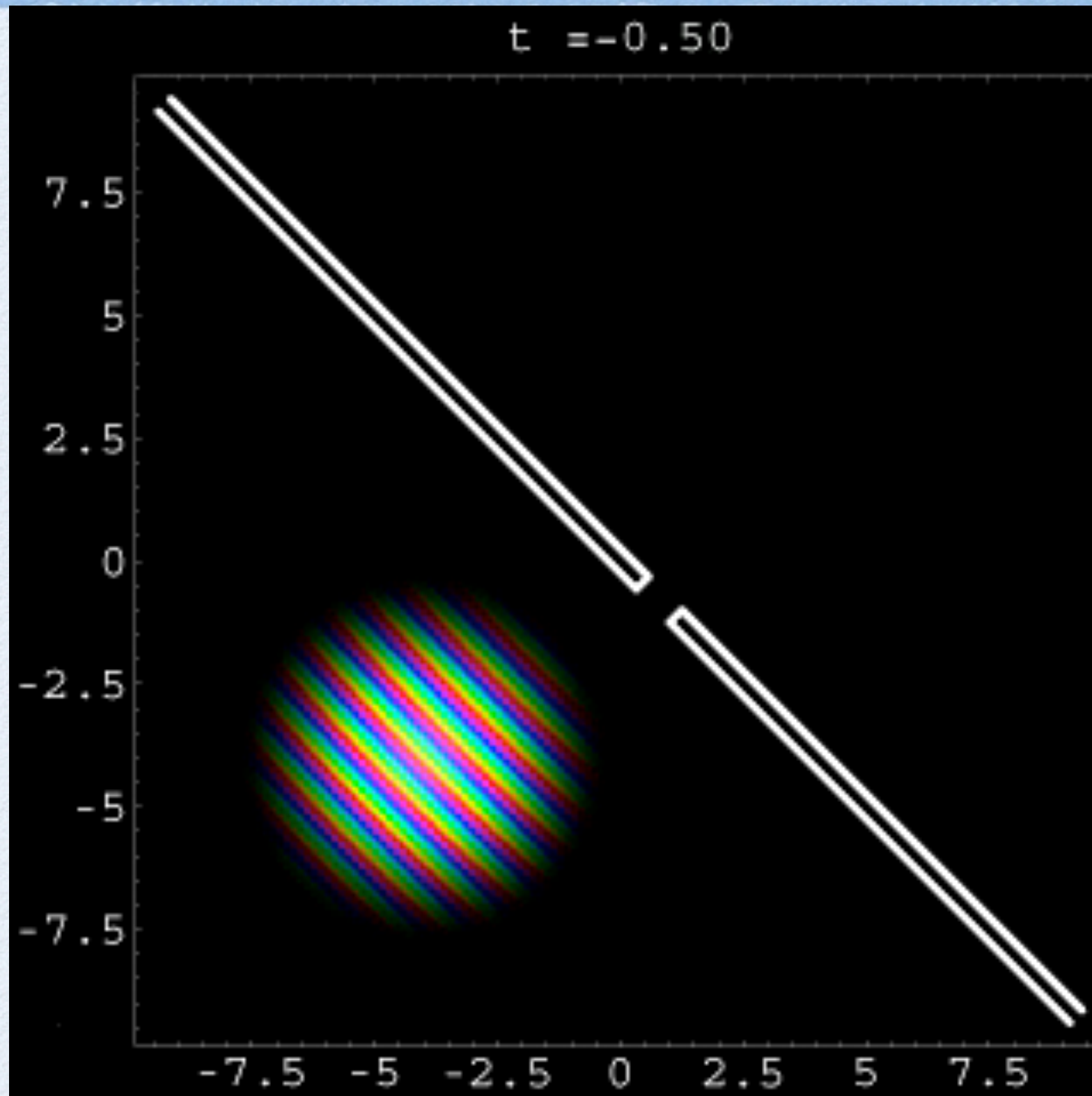


BLACK HOLES

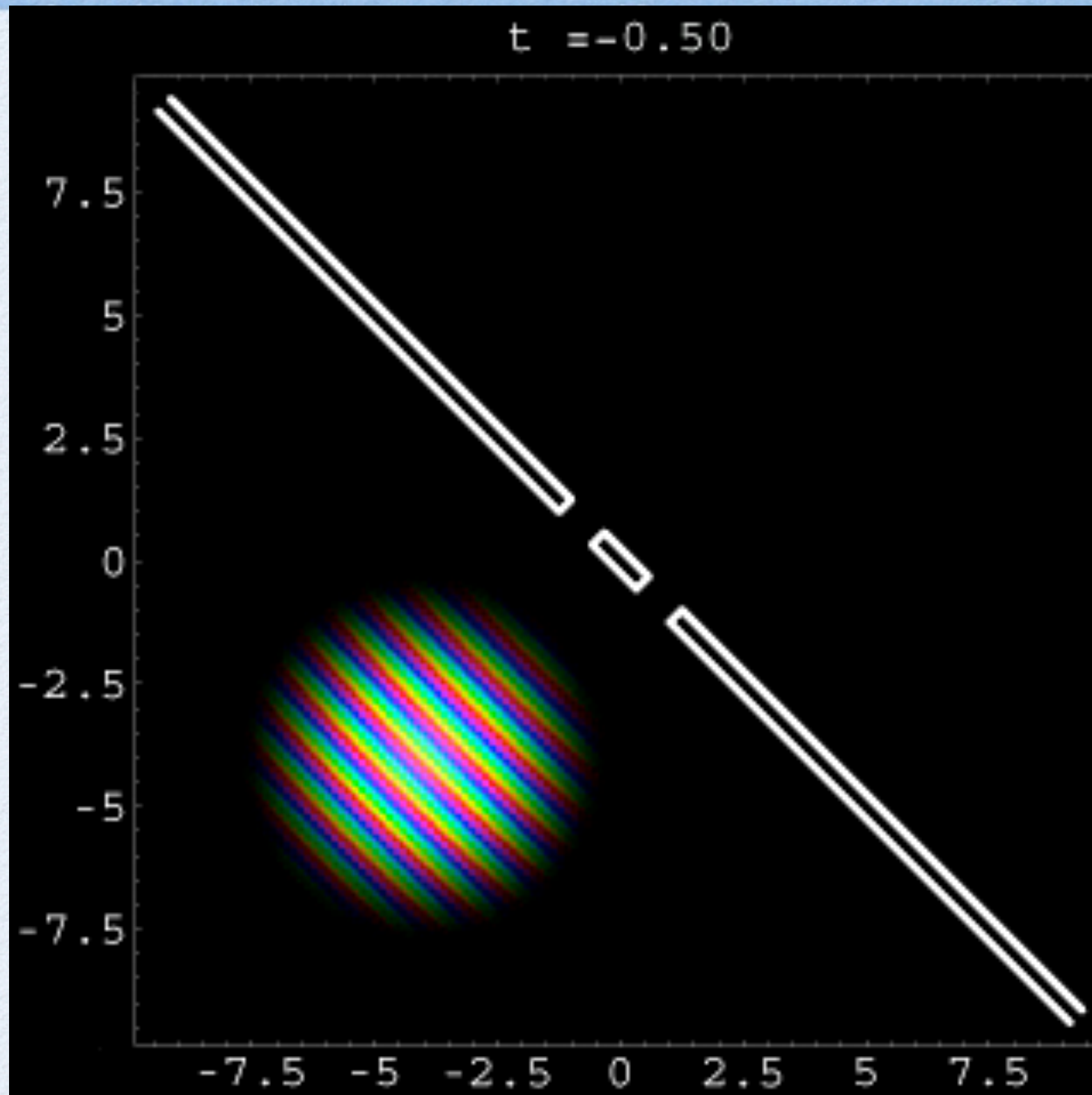
Alice



SINGLE SLIT EXPERIMENT



DOUBLE SLIT EXPERIMENT



RELATIVITY VS QUANTUM

Relativity:

