

# ***TIME & QUANTUM MECHANICS***

**John Ashmead**

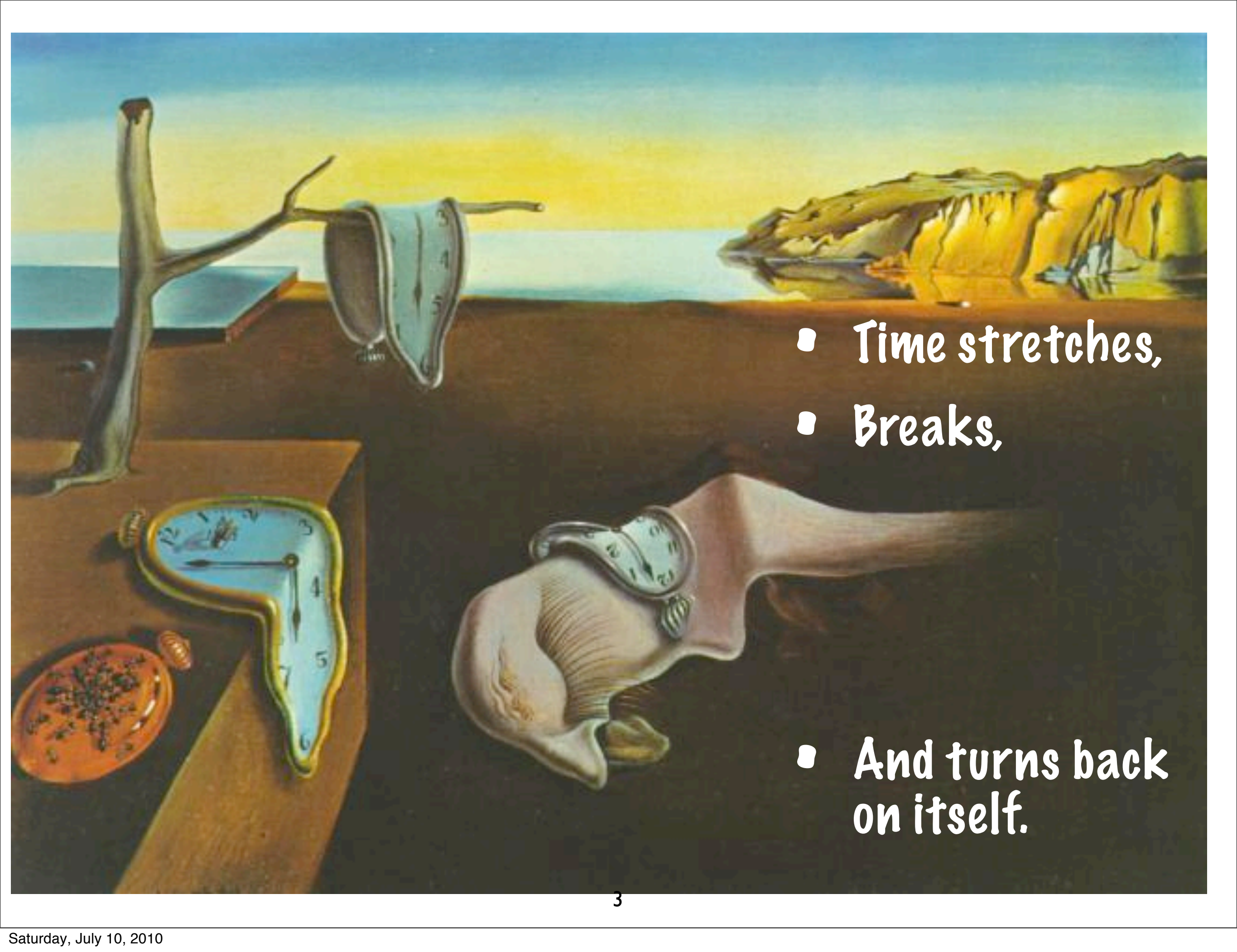
**Chestnut Hill Book Festival, 2010**

# ***LORD HELVIN'S TWO SMALL PROBLEMS***

Black body  
radiation

Properties of  
light

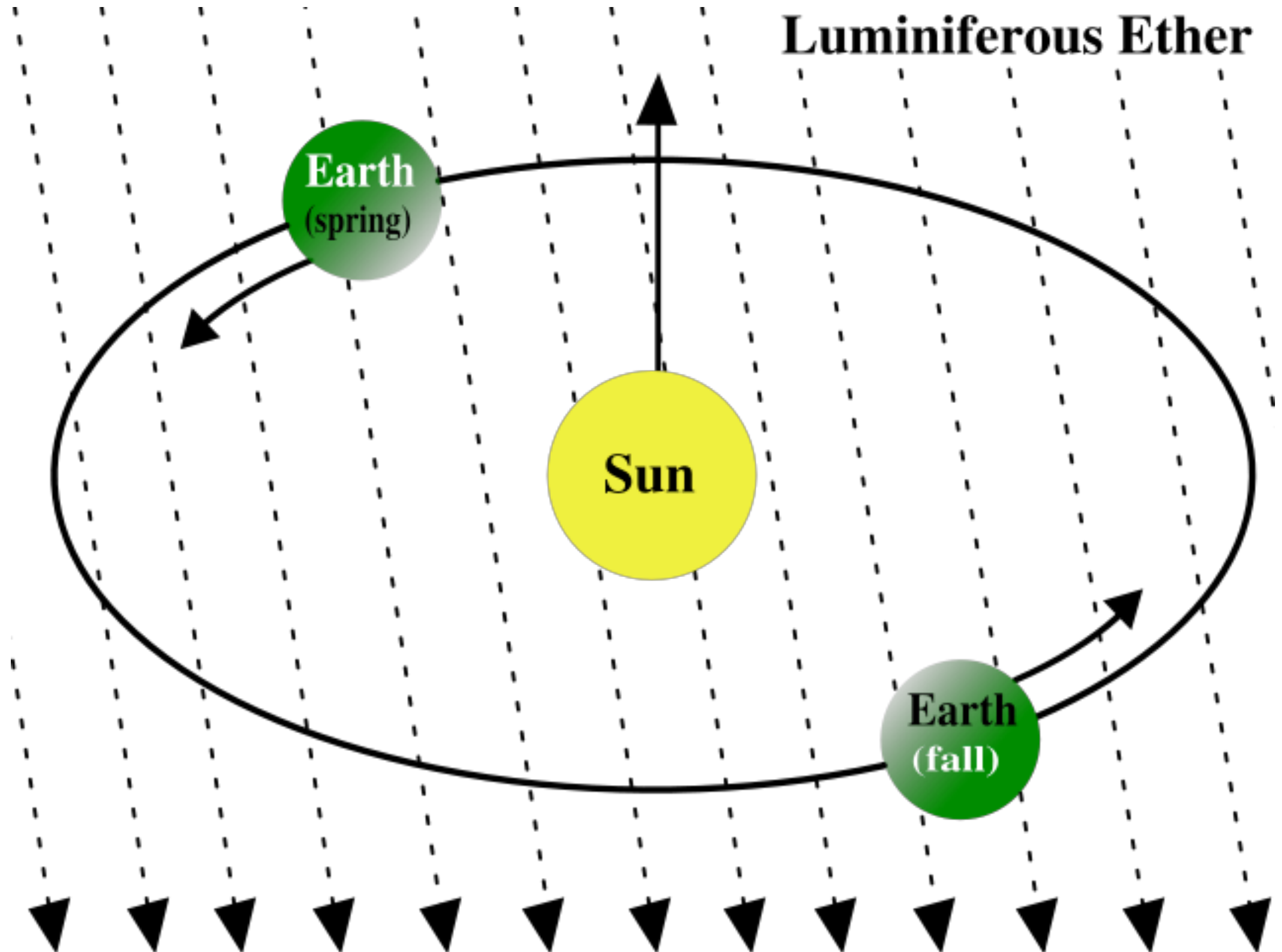




- Time stretches,
- Breaks,

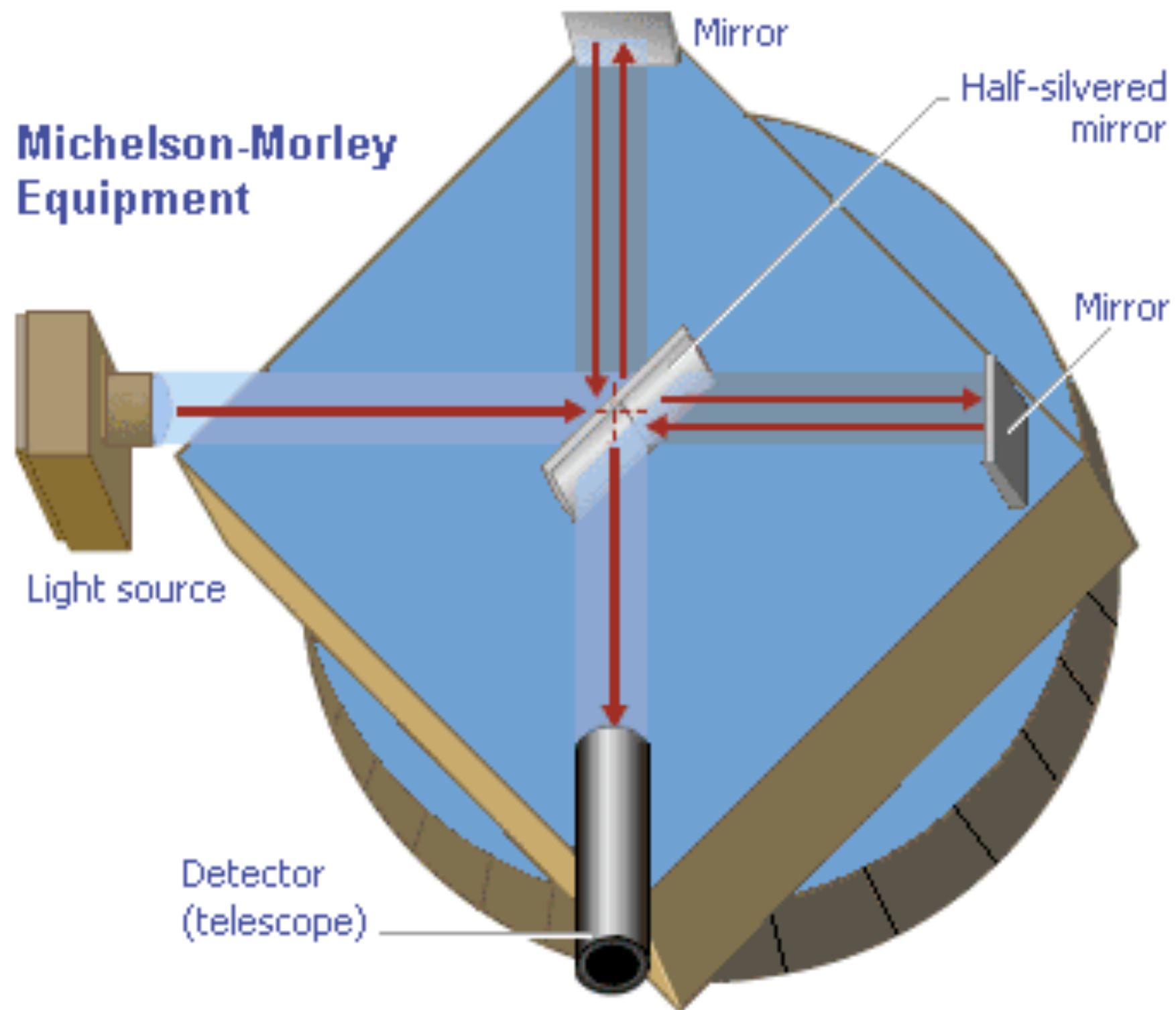
- And turns back on itself.

