

RELATIVISTIC HYPERCOMPUTING

PHYSICAL REALISTICITY

by Hajnal Andréka, István & Péter Némethi

PLAN OF TALK

Physical realism (consistency with present knowledge)

Connections: Mark, Philip, Felix, John T., Mike, Selim

- How Relativistic Hypercomputing works
- Movies: flying through wormholes, "tutorial"
- Realistic issues one-by-one. New hypercomputation-friendly trends in physics.

THE IDEA

- ☞ New physics brings in new horizons, new possibilities and breaks old barriers.
- ☞ Church Thesis (1934 - 48) was formulated in the pre-relativistic (Newtonian) worldview
- ☞ Turing Machine concept incorporates “**ABSOLUTE TIME**”



- ☞ Believable that after Black Hole Physics breaking the Turing Barrier becomes conceivable.

G. R.



you can manipulate TIME (just like space)

Kurt Gödel was fascinated with this feature of GR.

CONCEPT

Ways to break the Turing-barrier:

- ☞ infinitely accelerating processors
- ☞ infinitely precise measurement
- ☞ infinitely shrinking computer
- ☞ infinitely small mass-points

NOT REALISTIC

CONCEPT

Another way is: using Time Travel (Selim Akl)

☞ We do not need even this one, we need only:

GR & Black Hole physics

(In the far future one can even derive an engineering project from this concept!)

BASES



GR - computing

General
Relativity

Observational
BH - astronomy
(New!)

High precision
cosmology
(New!)

SPEEDING UP TIME USING GRAVITY

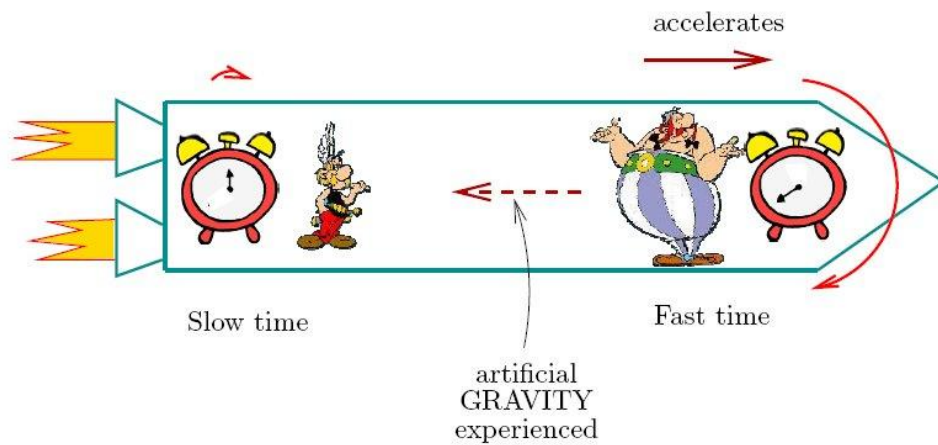


Figure 1: A THEOREM of Special Relativity (SR) (easily proved in first-order logic version of SR).

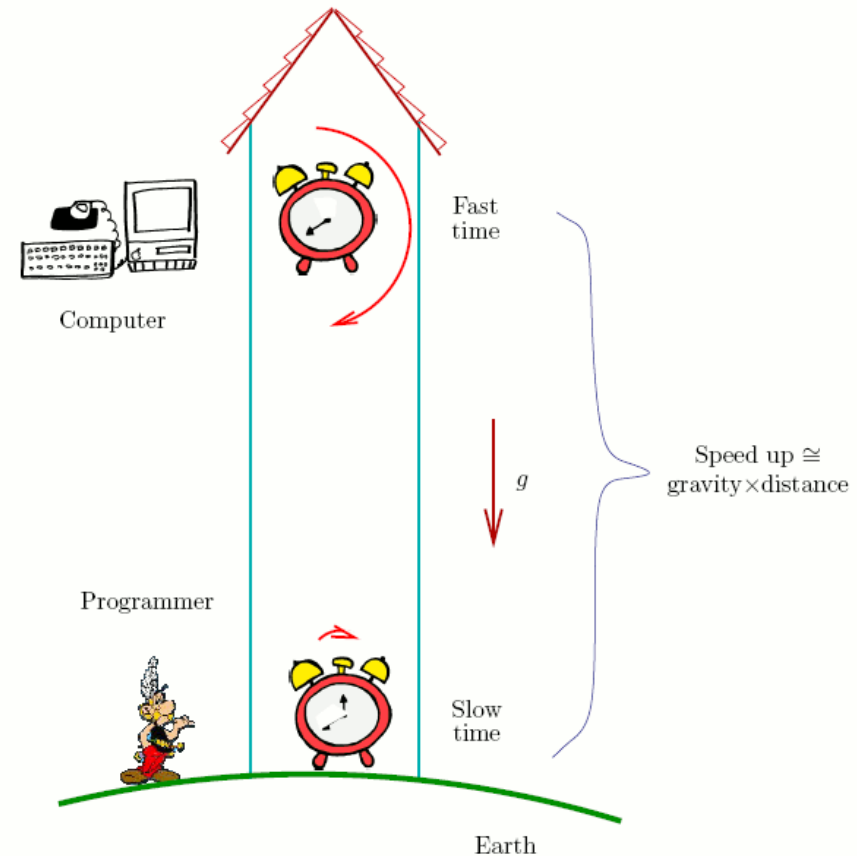


Figure 2: TIME WARP (Tower Paradox, effects of gravity on time). Clocks higher in a gravitational well tick faster.

SPEEDING UP TIME USING GRAVITY

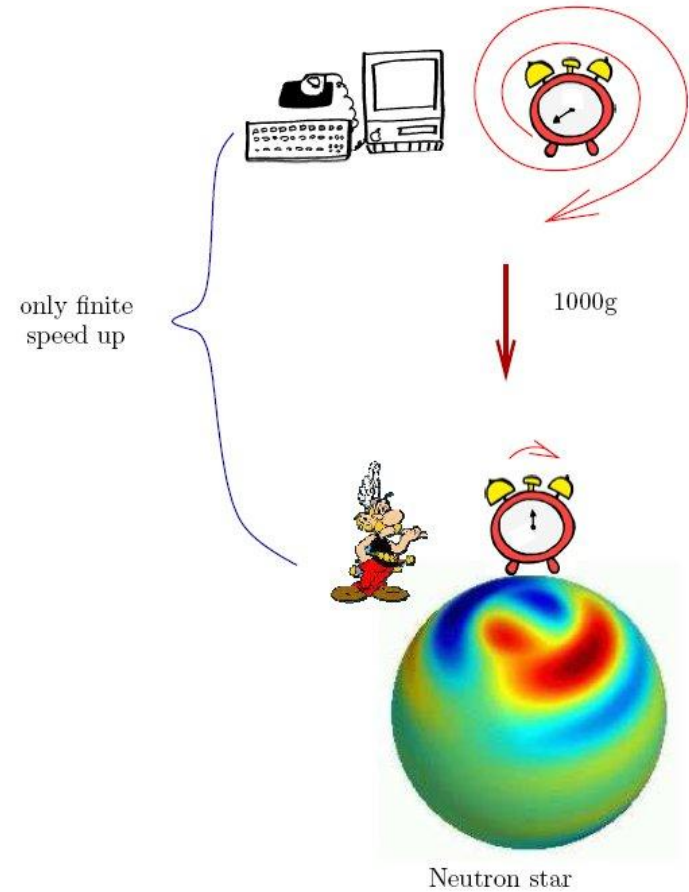
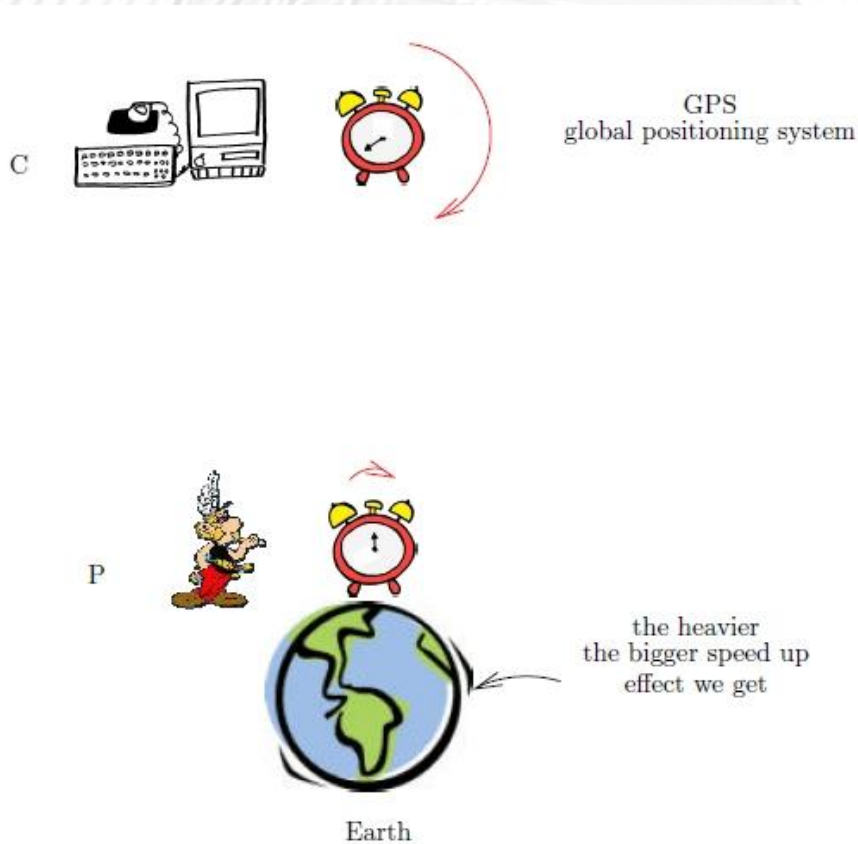
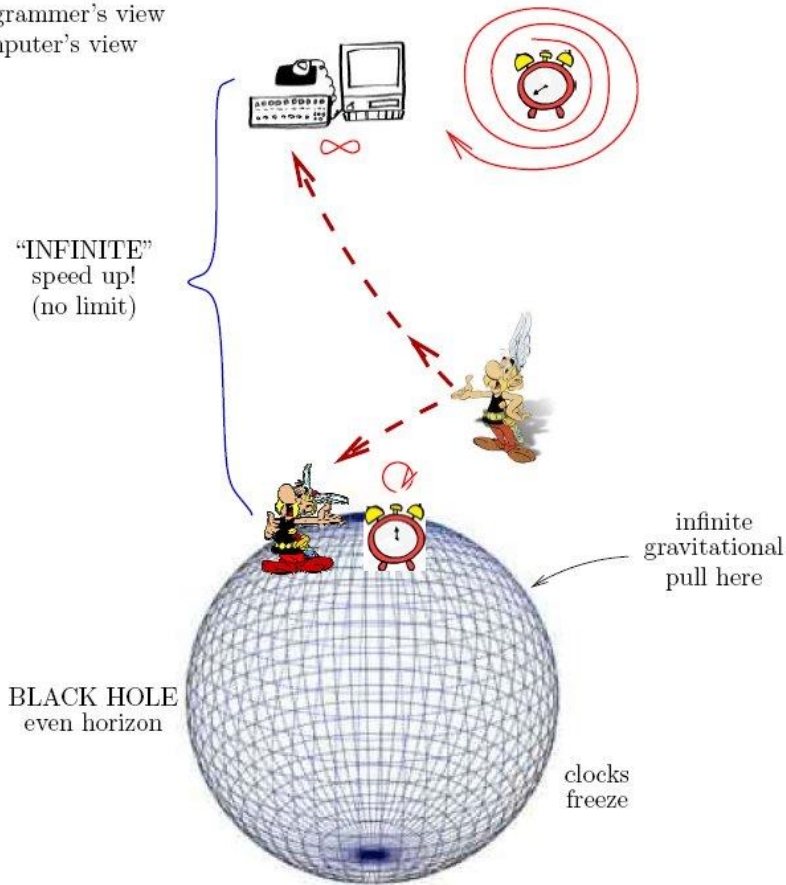


Figure 3: Thought experiment for fast computation: The programmer “throws” his slave-computer to a high orbit. Communicates via radio.

Figure 4: The speed-up effect can be increased by using a neutron star in place of the Earth, but it still remains finite.

SPEEDING UP TIME USING GRAVITY

Programmer's view
Computer's view



"INFINITE"
speed up!
(no limit)

infinite
gravitational
pull here

BLACK HOLE
even horizon

clocks
freeze

Figure 5: The speed-up effect can be made "infinite" by using a black hole.

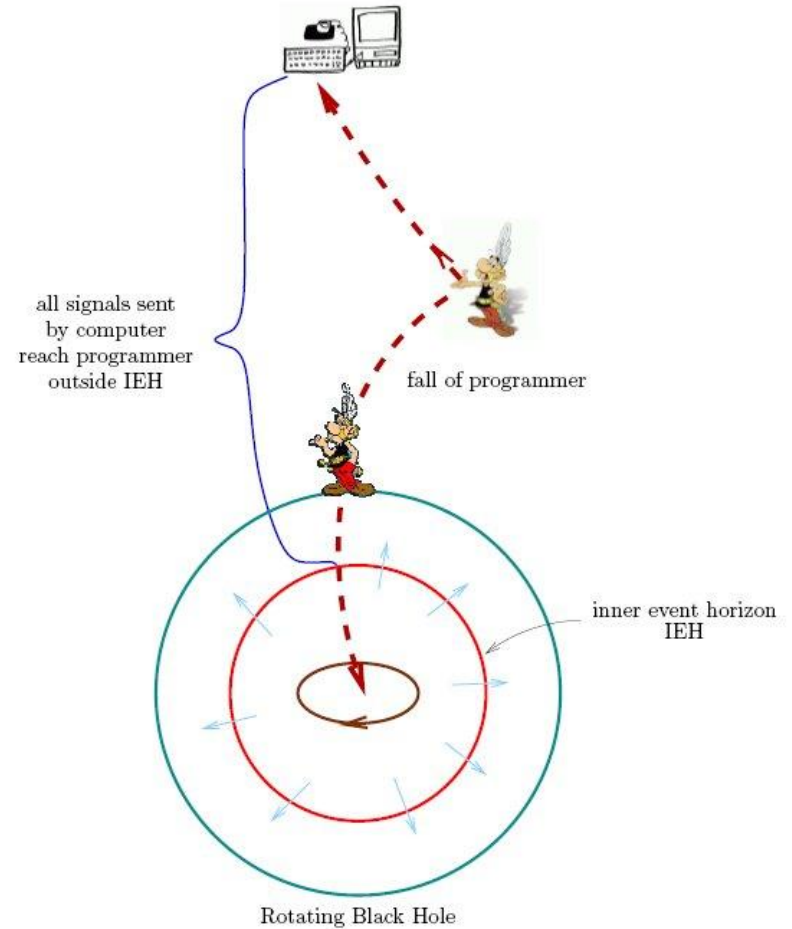


Figure 6: Rotating Black Hole has two event horizons. Programmer can survive forever. (Ring singularity can be avoided.)

REALISTICITY – OBSERVATIONAL EVIDENCE

Google

+observational +evidence+for spinning+supermassive+huge+rotating +black Search

Web

Results 1 - 10 of about **17,500** for **+observational +evidence+for spinning+supermassive+huge+rotating +**

Colliding **Black Holes** Observed | Universe Today

Do the two **supermassive black holes spin**, recoil and then blast away from each ... but astronomers now have **observational evidence** of a **black hole** being ...

www.universetoday.com/2008/04/29/supermassive-black-hole-kicked-out-of-galaxy-first-ever-observation/ - 53k - [Cached](#) - [Similar pages](#) -

Understanding the fate of merging **supermassive black holes**

The first **observational evidence** of a galaxy with a pair of active galactic maximal **rotating black holes** with spins parallel to the orbital angular ...

www.iop.org/EJ/article/0264-9381/22/10/034/cqg5_10_034.pdf - [Similar pages](#) -

Google Answers: Viewing **Black Holes** from Earth

The **observational evidence** for the existence of **black holes** can only be gathered by ... The most plausible candidate is a **rotating, supermassive black hole** ...

answers.google.com/answers/threadview/id/288965.html - 13k - [Cached](#) - [Similar pages](#) -

Supermassive Black Holes Produce Powerful Galaxy-shaping Winds

Precocious **Supermassive Black Holes** Challenge Theories (Nov. 23, 2004) — **NASA's** Chandra X-ray Observatory has obtained definitive **evidence** that a distant ...

www.sciencedaily.com/releases/2007/10/071031152914.htm - 53k -

Astrophysicists Detect Energy Emanating from **Spinning Black Hole** ...

