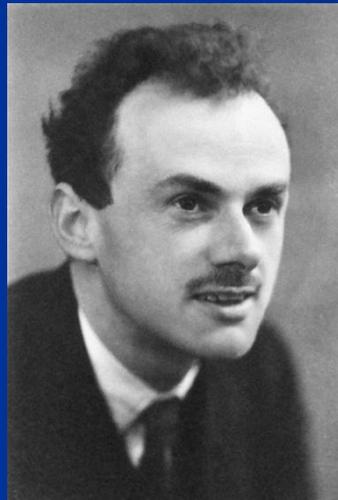
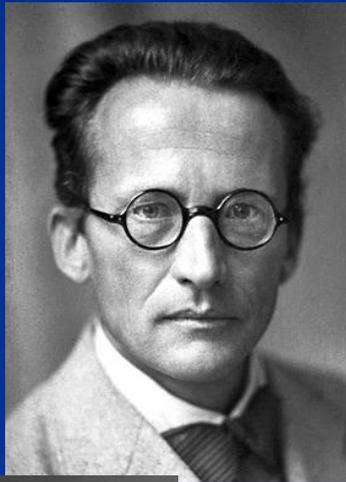
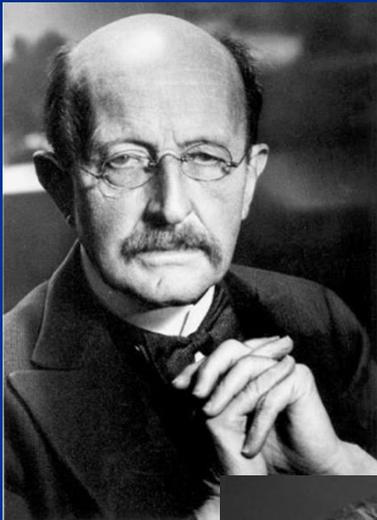


# Quantum Mechanics



Quantum mechanics is the basis of all of modern physics, and has been so since the 1920s

And it's weirder than we can possibly imagine  
But it's NOT science fiction

Some ideas from “classical” (pre-1900) physics:

Light is composed of waves

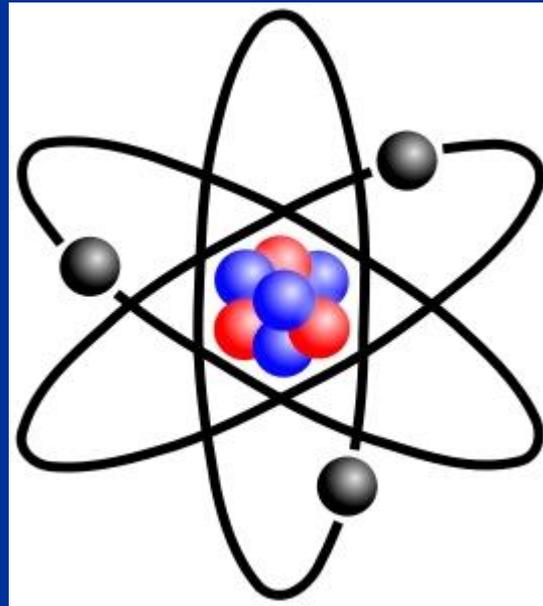
Matter is composed of particles

The laws of physics are deterministic

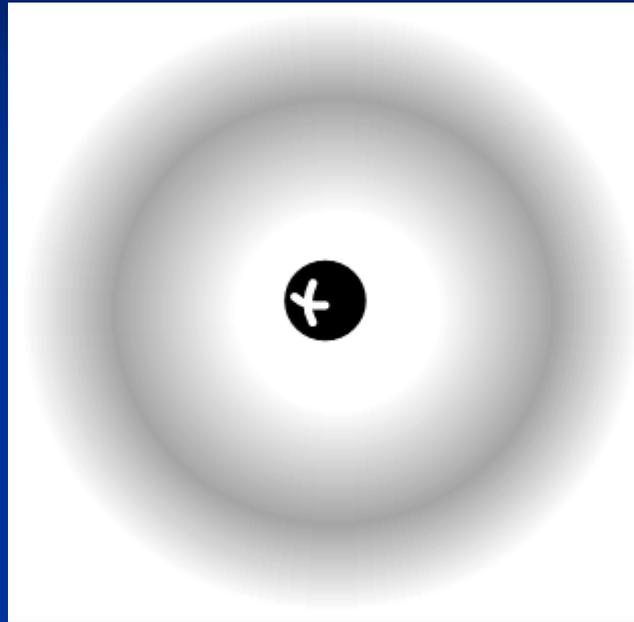
Reality is independent of the observer

Quantum mechanics overturns all of these

The Rutherford atom (pre-quantum mechanics):



## The atom of quantum mechanics:



1. The electron behaves like a wave.