- Smooth
- Localized
- Predictable
- But time is dynamic

Quantum mechanics:

- Quantized
- Fuzzy
- Uncertain
- But time is boring

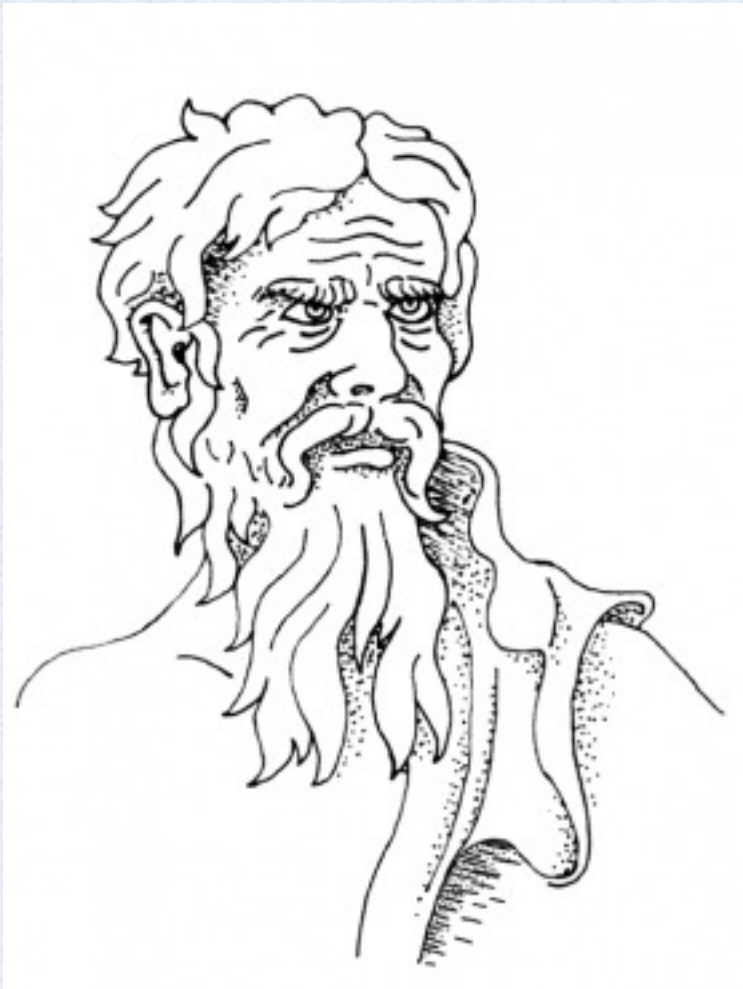
How wonderful that we have met with a paradox. Now we have some hope of making progress. – Niels Bohr

KINDS OF TIME?



- Fleeting instant
- Block universe
- Massively parallel
- Spreadsheet

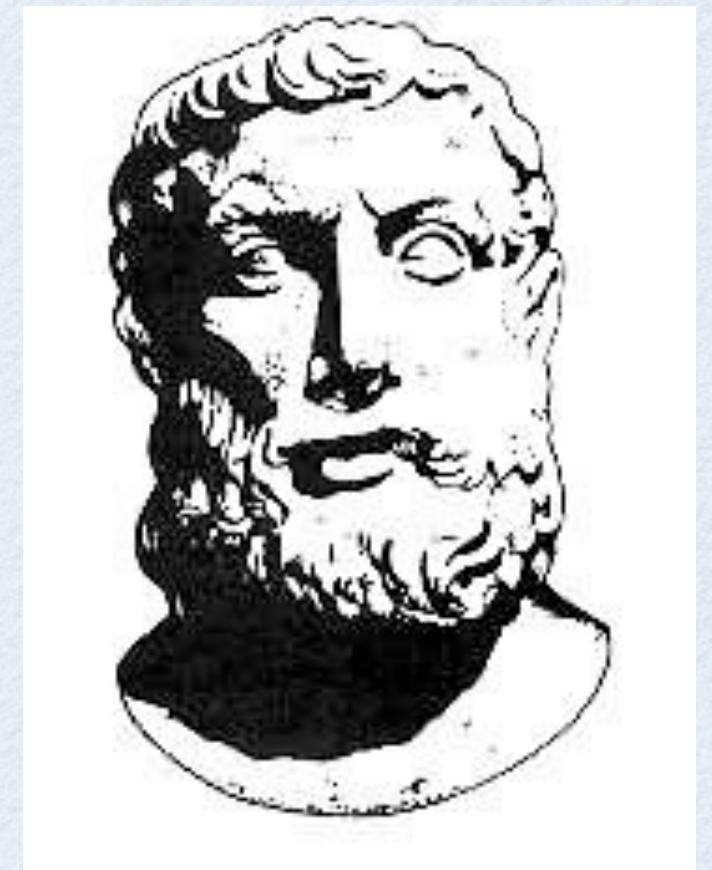
THE INSTANT & ETERNITY



You can't step in
the same river
twice
– Heraclitus



[What exists] is
now, all at once,
one and
continuous...
— Parmenides



PARALLEL UNIVERSES

Symbol	Value	Meaning
N	1,000,000,000,000,000,000,000, 000,000,000,000,000,000,000 (Douglas Adams Big)	Ratio of fine structure constant to gravitational constant
ϵ	0.007	Strong force
Q	1 / 100000	Lumpiness of universe
D	3	# of space dimensions
Λ	0.7	Cosmological constant
Ω	1	Density of universe, compared to critical density

COINCIDENCE, MR BOND?

- It isn't that much of a coincidence
- Or, we just got insanely lucky
- Or, there are a nearly infinite number of universes out there
- And, only those hospitable to intelligence life will have sentients asking, did we get insanely lucky?

