NEW PHYSICS AND HYPERCOMPUTATION

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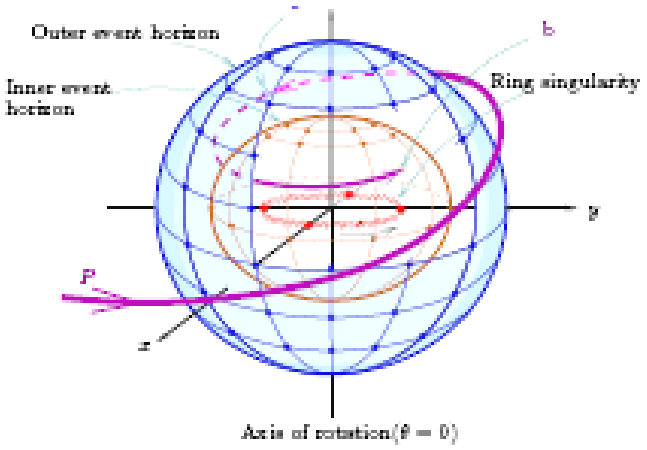
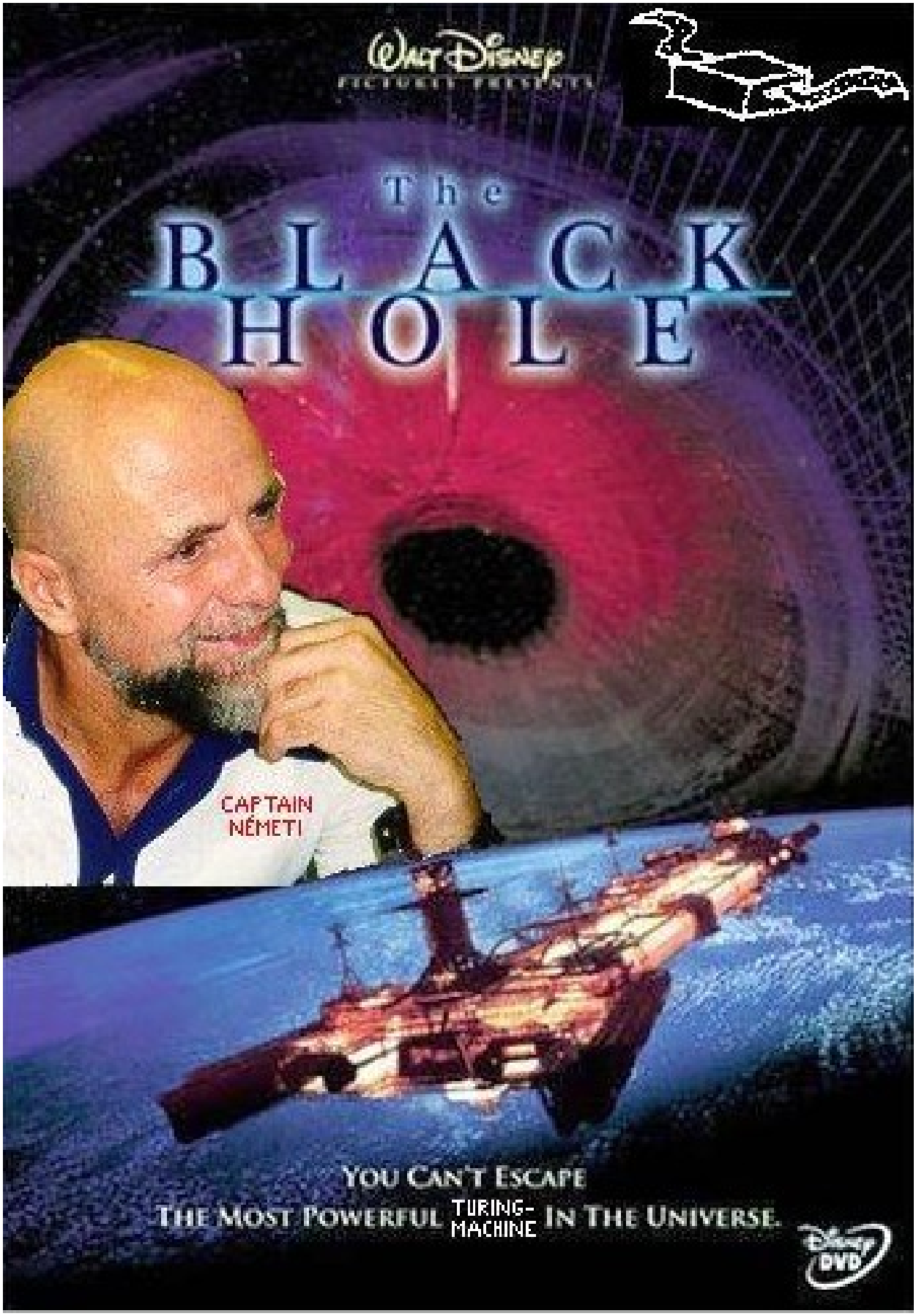
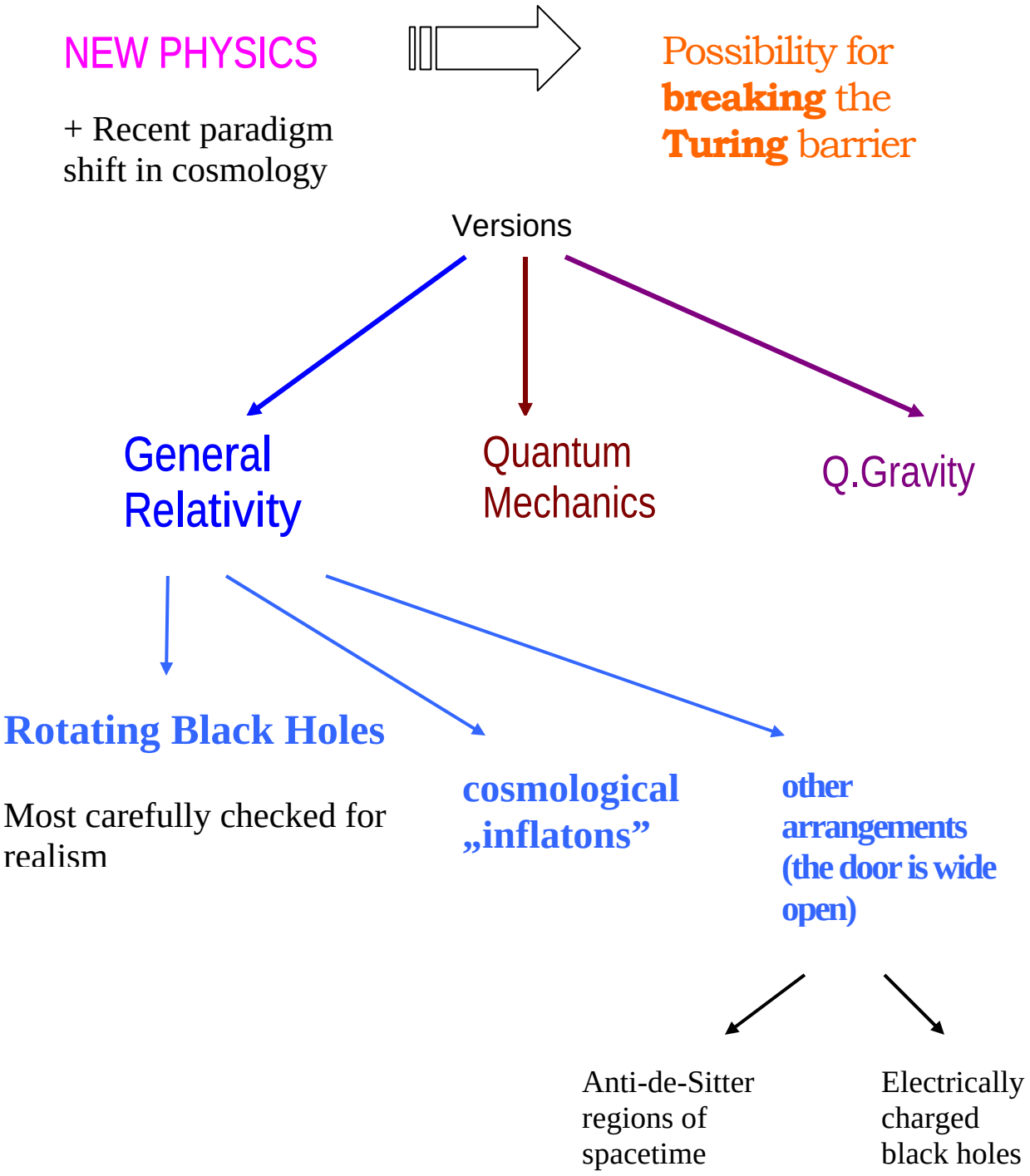
Extended abstract:
http://ftp.math-inst.hu/pub/algebraic-logic/sofsem06abstract.pdf

Cf. also
http://ftp.math-inst.hu/pub/algebraic-logic/beyondturing.pdf




Walt Disney
Pictures Presents
The
BLACK
HOLE
CAPTAIN
NÉMETI
You Can't Escape
The Most Powerful TURING-MACHINE In The Universe.
Disney DVD


NEW PHYSICS
+ Recent paradigm shift in cosmology
Possibility for breaking the Turing barrier
Versions
General Relativity
Quantum Mechanics
Q.Gravity
Rotating Black Holes
Most carefully checked for realism
cosmological „inflatons”
other arrangements (the door is wide open)
Anti-de-Sitter regions of spacetime
Electrically charged black holes

Clockwork Universe ⟺ **"Feedback Universe"**

"Mechanical"
"Newtonian world-view"

Living Universe
Last 10 years of cosmology
Lee Smolin

Barry Cooper — **Emergence**

Cybernetics
System Theory

Jiri Wiedermann
Jan van Leeuwen

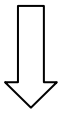
AI, Internet, Open Systems

Tangible,
hard experimental data

Revolution in cosmology

Church Thesis was formulated in the pre-relativistic (Newtonian) worldview

Turing Machine concept incorporates "ABSOLUTE TIME"



Believable that after General Relativity (GR) breaking Turing barrier becomes conceivable.