Image: **NASA Supermassive black holes**, like their smaller stellar counterparts ... the new finding may represent the first **observational evidence** of a theory ...

www.sciam.com/article.cfm?id=astrophysicists-detect-en - 54k - [Cached](#) - [Similar pages](#) -

Black hole - Wikipedia, the free encyclopedia

"The **Spin** of the Near-Extreme **Kerr Black Hole GRS 1915+105**", ... "**Observational evidence** for stellar mass **black holes**" in *Proceedings of IAU Symposium 238*: ...

en.wikipedia.org/wiki/Black_hole - 233k - [Cached](#) - [Similar pages](#) -

REALISTICITY – OBSERVATIONAL EVIDENCE

- ☞ Astronomer F. Melia in his book “Supermassive BH's in the Universe” (Cambridge University Press) reports on p.58 the discovery of a rotating BH of 100 million solar masses (10^8 solar masses) in MCG-6-30-15 (NASA observation). (Diameter = Mars' orbit around the Sun.) Moreover, on p.118 a 3-billion (3 times 10^9) solar masses rotating BH in the nucleus of M87 is reported. Its diameter is roughly the size of the Solar system, cf p.118, lines 9-7 bottom up.
- ☞ http://www.bookrags.com/wiki/Supermassive_black_hole reports observation of BH's of 2.6 million solar masses.
- ☞ Sir Roger Penrose in his 2005 book reports observation of event horizon of BH's [Journ. Astronom. Geophysics 44(6) (2003)].
- ☞ “Star orbiting the supermassive black hole at the centre of Milky Way”, European Southern Observatory Press Release 17 / 2002.
- ☞ “Detecting the event horizon of Sgr A*”, by Miyoshi, M. In: Proceedings of the 7th European VLBI Network Symposium. October 12/15, 2004. Toledo, Spain.
- ☞ “HST Spectroscopic Evidence for a 10^9 – solar mass Black Hole in NGC 4594”, by Kormendy, J., Bender, R., Ajhar, E. A., Dressler, A., Faber, S. M., Gebhardt, K., Grillmair, C., Lauer, T. R., Richstone, D., and Tremaine, S. 1996, Astrophysical Journal (Letters), 473, L91.
- ☞ “Axisymmetric Dynamical Models of the Central Regions of Galaxies”, by Gebhardt, K., Richstone, D., Tremaine, S., Lauer, T. R., Bender, R., Bower, G., Dressler, A., Faber, S. M., Filippenko, A. V., Green, R., Grillmair, C., Ho, L. C., Kormendy, J., Magorrian, J., and Pinkney, J. 2003, Astrophysical Journal 583, 92 .
- ☞ <http://www.newscientist.com/article/dn13166> reports observation of BH's of 18 billion solar masses.
(by Tuorla Observatory & American Astronomical Society)

ASTRONOMICALLY OBSERVED BH'S:

- ☞ Mass: $2 * 10^{10}$ Solar masses
- ☞ Diameter: 20 Solar system
- ☞ Surface temperature: 10^{-18} K



mirrors become superconductors

- ☞ Rotates

REALISTICITY

☞ New cosmology says :

Space & Time are both ∞

Expansion forever, no Big Crunch

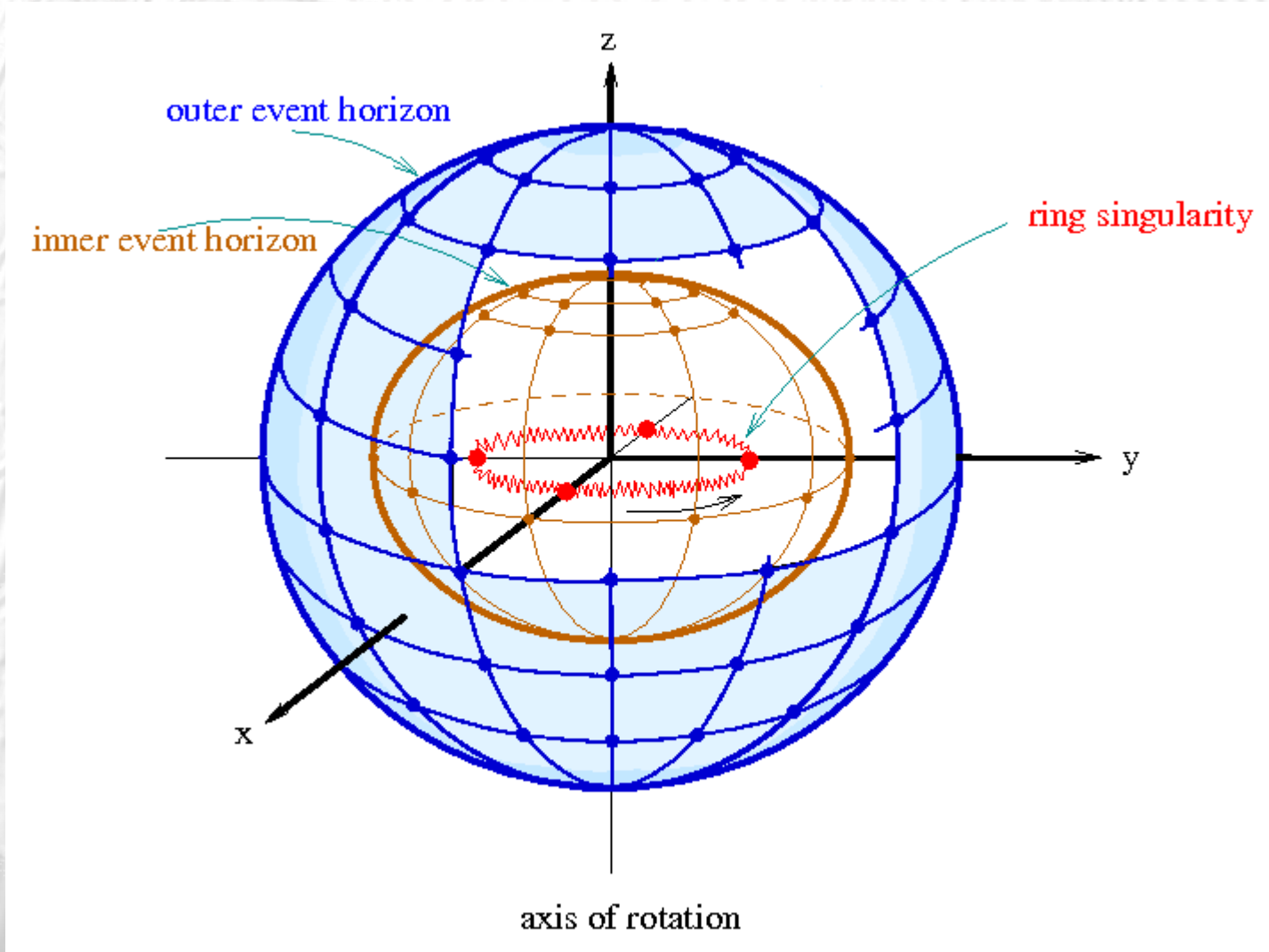
REALISTICITY

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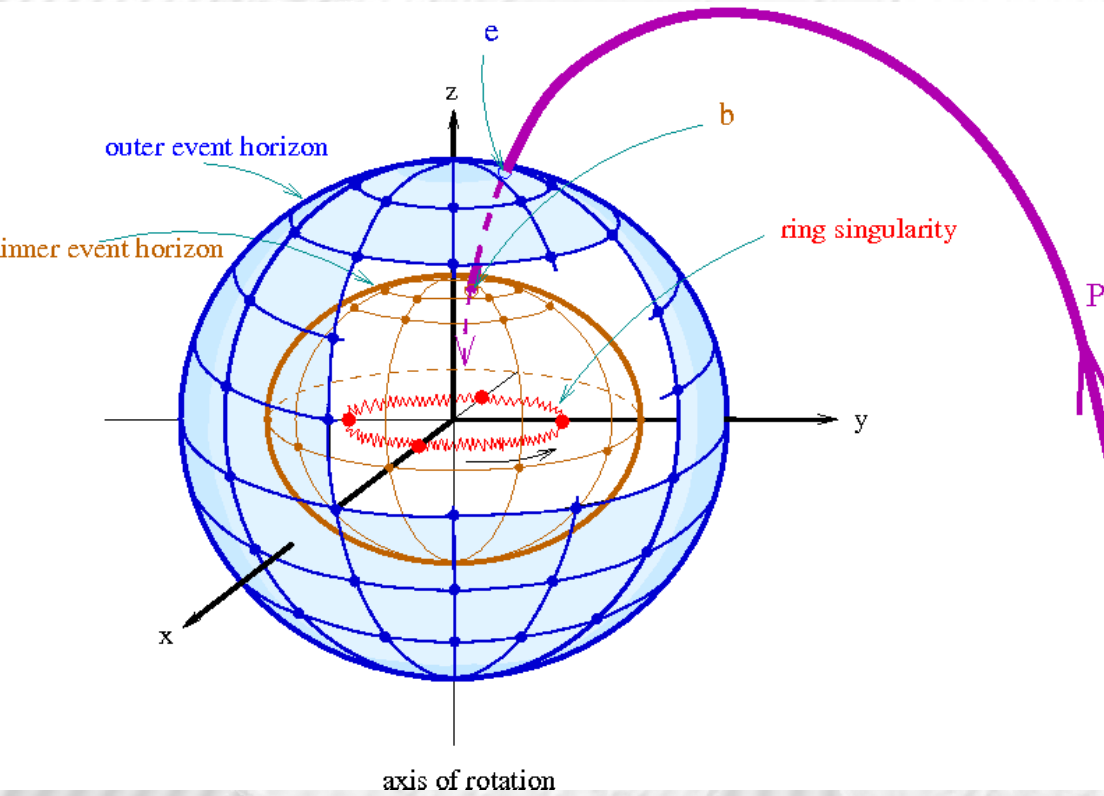
Space & Time are both ∞

☞ You do not have to believe in such BH, future generations may manufacture them.

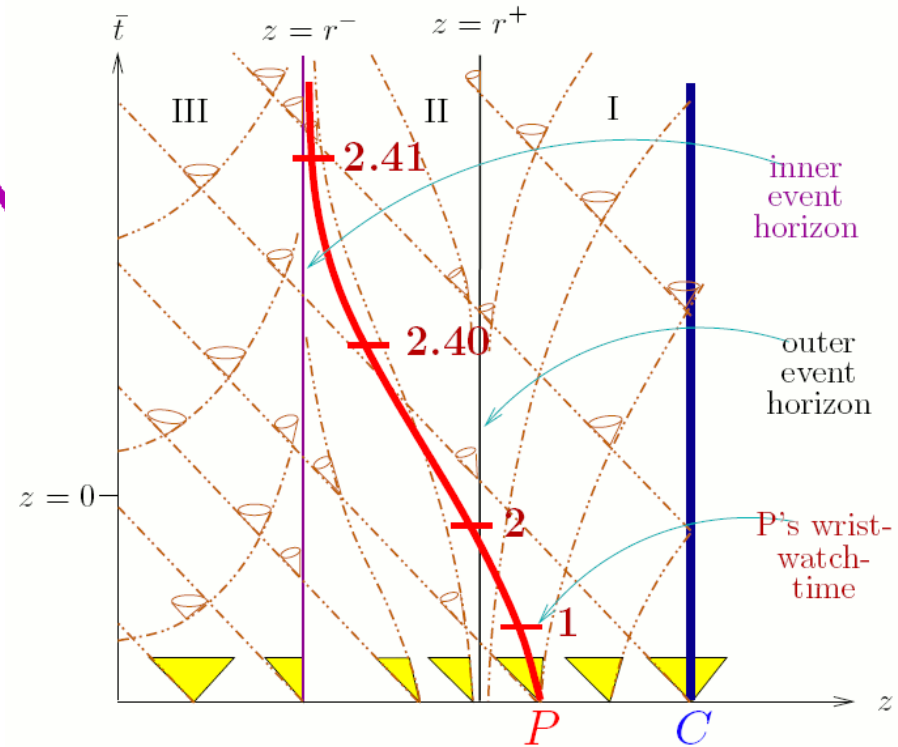
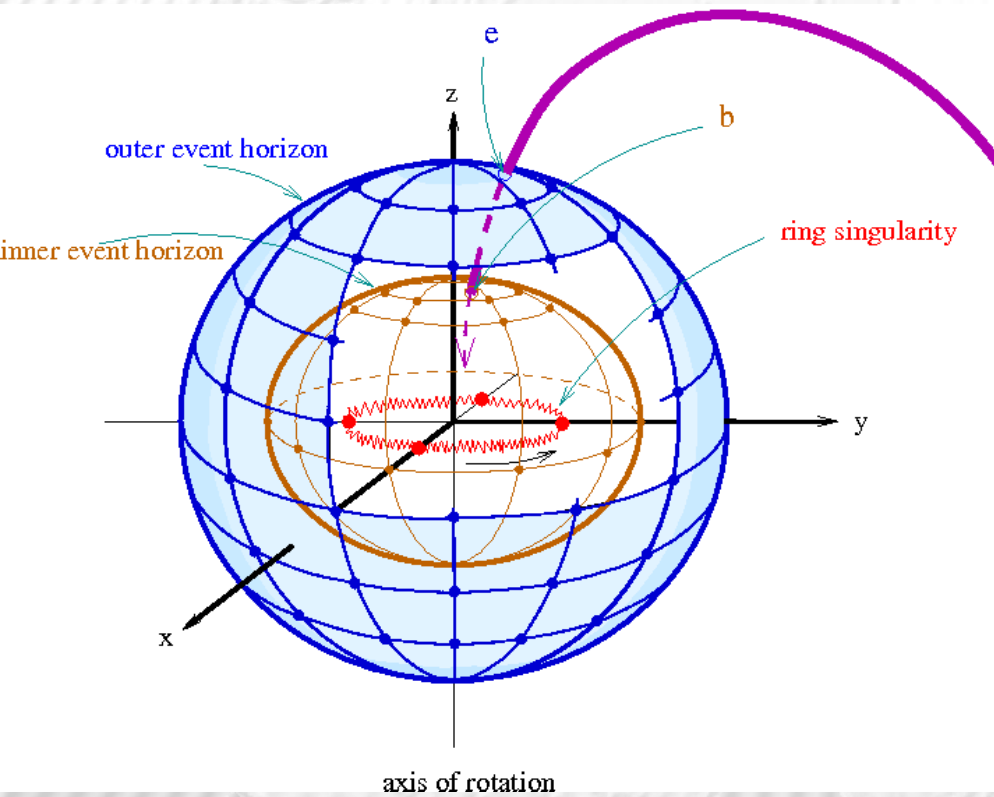
IMPLEMENTATION- ROTATING BH



IMPLEMENTATION

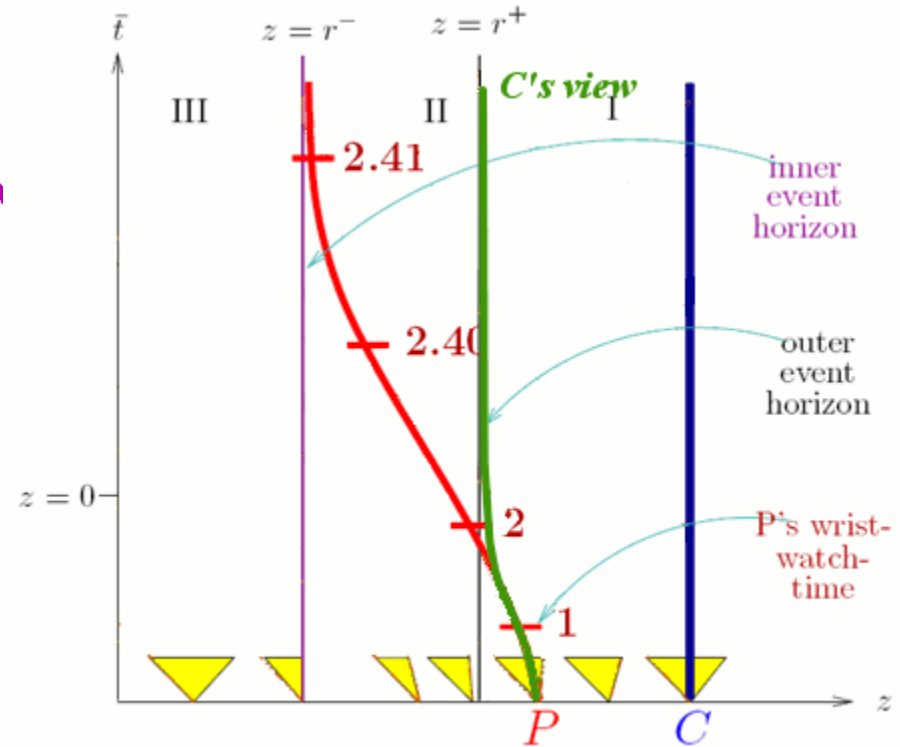
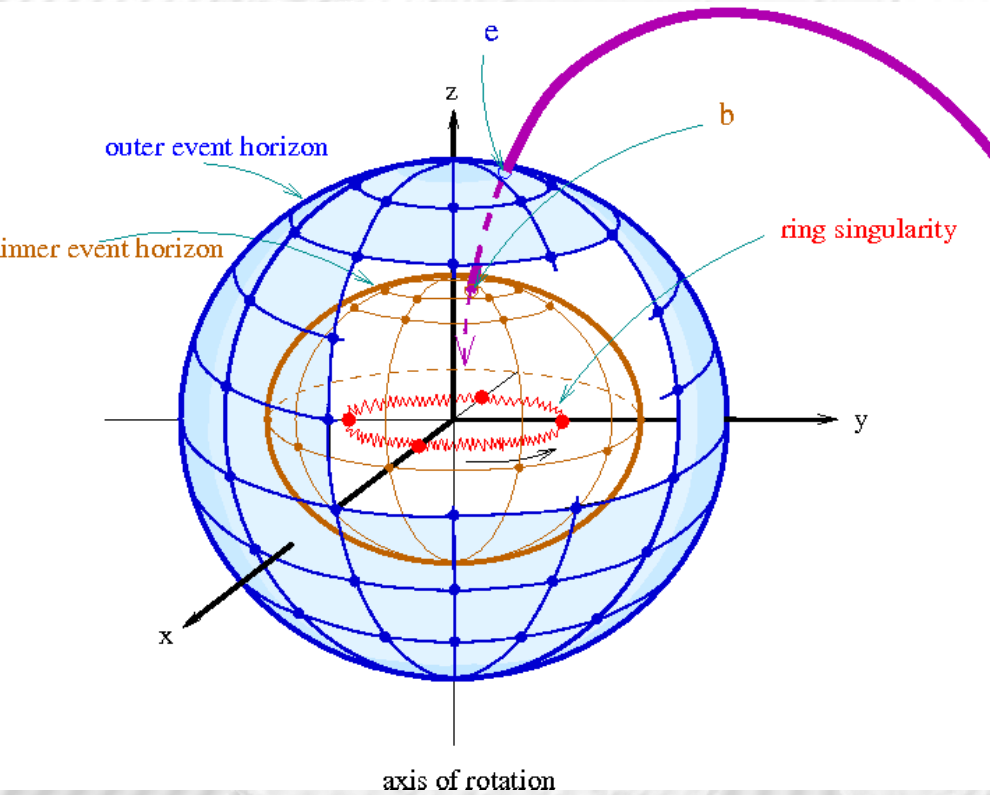