# Luminiferous Ether





# MICHELSON-MORLEY



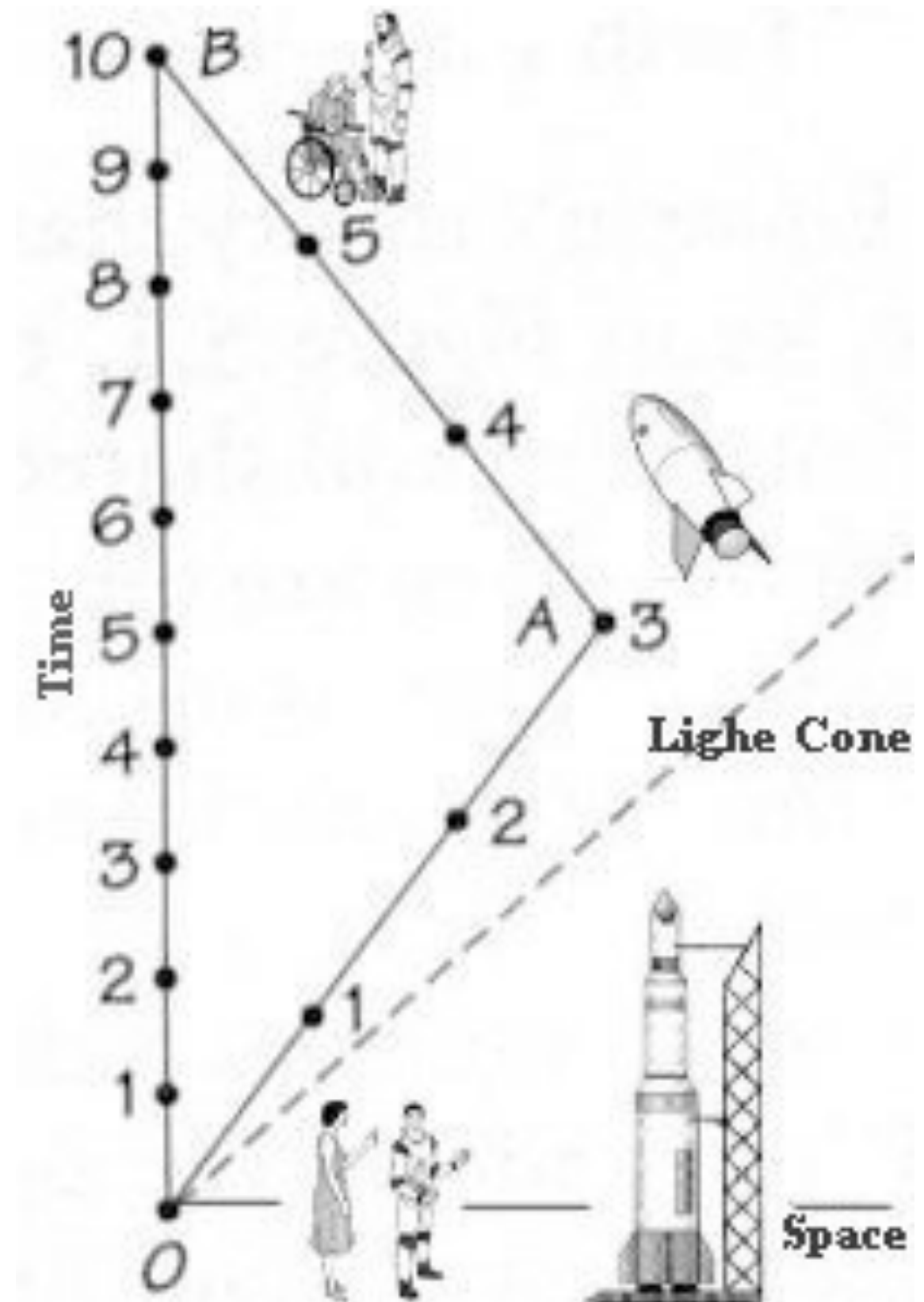
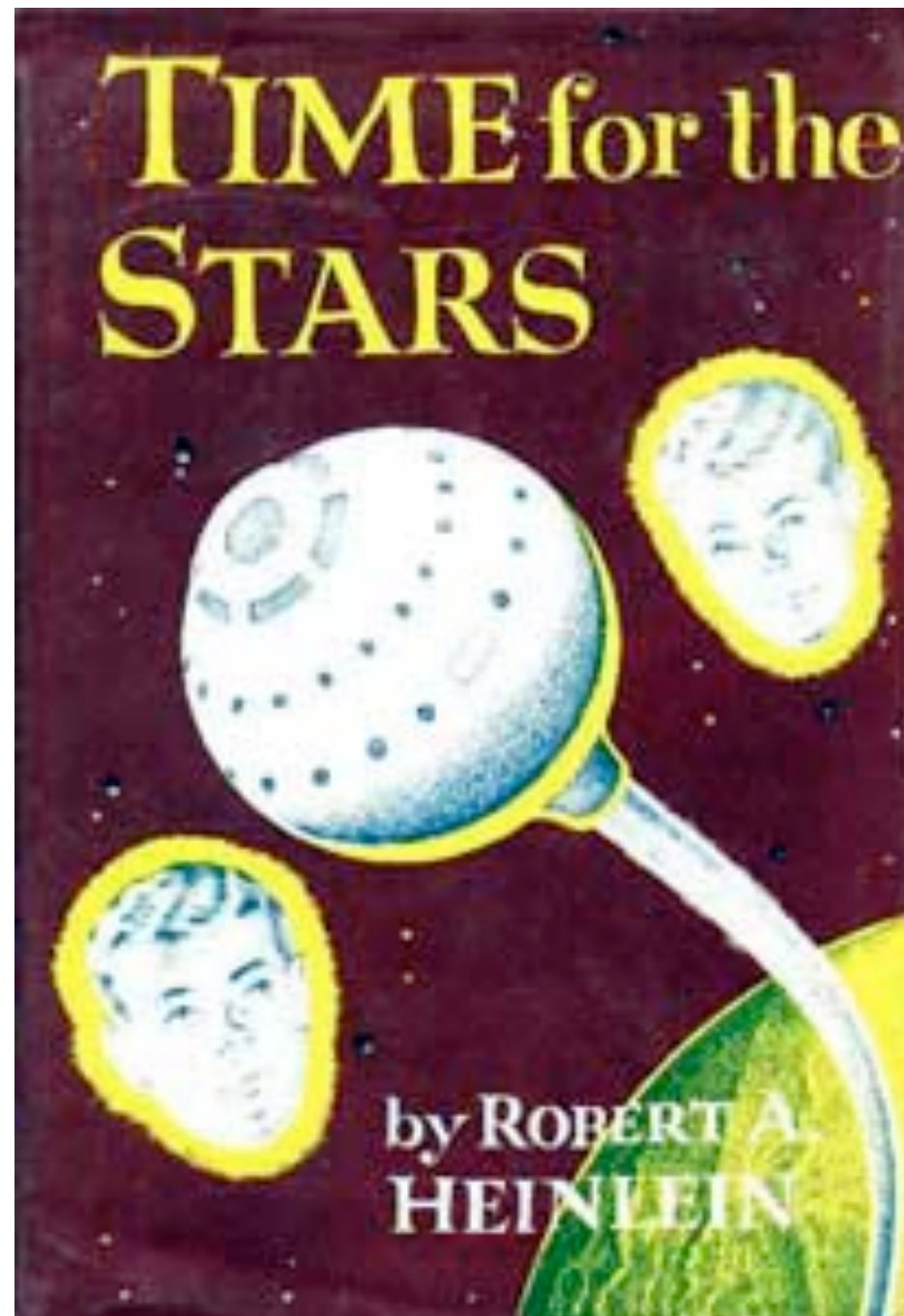
# RELATIVITY



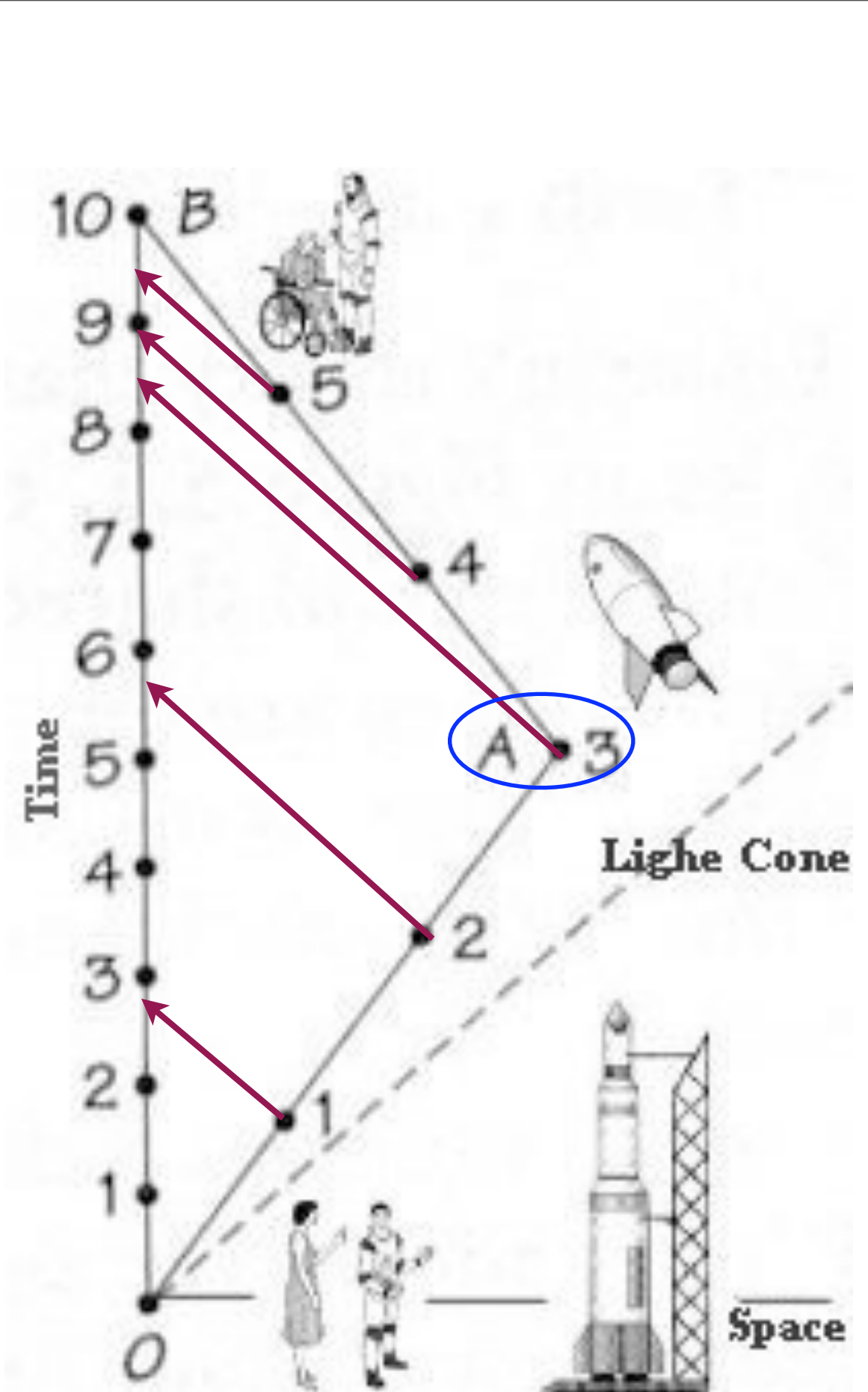
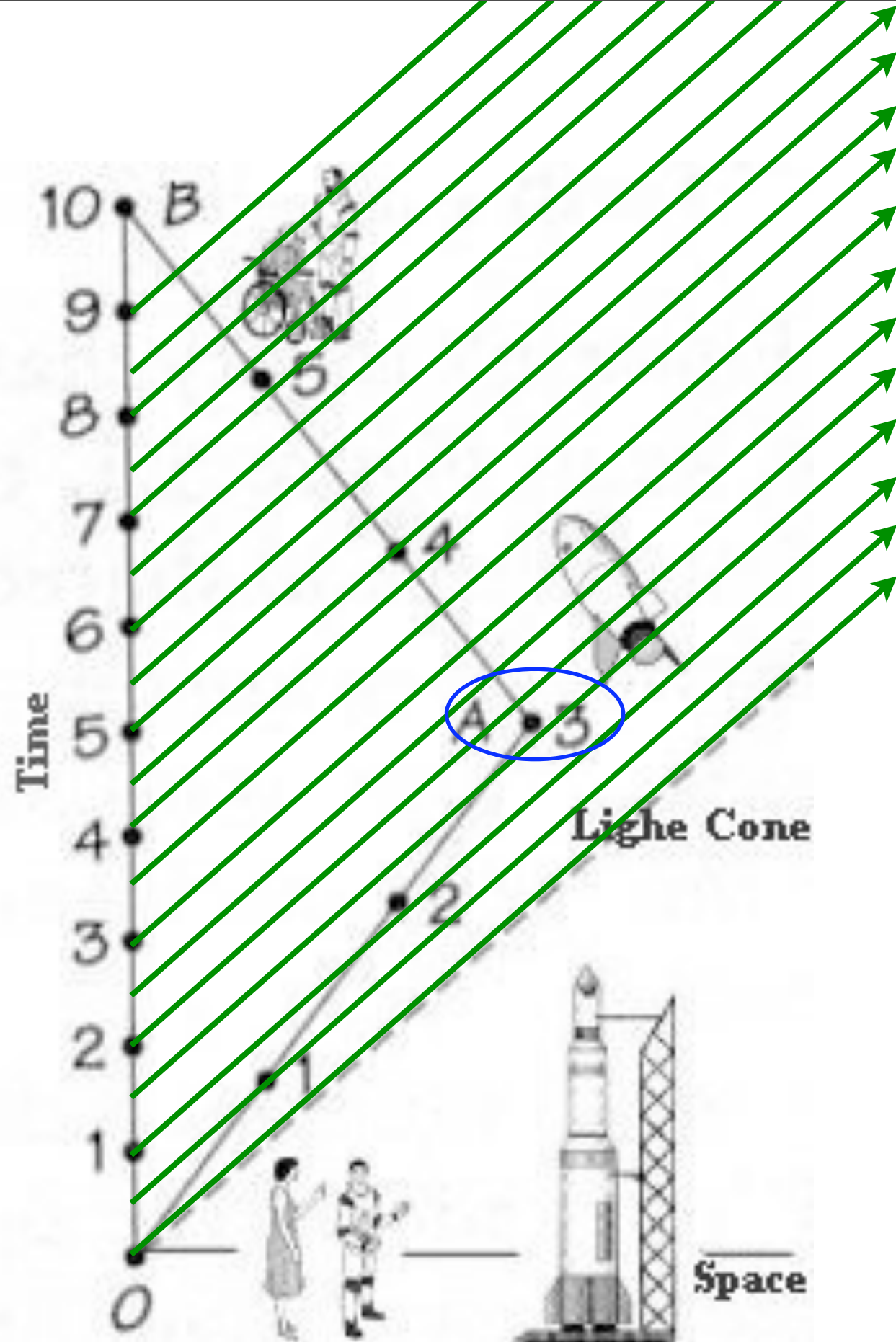
- speed of light constant
- laws of physics the same for all observers\*

\*but definition of simultaneity may differ!