GR ⇨ you can manipulate time (just like space)

Kurt Gödel was fascinated with this feature.

New freedom (handle on the problem):

We can manipulate time in GR.
(Already in SR. But that is not enough.)

Fourth dimension: “moving in time”

Boldly: Assume for a second (only!!!) that time travel exists.

Time travel → Beyond Turing computer.

Less boldly: Instead of time travel use **huge rotating black holes** (observed).

Restrict attention for **concreteness**

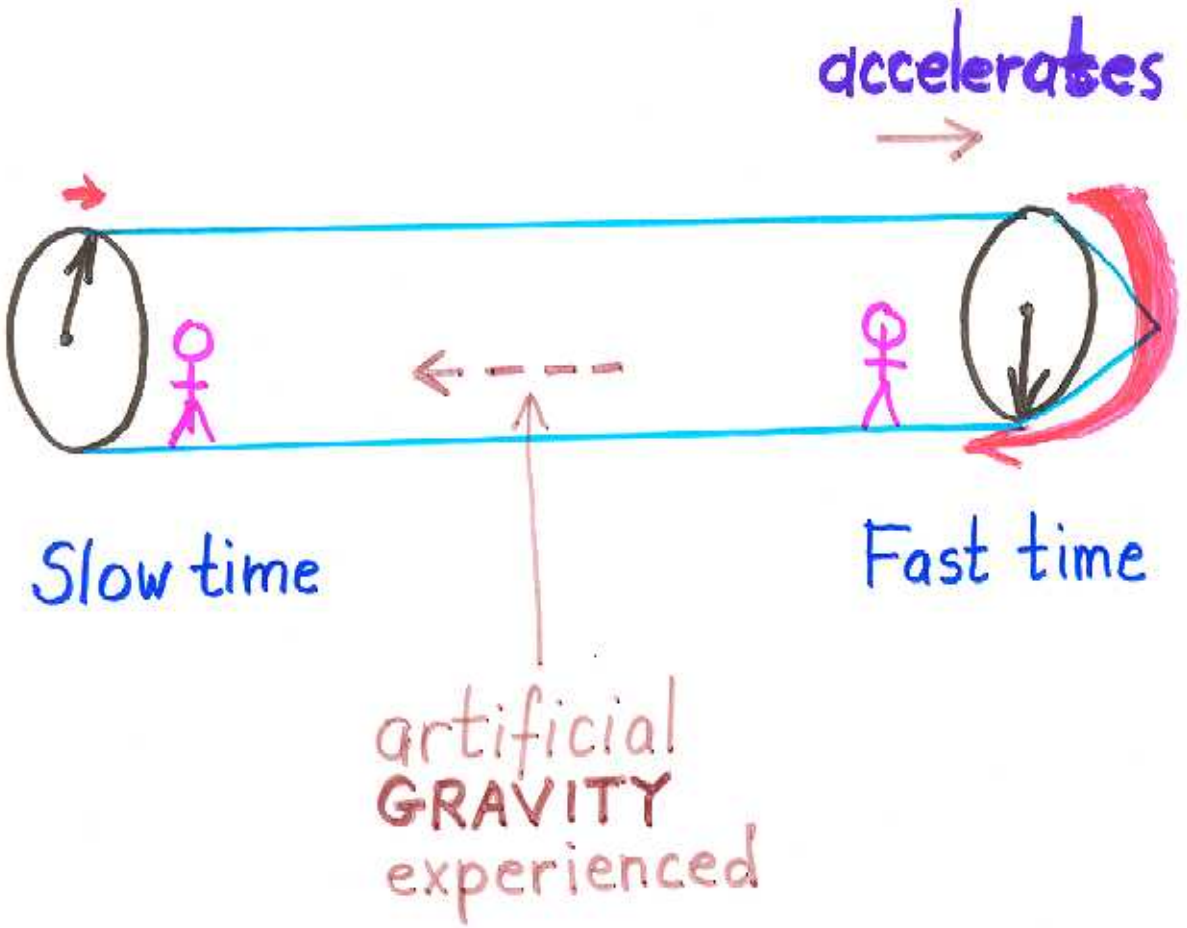
--- task: **deciding recursively enumerable sets.** E.g. the task is deciding all theorems of FOL. Or deciding whether ZF set theory is consistent.

--- tools: **huge rotating black holes**. Astronomical evidence exists for this, cf. Internet under “spin of black hole”. Other (than BH) relativistic hypercomputers: anti de Sitter spacetime, inflatons, quintessence.

Part II

General outline of the Thought Experiment (Hypercomputation).
Details come later.

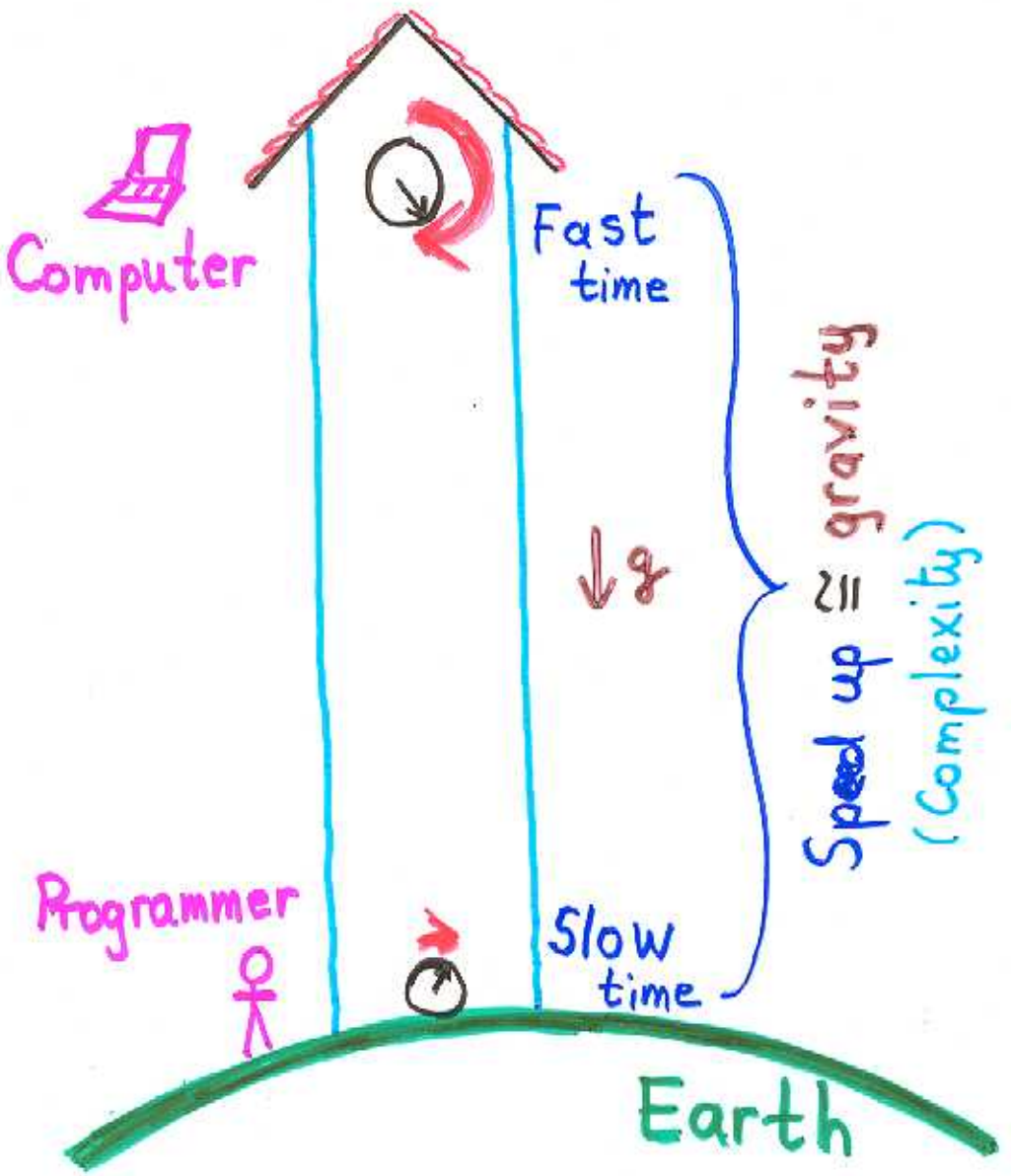
Key Ingredient: (SR Time Warp)