2. We can only specify the PROBABILITY of observing it in a definite location
3. It has no definite location until you go looking for it.

Einstein: God does not play dice....

Maybe quantum mechanics is really just very complicated, and only apparently random: “hidden variables theory”



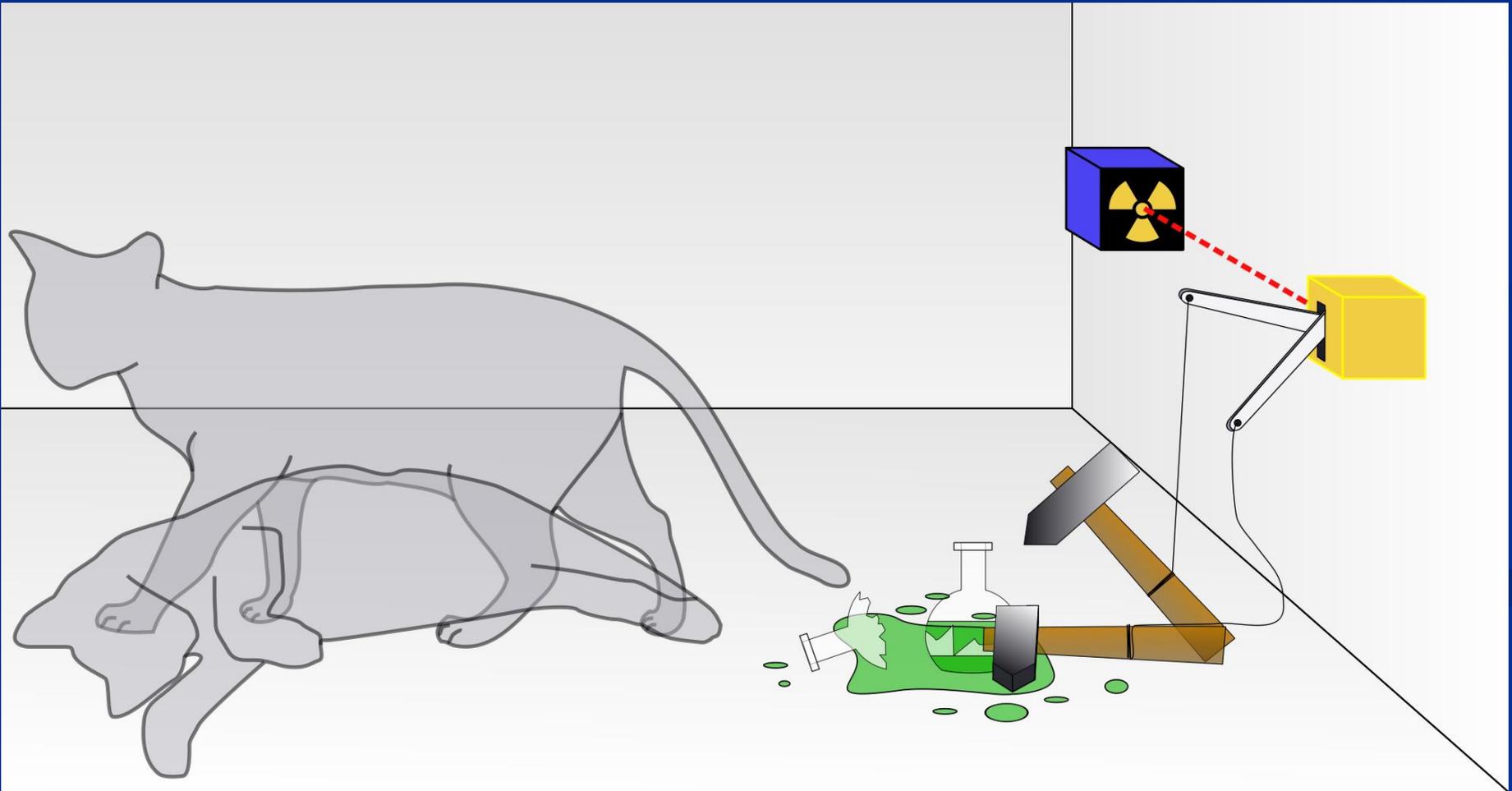
But all our experiments seem to refute this