# TWIN PARADOX









# ***TIME SERIOUSLY TWISTED***



<http://www.youtube.com/watch?v=f0VOn9r4dq8>

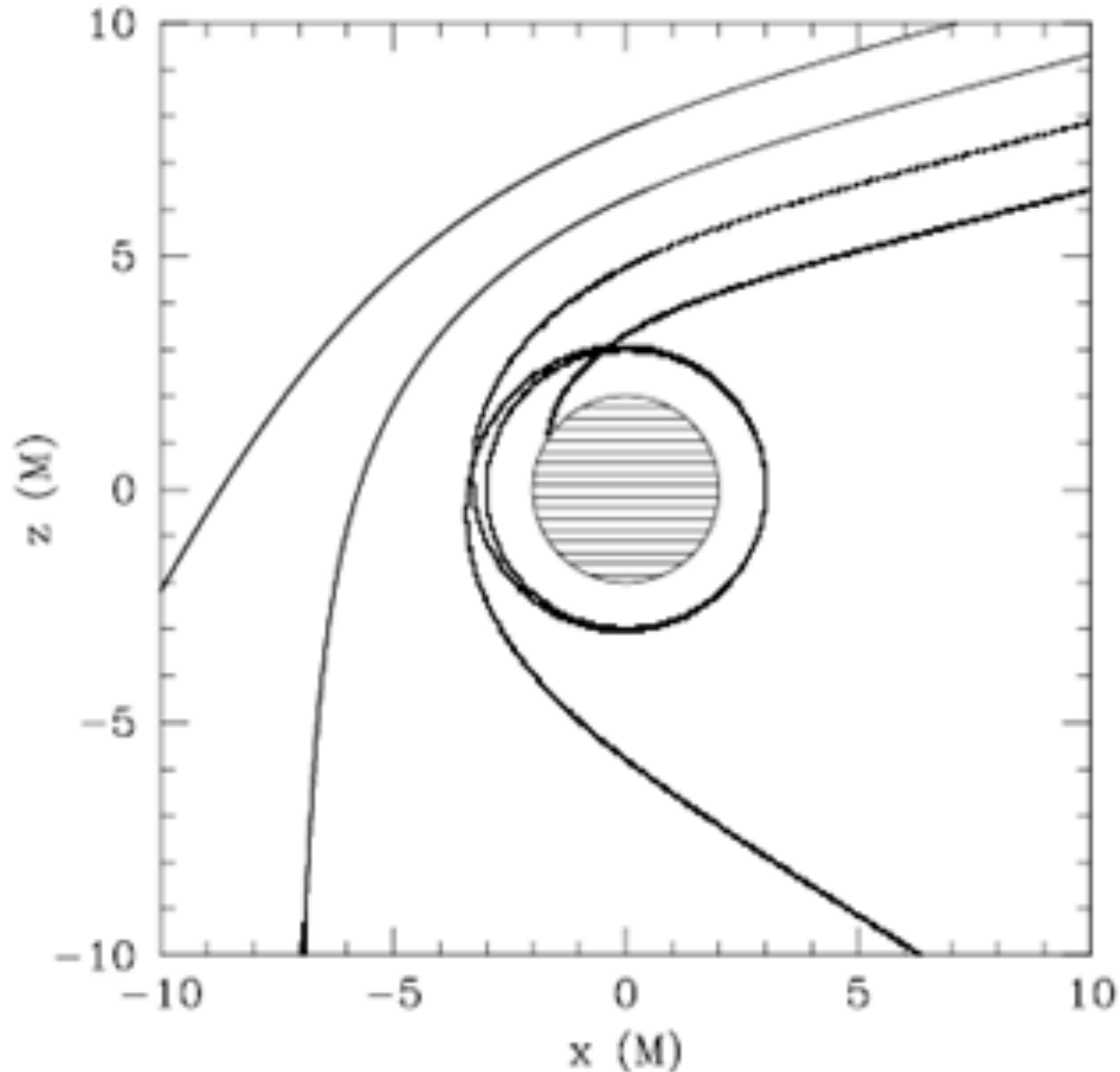


# ***BLACK HOLE AT THE CENTER OF THE GALAXY***



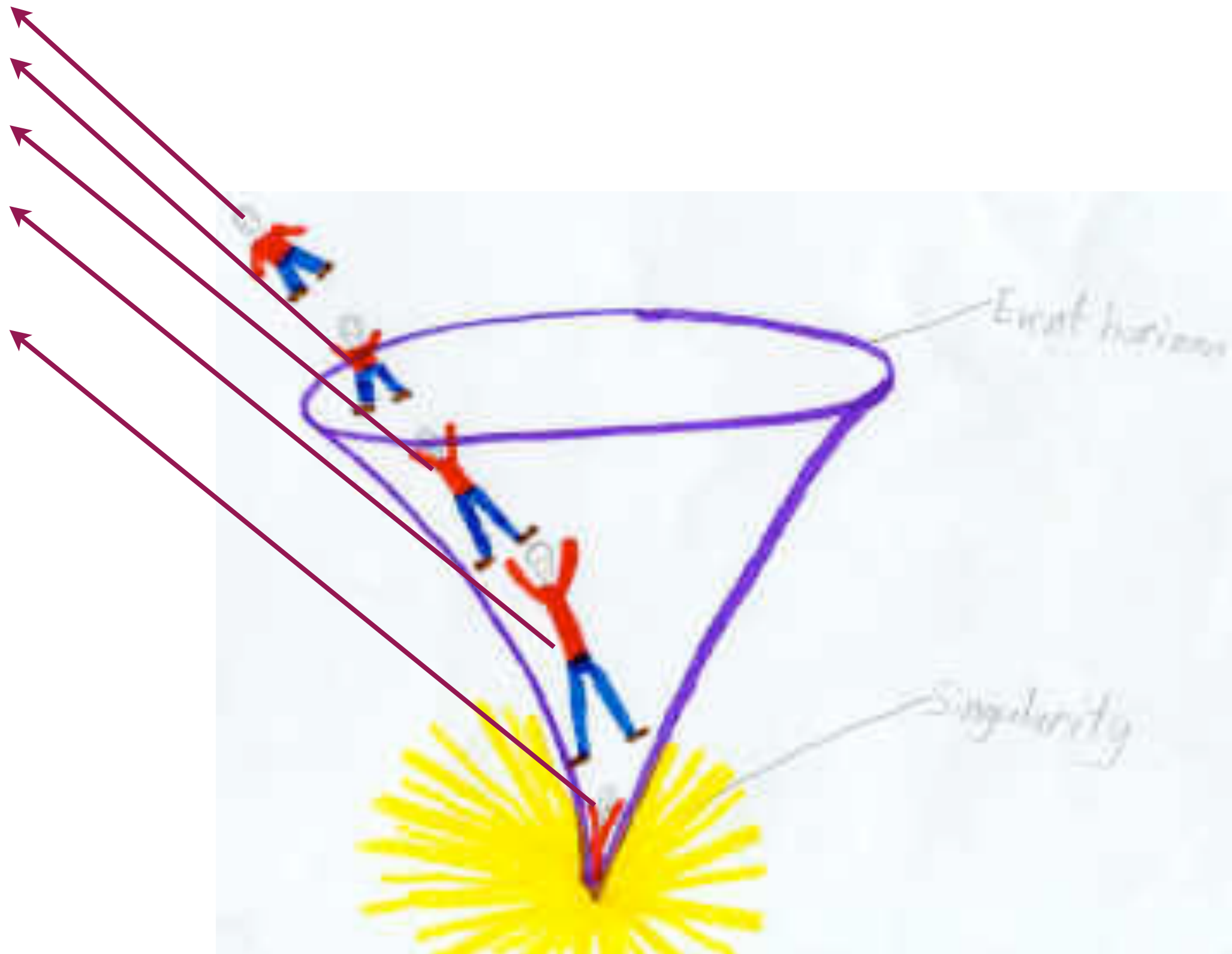


# ***BLACK HOLES SHOULD GENERATE RING OF LIGHT***

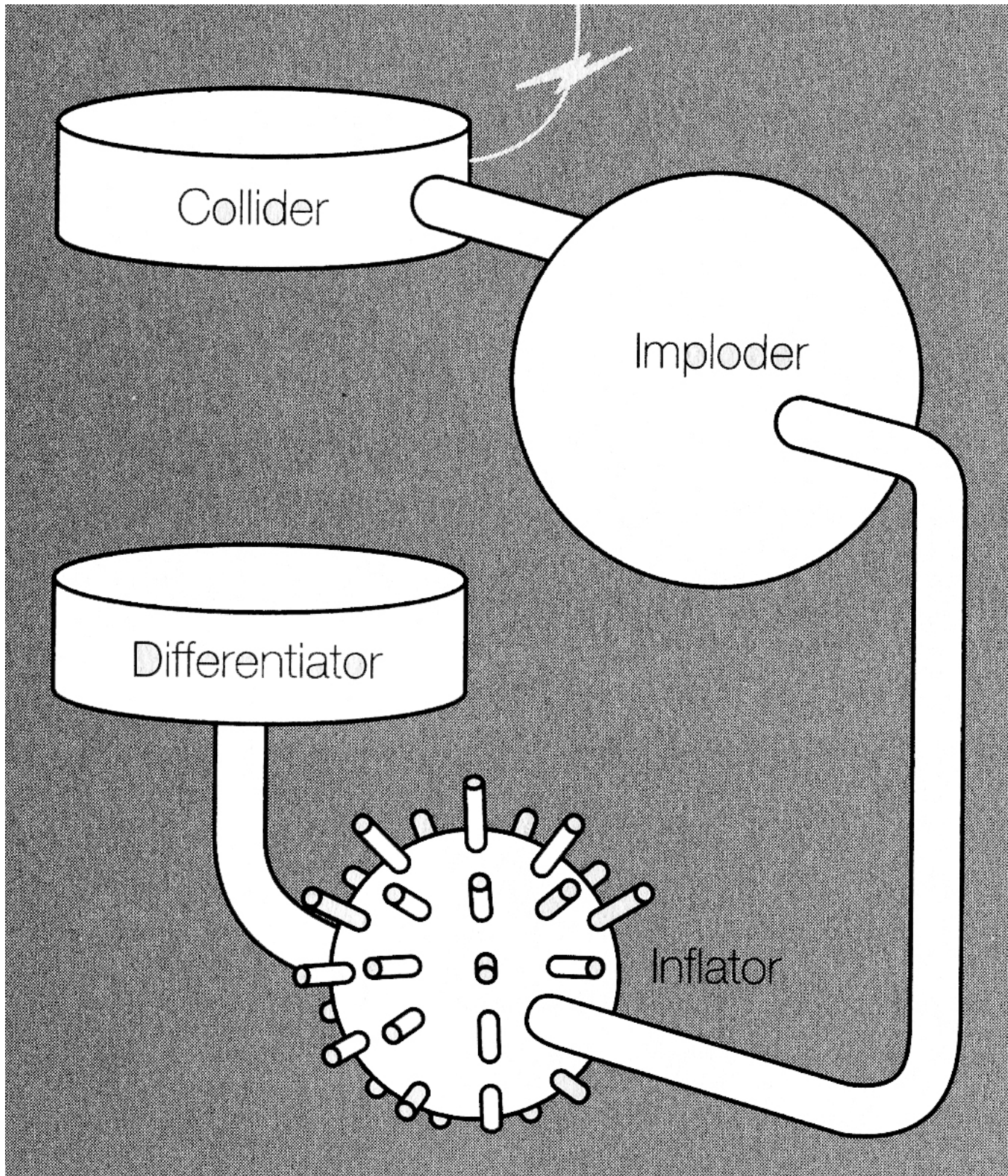


<http://www.technologyreview.com/blog/arxiv/25182/>

# FALLING INTO A BLACK HOLE



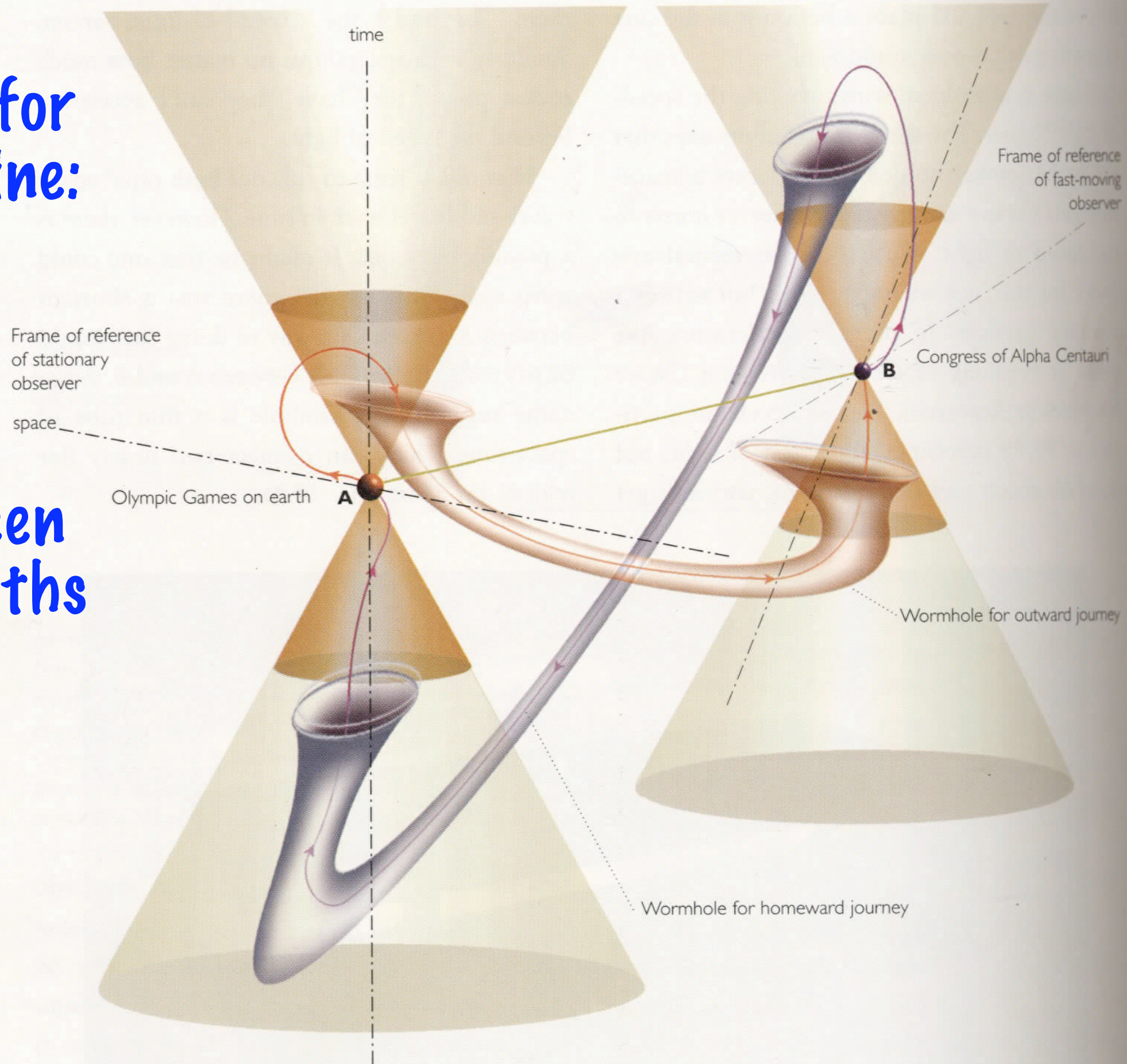




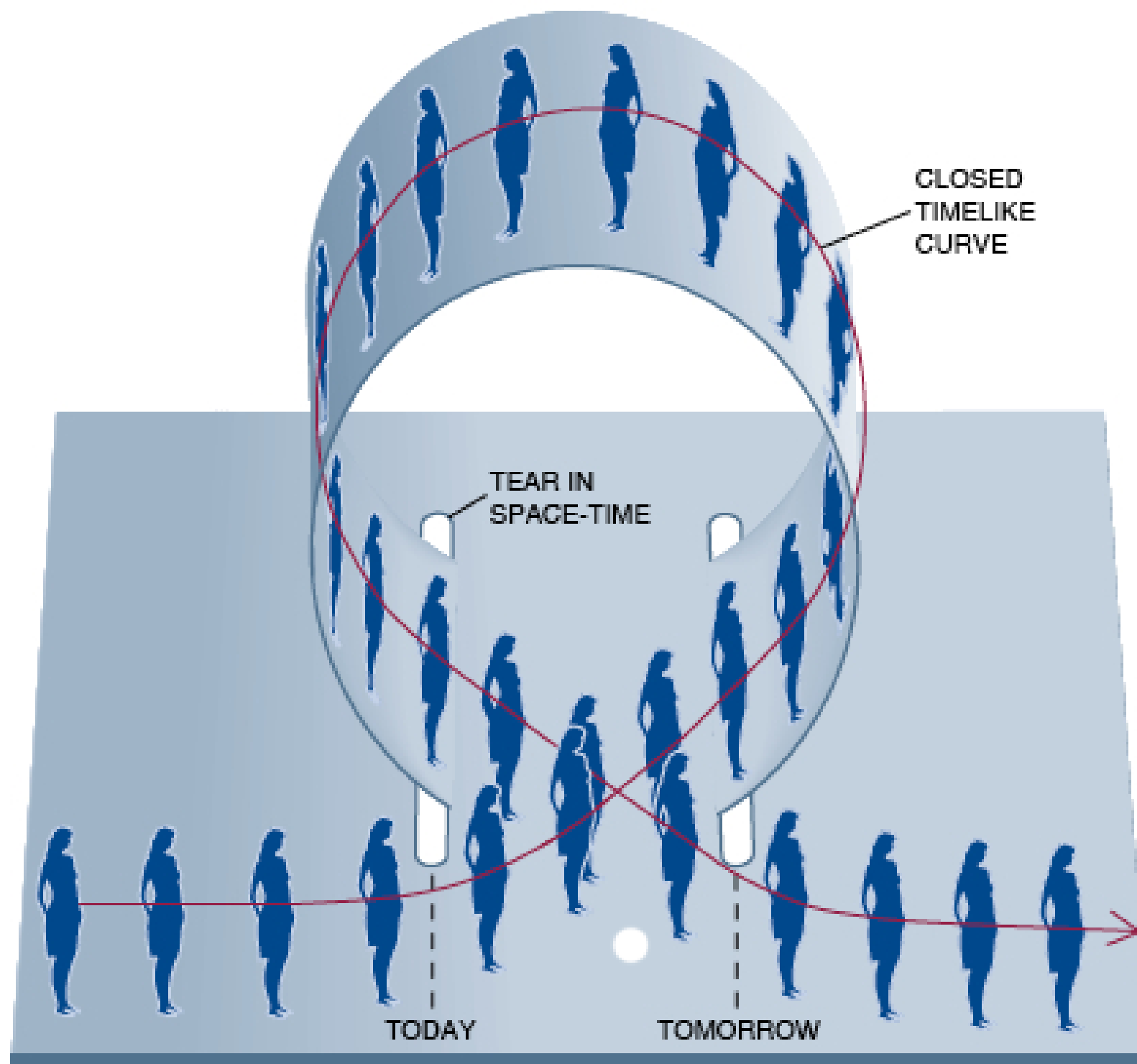
# ***HOW TO BUILD A TIME MACHINE***



**Visser's recipe for  
a time machine:  
Acquire a  
traversable  
wormhole  
Induce a "time-  
shift" between  
the two mouths  
of the  
wormhole  
Bring the  
wormhole  
mouths  
together**

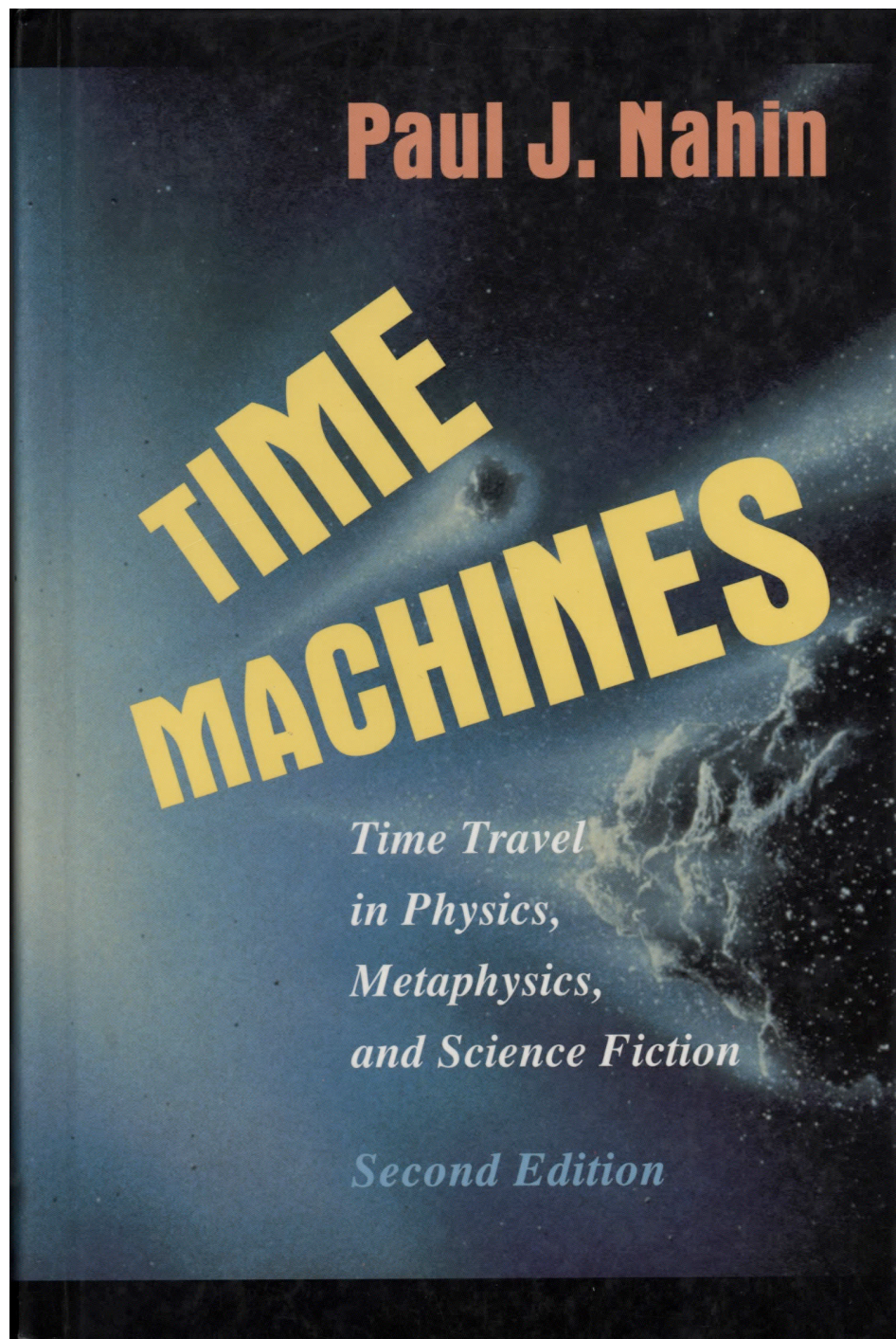