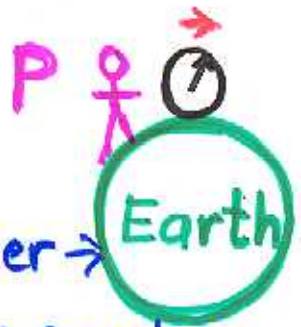
A THEOREM of Special Relativity (SR)
(easily proved in first-order logic version of SR)

TIME WARP (Tower Paradox, effects of gravity on time)

CLOCKS HIGHER in a GRAVITATIONAL WELL TICK FASTER



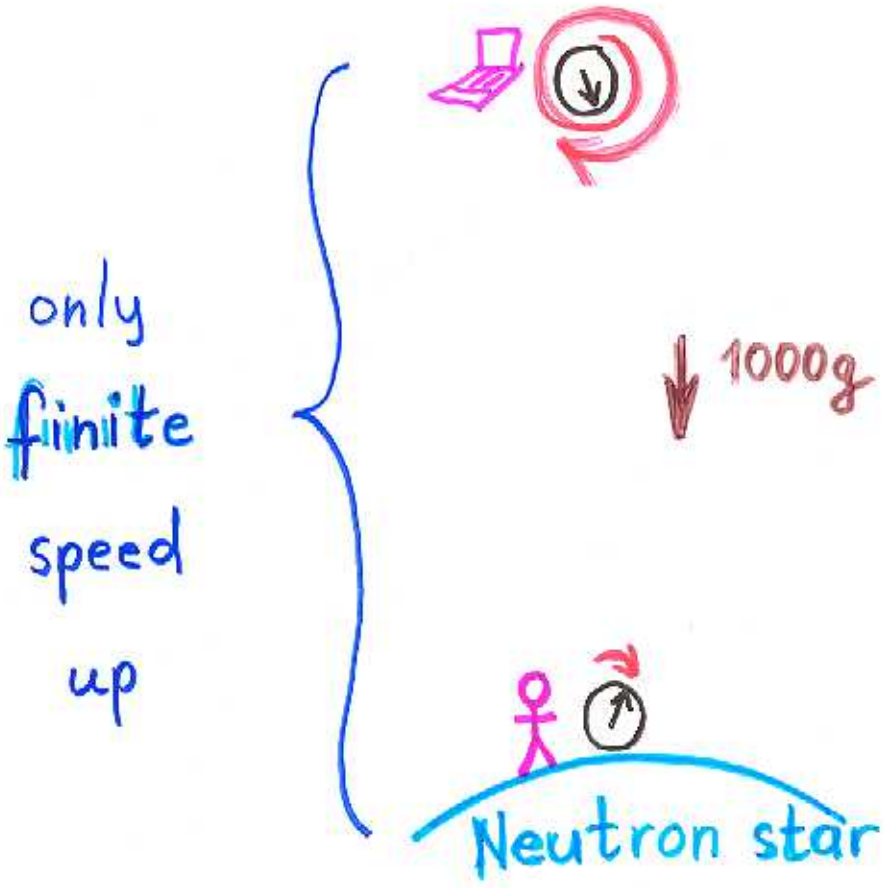
GPS
general positioniag system

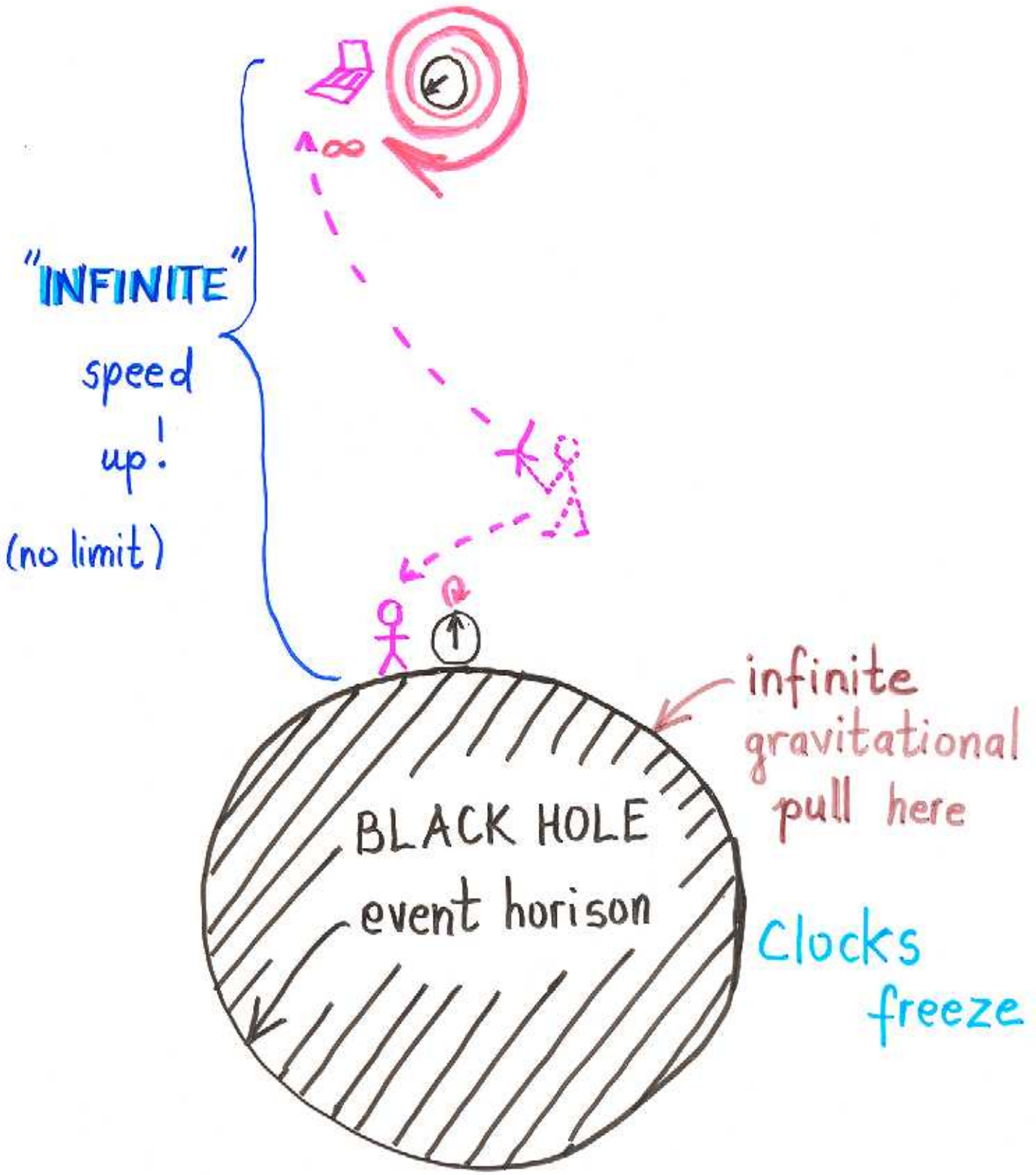


the heavier → the bigger speed up effect we get

Increase the effect:

THOUGHT EXPERIMENT for fast computation: The programmer "throws" his slave-computer to a high orbit. Communicates via radio.