SPREADSHEET TIME



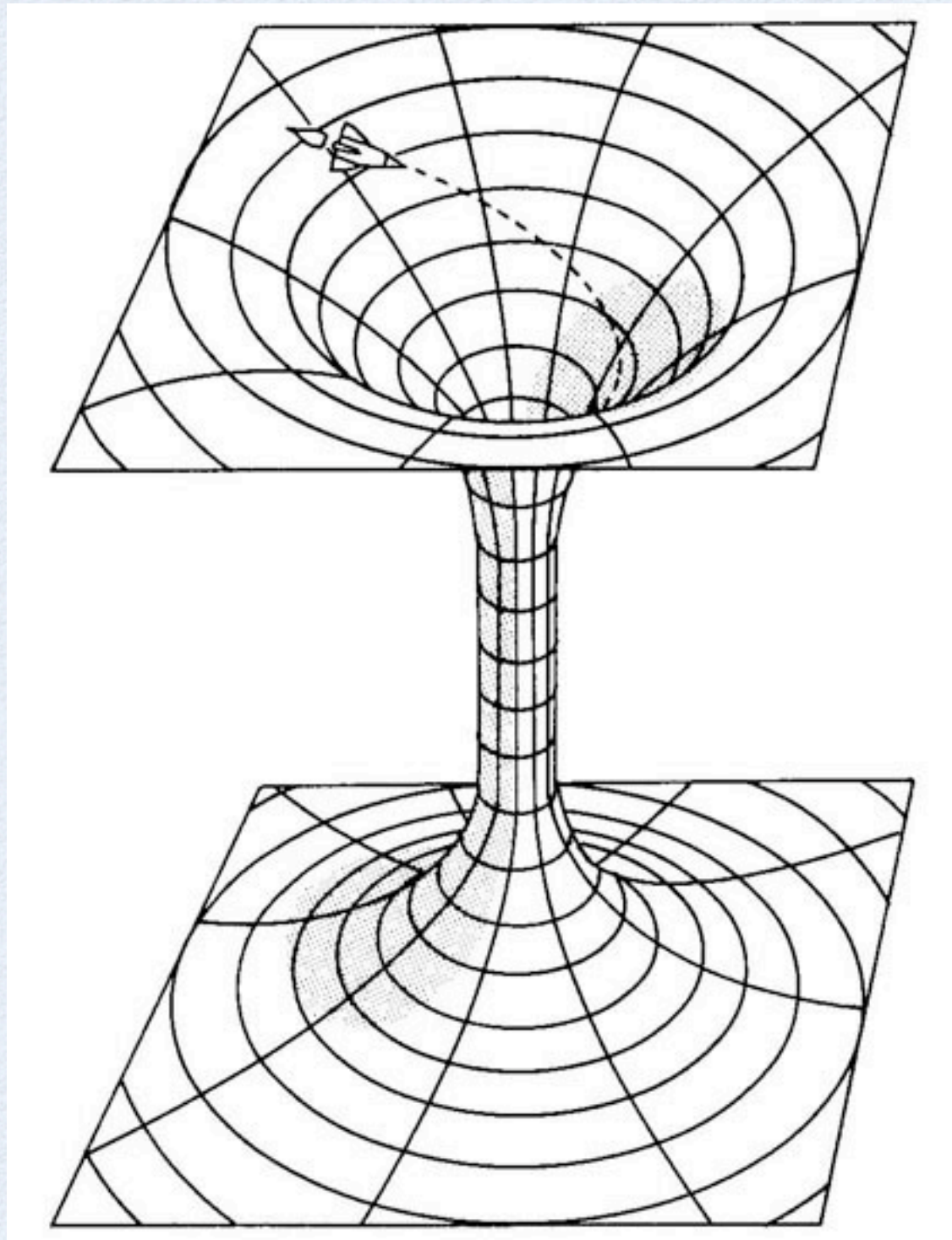
And who can
forget the fading
photographs?

COULD WE TRAVEL IN TIME?



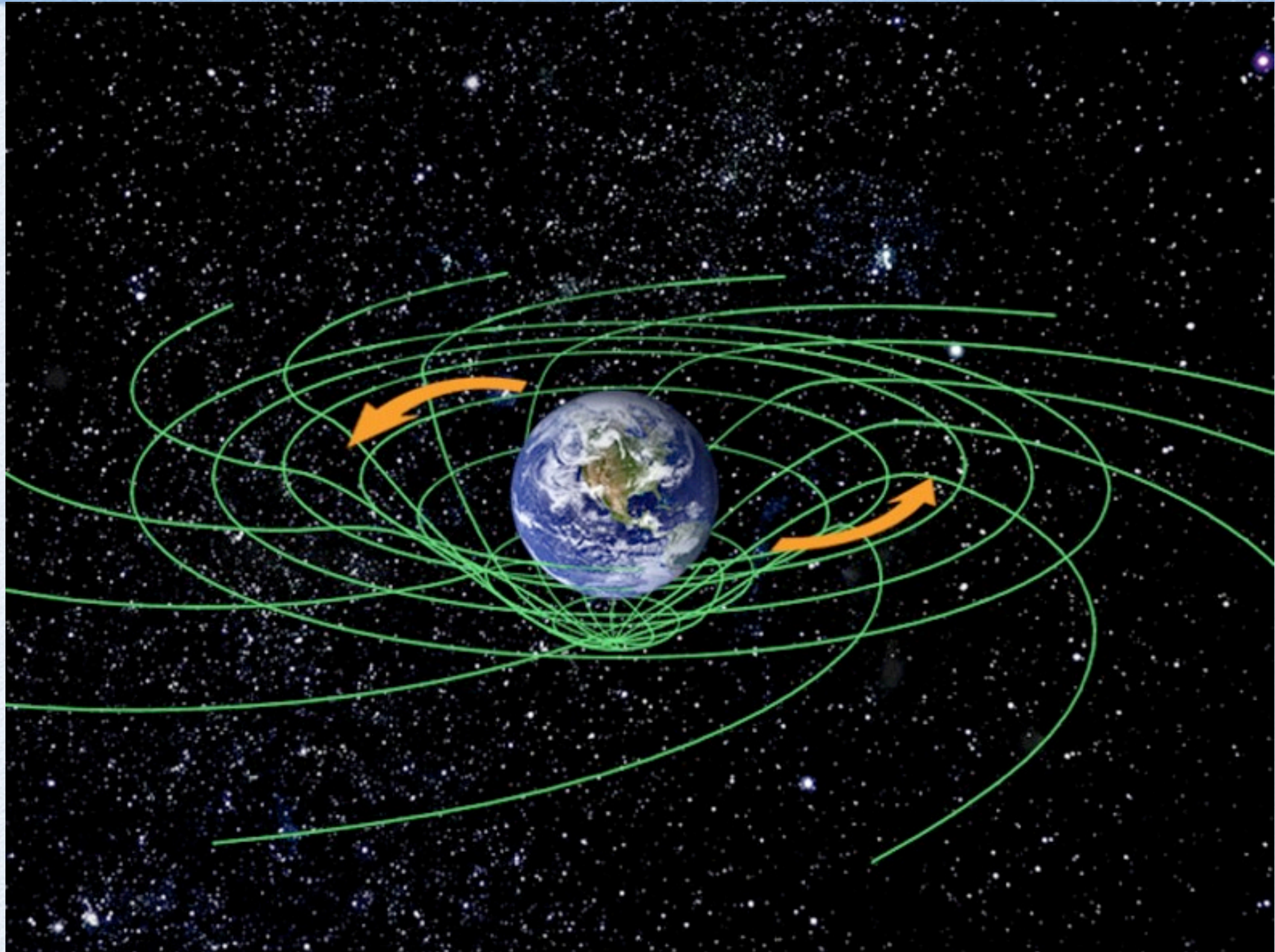
- Wormholes
- Frame dragging
- The Large Hadron Collider