# ***CLOSED TIME- LIKE CURVES***

**CLOSED TIMELIKE CURVE** can be formed if space-time loops around. Entering such a curve tomorrow and moving forward in time, we can end up at today.



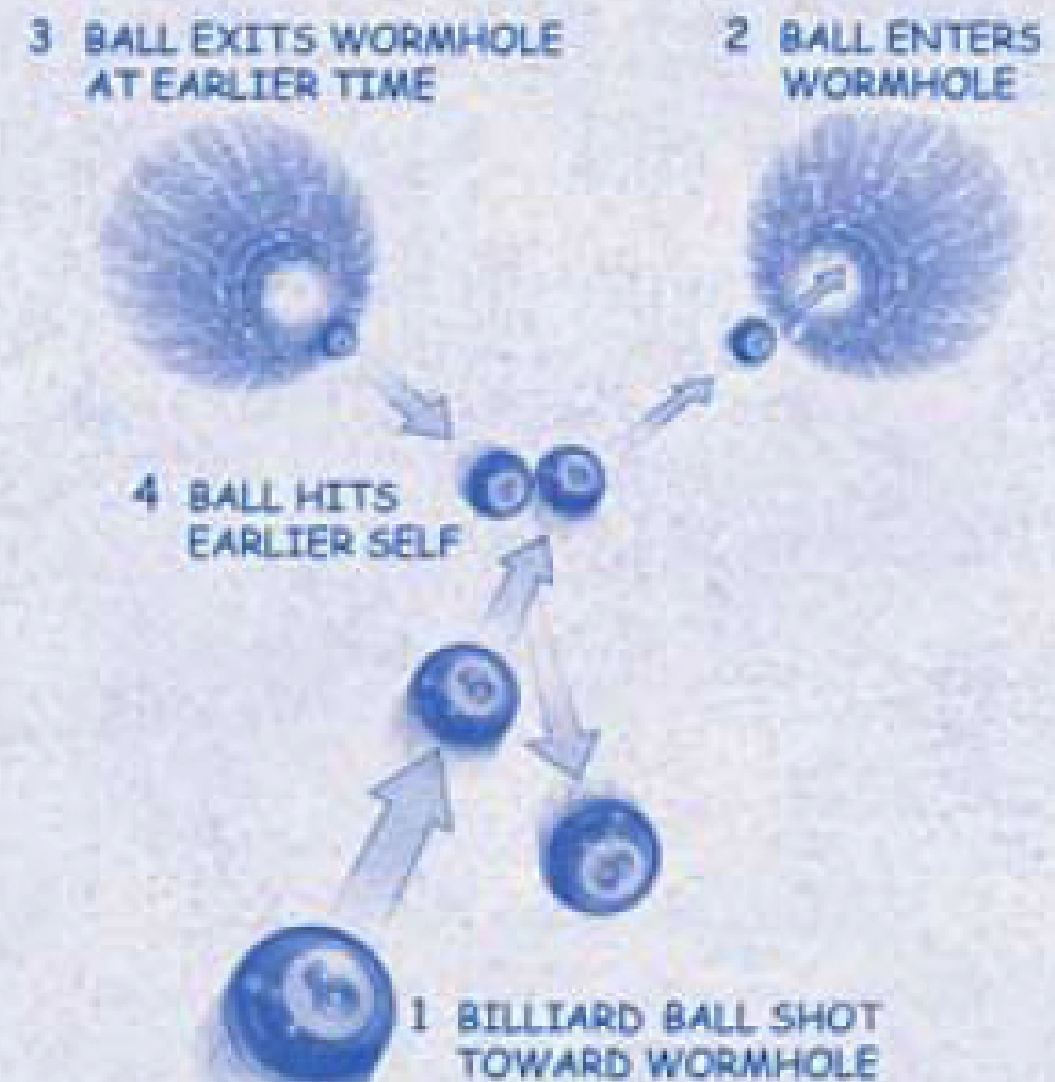
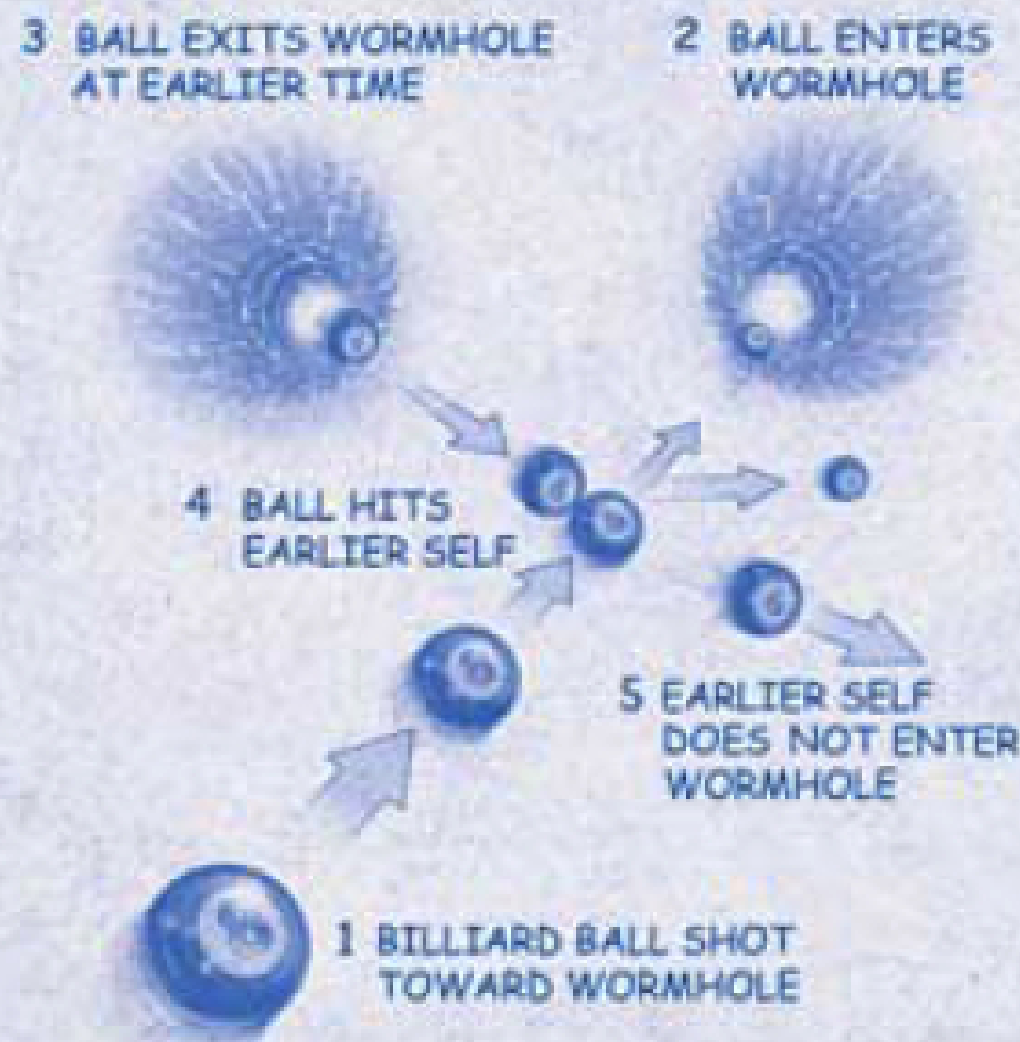
Why pick on grandfather? It seems that the only way to prove that time travel is impossible is to cite a case of killing one's own grandfather. This incessant murdering of harmless ancestors must stop. Let's see some wide-awake fan make up some other method of disproving the theory." – letter to Astounding Stories



# Mother of All Paradoxes

THE NOTORIOUS MOTHER PARADOX (sometimes formulated using other familial relationships) arises when people or objects can travel backward in time and alter the past. A simplified version involves billiard balls. A billiard ball passes through a wormhole time machine. Upon emerging, it hits its earlier self, thereby preventing it from ever entering the wormhole.