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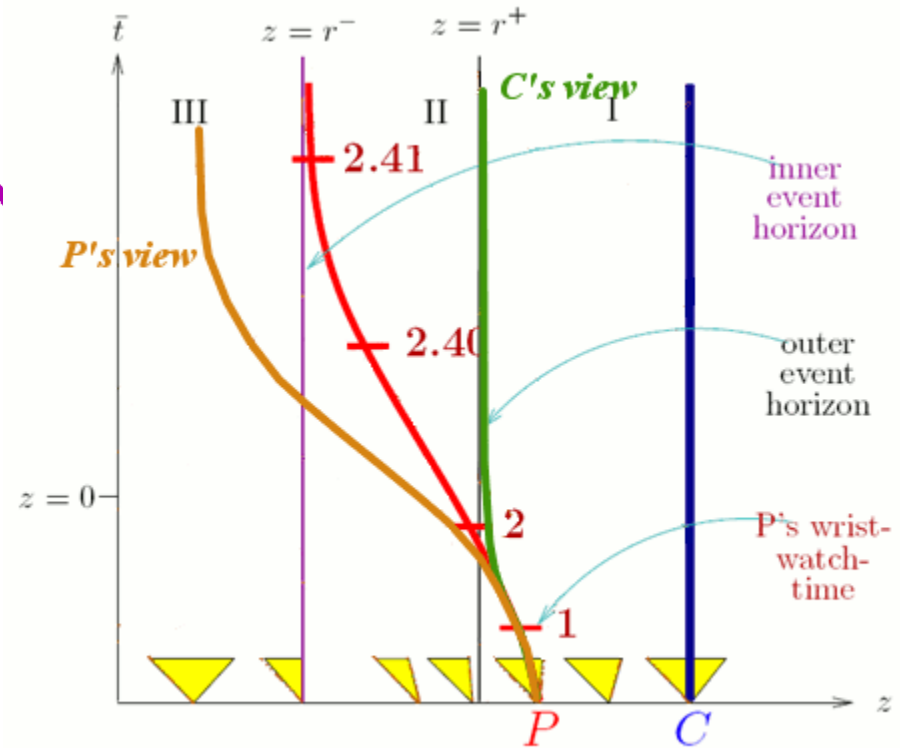
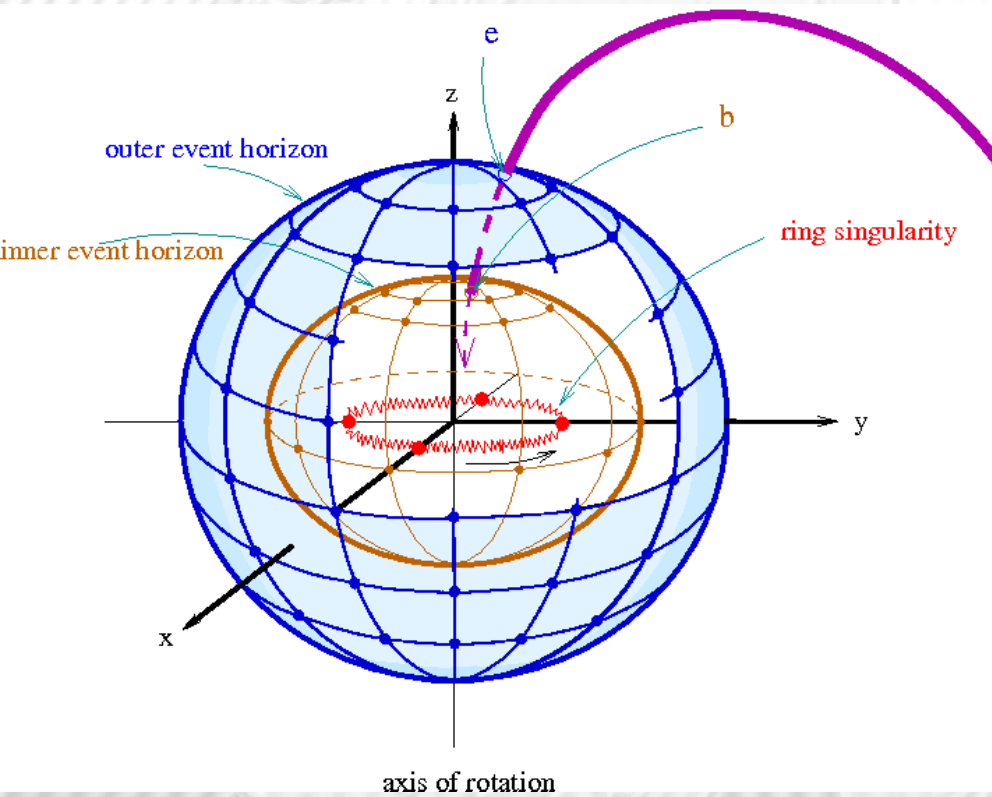
The "tz-slice" of space-time of slowly rotating black hole.

IMPLEMENTATION



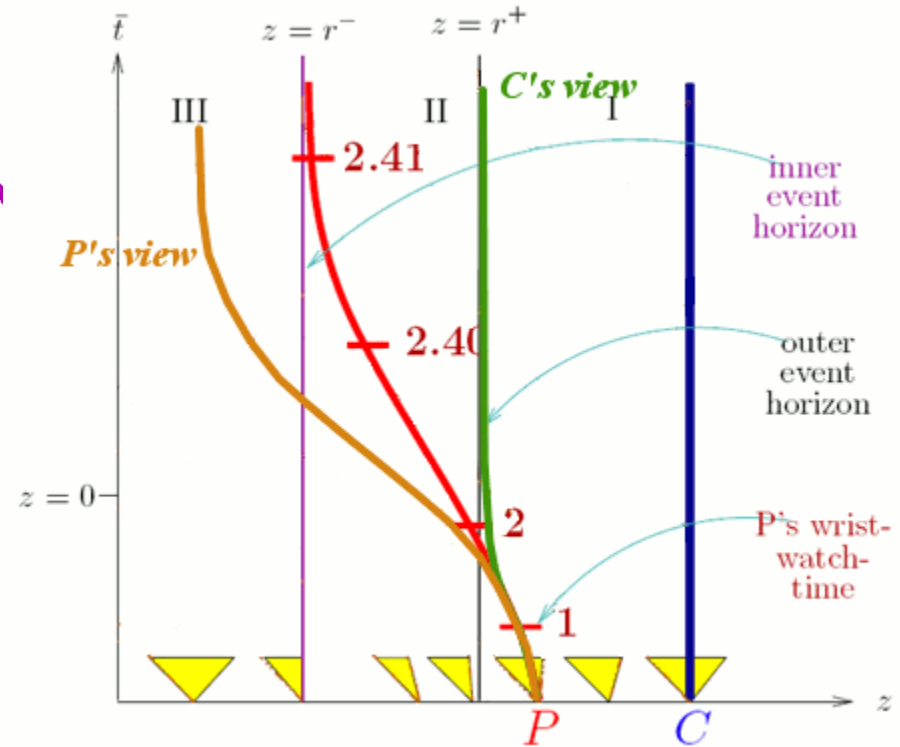
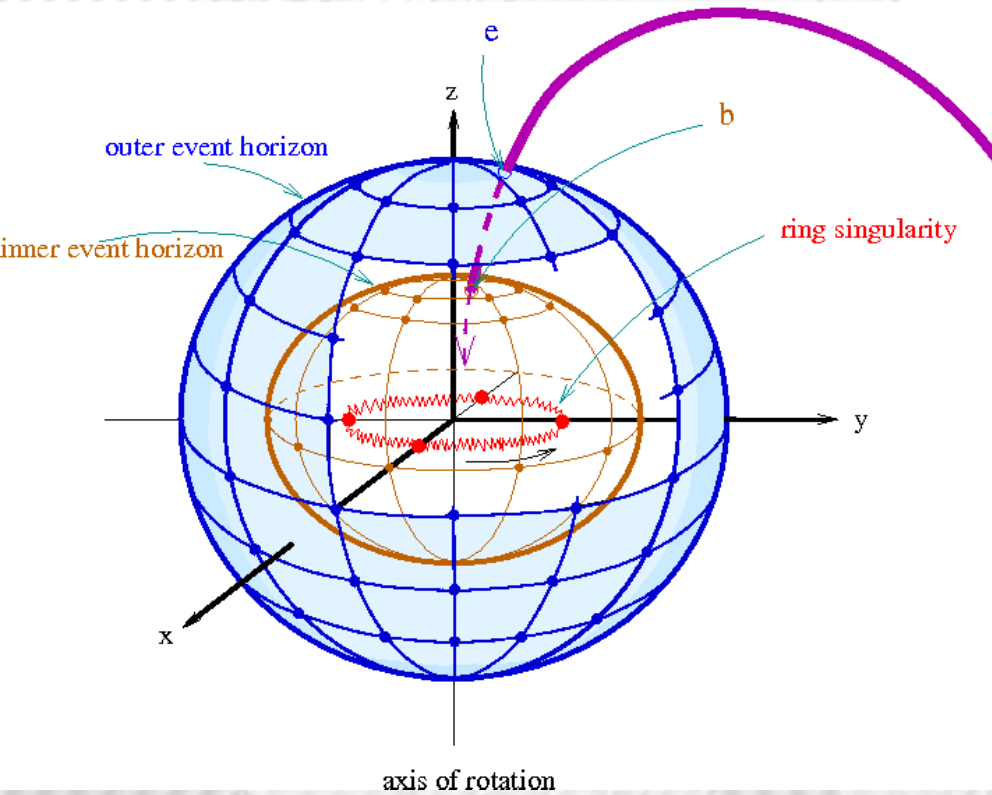
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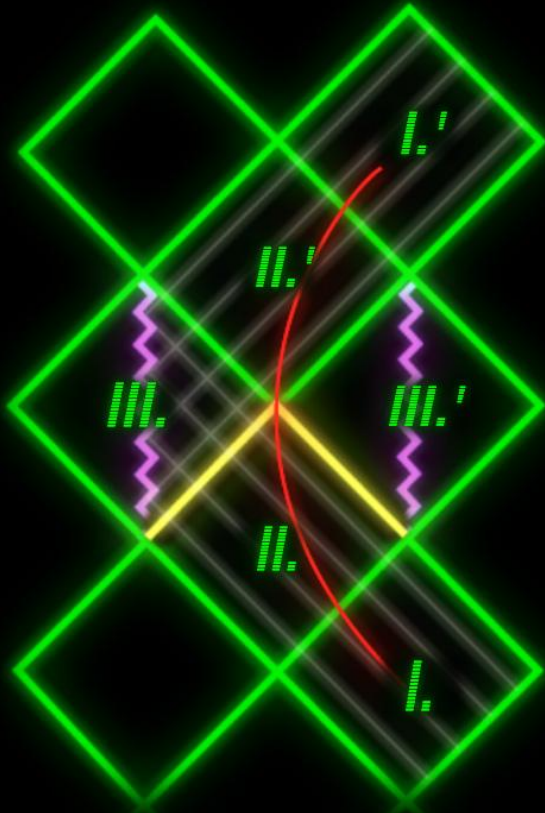
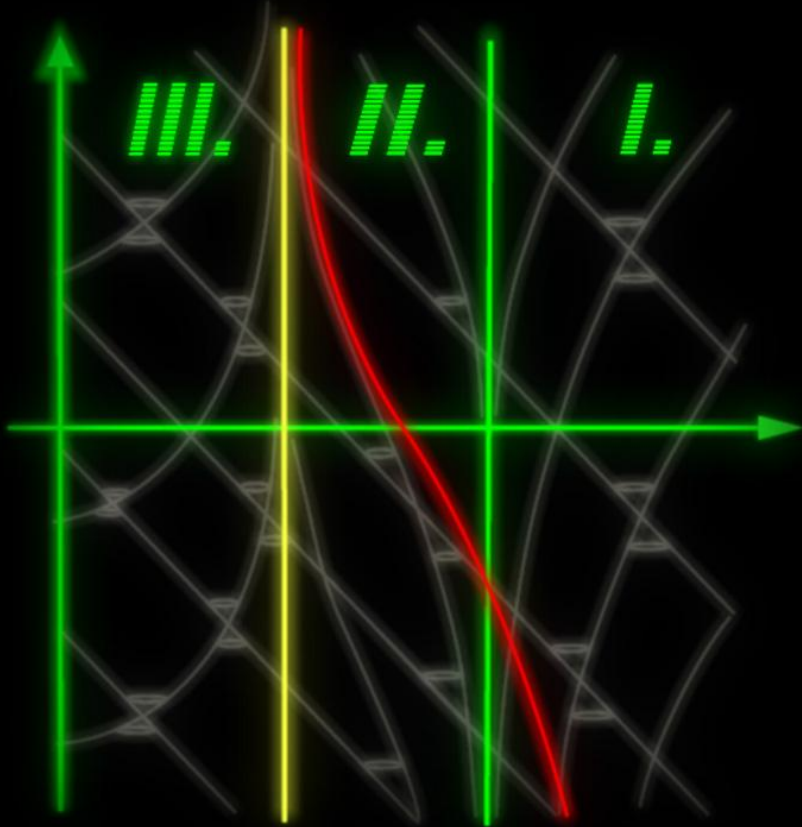
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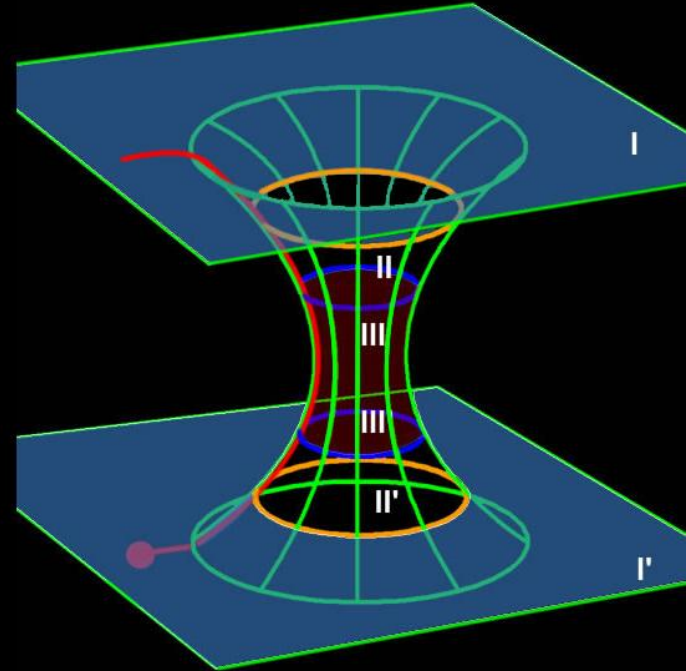
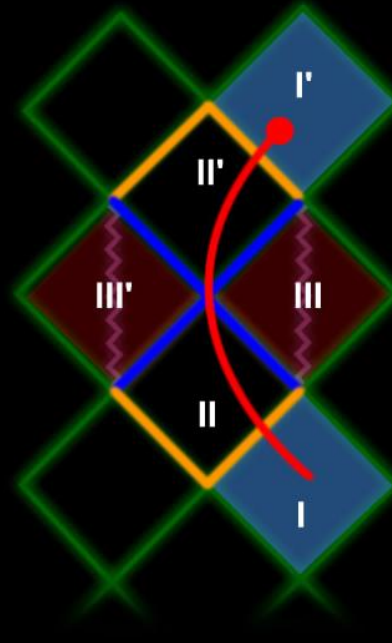
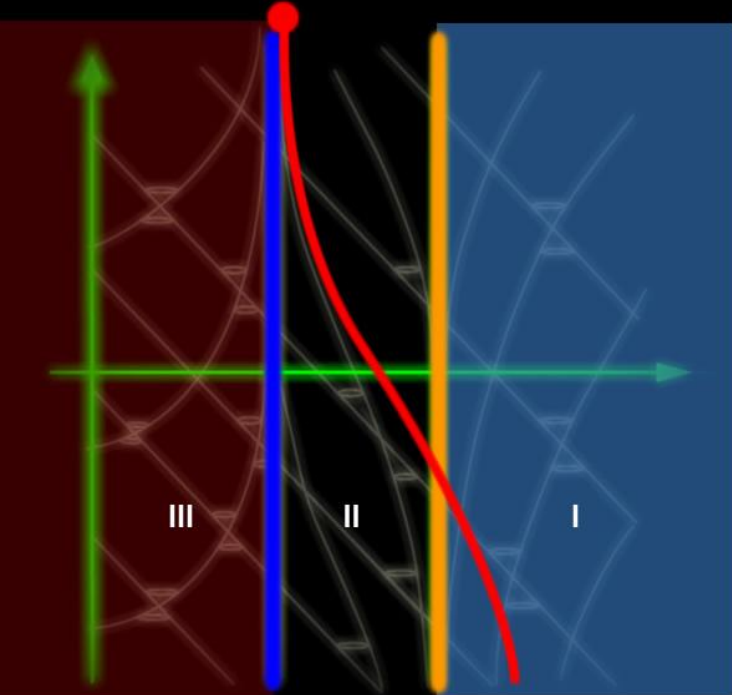