only
finite
speed
up
1000g
Neutron star



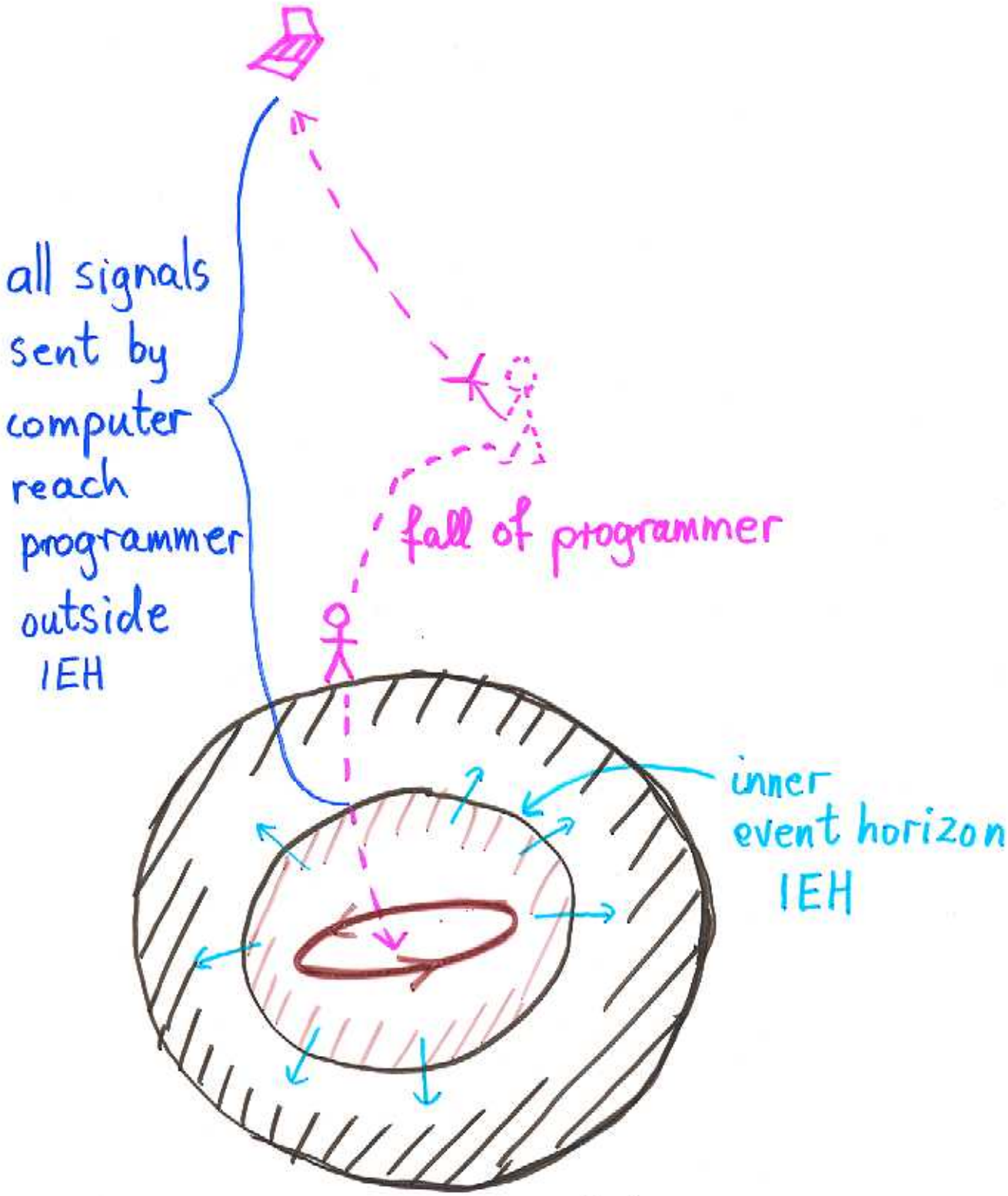
Programmer's view
Computer's view

Survive tidal forces? → Huge black hole
(practically no tidal forces, no spaghettifying!)

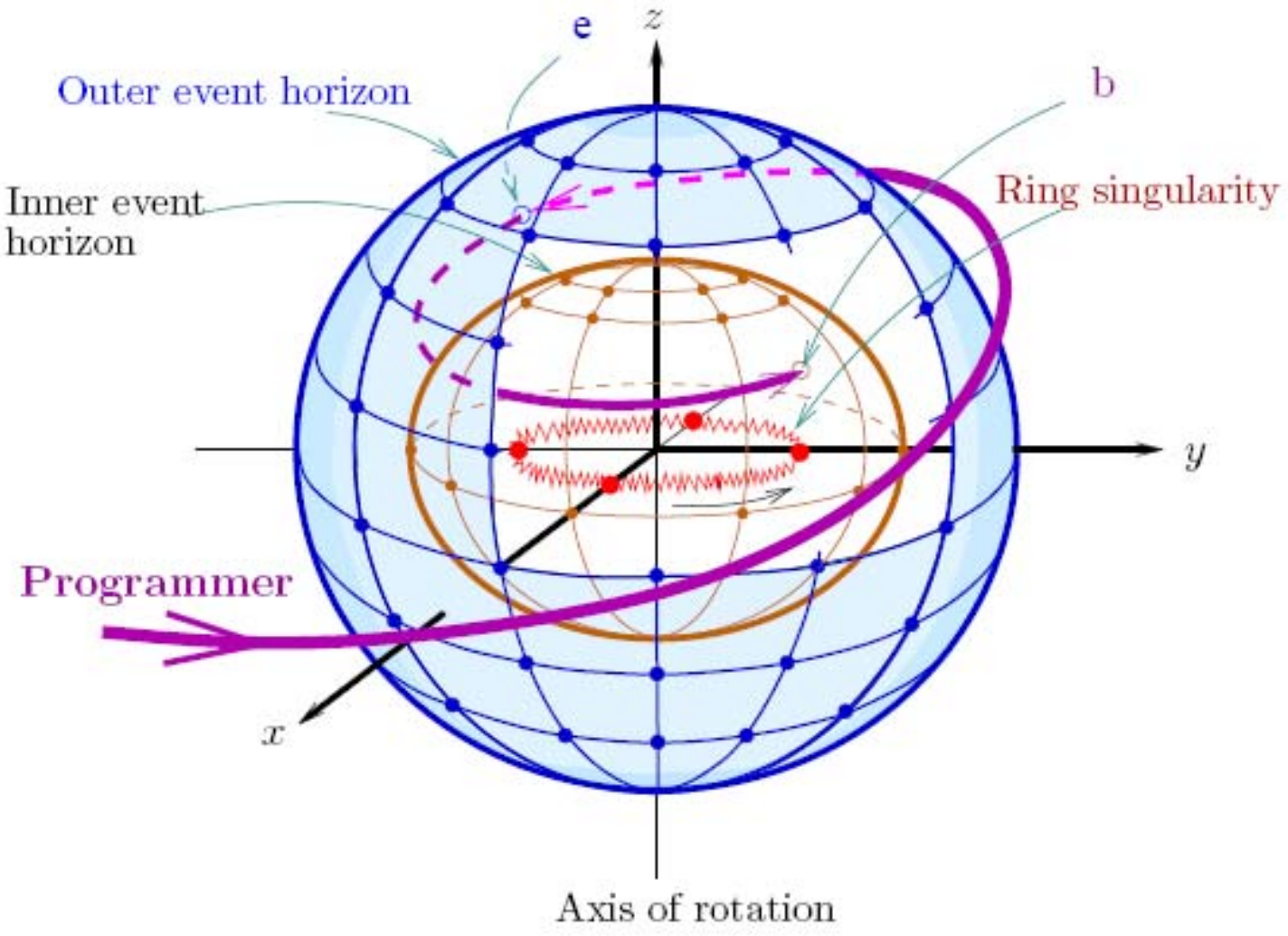
Problem: Enough time for enjoying having received the result.

Needed: cushioning effect, i.e. repellent force. A second effect counter-acting gravitation.

Plenty of solutions for this, e.g. rotating BH (centrifugal force for cushion) or electrostatic repulsion



Rotating Black Hole
has 2 event horizons
Programmer can survive forever.
(Ring singularity can be avoided.)