# The Copenhagen Interpretation

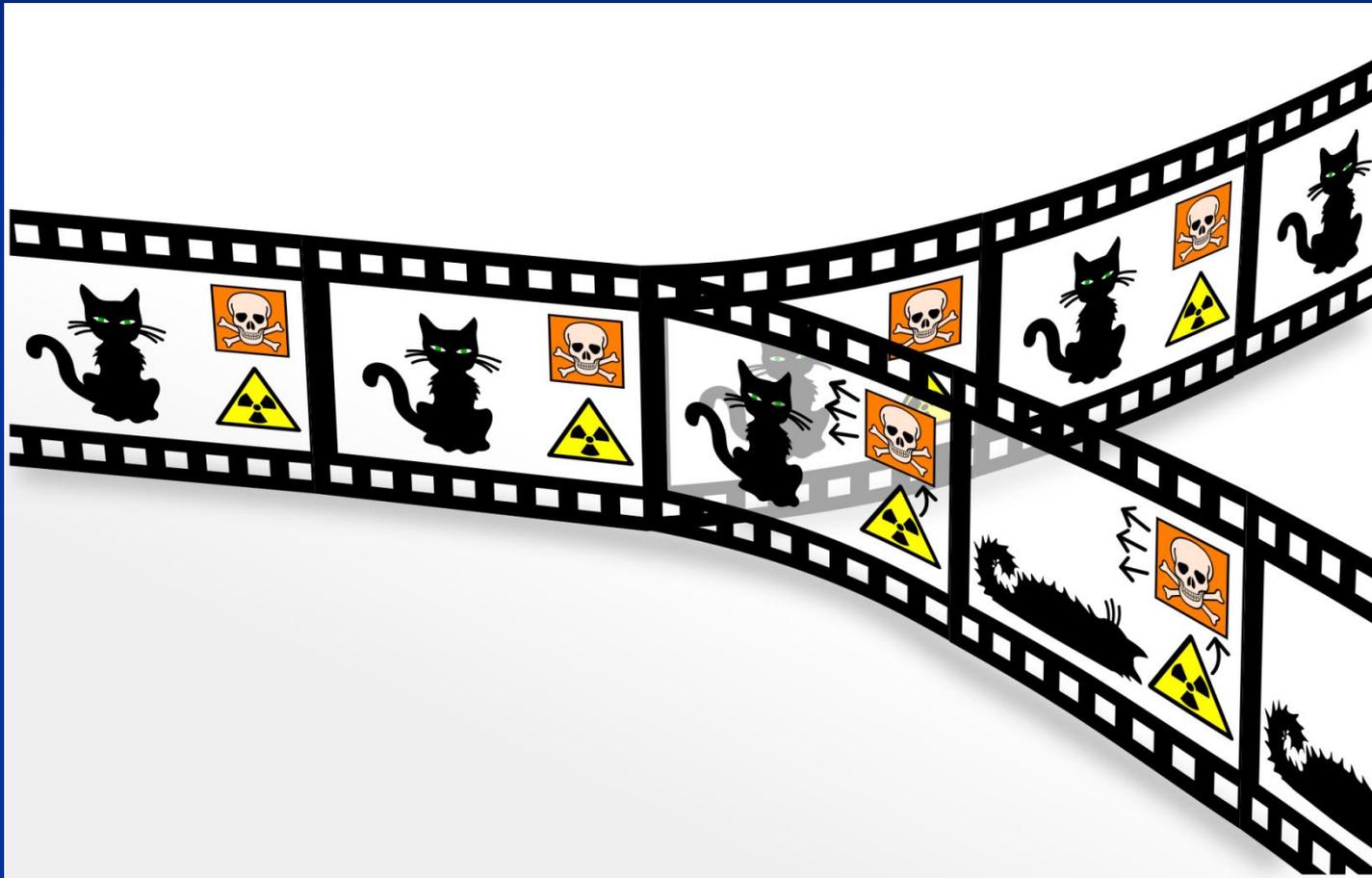


The electron is really in a superposition of all possible locations; observing it causes the wave to “collapse” to a single location.