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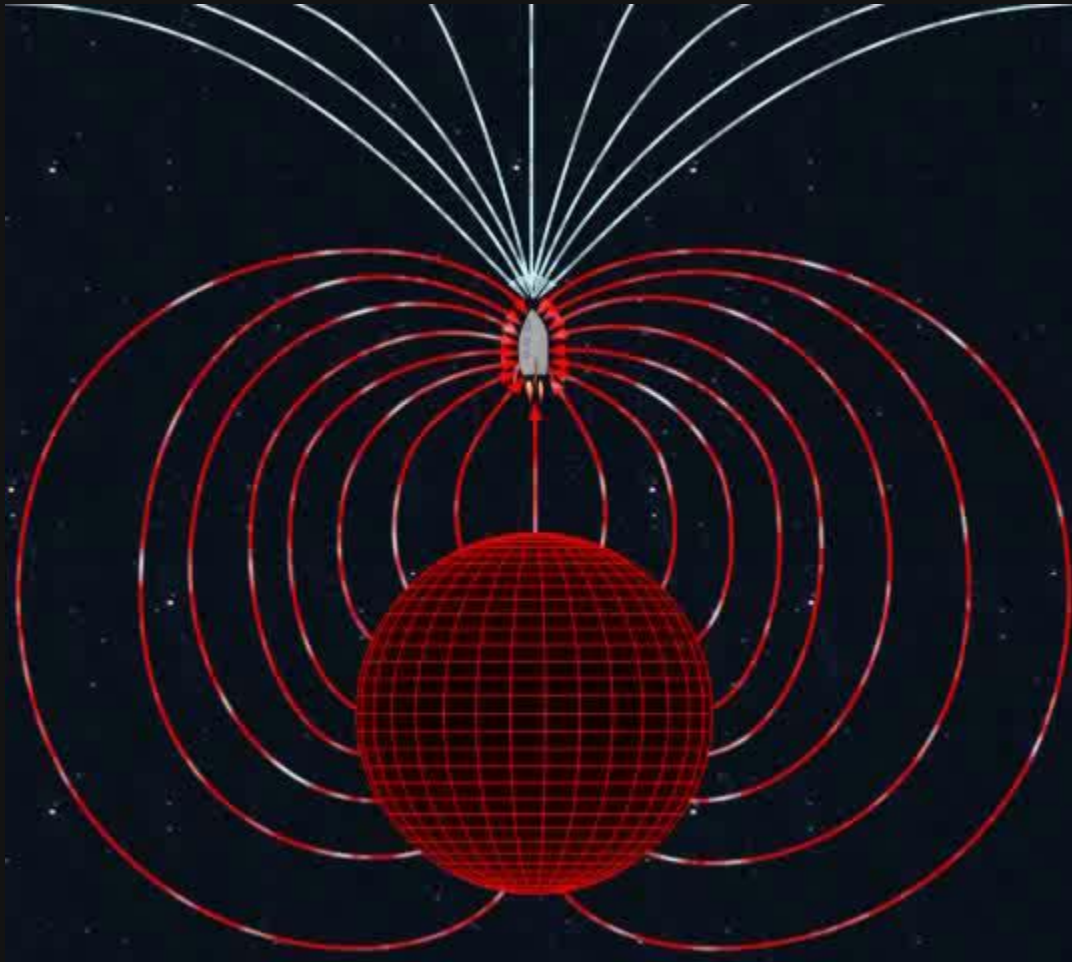
PENROSE DIAGRAM OF SPACETIME



WORMHOLE STUDY



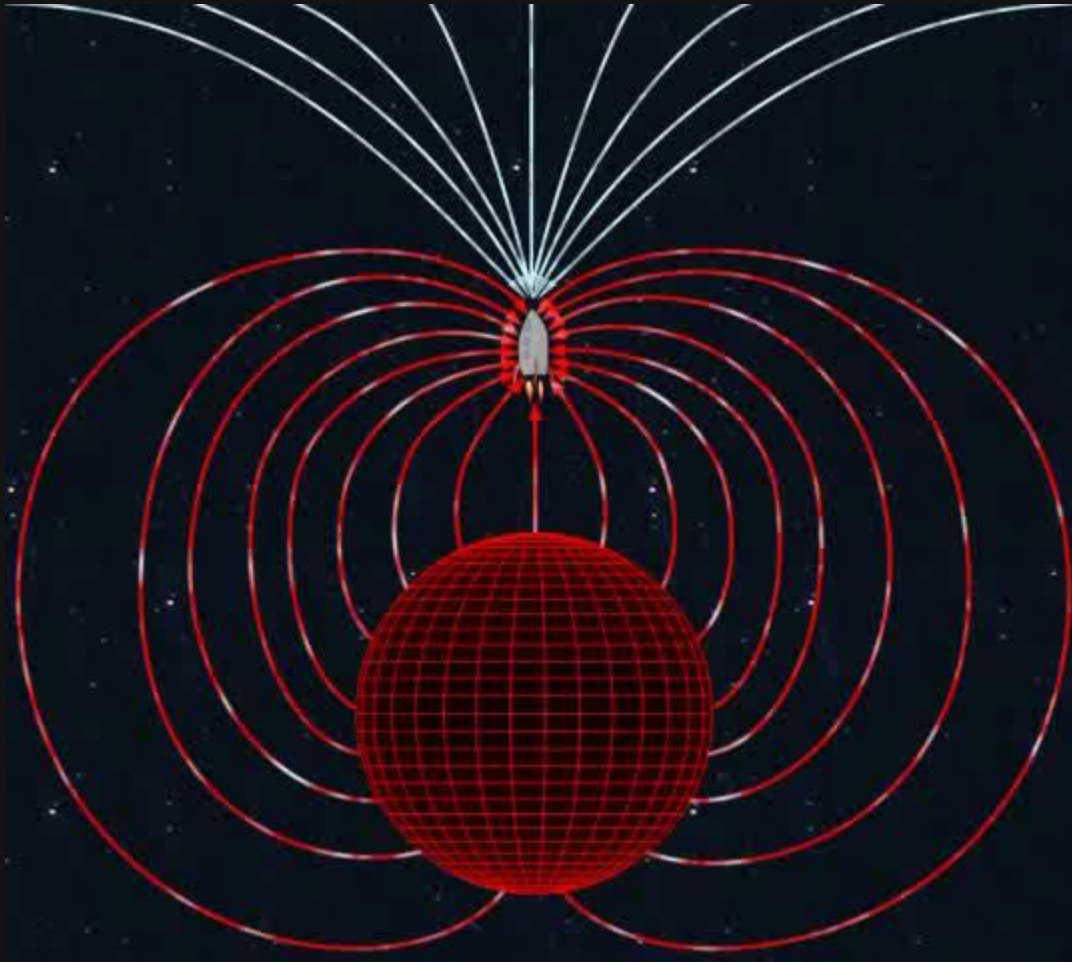
VISUAL EFFECTS NEAR BLACK HOLE



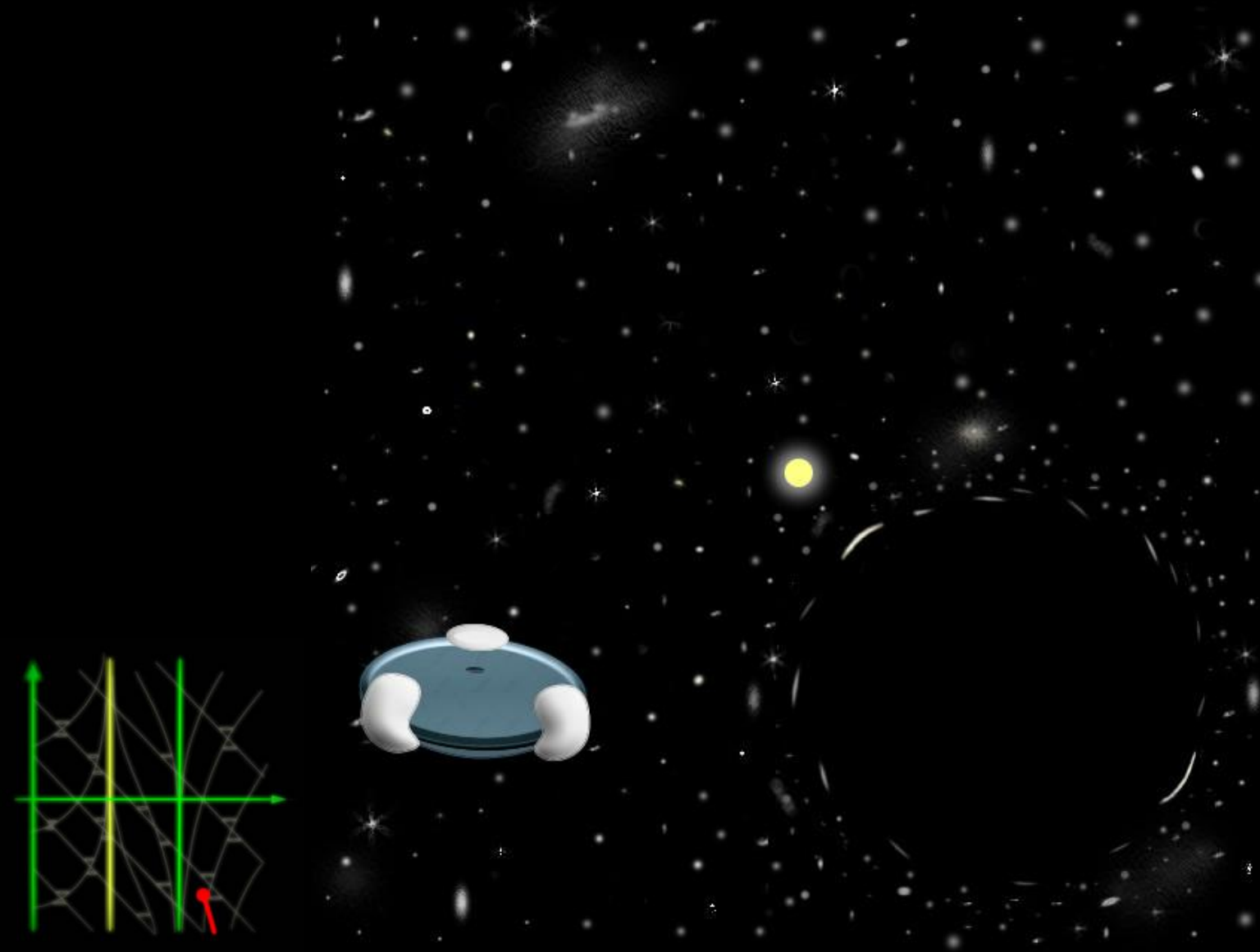
AND NOW...

MOVIE

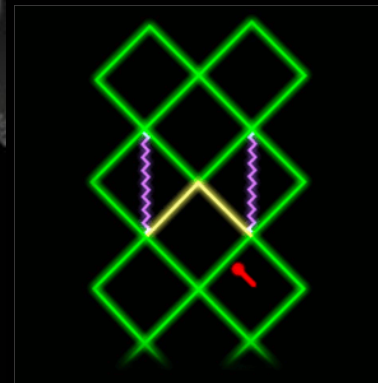
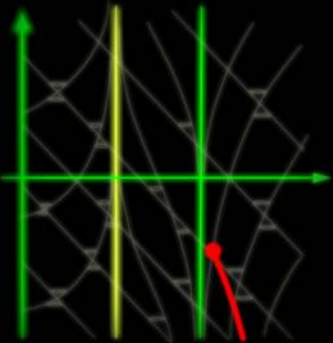
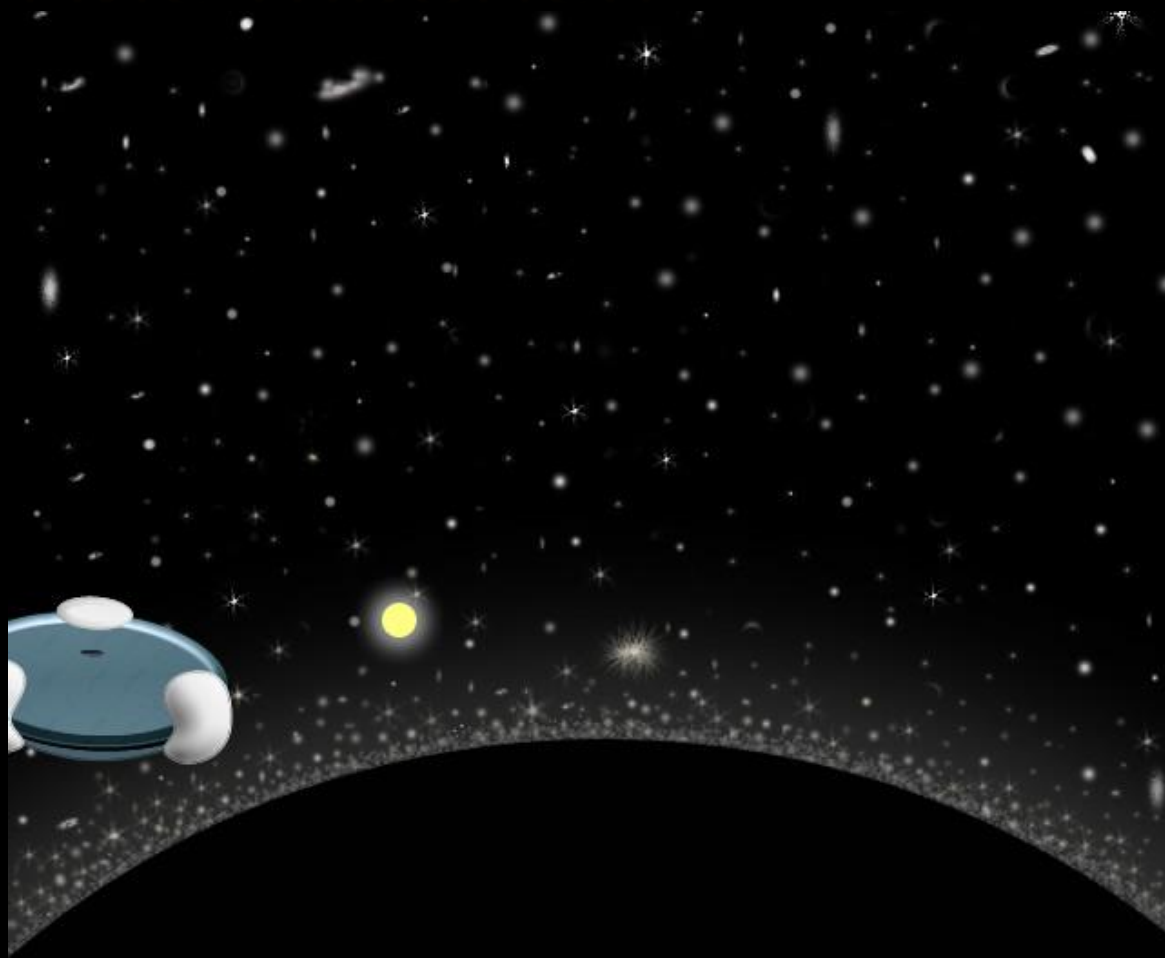
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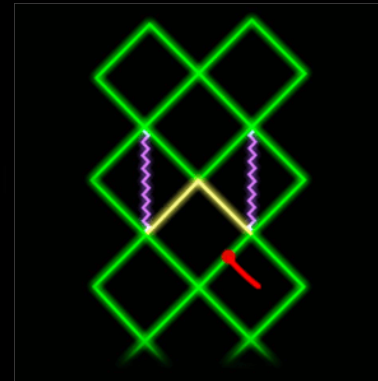
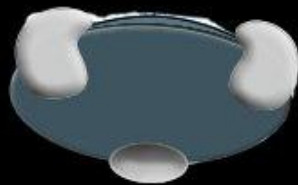
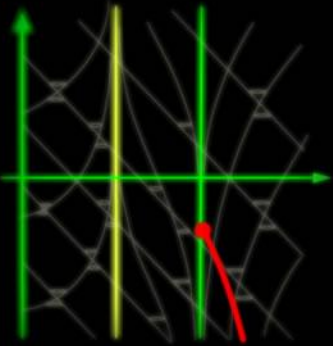
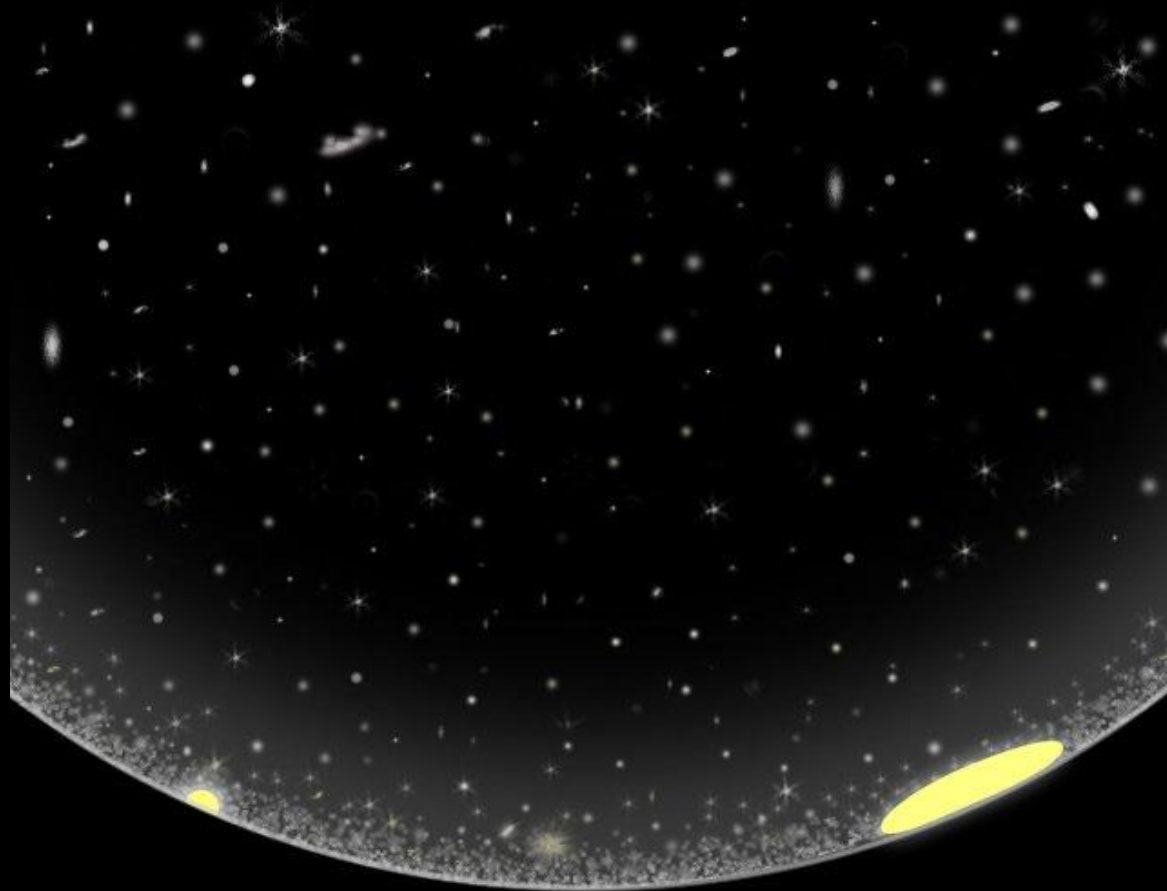
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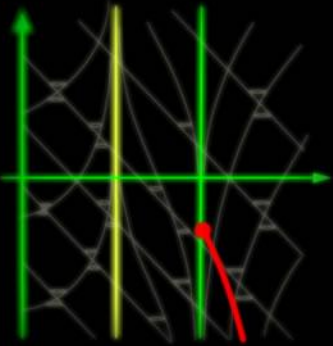
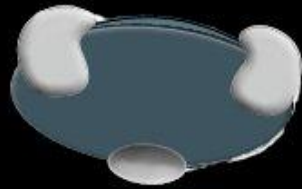
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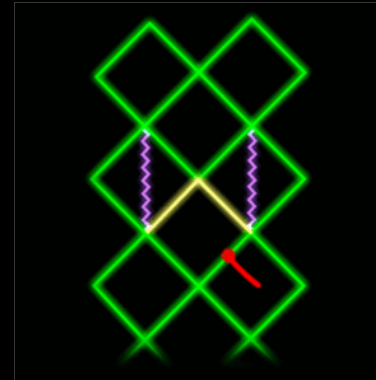
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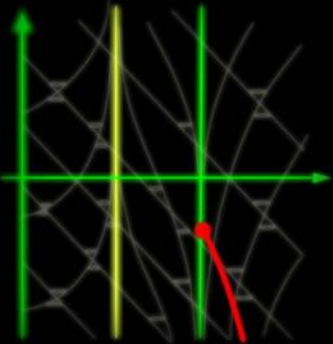
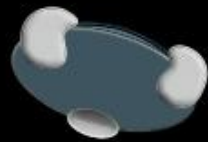
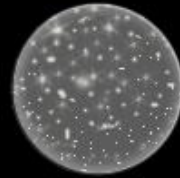
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Relativistic Hyper Computing