WORMHOLES

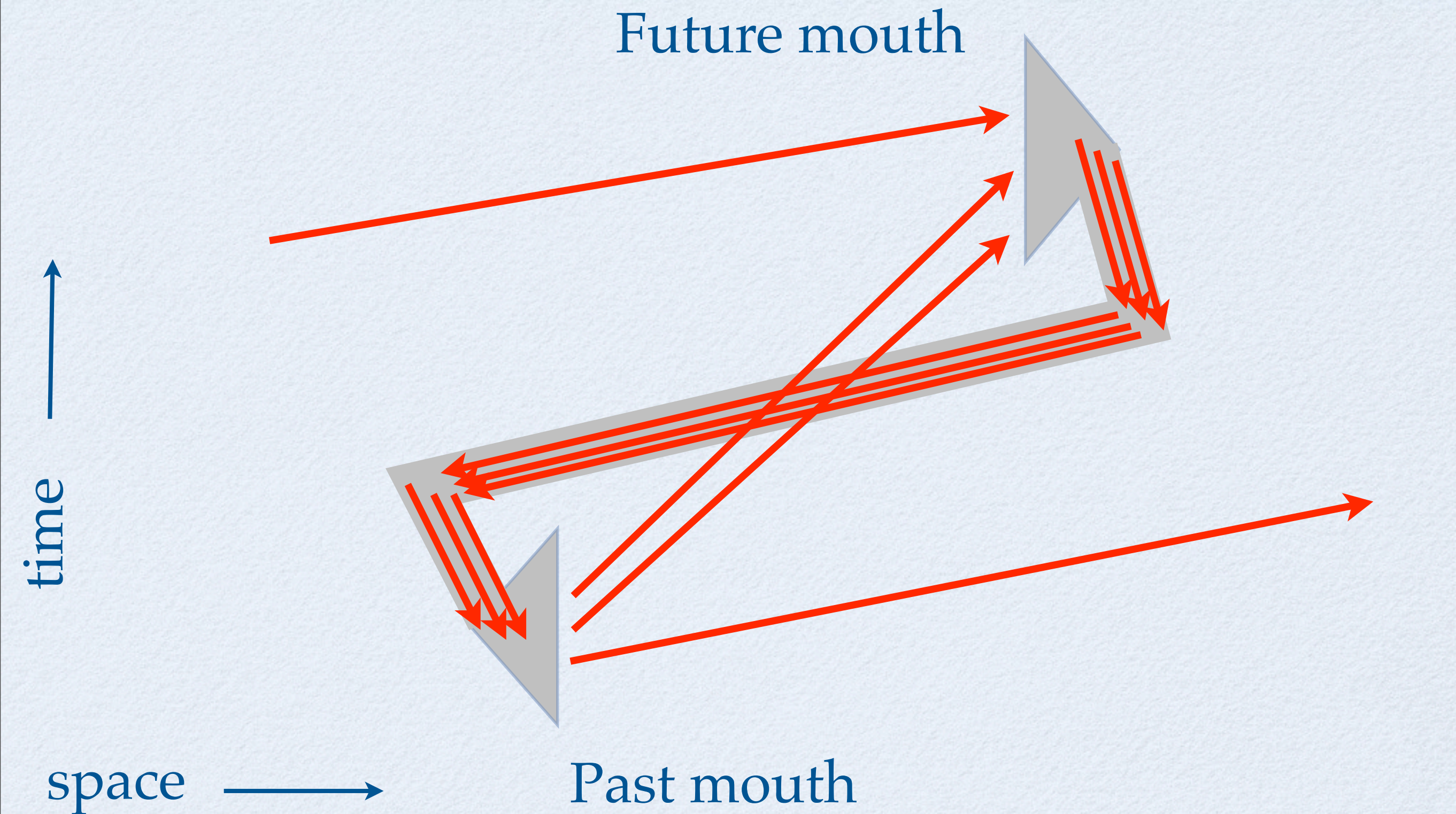


- A wormhole is two black holes stitched together with mathematical sutures
- Needs negative energy / mass “stuff” to stay open

FRAME DRAGGING

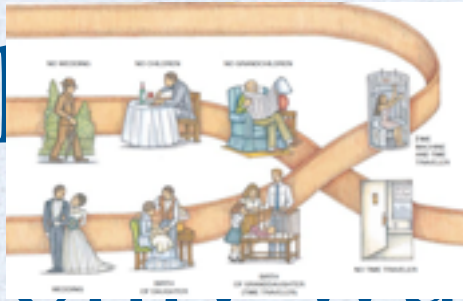


LOOPING THRU A WORMHOLE

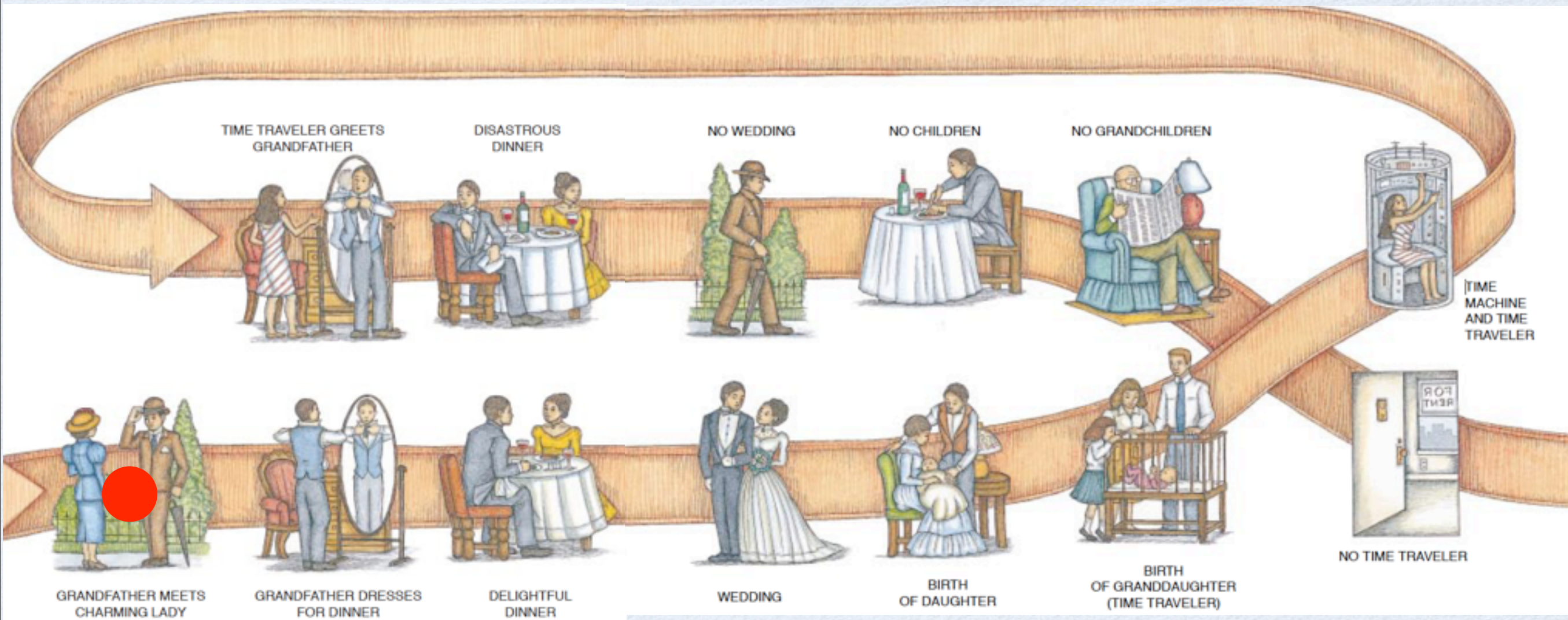


POSSIBLE PARADOX?

“Will you grandfather? It seems that the only way to prove that time travel is impossible is to cite a case of killing one's grandfather. This incessant murdering of harmless ancestors must stop. Let's see some wide-awake fan make some other free will paradoxes.”