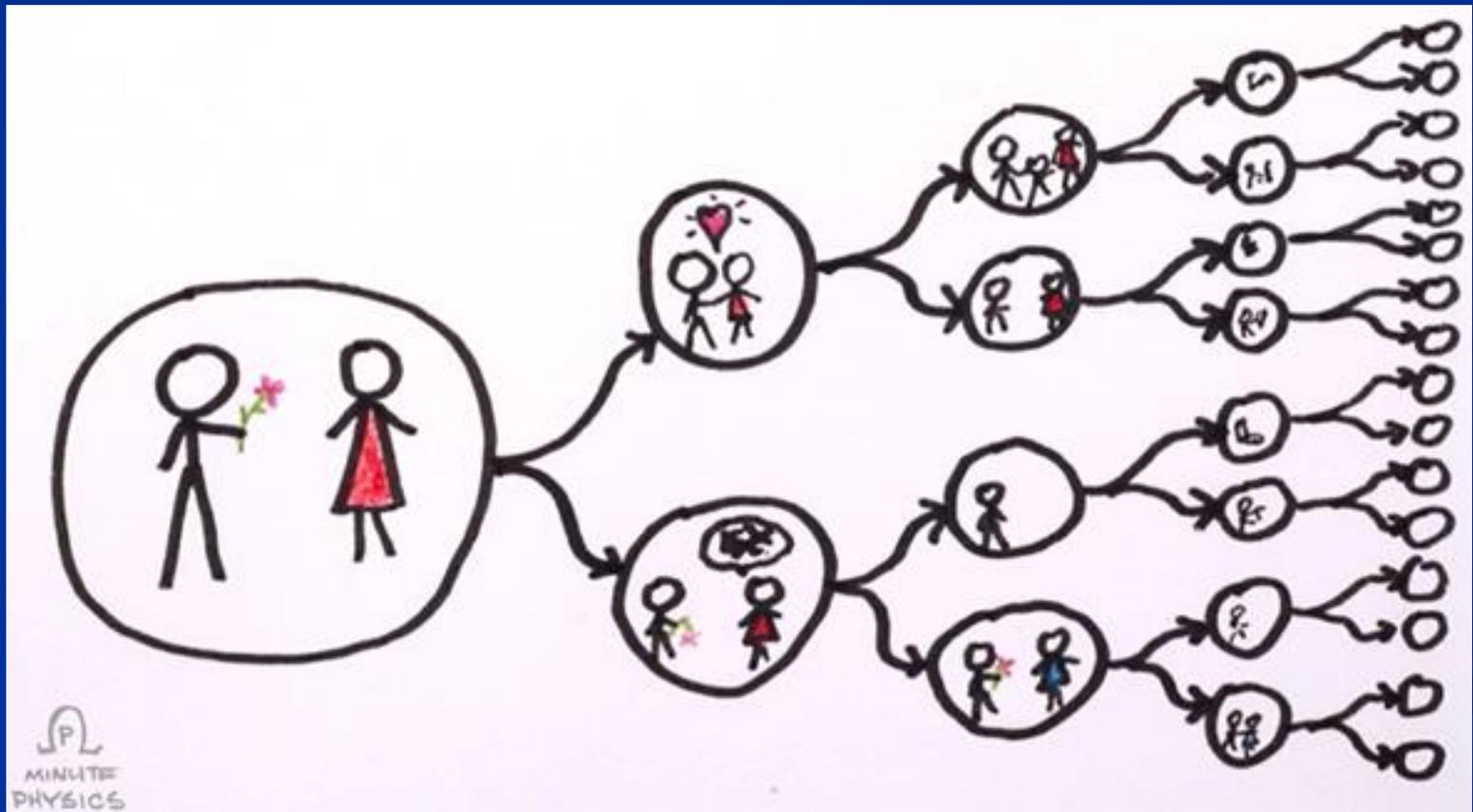
# Schrodinger's Cat



# The Many Worlds Hypothesis



Many interesting implications....



How has science fiction utilized quantum mechanics?

Variations on Schrodinger's Cat:

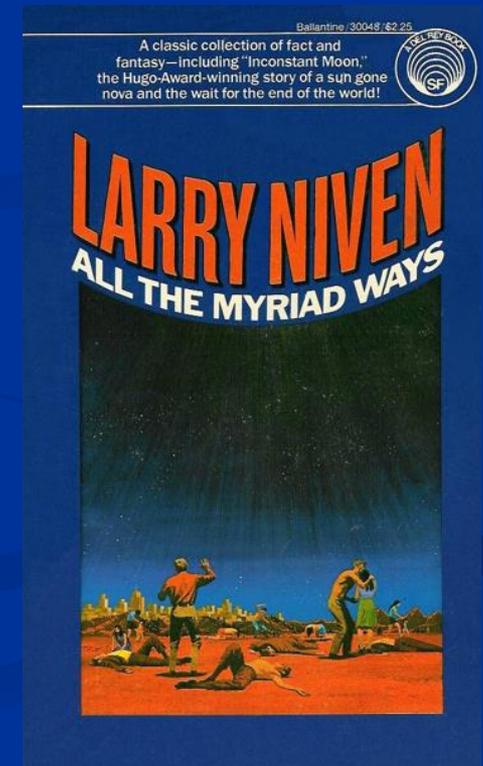
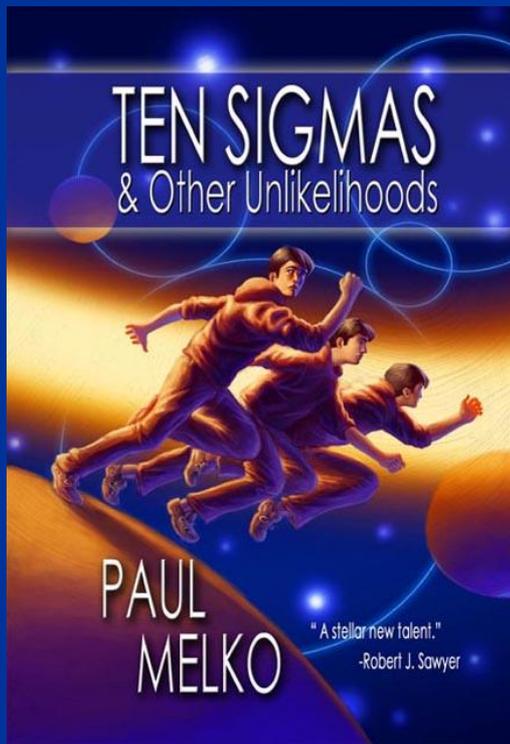
Greg Bear: "Schrodinger's Plague"

Greg Egan: "Quarantine"

# The Many-Worlds Hypothesis

Larry Niven: “All the Myriad Ways”

Paul Melko: “Ten Sigmas”