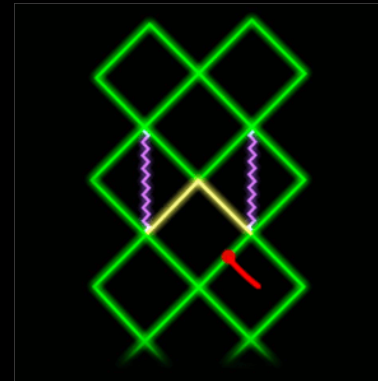


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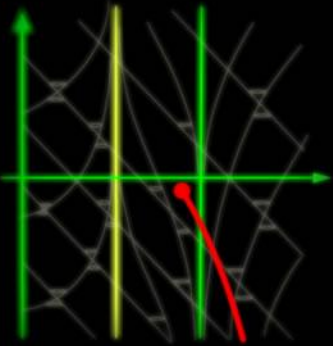


Relativistic Hyper Computing

Azores, September 7-11, 2009

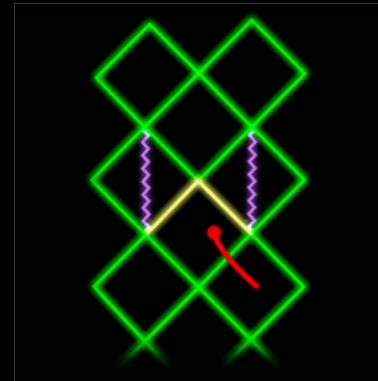


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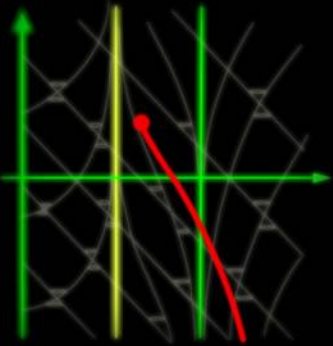


Relativistic Hyper Computing

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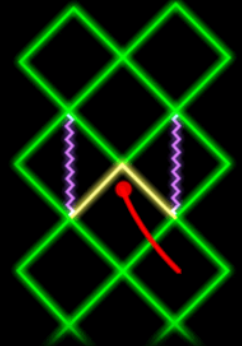


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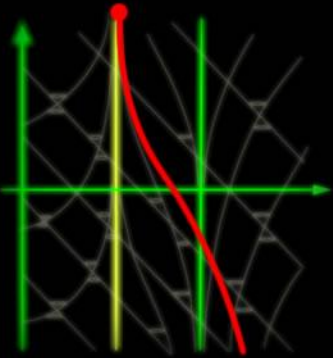
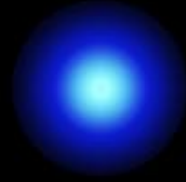


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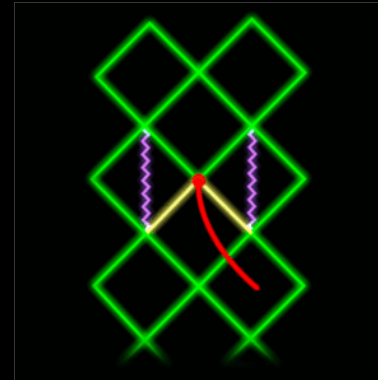


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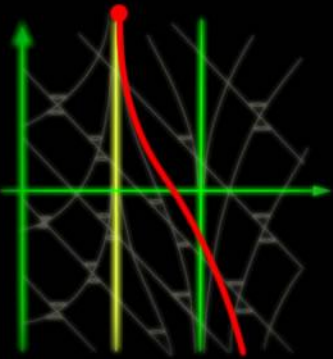


Relativistic Hyper Computing

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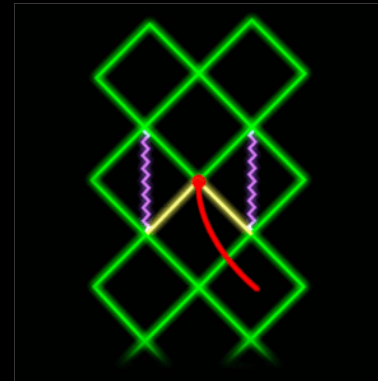


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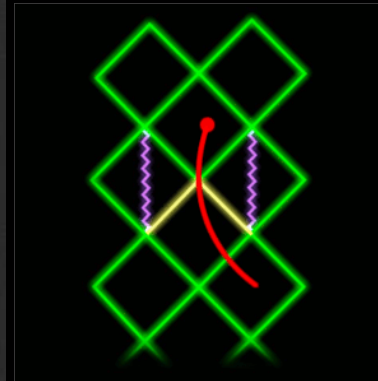
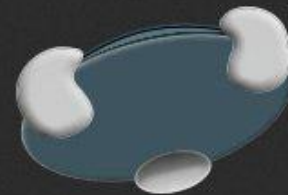
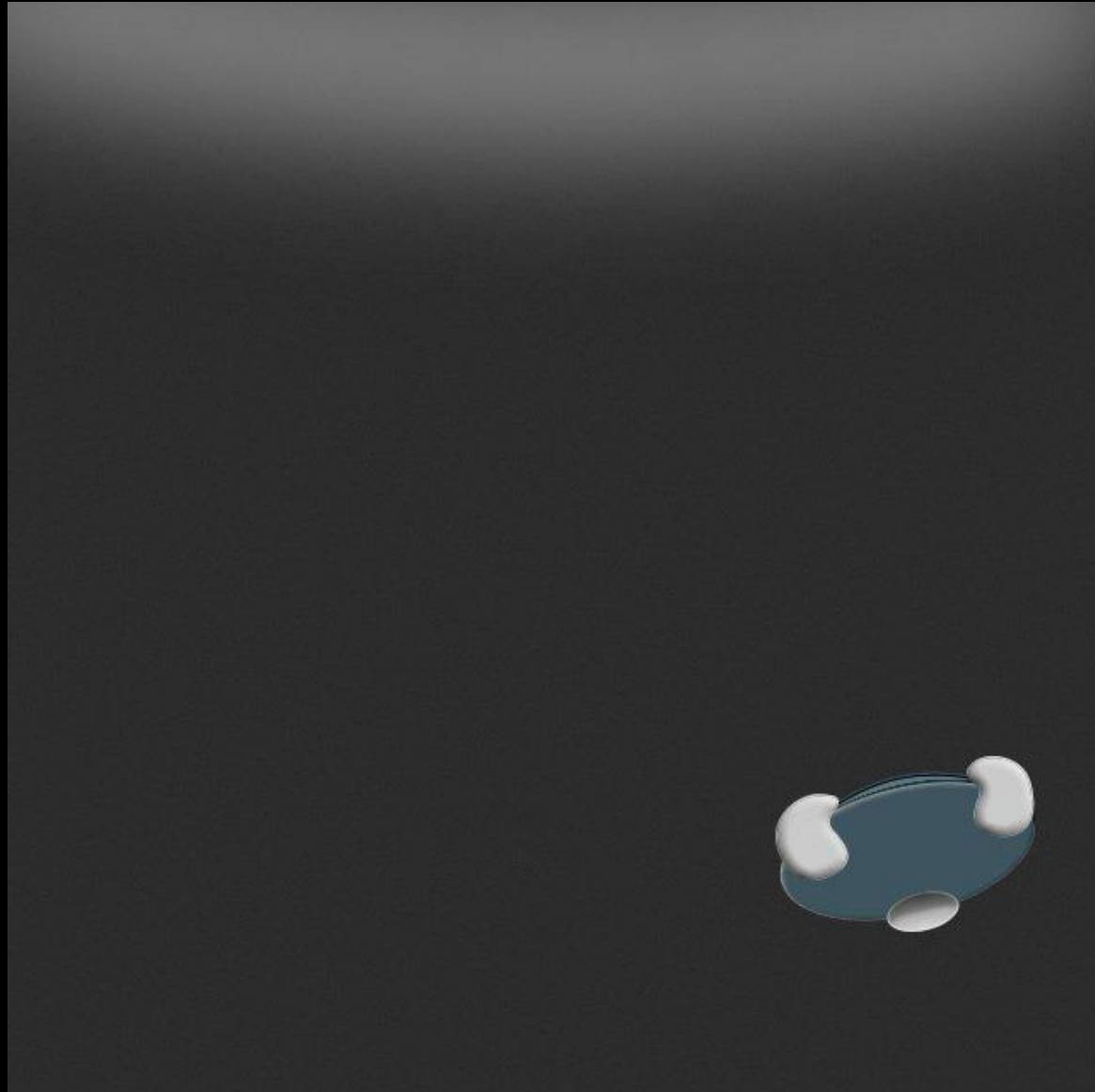