GRANDFATHER PARADOX



The quantum physics of time travel -
Deutsch & Lockwood

BOOTSTRAP PARADOX

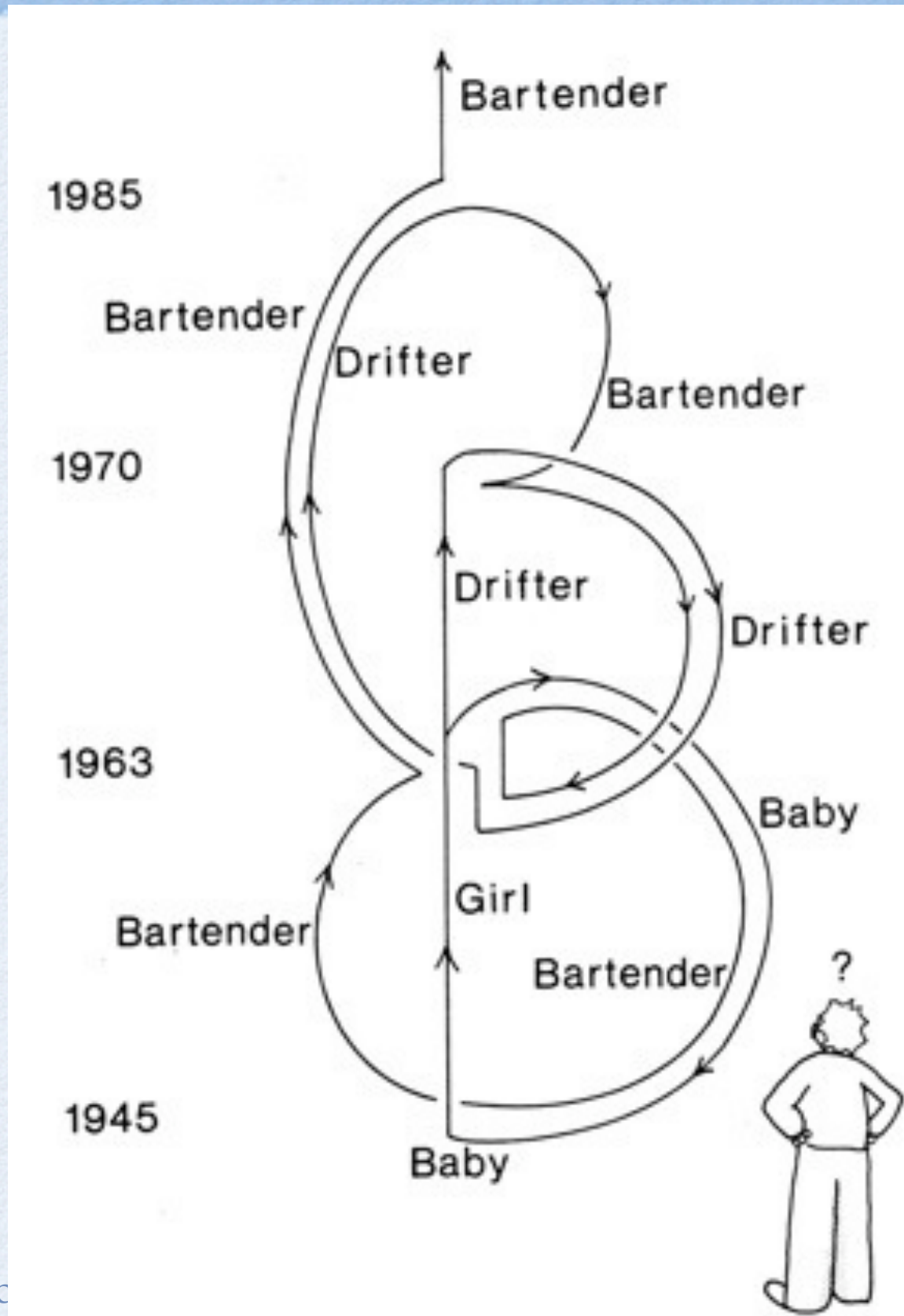


- An engineer goes 30 years into the future,
- Reads some patents a later version of himself filed,
- Take the (information in) the patents back in time,
- And files them.
- *Did the patents write themselves?*

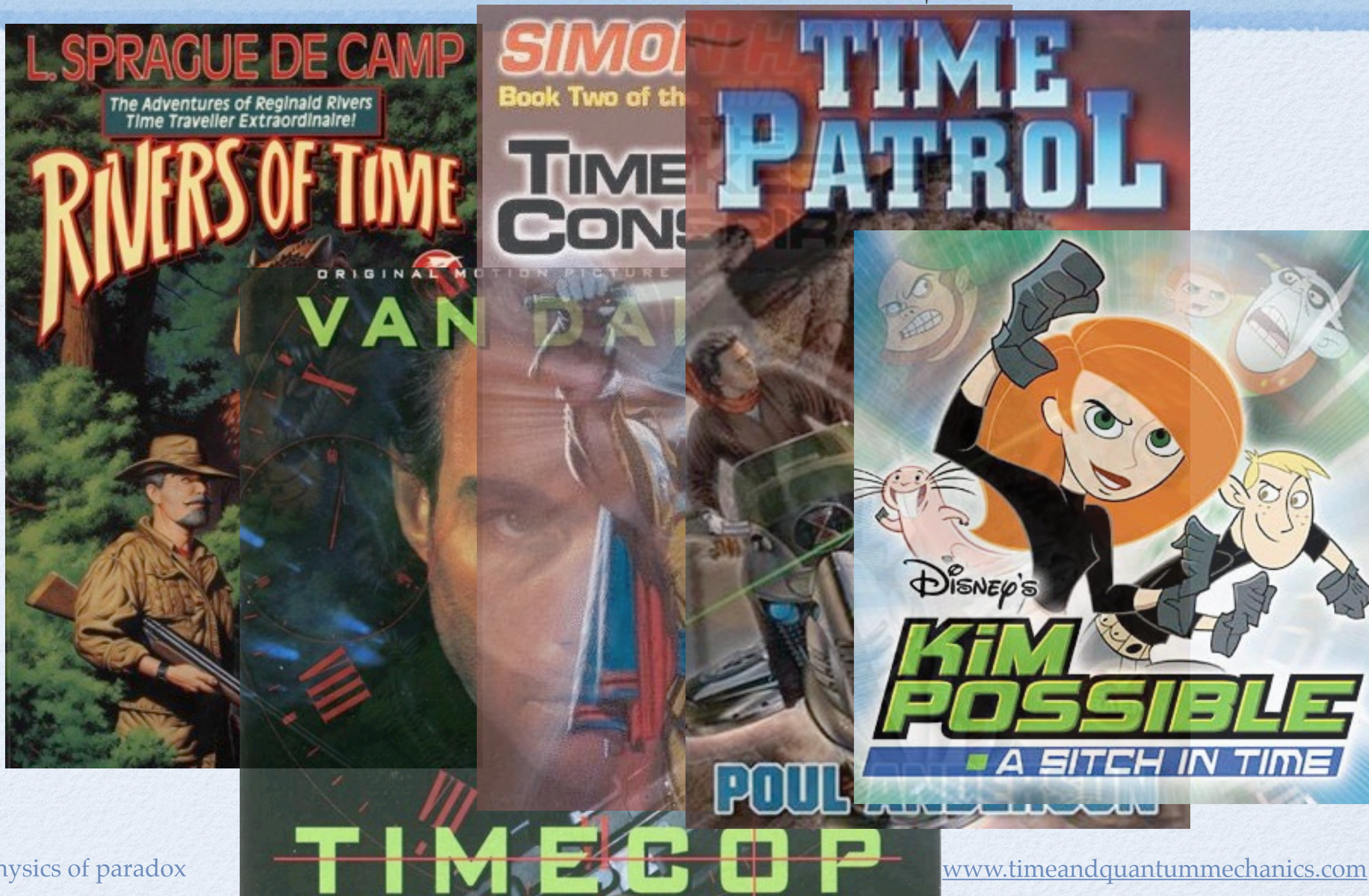
ALL YOU ZOMBIES

The By-laws of time:

- Never Do Yesterday What Should Be Done Tomorrow.
- If at Last You Do Succeed, Never Try Again.
- A Stitch in Time Saves Nine Billion.
- A Paradox May Be Paradoctored.