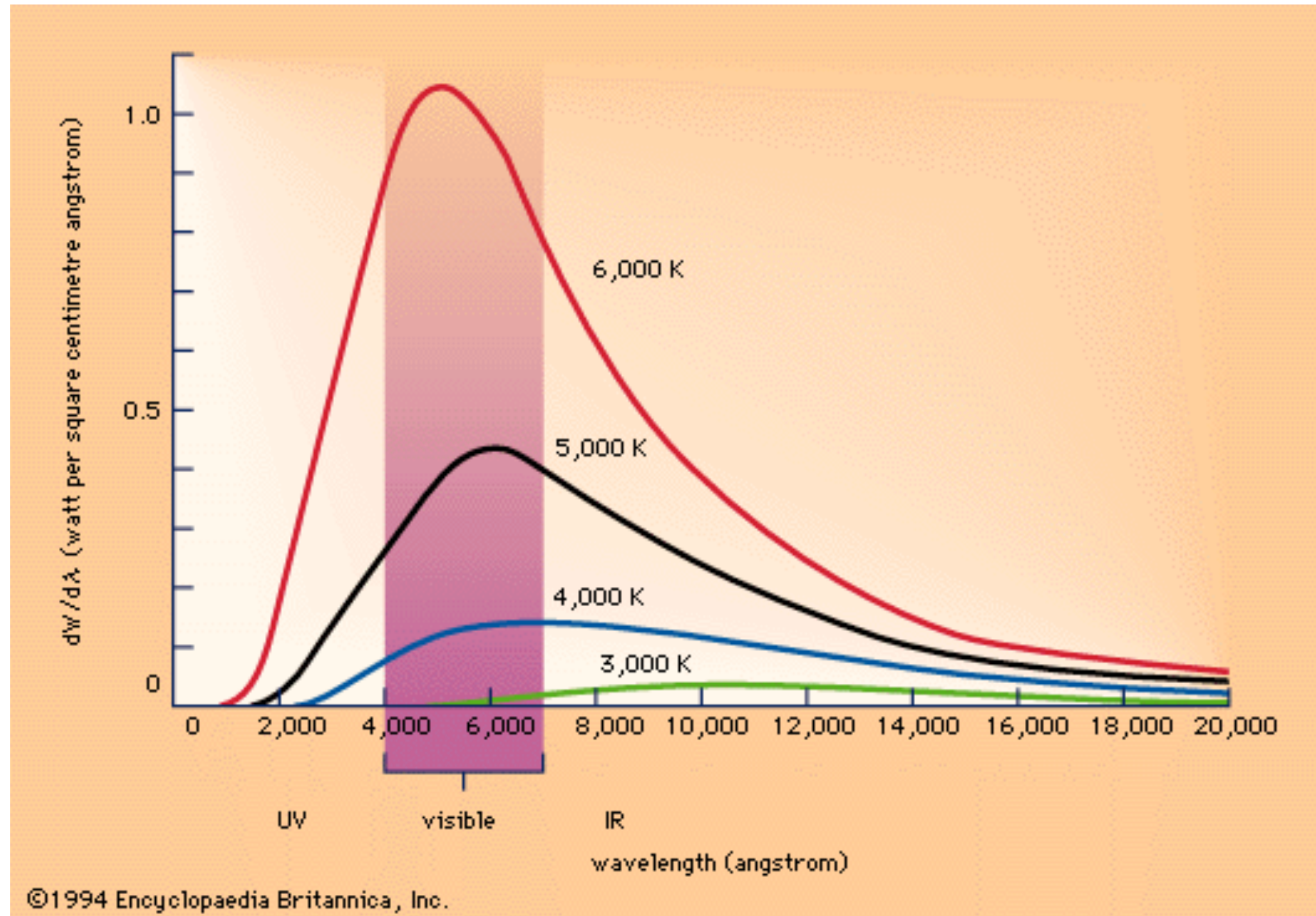
RESOLUTION OF THE PARADOX proceeds from a simple realization: the billiard ball cannot do something that is inconsistent with logic or with the laws of physics. It cannot pass through the wormhole in such a way that will prevent it from passing through the wormhole. But nothing stops it from passing through the wormhole in an infinity of other ways.