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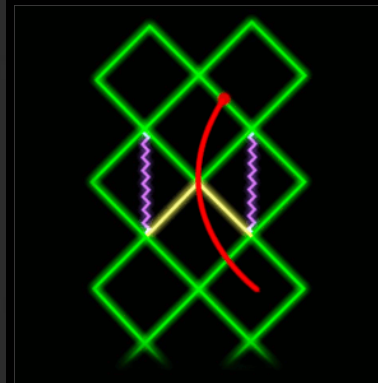
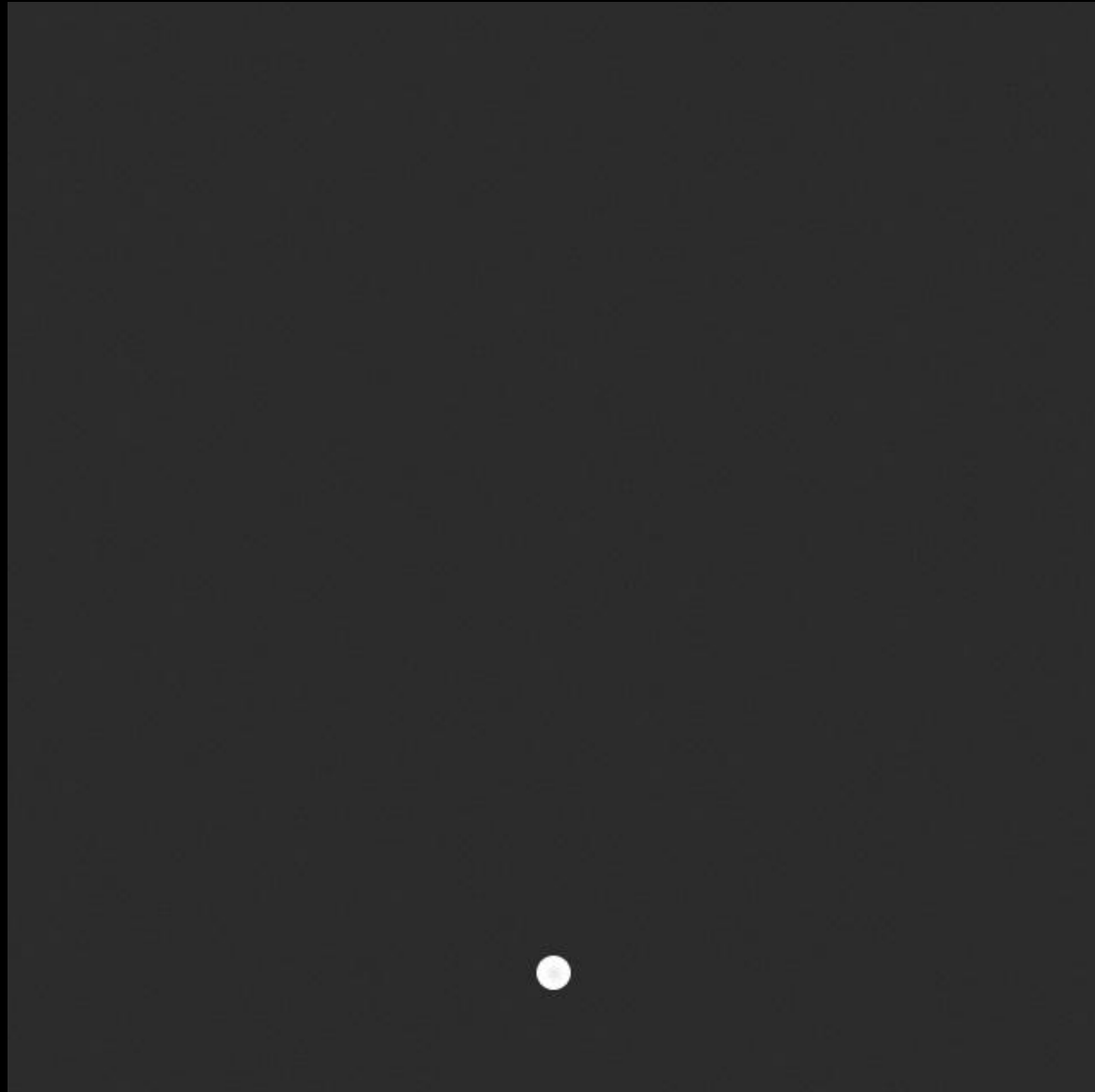
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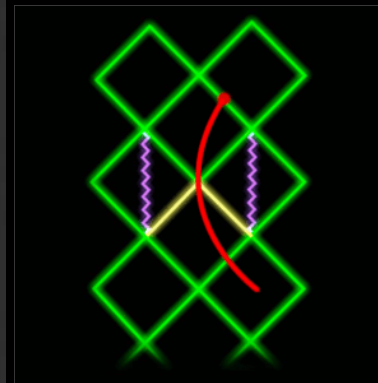
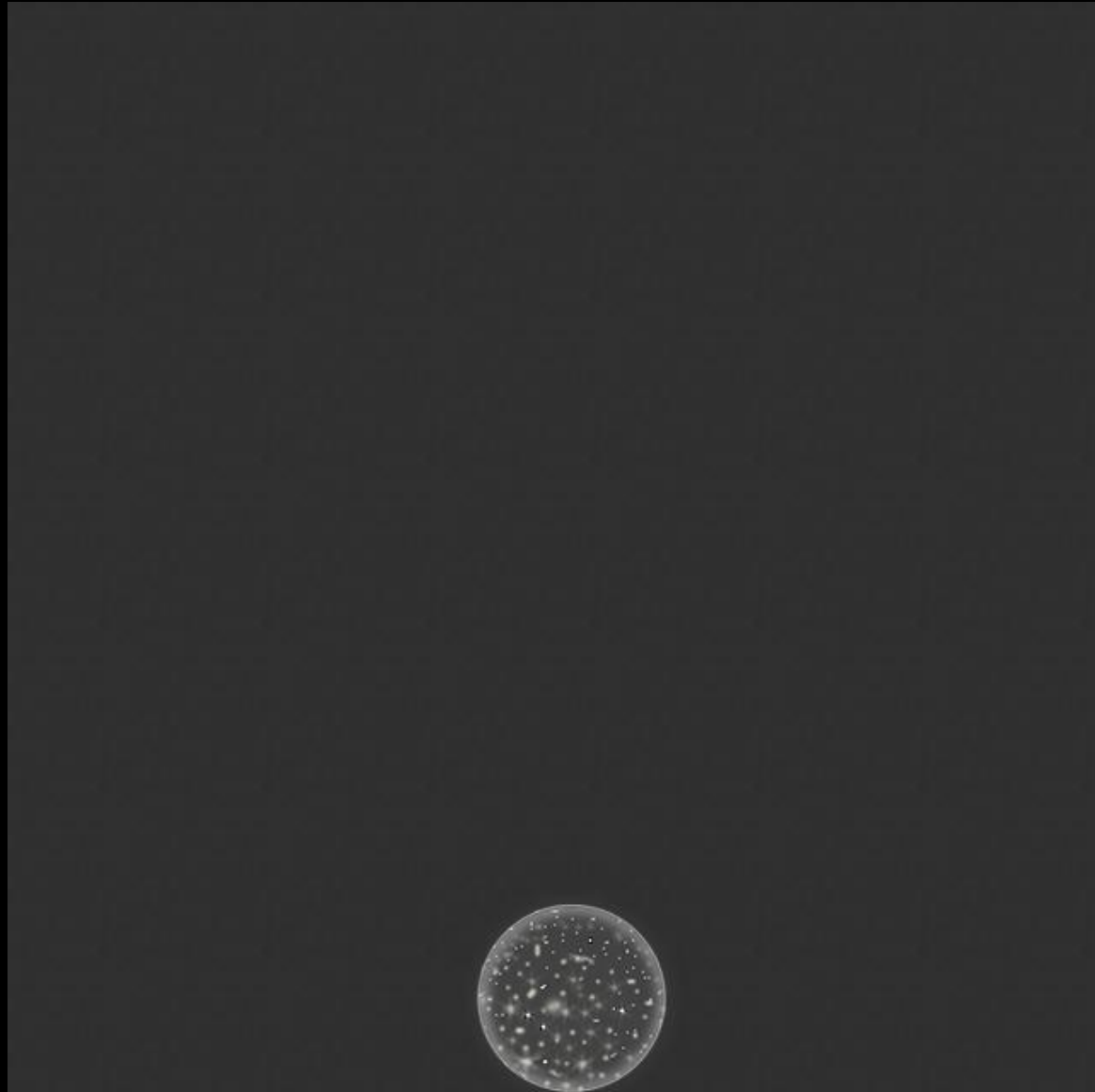
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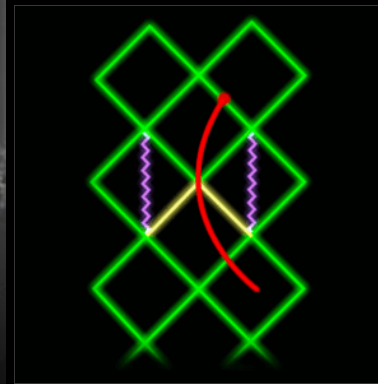
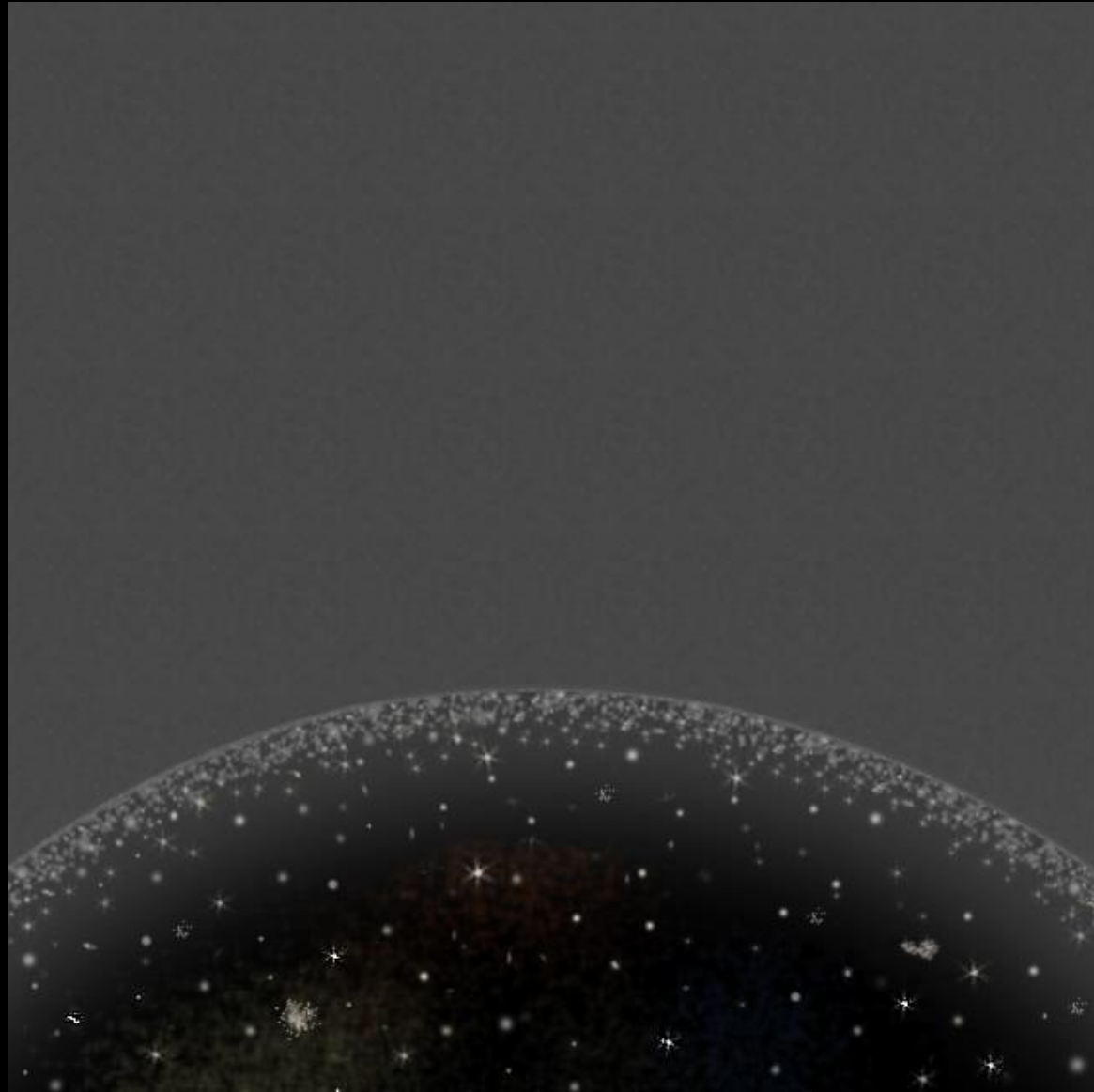
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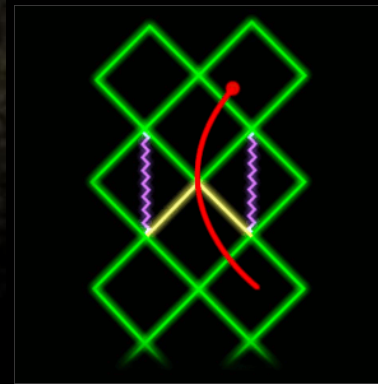
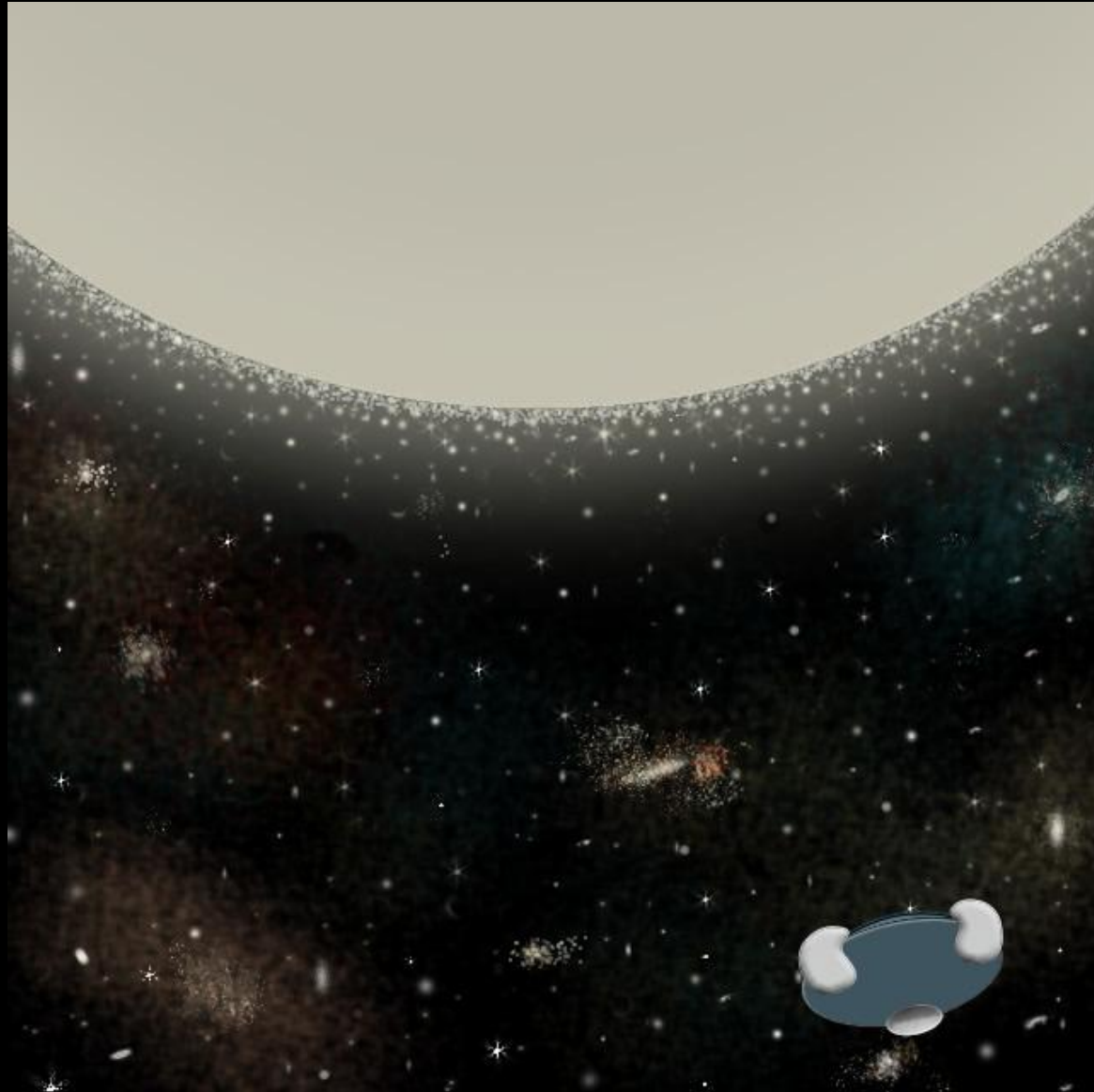