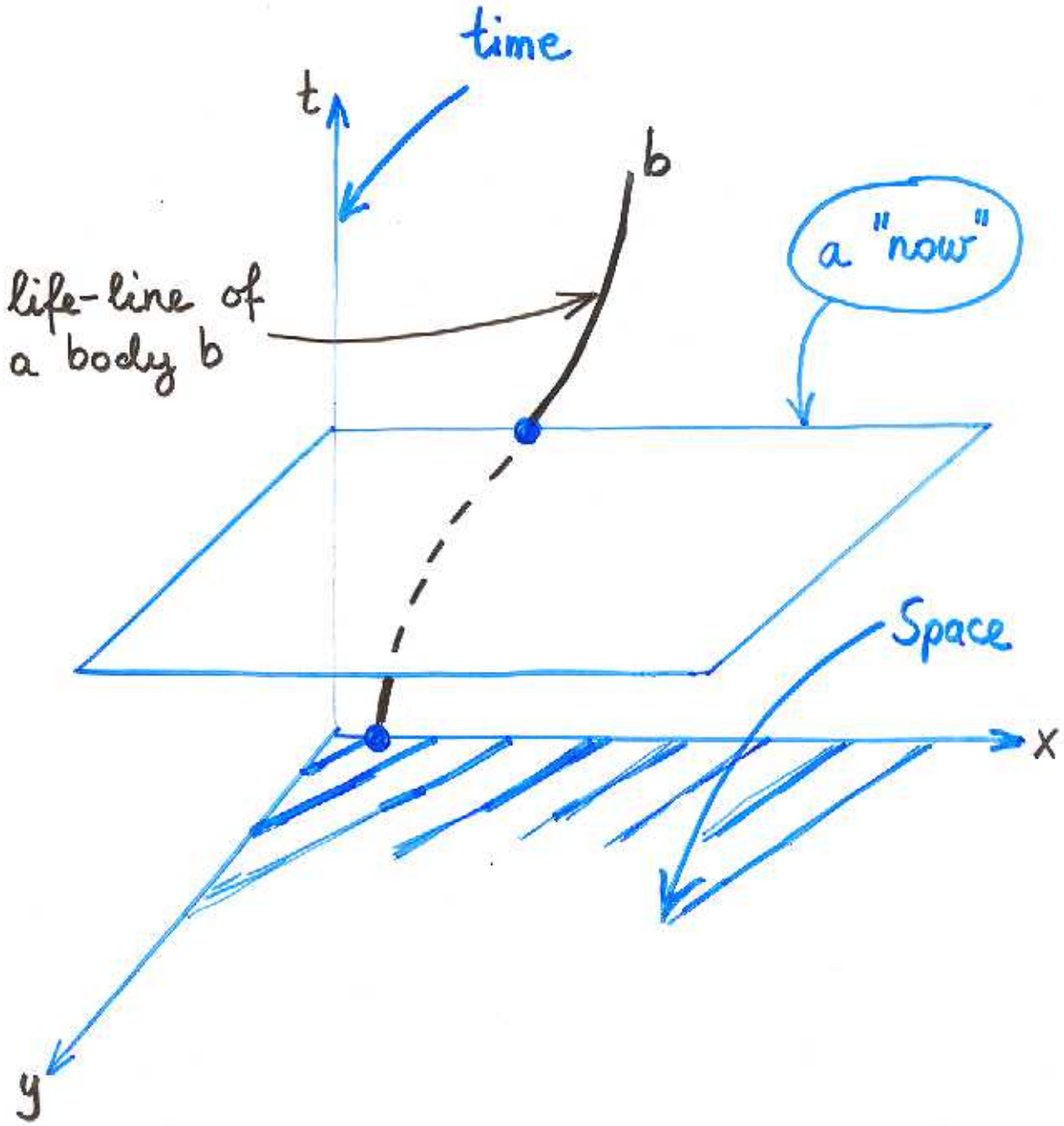

e
z
Outer event horizon
b
Inner event
horizon
Ring singularity
y
Programmer
x
Axis of rotation

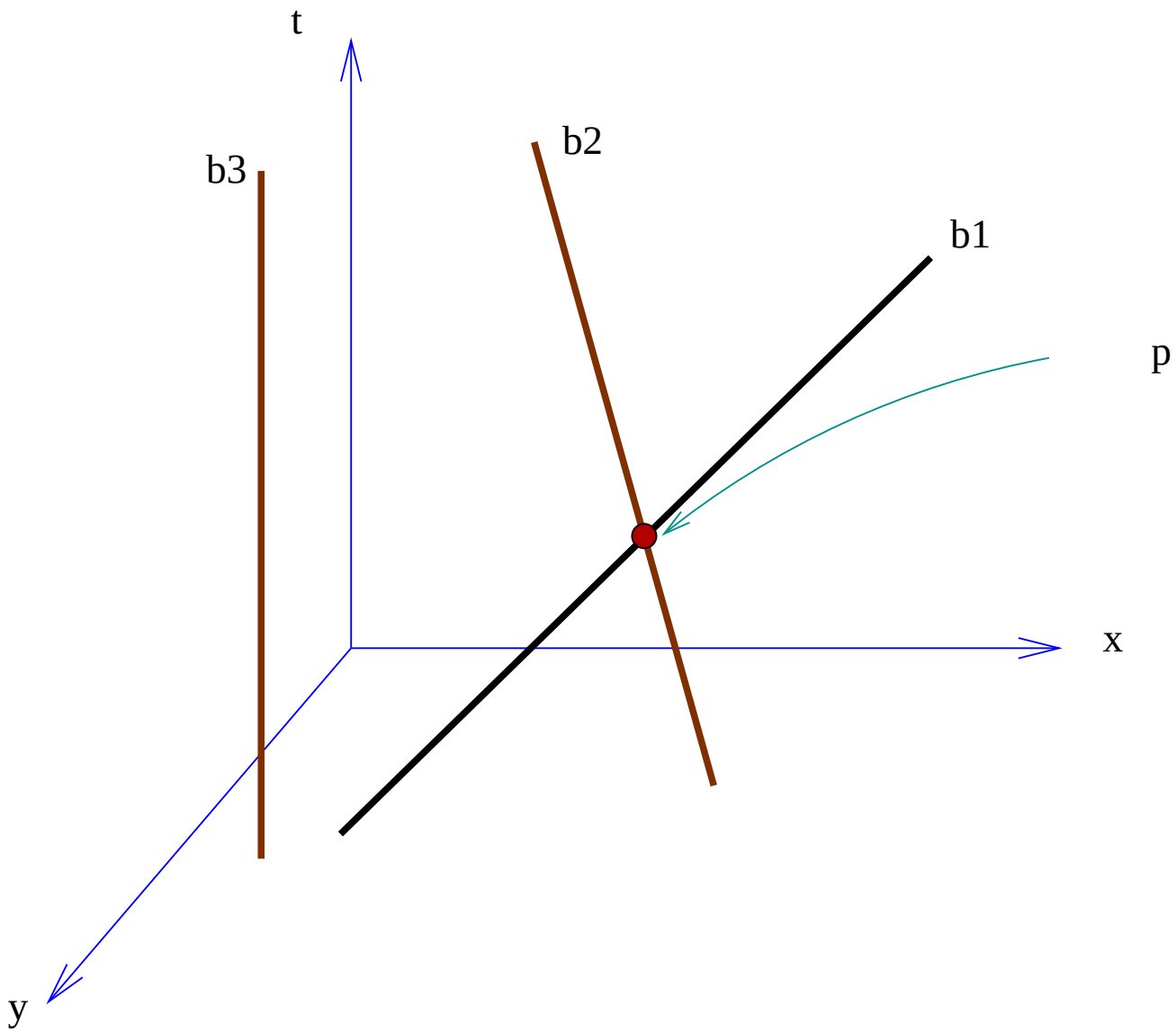
SUMMARY

- Gravitation can be used for **speeding up time**
- Black holes provide **unlimited resource** for this effect
- Undesirable side-effects of falling into a black hole can be eliminated by choosing **exotic black holes** (with a repellept, cushioning force)
- All this is not a fairy tale, it can be **mathematically verified** via GR (no misuse of idealizations). Physical realism checked in *Németi-Dávid: Relativistic computers and the Turing Barrier, JAMC to appear*.
- New, high precision cosmology: **No Big Crunch**, space is infinite, conditions for relativistic computer friendly.
- **Universe is infinite both in time and space.**

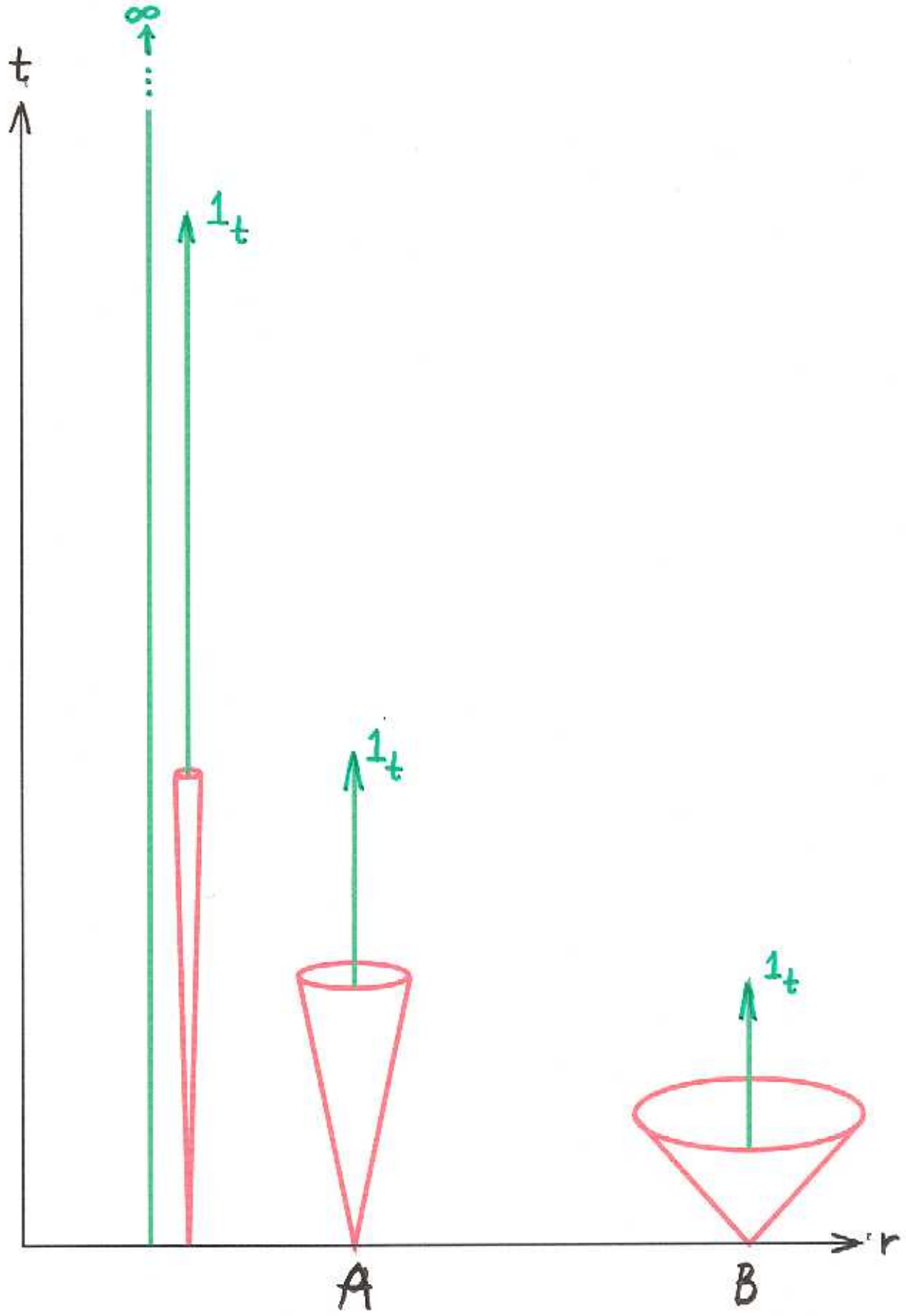
Part III

Spacetime theoretical elaboration of the same Thought Experiment.