# The Quantum Immortality Hypothesis

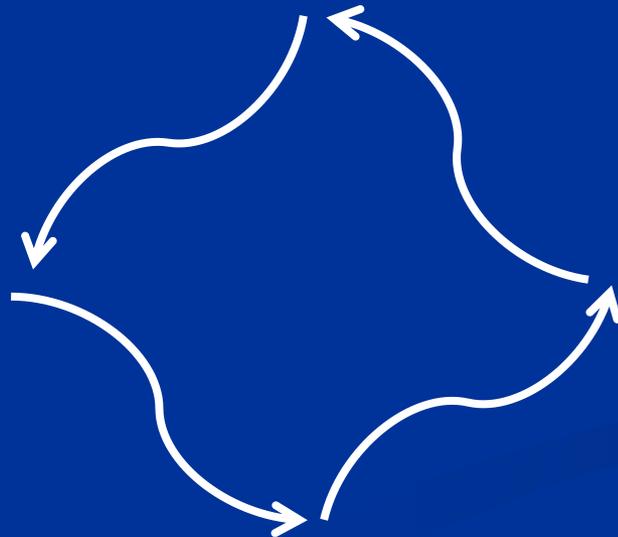
Robert Charles Wilson: “Divided by Infinity”

# Time Travel



In physics, time acts as a fourth dimension.

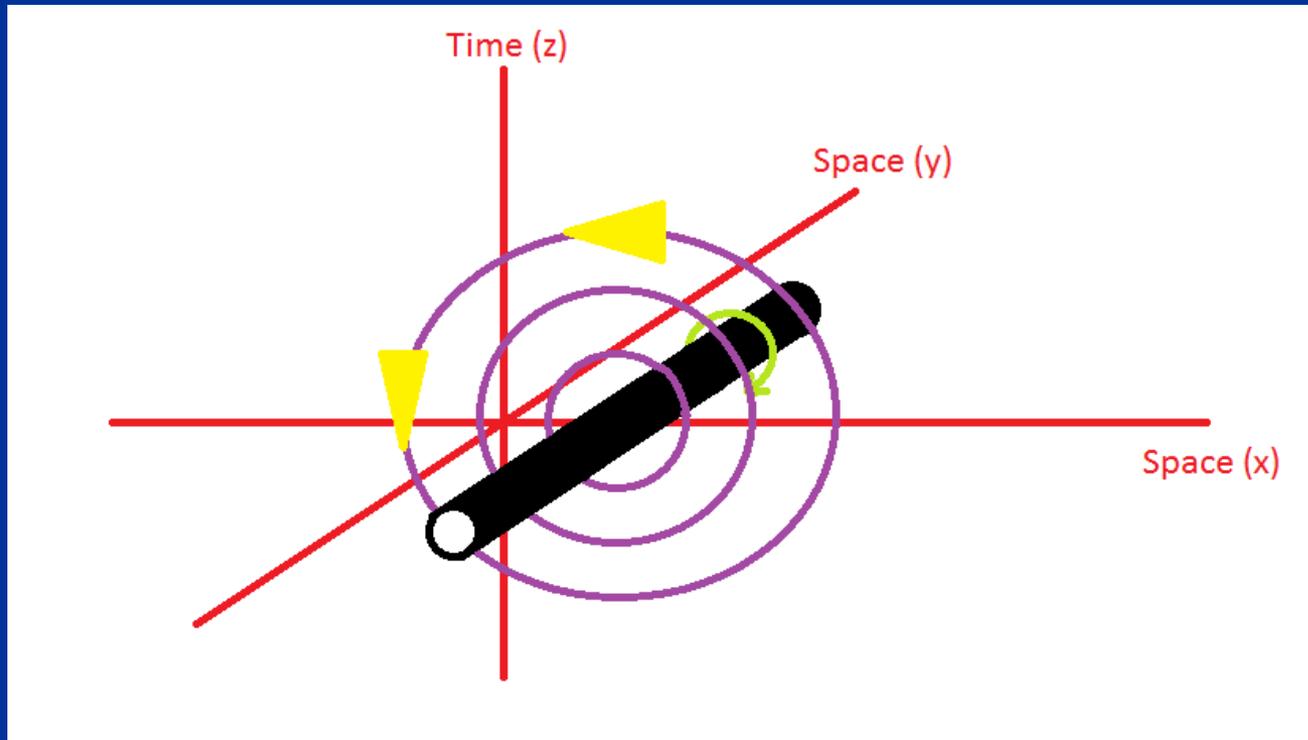
Can we have a path that is closed in space  
AND in time?