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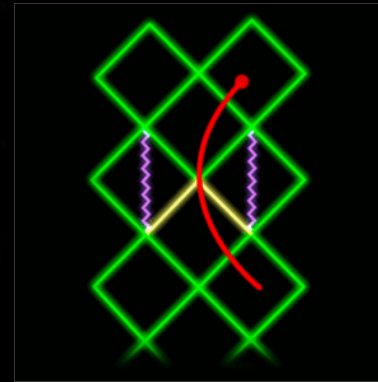
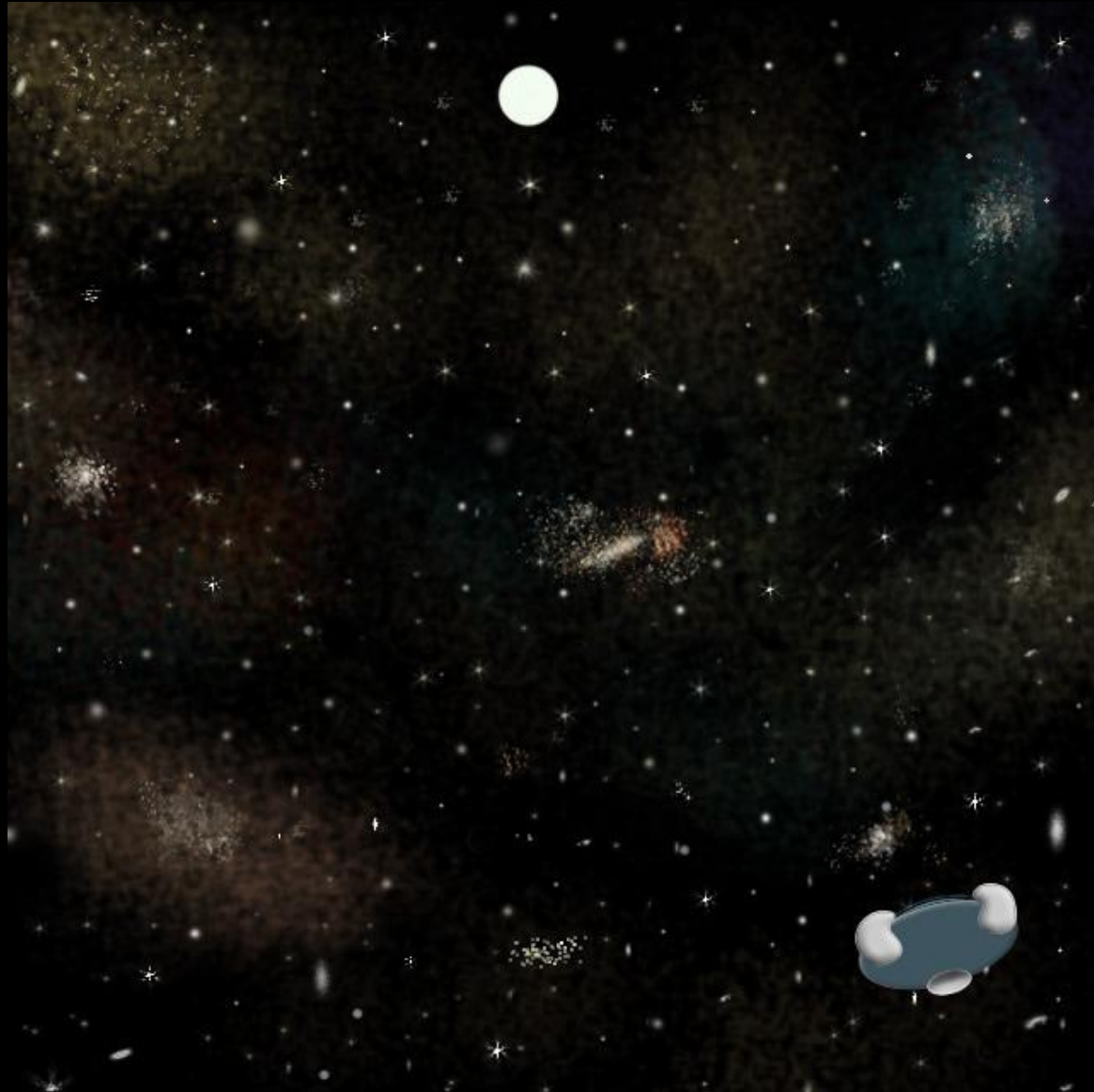
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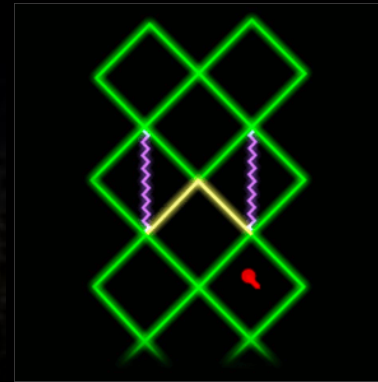
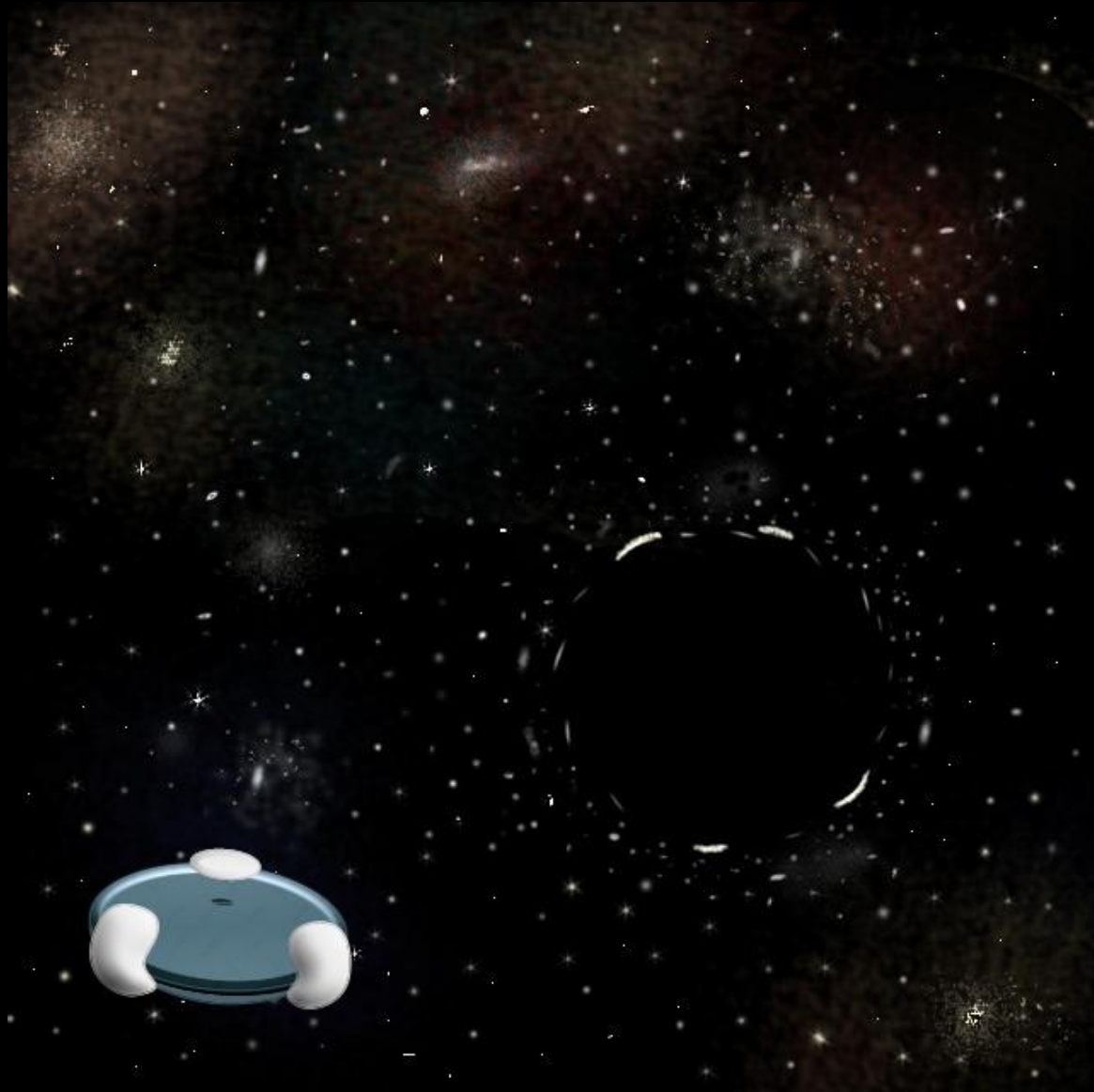
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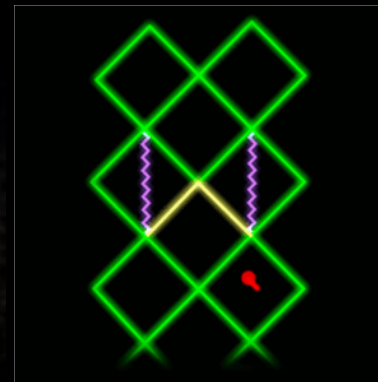
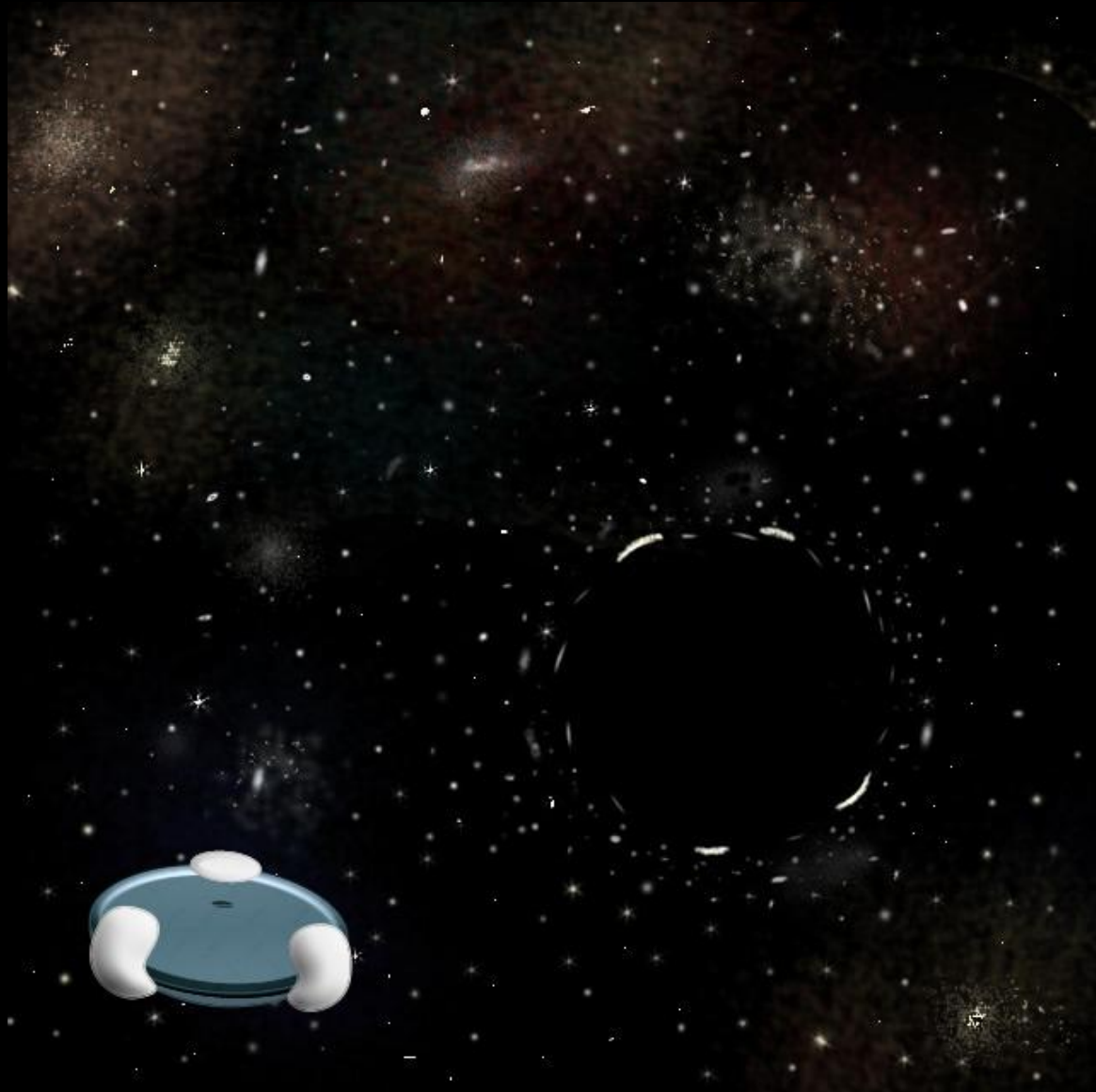
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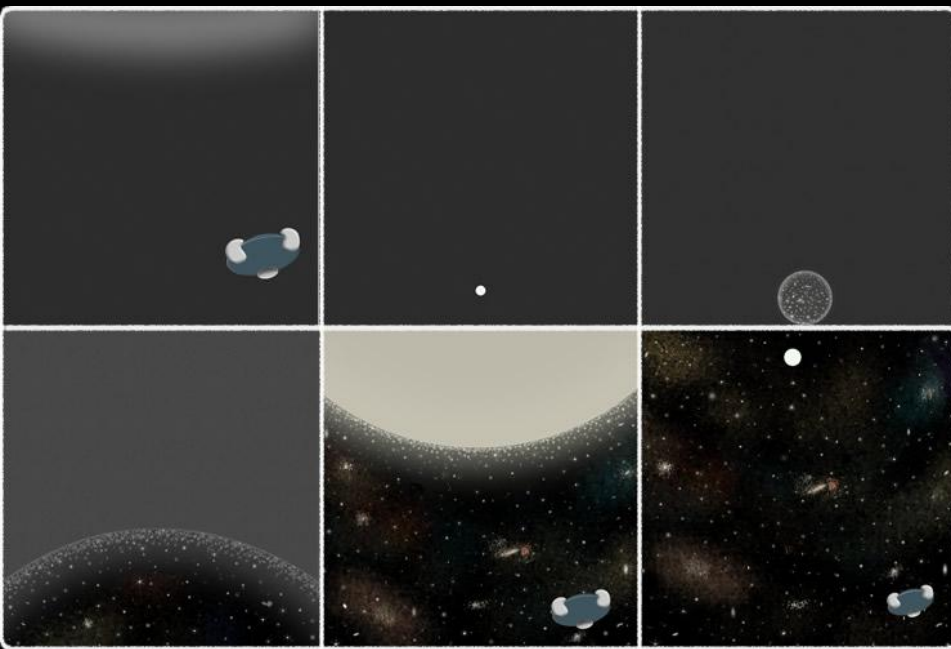
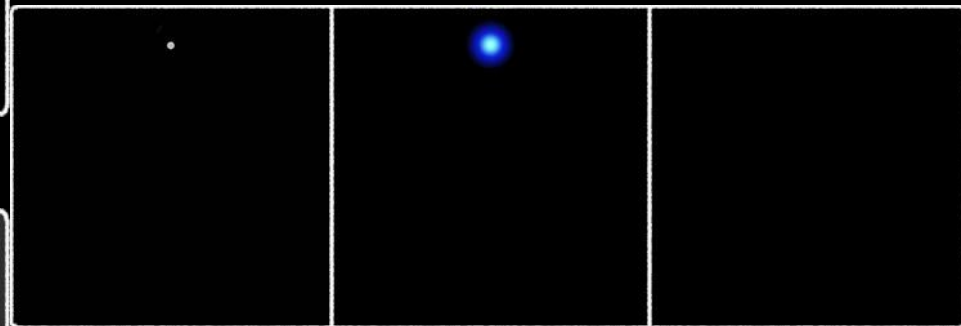
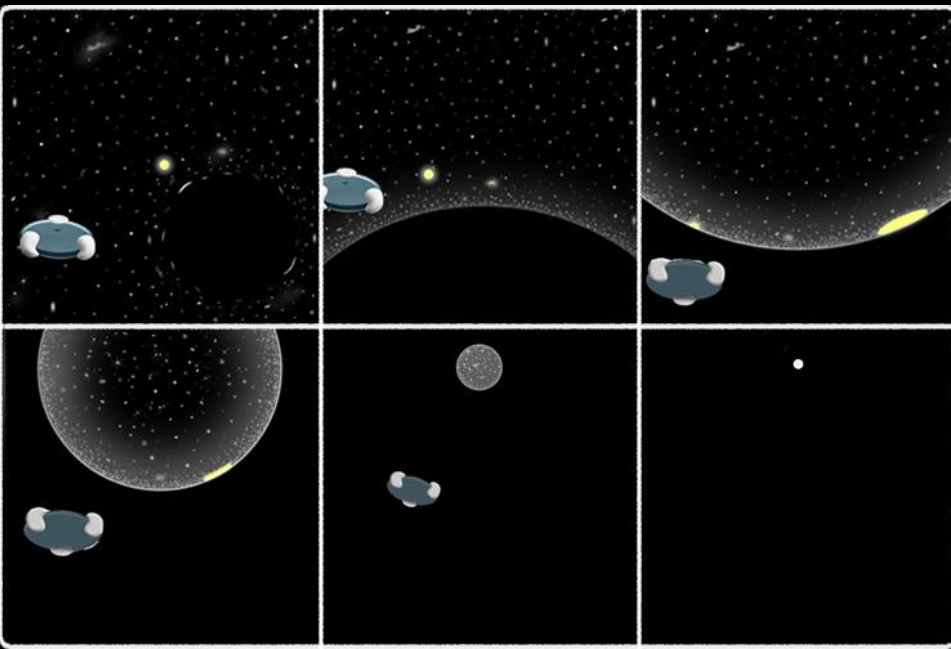
TRAVELLING THROUGH