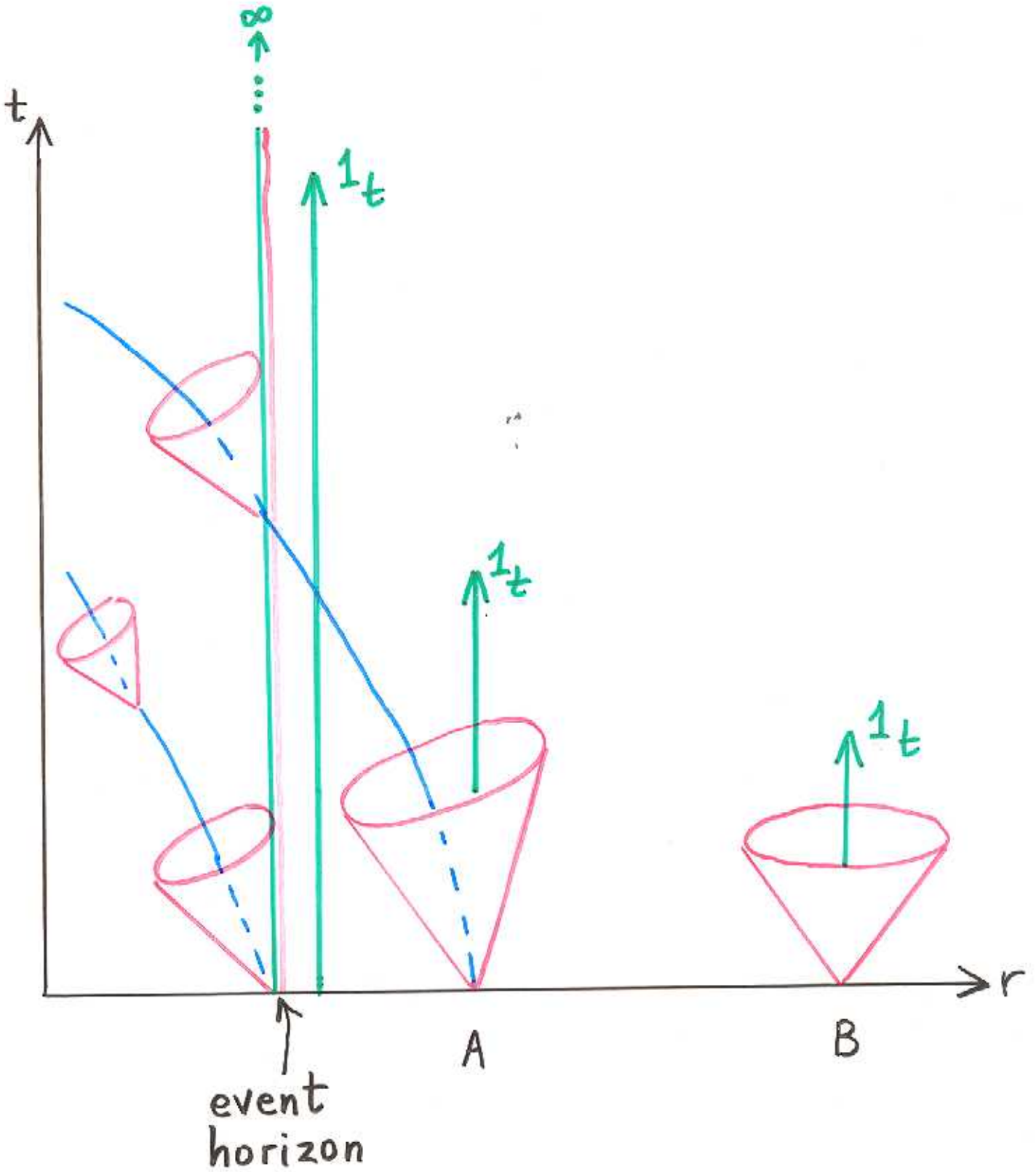

time
t
b
a "now"
life-line of
a body b
Space
x
y


t
b3
b2
b1
p
x
y

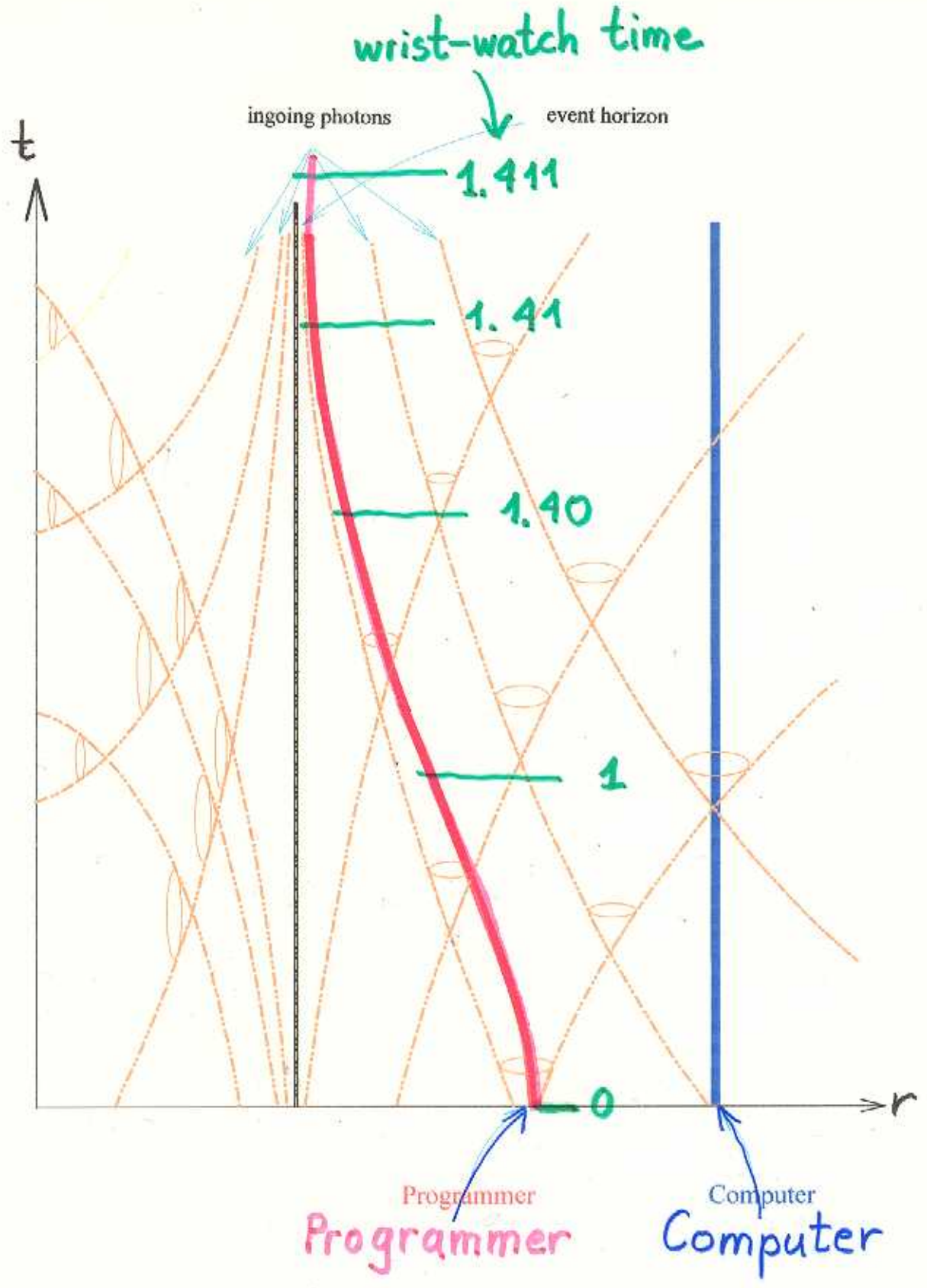
roadmap