# ***QUANTUM MECHANICS***

- **Black body radiation**
- **Atoms**
- **The double slit experiment**

# BLACK BODY RADIATION

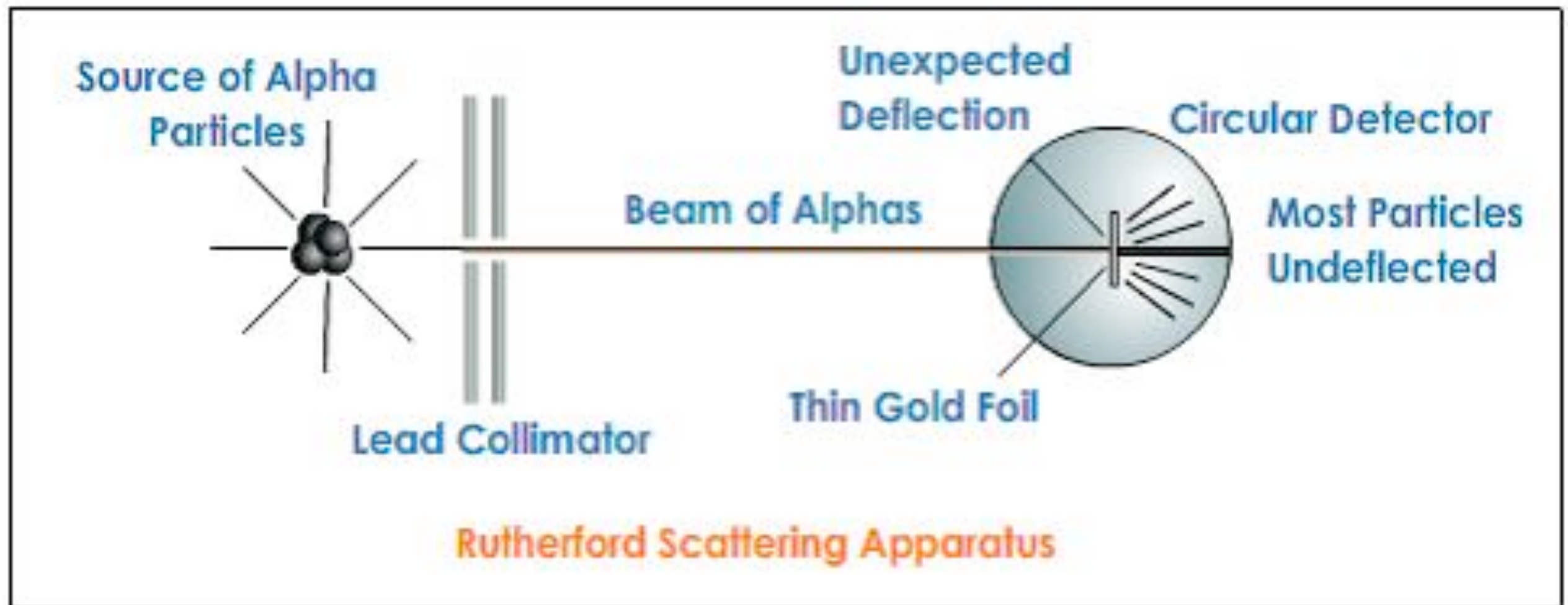


# ***NO TICKET!***

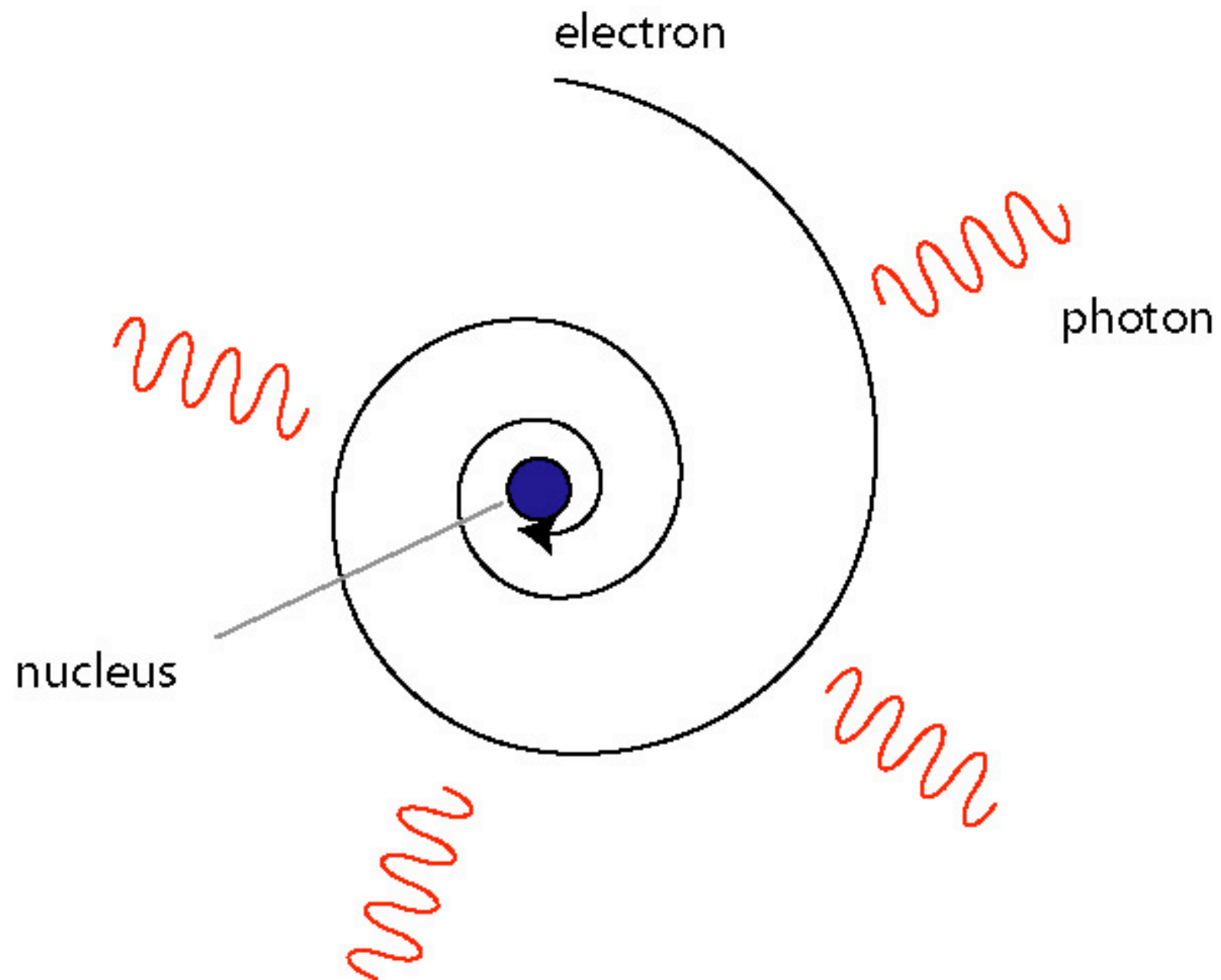




# ATOMS EXIST!

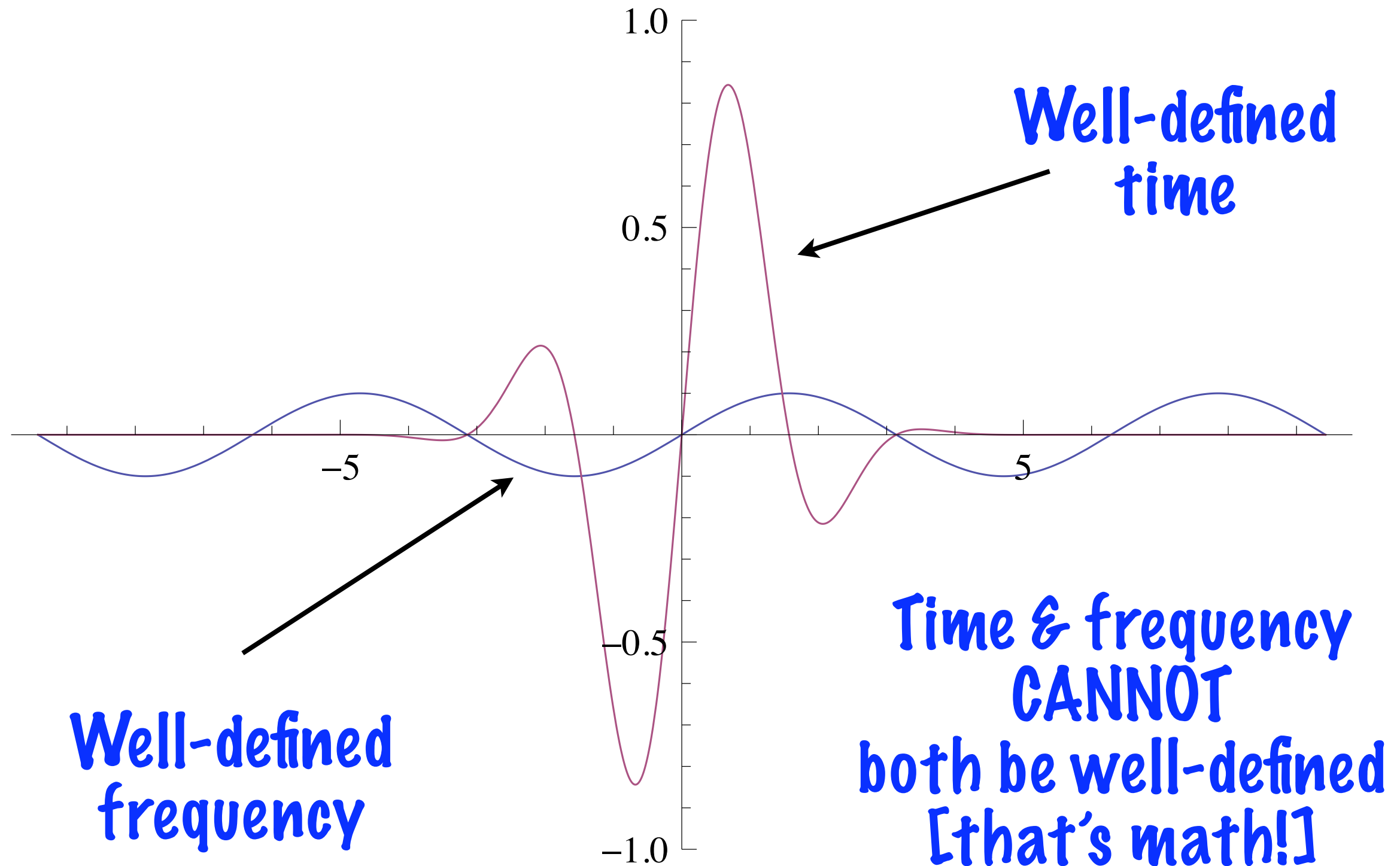


# ***BUT SHOULDN'T!***





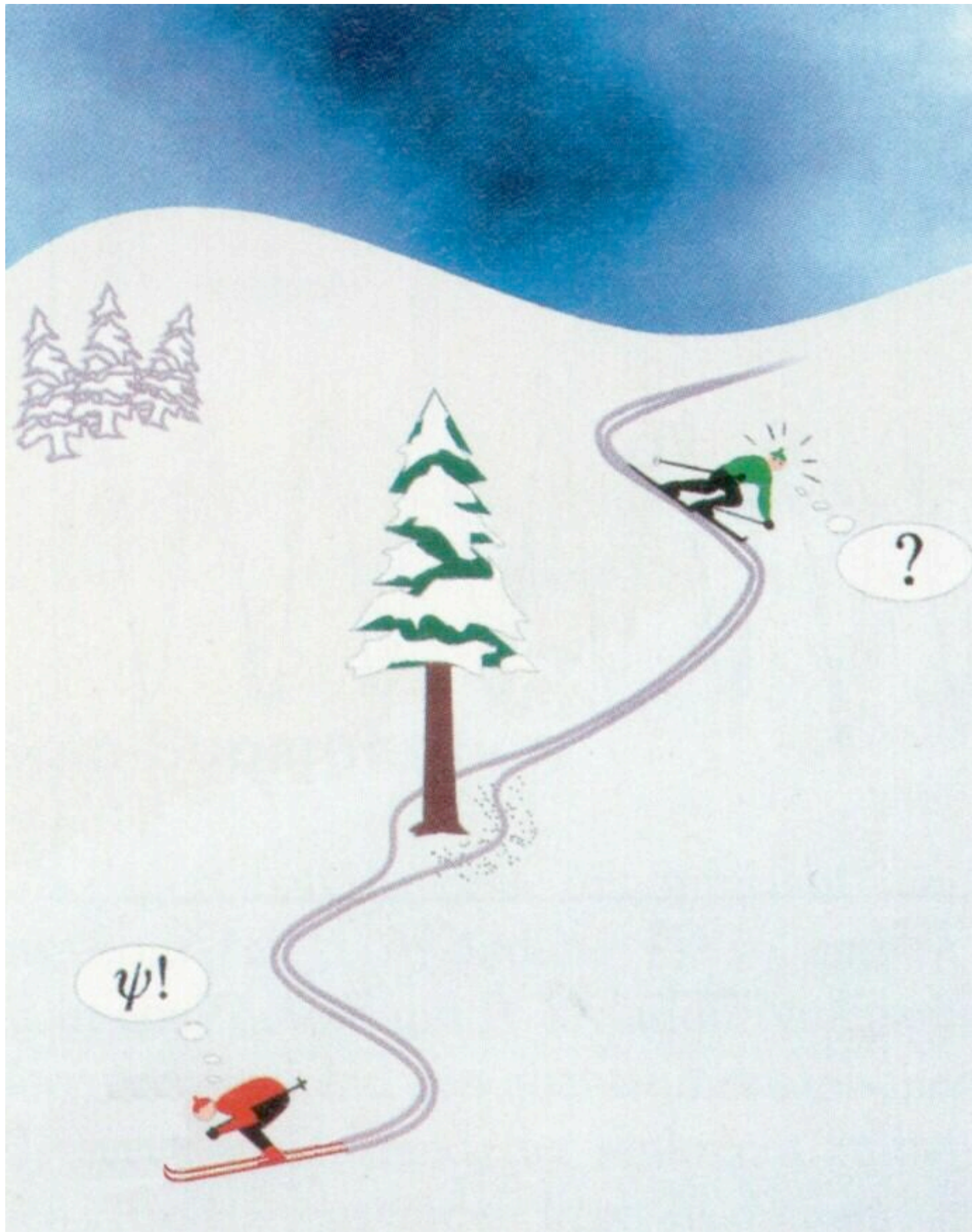
# UNCERTAINTY PRINCIPLE



# ***ELECTRON TRIES TO GET CLOSE, CAN'T***

- If far from atom pulled in
- As it gets close is squeezed up
- But then momentum builds up
- And it races out
- Atom is a balance of these two pressures.
- No uncertainty, no us!
- That's certain!

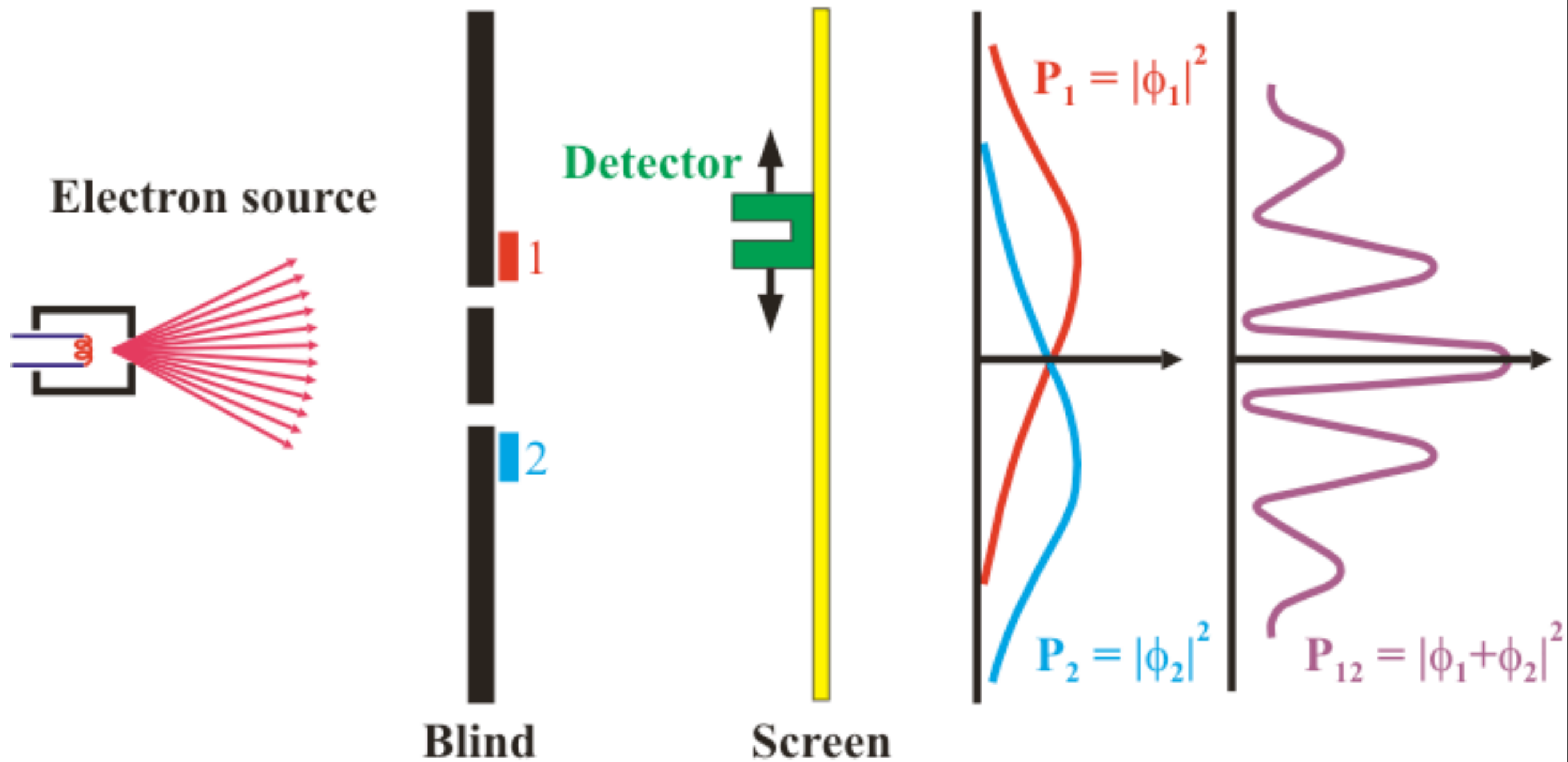




# ***DOUBLE-SLIT EXPERIMENT***

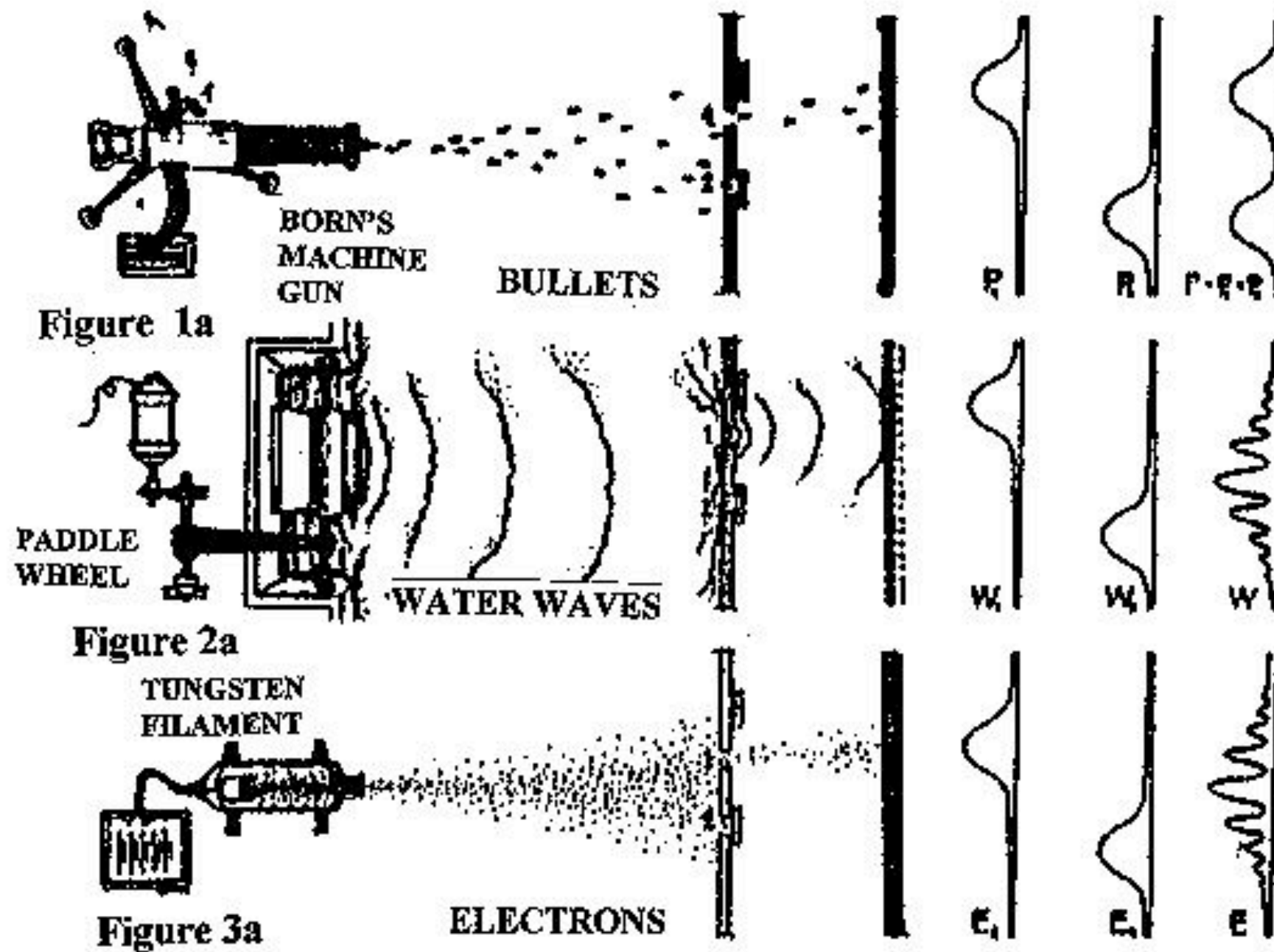
**How can you be  
in two places  
at once when  
you aren't  
anywhere at  
all? - Firesign  
Theater**