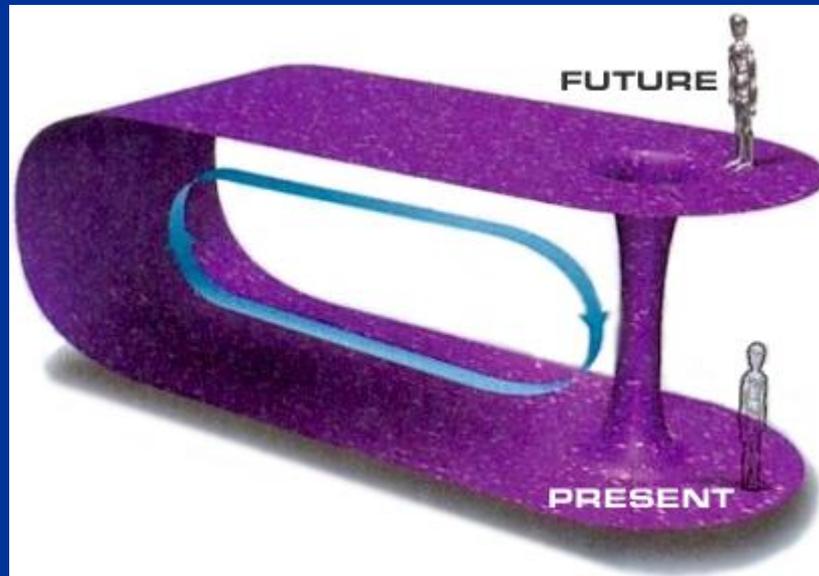
A closed  
timelike curve

# Closed Time-like curves

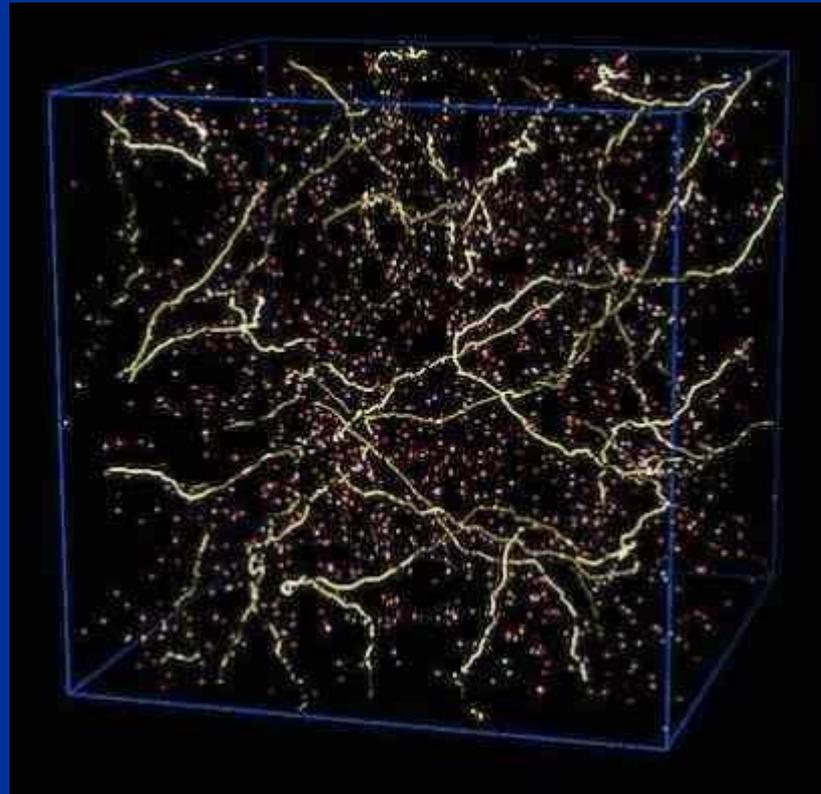
Frank Tipler: infinitely long rotating  
Cylindrical black hole