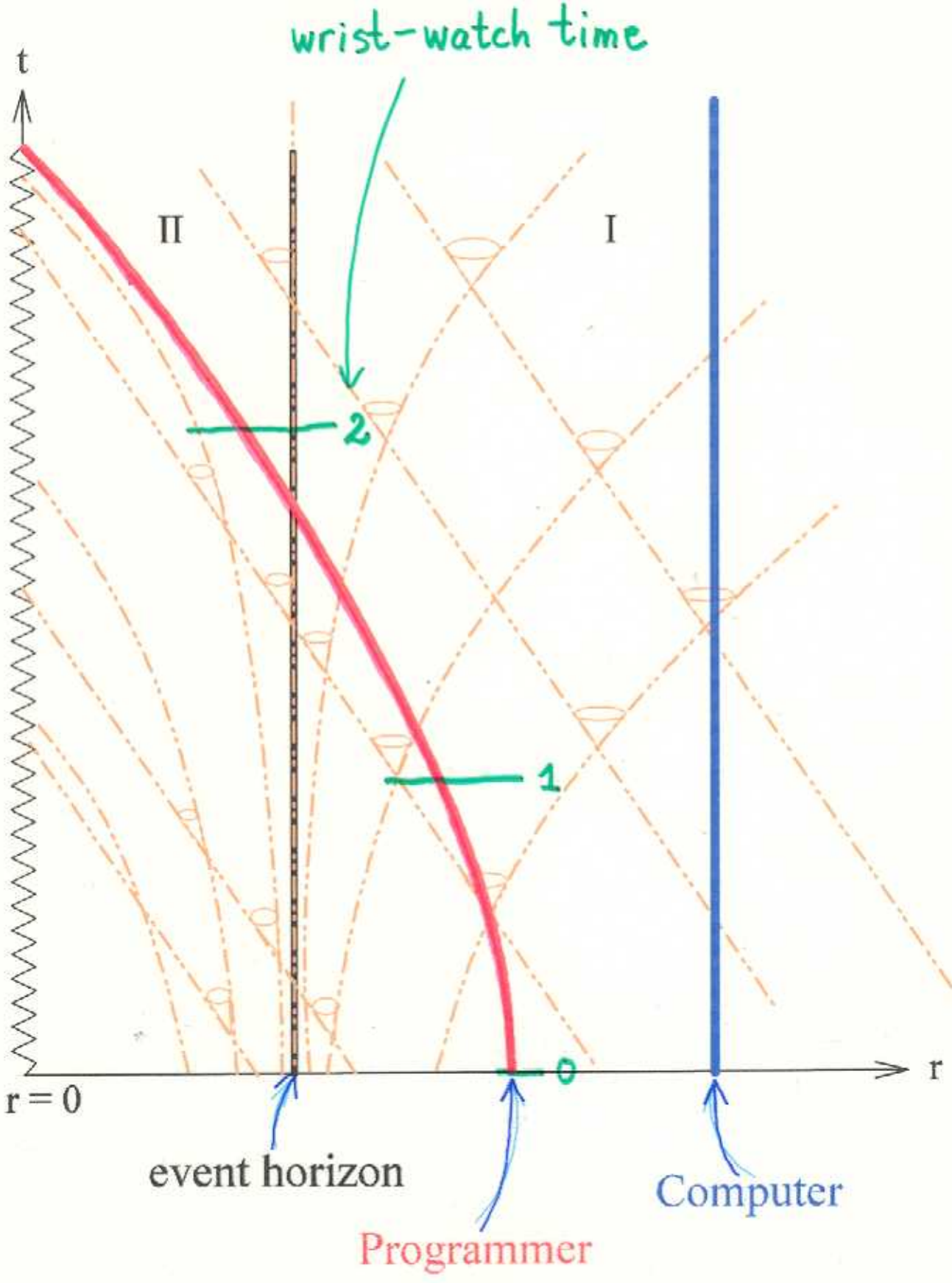
RELATIVITY!



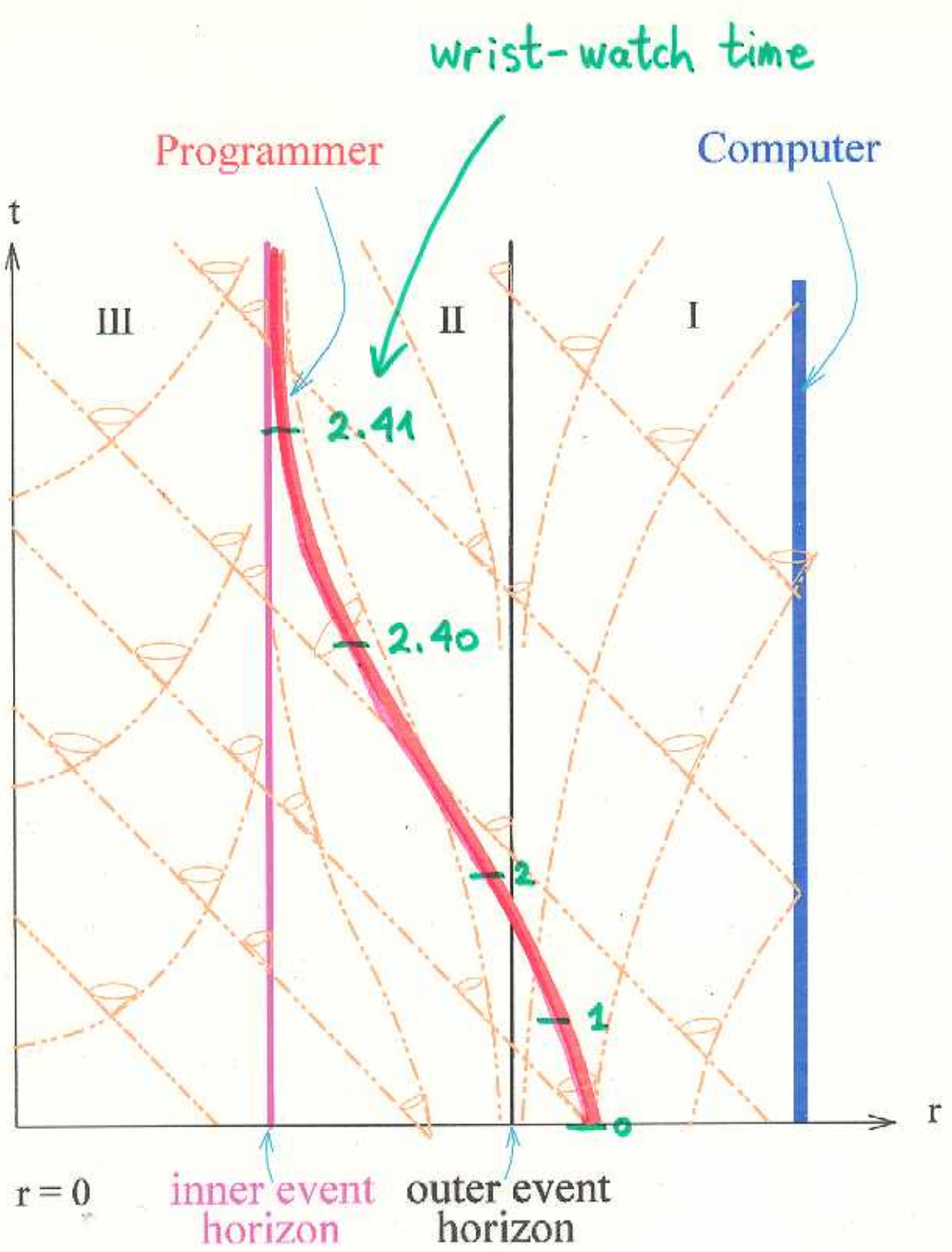
life-lines stay within light-cones
wrist-wathes tick according to local time-speed