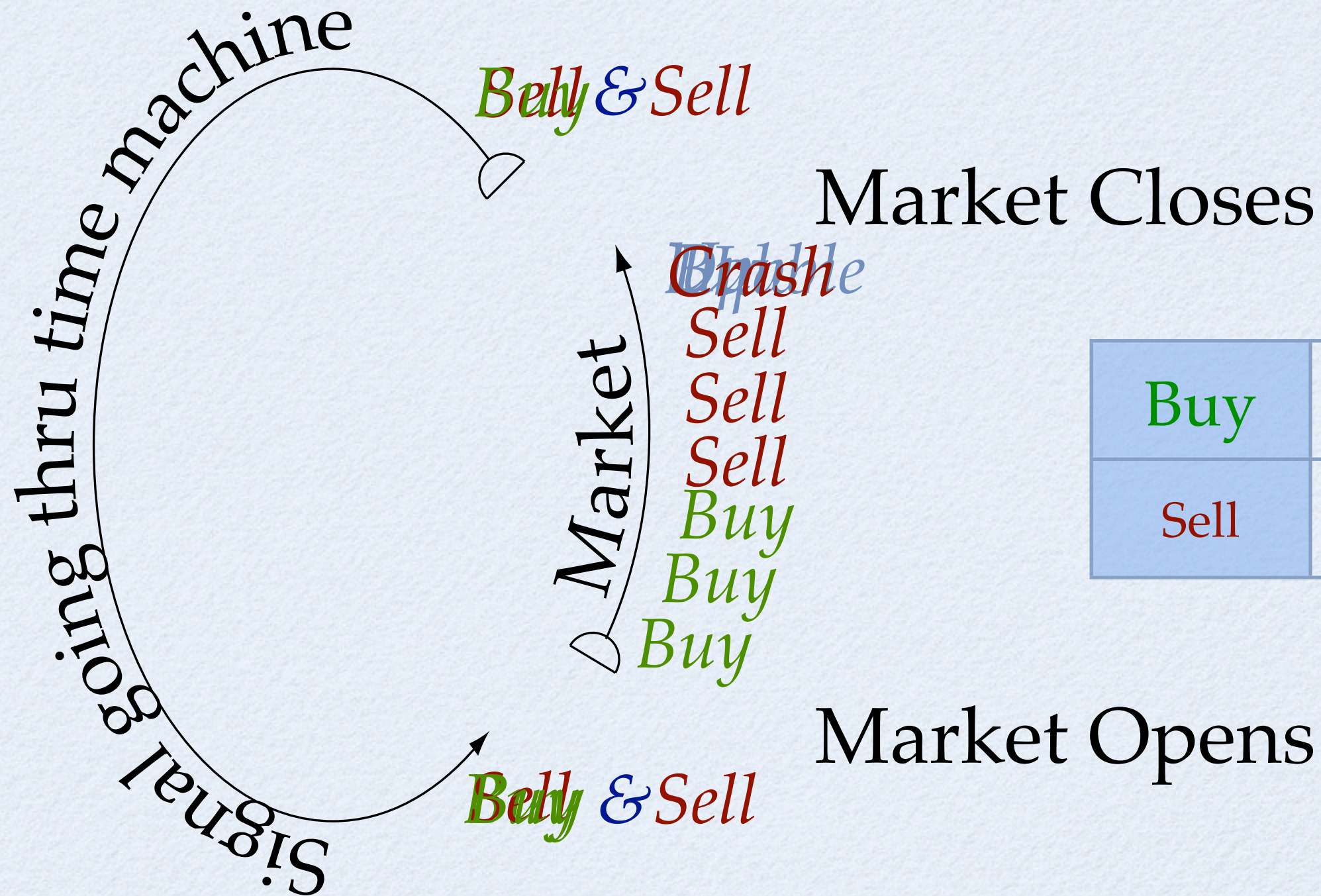
Tales of the time police



2 CONSISTENCY PRINCIPLES

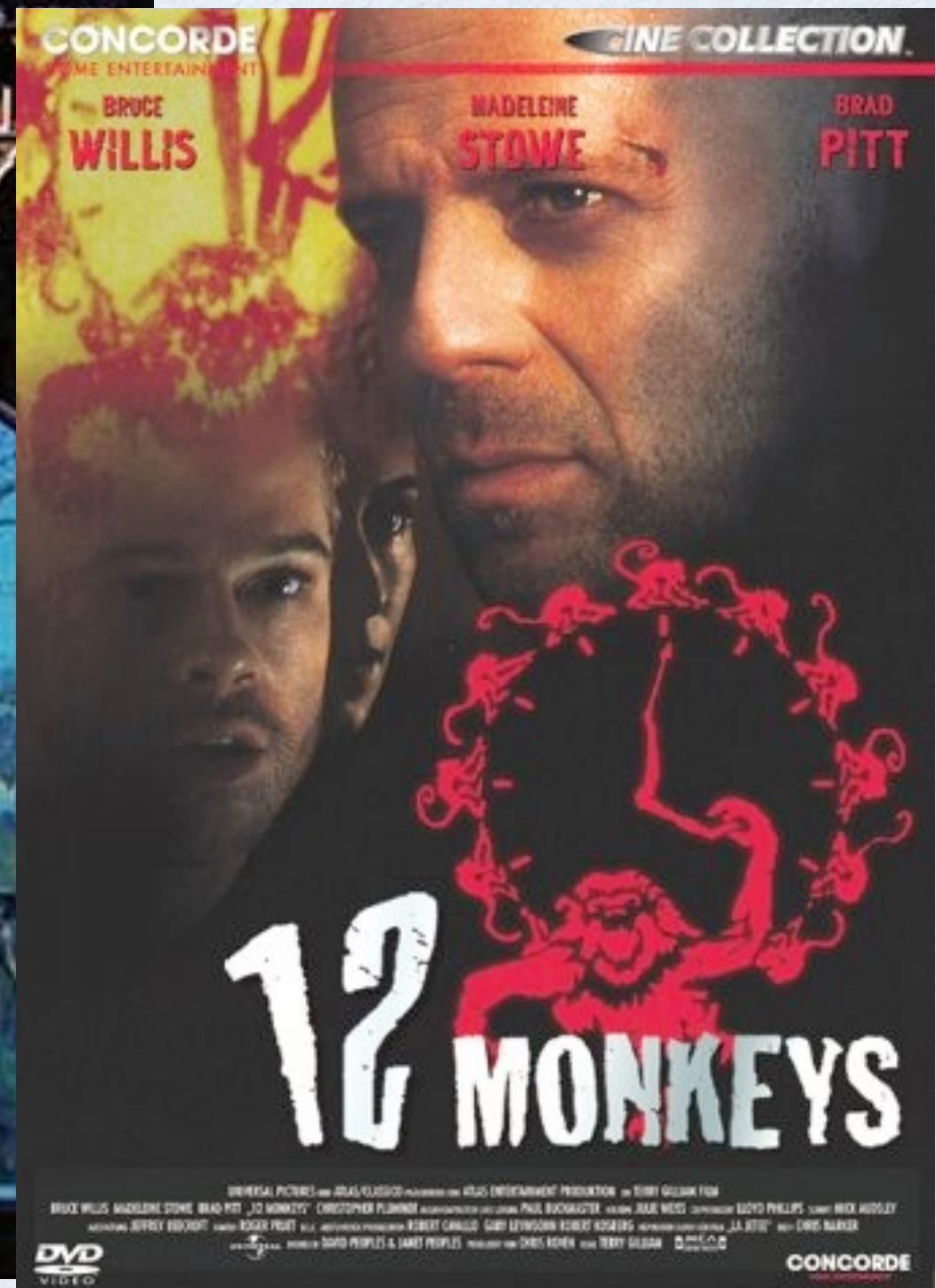
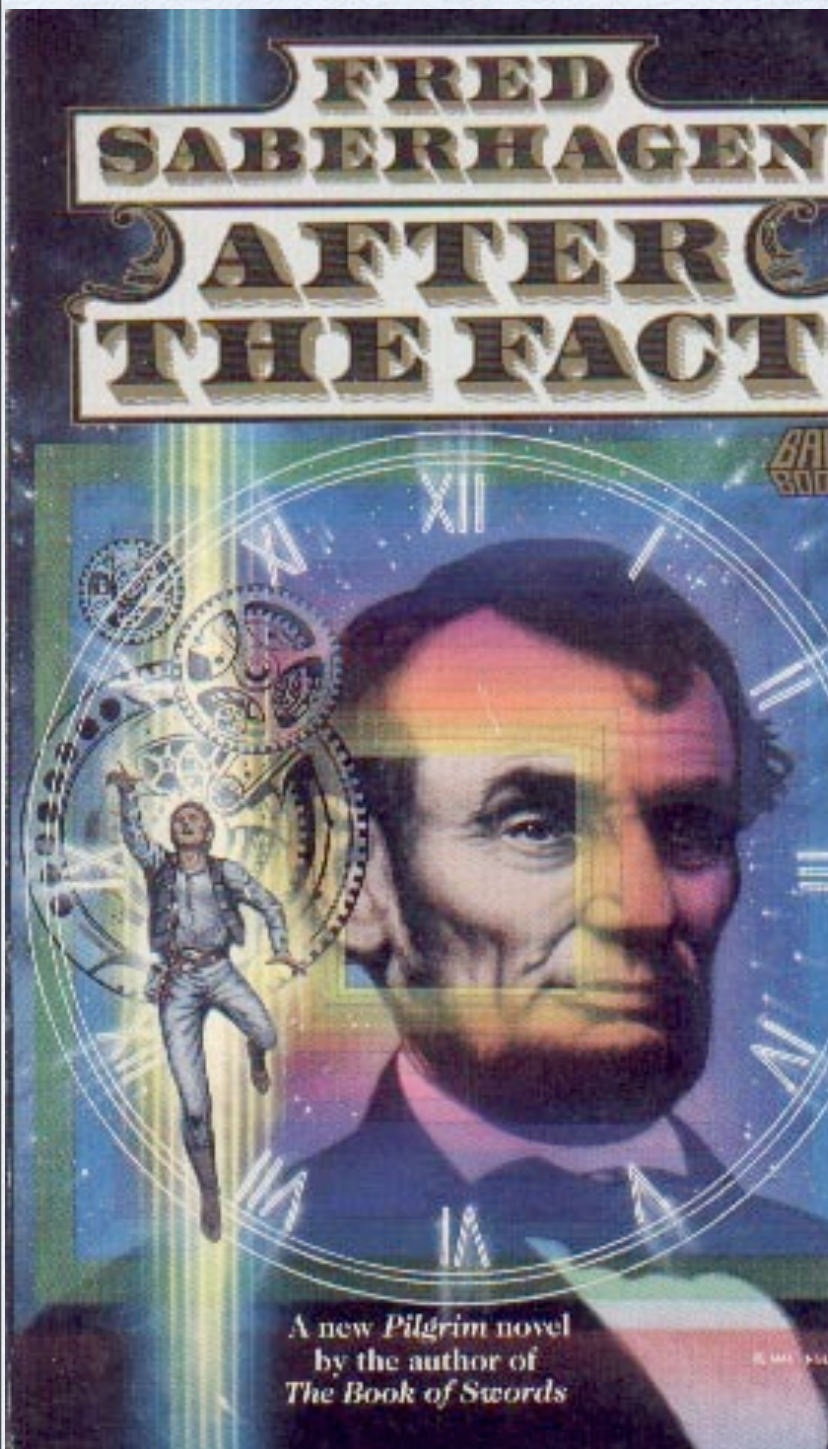
- Hawking: “The laws of physics do not allow the appearance of closed timelike curves.”
- Novikov: You can have closed timelike curves, and even travel along them. But if you go back in time, you can't change anything that is already known.