# Kip Thorne: wormholes



# J. Richard Gott: cosmic strings



All require something “exotic”

Stephen Hawking:

Chronology Protection Conjecture

You can never build a time machine

Igor Novikov:

Self-consistency Conjecture

You can build a time machine, but you cannot change the past

In Science fiction:

1. Let's change the past!
2. The past cannot be changed

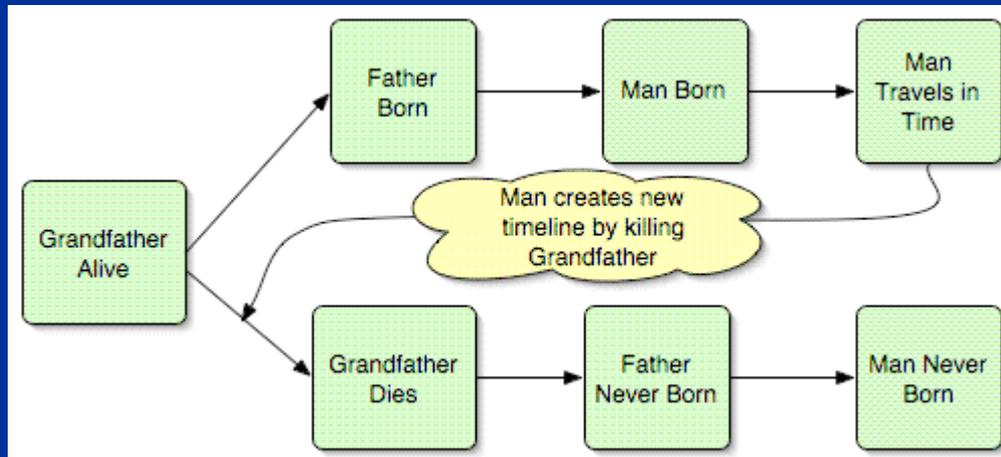
What if we could change the past...

Ray Bradbury: “A sound of Thunder”

William Tenn: “The Brooklyn Project”

Fun, but leads to logical paradoxes

# THE GRANDFATHER PARADOX



What if we cannot change the past?

Robert Heinlein: “By his bootstraps”

Robert Heinlein: “All you Zombies”

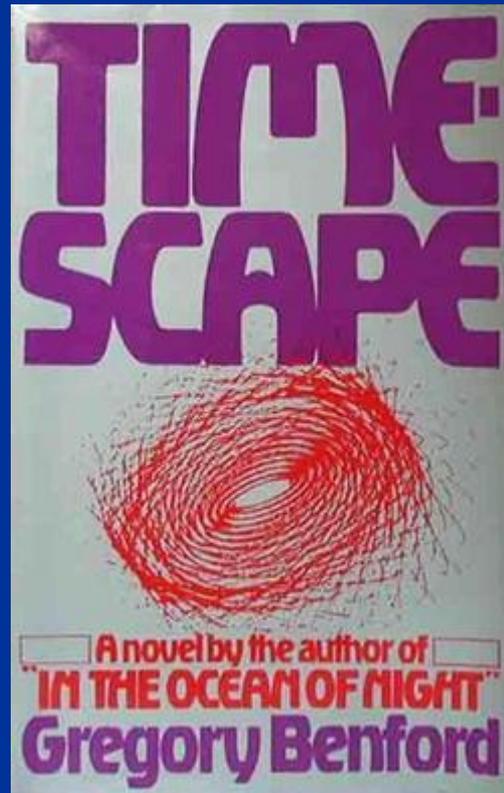
John Varley: “Air Raid”  
*Millennium*

Still leads to “issues” even when paradoxes are avoided

Much SF in this vein is thinly-veiled historical fiction (the Ben Hur effect)

Another way to do time travel

Gregory Benford: *Timescape*



# Next Week

## Cosmology

Steven Baxter: “Last Contact”

Robert Scherrer: “Extra Innings”

## Genetics

Nancy Kress: “Beggars in Spain”