# DOUBLE SLIT EXPERIMENT

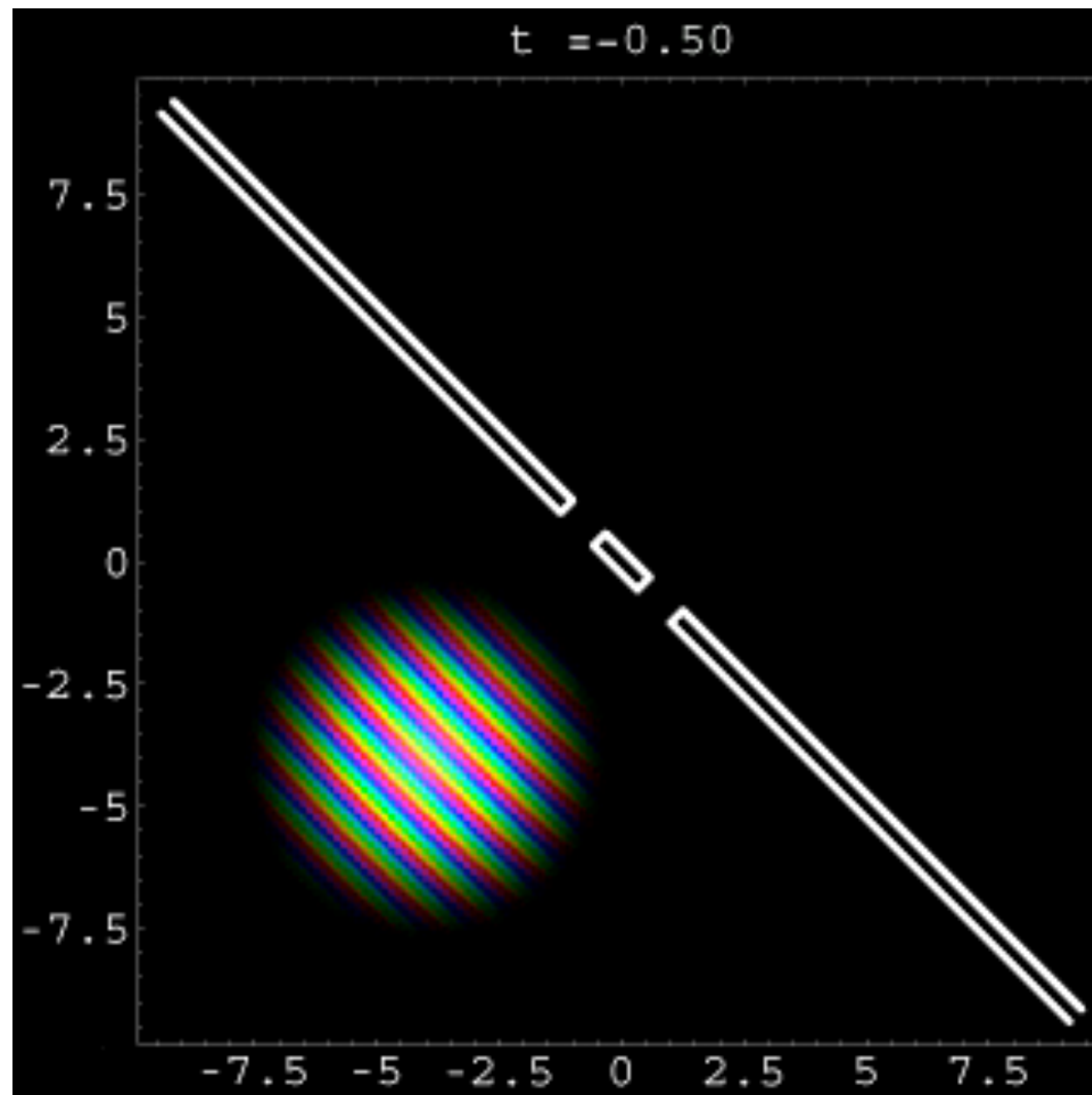




# BULLETS & WAVES

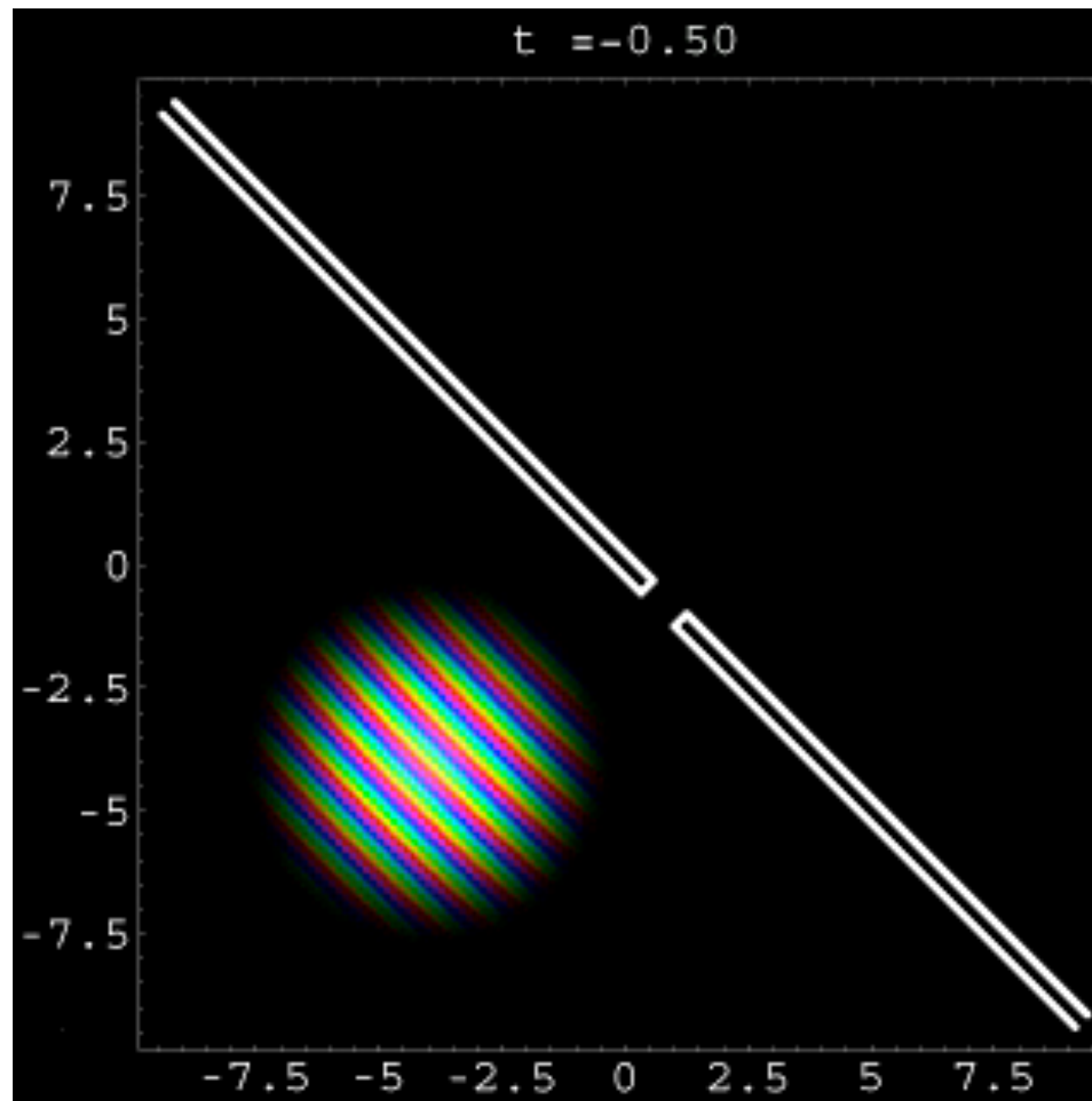


# ***DOUBLE SLIT, IN MOTION***

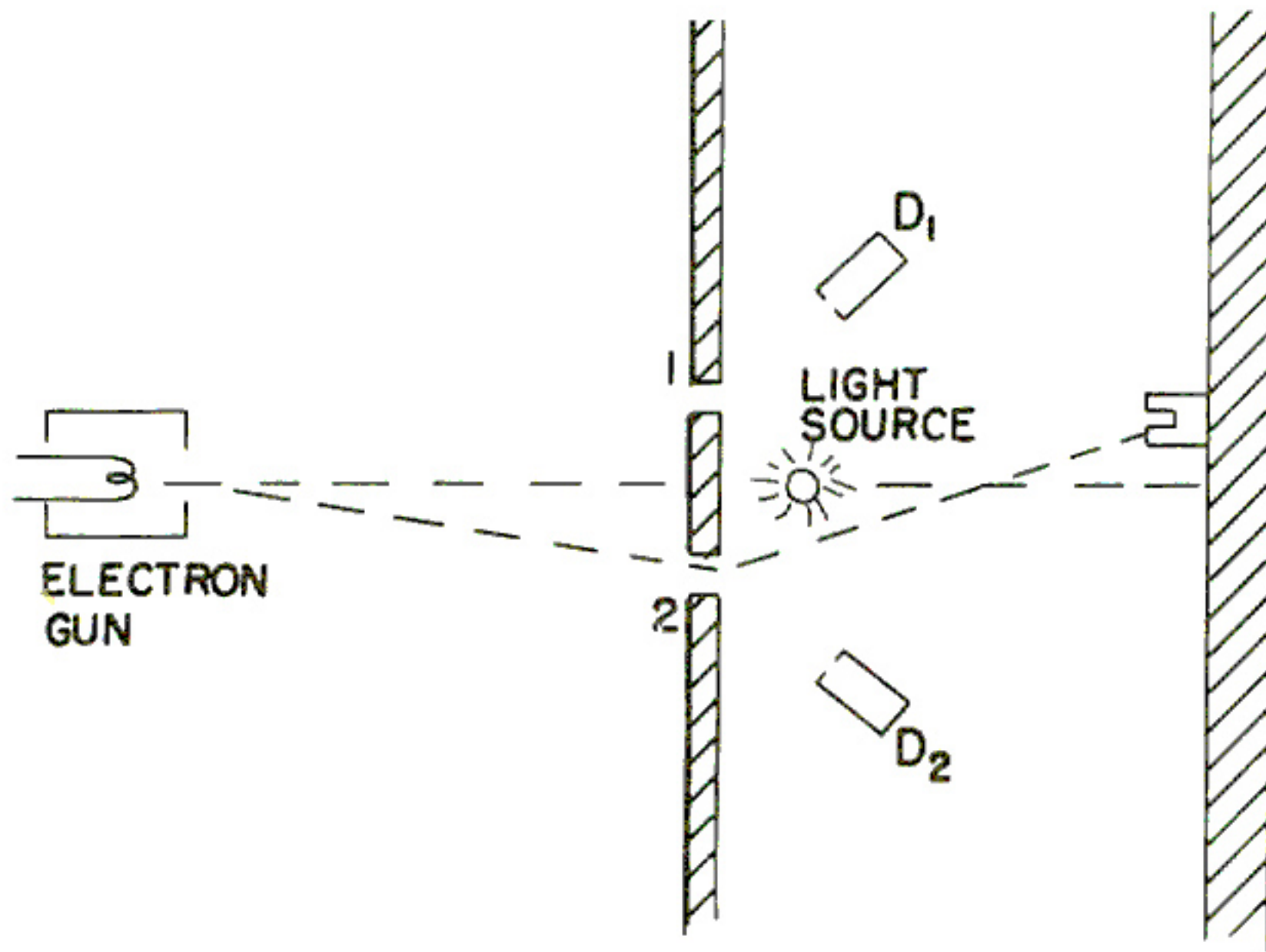




# ***SINGLE SLIT, IN MOTION***



# ***IF YOU LOOK, YOU DESTROY THE INTERFERENCE***





# RELATIVITY VS THE QUANTUM

Guess who

Niels Bohr

- Smooth
- Localized
- Predictable
- But time is dynamic



- Quantized
- Fuzzy
- Uncertain
- But time is boring

Relativity

*None of the others*

*Time a bit fuzzy*

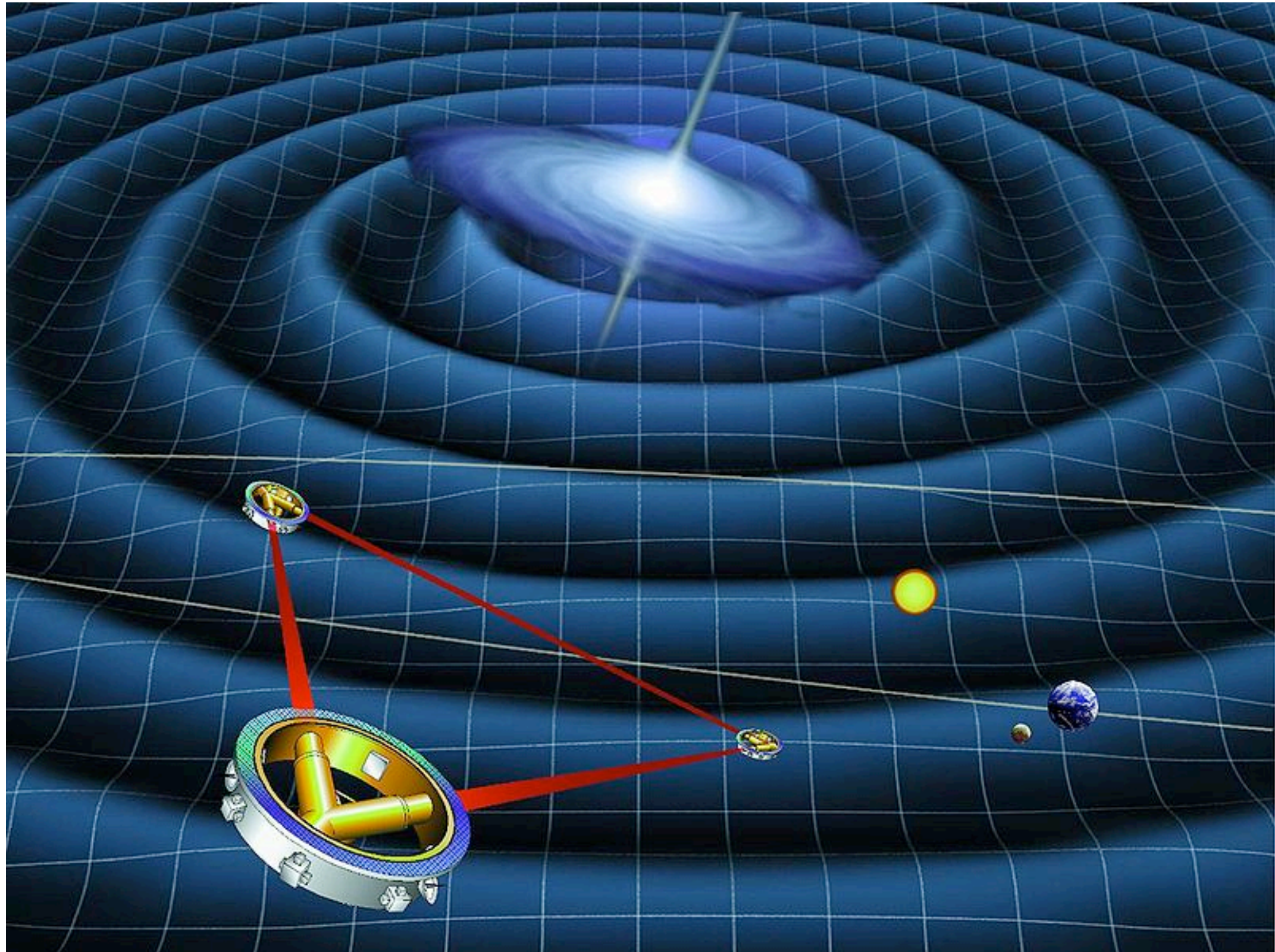
*Blend of relativity  
& quantum  
mechanics*