A MARKET IN TIME

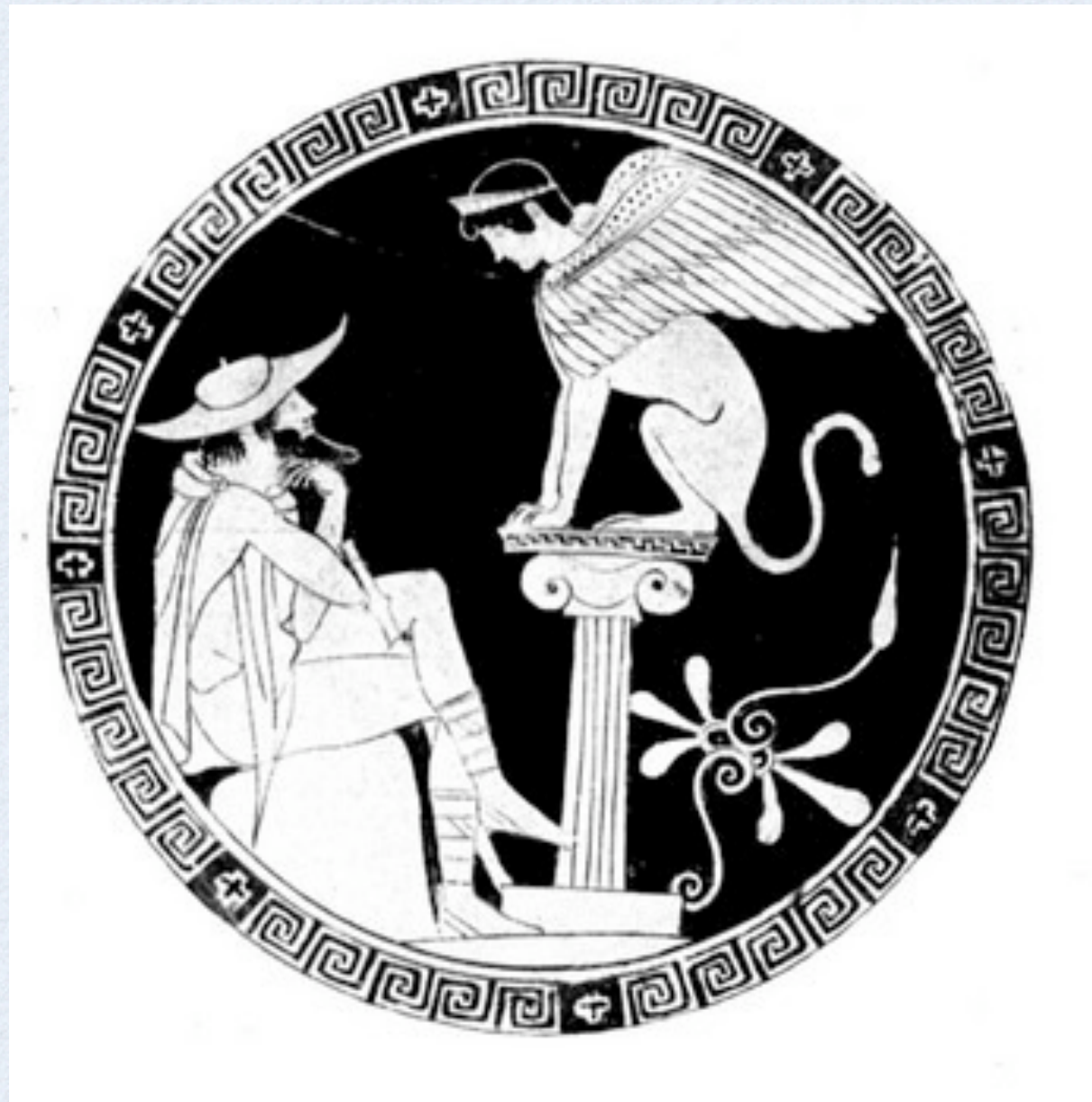


Buy	50%
Sell	50%

PARADOX NOISE

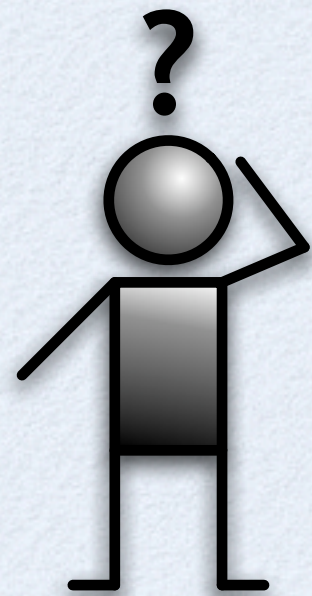


WHAT DOES THIS MEAN?

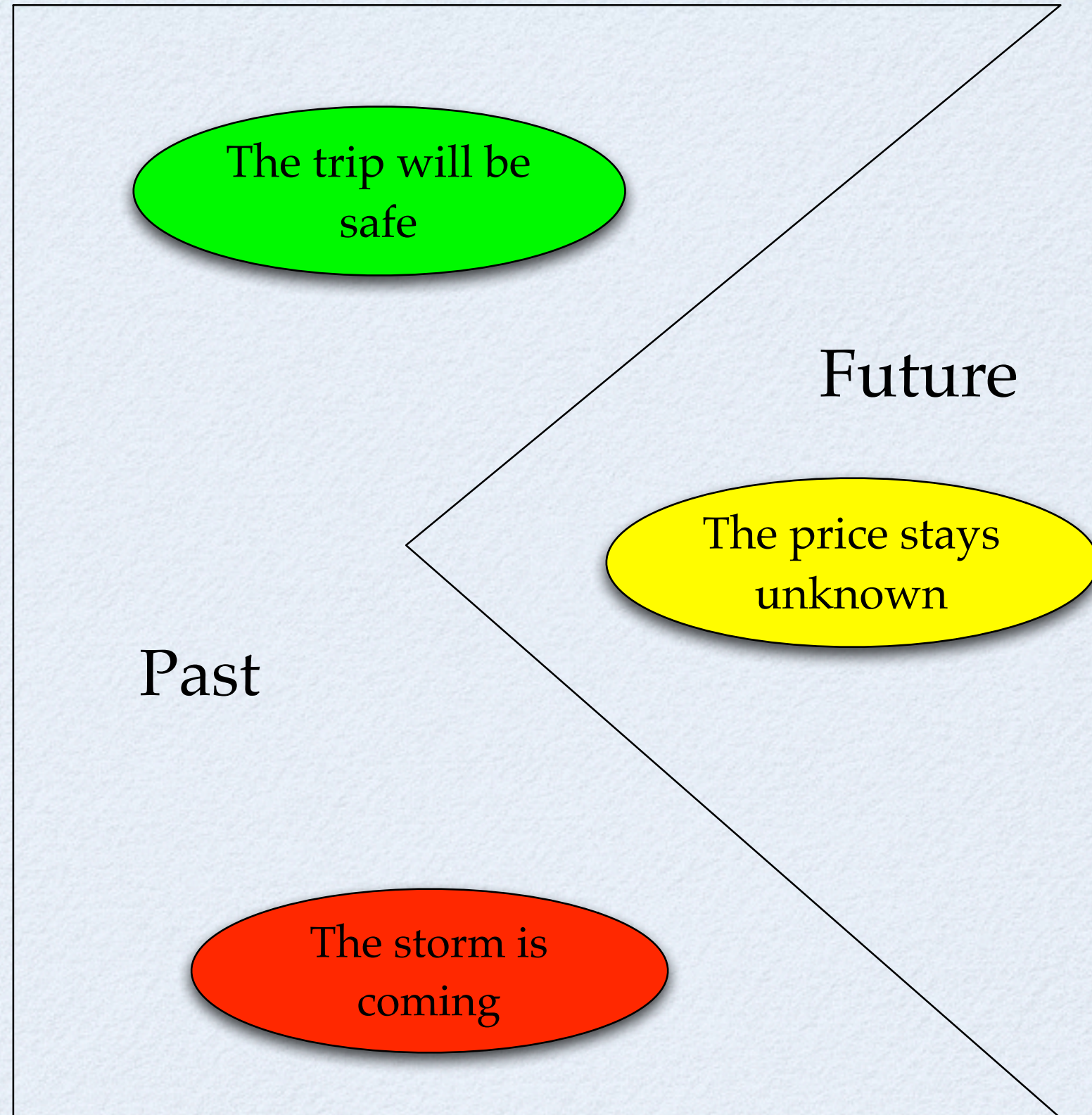


- What does paradox noise look like?
- Can you avoid it?
- Can you use it?

CRYSTALLIZING TIME



Now



TIME IN TIME TO COME

- Everything not forbidden is compulsory. — Gellmann
- If at first an idea does not sound absurd, there is no hope for it. — Einstein
- The only way of discovering the limits of the possible is to venture a little past them into the impossible. — Clarke

ATROPOS -- AKA FATE #3



- Time travel may be possible
- But if so, paradoxes will be self-canceling
- Whether the paradox is intended or not

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When “highly” improbable
just isn’t improbable enough!



Don’t get lost, take Oceanic!



The terminal alternative!

THANKS!

- Ferne Welch
- Nathan Evans & Colleen Cahill
- Margaret Trebling
- Library of Congress & Capclave
- Philcon

REFERENCES

Author	Title	Year
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Davies	How to Build a Time Machine	2001
Toomey	The New Time Travelers	2007
Kaku	Physics of the Impossible	2008
Carroll	From Eternity to Here	2010
Goldberg & Blomquist	A User's Guide to the Universe	2010