Computer's view



PROGRAMMER's VIEW



BLACK HOLE with REPELLENT FORCE

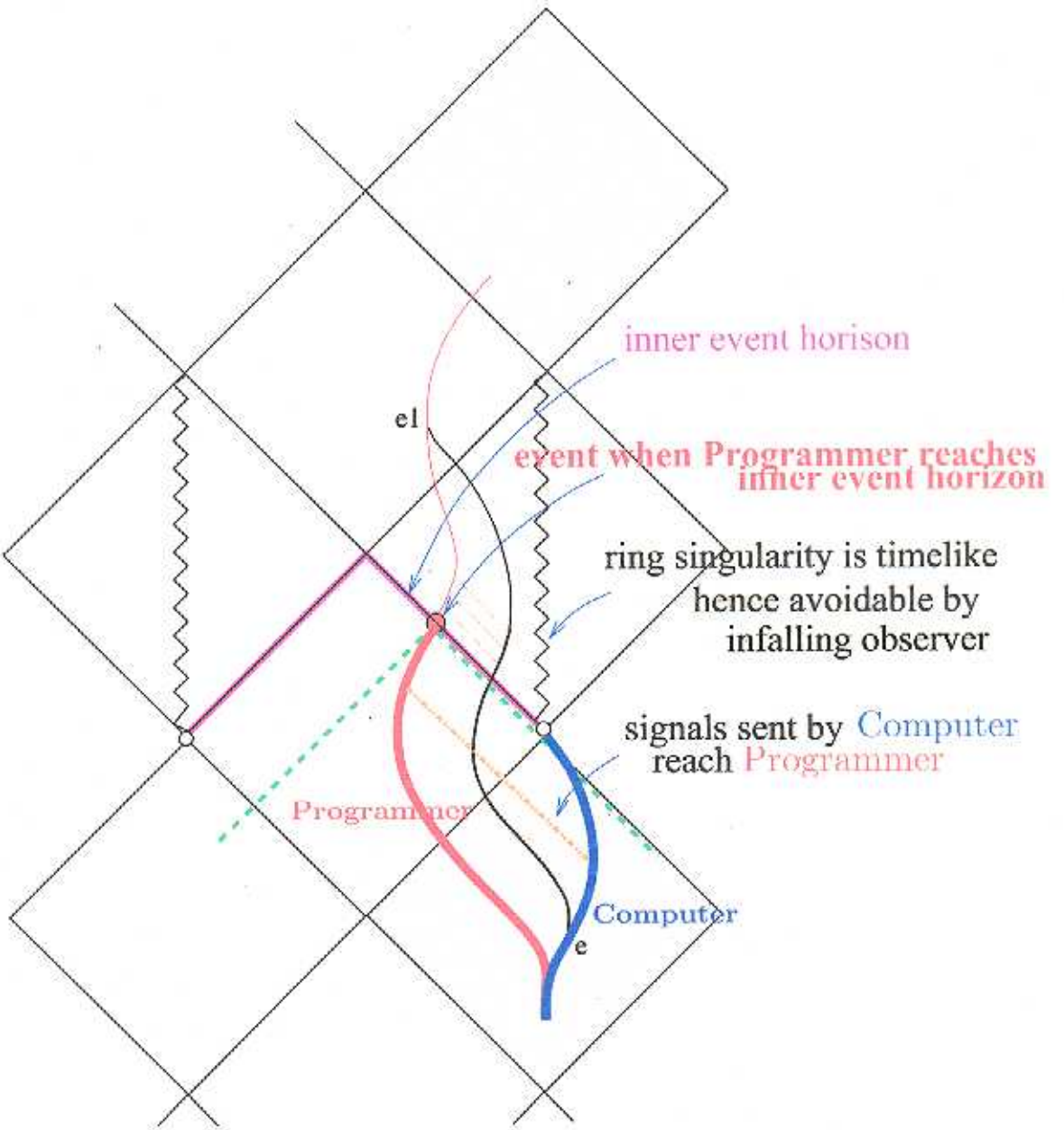


FIGURE 6. Penrose diagram of slowly rotating black hole along the symmetry axis. The red line represents a segment of the life-line of the Programmer, and the blue line represents the life-line of the Computer. The time passed on the red line is finite, while the time passed on the blue line, i.e. for Computer, is infinite.

HOMOMORPHIC IMAGE

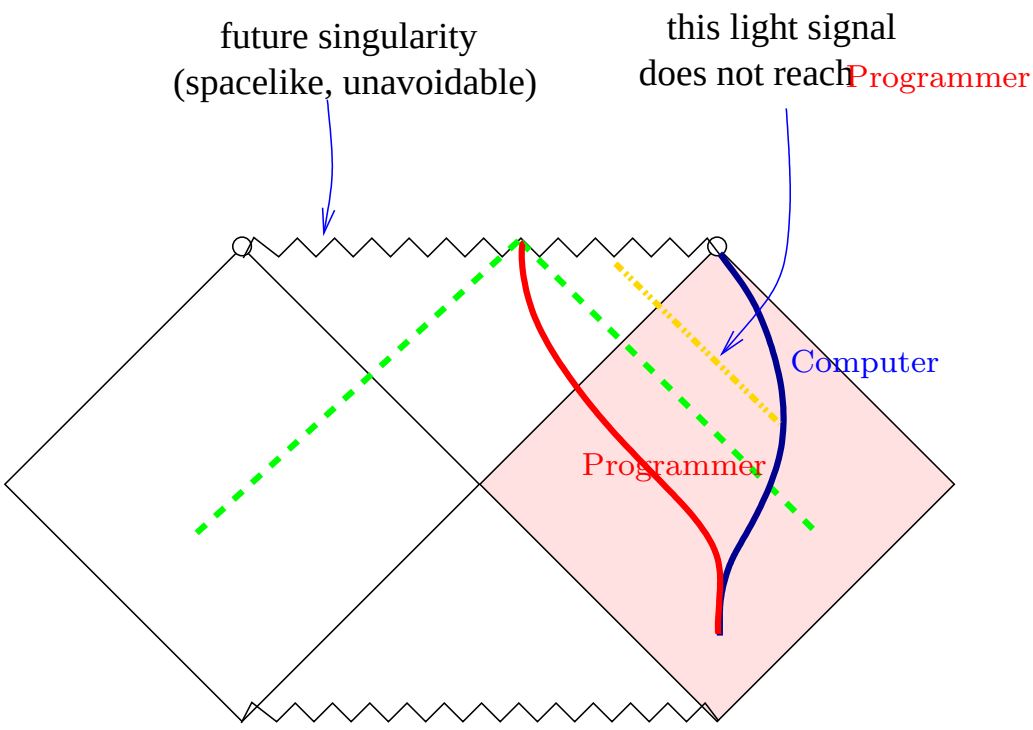


FIGURE 1. Penrose diagram of Schwarzschild black hole. There is no point in the spacetime whose causal past contains all of an upward-infinite future-directed curve.

Simple BH metric

$$ds^2 = \left(1-\frac{1}{r}\right) dt^2 - \left(1-\frac{1}{r}\right)^{-1} dr^2 - \underbrace{r^2 d\varphi^2}_{\text{trivial: Euclidean part}}$$

E. charged BH metric

$$ds^2 = \left(1-\frac{1}{r}+\frac{e}{r^2}\right) dt^2 - \left(1-\frac{1}{r}+\frac{e}{r^2}\right)^{-1} dr^2 - r^2 d\varphi^2$$

charge

$0 \le e < \frac{1}{2}$

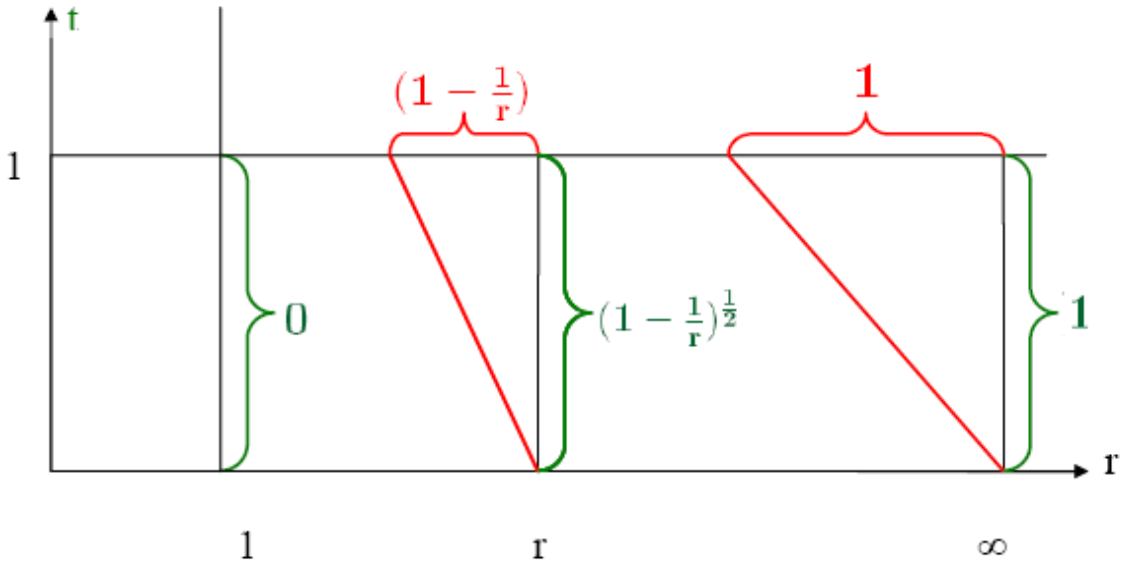
$\frac{ds}{dt} = 0$ iff $r = \frac{1}{2} \pm \sqrt{\frac{1}{4} - e}$

programmer's clocks freeze = event horizons

THM: These metrics satisfy Einstein's F. Equations

Simple Black Hole metric

$$ds^2 = \underbrace{(1 - \tfrac{1}{r})dt^2}_{\text{Tells how much the wrist-watch of local ant shows at 1}} - \underbrace{(1 - \tfrac{1}{r})^{-1}dr^2}_{\text{Tells how narrow the local light-cone is}} - \underbrace{r^2 d\varphi^2}_{\text{Trivial: Euclidean part}}$$



Electrically charged Black Hole metric:

$$ds^2 = (1 - \tfrac{1}{r} + \tfrac{e}{r^2})dt^2 - (1 - \tfrac{1}{r} + \tfrac{e}{r^2})^{-1}dr^2 - r^2 d\varphi^2$$

Some people with results on relat. Computers:

Hogarth (Cambridge)
Pitowsky (Israel)
Shagrir (Israel)
Earman (Pittsburgh)
Norton (Pittsburgh)
Malament (USA)
Etesi (Hungary, Dept. Phys.)
Dávid (Hungary, Dept. Phys.)
Tipler
Barrow
Jiří Wiedermann
A&N 1987 Ames USA Lecture Notes

Logical Foundation of General Relativity

RELATIVITY for LOGICIANS

Available from us
(manuscript)