*Time an average over quantum fluctuations*

Quantum mechanics

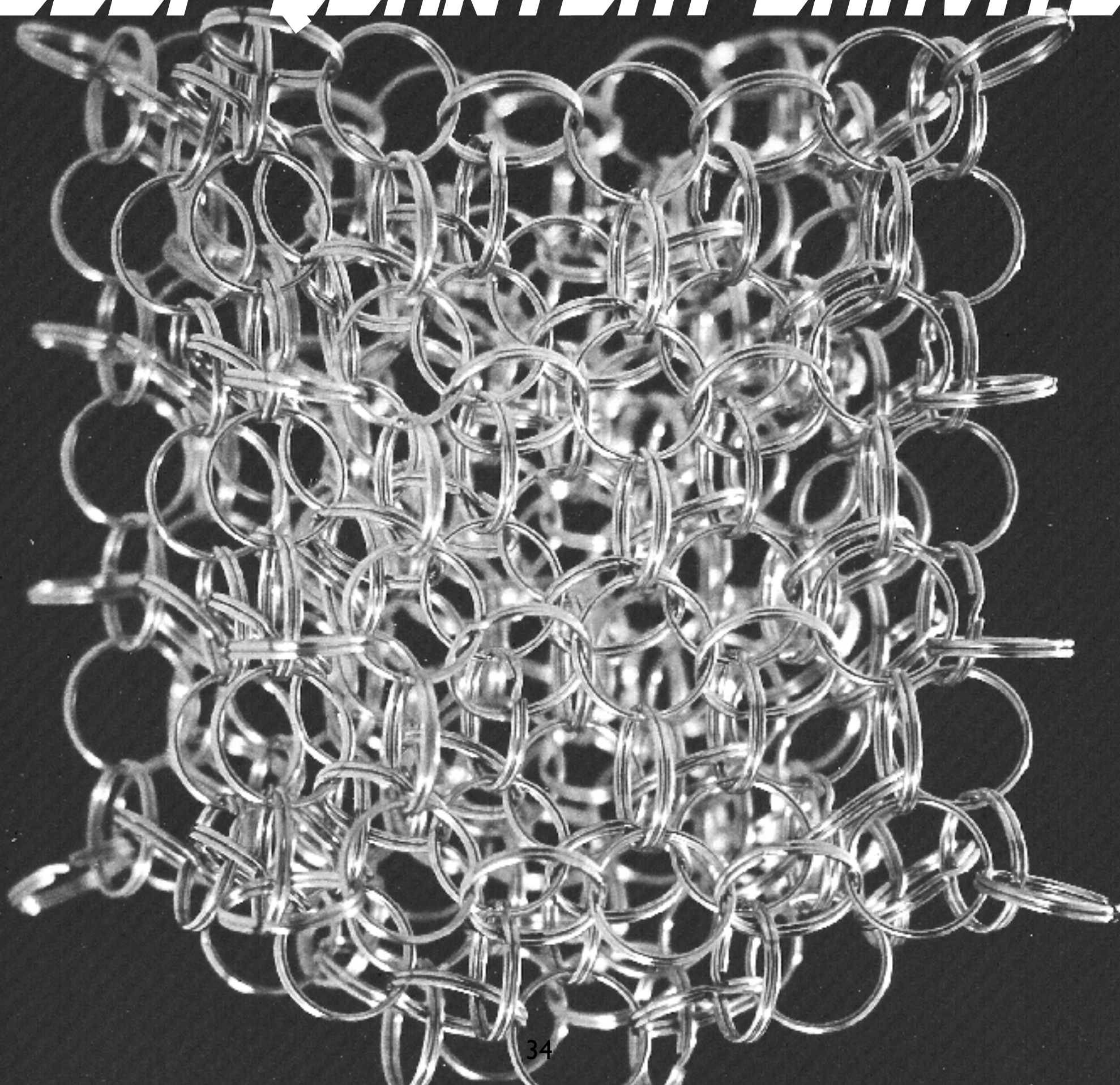


# ***GRAVITATIONAL RADIATION***





# LOOP QUANTUM GRAVITY

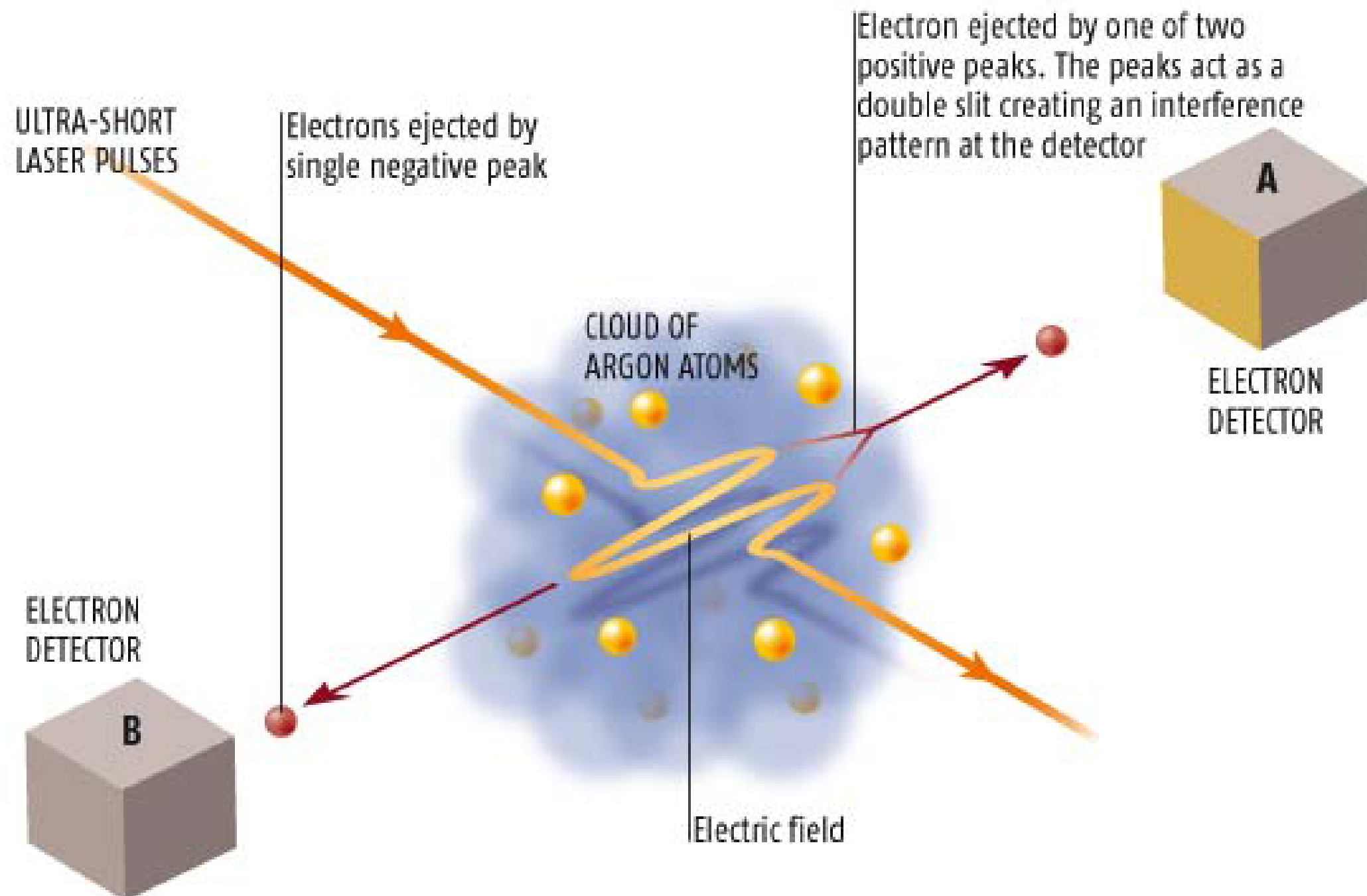




# LINDNER'S DOUBLE SLIT IN TIME

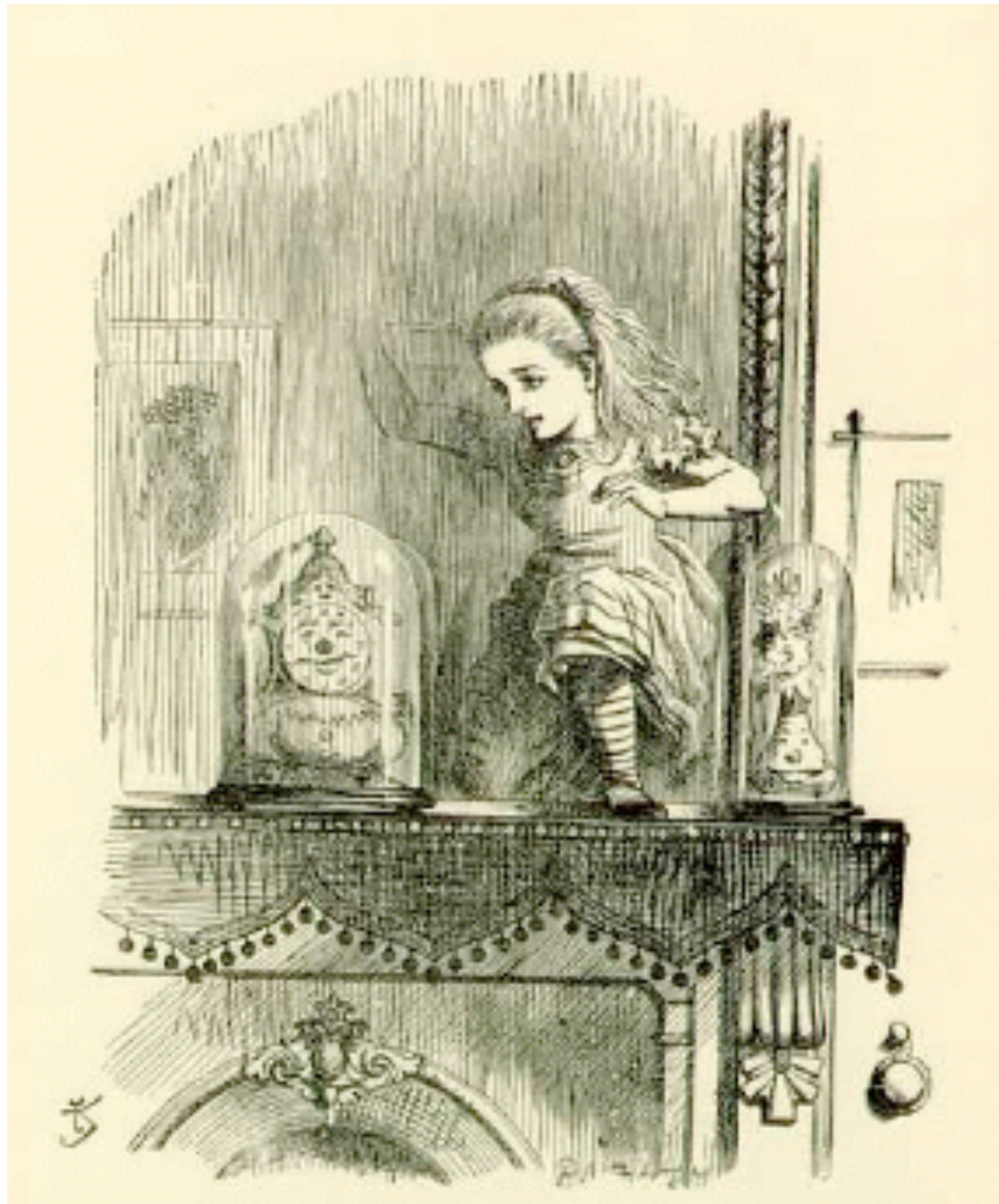
## DOUBLE SLIT IN TIME

A modern twist on a classic experiment in quantum physics



- **New Theories of Everything, Barrows**
- **From eternity to here, Sean Carroll**
- **How to build a time machine, Davies**
- **Physics of the Impossible, Kaku**
- **Time Machines, Nahin**
- **Timeless Reality, Stenger**
- **Endless Universe, Steinhardt & Turok**
- **Black Holes & Time Warps, Thorne**
- **The New Time Travelers, Toomey**





I have no doubt that in reality the future will be vastly more surprising than anything I can imagine. Now my own suspicion is that the universe is not only queerer than we suppose, but queerer than we can suppose. – J. B. S. Haldane

[www.timeandquantummechanics.com](http://www.timeandquantummechanics.com)