TRAVELLING THROUGH – ALL TOGETHER

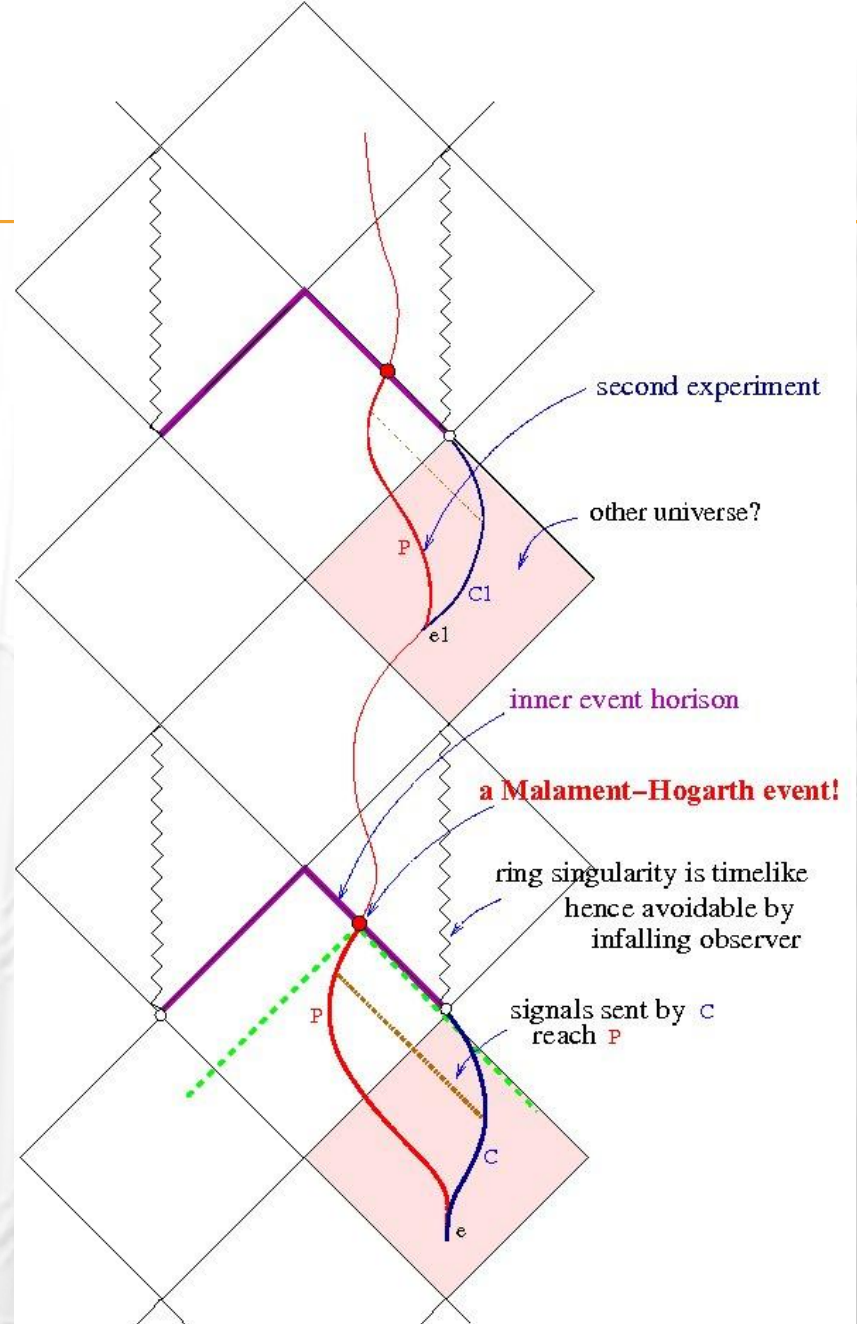


OVERVIEW



REALISTICITY

☞ Repeatable



WORRIES OR FLEXIBILITY OF OUR DESIGN

☞ G.R. → Hyper-Computing experiment

Implementation project

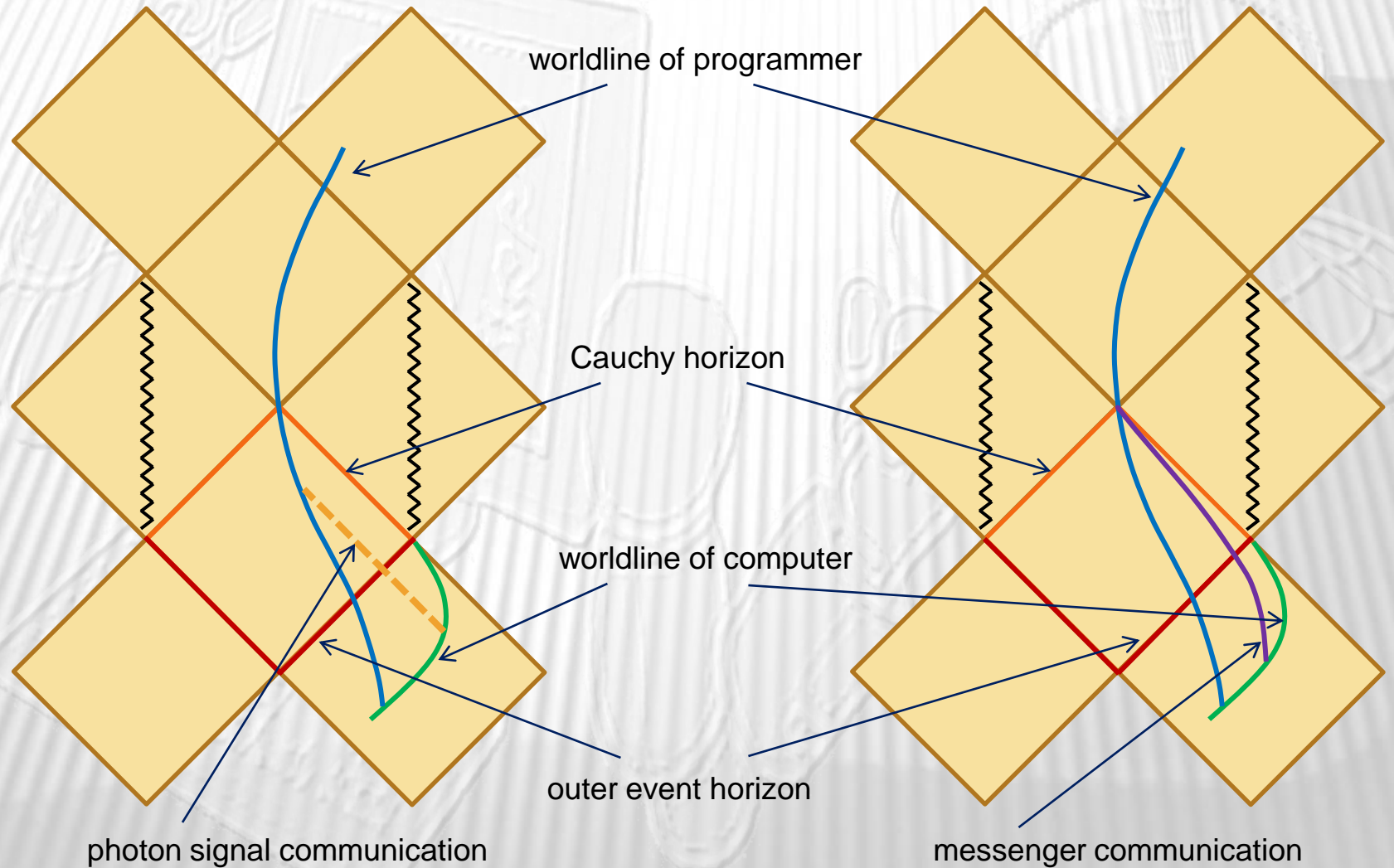
- ?
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WORRIES – ONE BY ONE

1. Blue shift (communication)
2. Evaporation of BH
3. Cosmic Censor Hypothesis
4. Instability of Cauchy Horizon
5. Blue shift (cosmic, distant galaxies)
6. Unlimited tape
7. Predictability, Repeatability, Radiation from singularity
8. Decay of protons
9. Heat Death

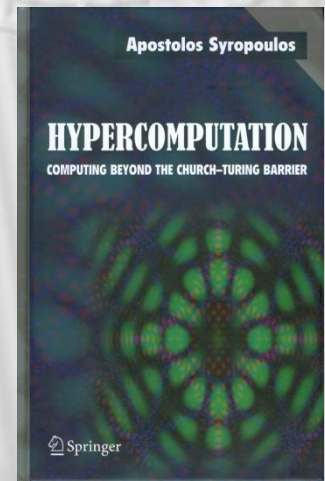
WORRIES: 1. COMMUNICATION BLUE SHIFT

already solved in [ND], Fig.5, sec.5.3.2, p.133



WORRIES: 2. EVAPORATION OF BH

- Shielding (only gradually) CMB
- Apostolos' book, p.146:
- Therefore since we are using a huge BH for hypercomputing, Hawking radiation should cause no problem.

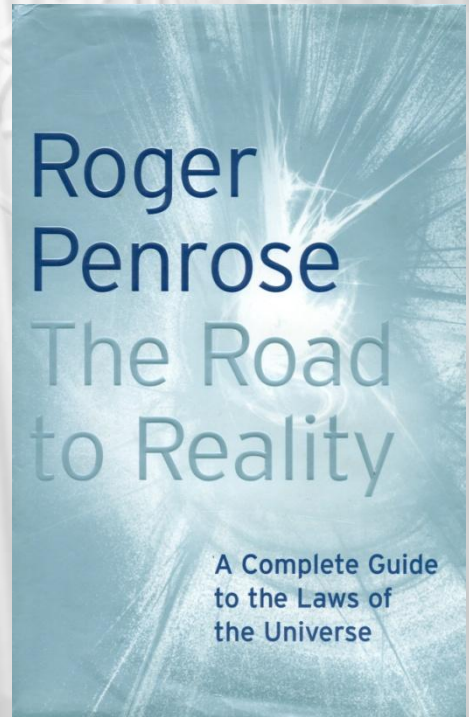


WORRIES: 2. EVAPORATION OF BH

- ☞ Evaporation is only hypothetical Penrose 2004, p.848:
 - ✦ “... BH evaporation is an entirely theoretical ... might be that Nature has other ideas for future of BH’s.”

☞ Papers:

- ☞ Nikolic, H., Black holes radiate but do not evaporate. arXiv:hep-th/0402145v3, Aug 2005.
- ☞ Helfer, A. D., Do black holes radiate? arXiv:gr-qc/0304042v1, Apr 2003.

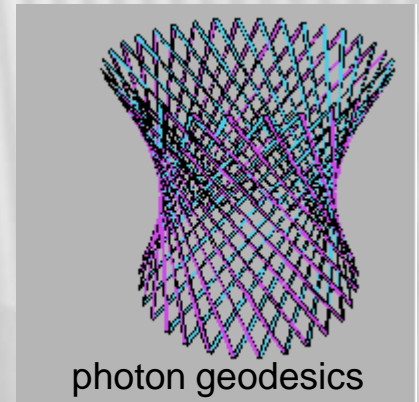
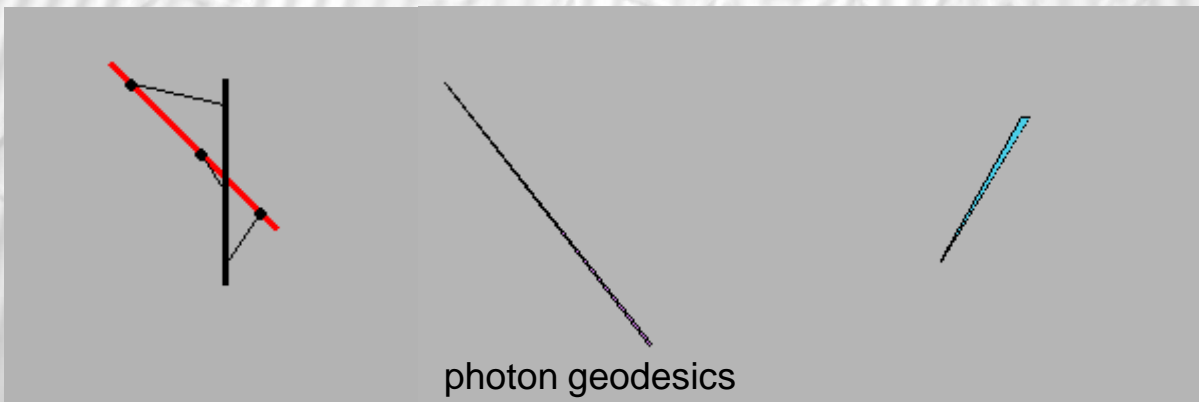
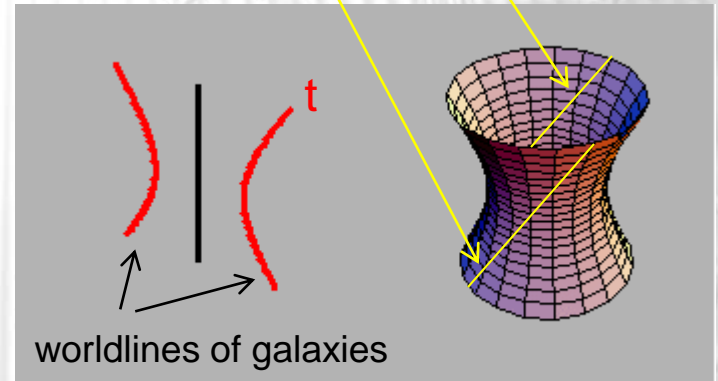


WORRIES: 3. - 4. - 5.

- 3. Cosmic Censor Hypothesis
 - 4. Instability of Cauchy Horizon
 - 5. Blue shift (cosmic, distant galaxies)
- Expansion of Universe forever
 - Asymptotically de Sitter background implies stability

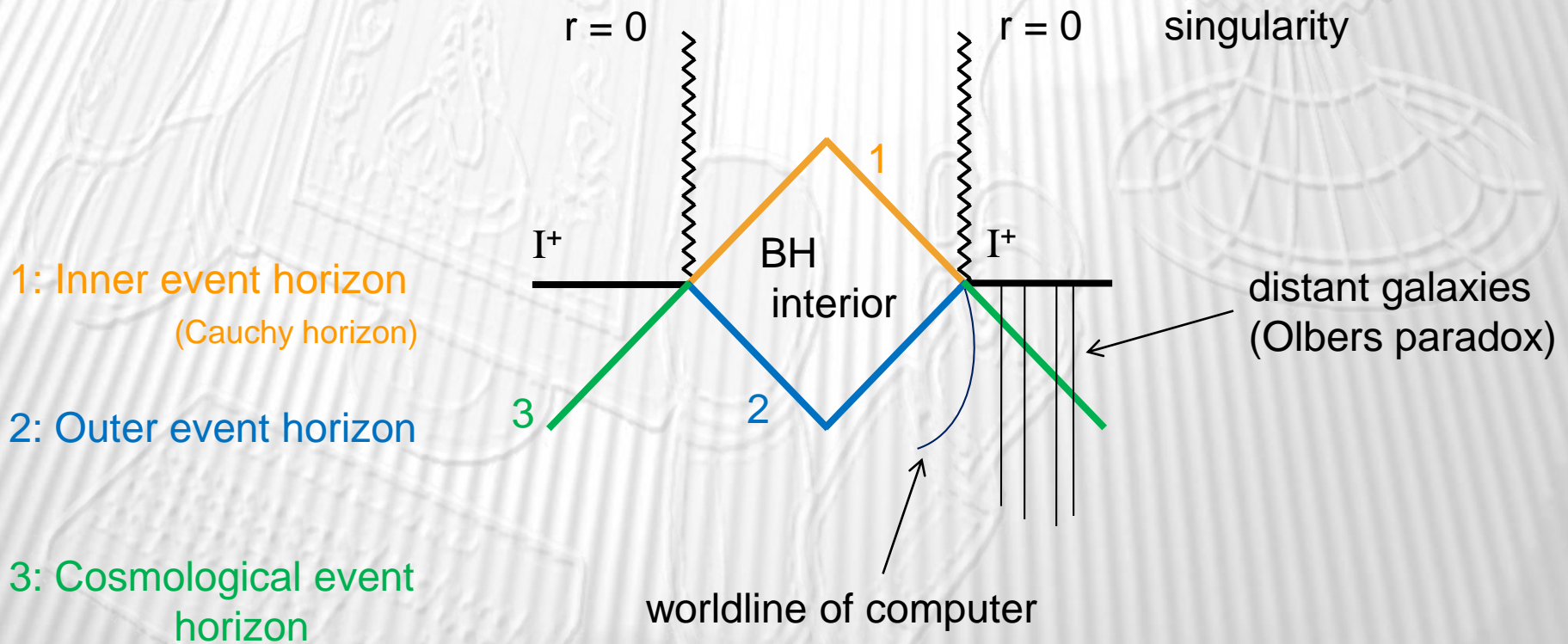
FOREVER EXPANDING UNIVERSE

cosmological event horizon



KERR-NEWMANN WORMHOLE IN FOREVER EXPANDING UNIVERSE

Kerr-Newmann-deSitter space-time



WORRIES: 3. – 4. – 5.

☞ Papers for “fall of censor”:

- ✦ Joshi, P.S., Do naked singularities break the rules of physics? Scientific American, January 2009.
- ✦ Chambers, C. M., The Cauchy horizon in black hole-de Sitter spacetimes. arXiv:gr-qc/9709025v1, Sep 1997.
- ✦ German, W.S., Moss, I.A., Cauchy horizon stability and cosmic censorship. arXiv:gr-qc/0103080v1, Mar 2001.
- ✦ Lobo, F.X. N., Exotic solutions in general relativity: traversable wormholes and “warp drive” spacetimes. arXiv:0710.4474v1 Oct 2007.

WORRIES: 3. – 4. – 5.

☞ Weak Energy Condition is not LAW:

- ✦ Barcelo, C., Visser, M., Twilight for the energy conditions?, Int. J. Mod. Phys. C 11 (2002), 1553.
- ✦ arXiv:gr-qc/0205066.
- ✦ Cosmology accelerated expansion, dark energy
- ✦ Wormholes' boom implies new kinds of MH-regions

WORRIES: 6. – 7. – 8.

➤ 6. Unlimited tape

information \neq energy

➤ 7. Predictability

➤ Repeatability

➤ Radiation from singularity

New orbit for programmer

➤ 8. Decay of protons

Small enough particles do not decay
(electron, positron, neutrino)

➤ 9. Heat Death

OUTCOME / APPLICATIONS

➤ ZF consistency

- ✦ „Prove that your set theory is consistent” (by Gödel’s THM impossible)
(motivated by Martin Löf Foundation)

➤ Touching the actual ∞

➤ Validity of FOL – formulas

➤ Halting problem for TM’s

➤ Working with „Deep Thought” 😊

(Hitchhikers Guide to the Galaxy)

PEOPLE, HISTORY

History of relativistic computing

☞ 1987 - start:

Andréka & Németi Univ. Ames USA Lecture Notes

☞ 1992 - Independent start:

Hogarth (Cambridge)

☞ Other authors:

Pitowsky (Israel), Shagrir (Israel), Earman (Pittsburgh), Norton (Pittsburgh), Malament (USA), Etesi (Hungary, Dept. Phys.), Dávid (Hungary, Dept. Phys.), Tipler, Barrow, Jiří Wiedermann, Gyenis B. (Pittsburgh)

AND IF WE STILL HAVE TIME...



ANOTHER

MOVIE

PUBLICATIONS

More concrete material available from our group:

(1) Logic of Spacetime

<http://ftp.math-inst.hu/pub/algebraic-logic/Logicofspacetime.pdf>

(2) in General Relativity and Gravity

<http://www.math-inst.hu/pub/algebraic-logic/AndrekaNemetiWuthrich07.pdf>

(3) in foundation of Physics

<http://ftp.math-inst.hu/pub/algebraic-logic/springer.2006-04-10.pdf>

(4) FOL 75 papers

<http://www.math-inst.hu/pub/algebraic-logic/foundrelo3nov.html>

<http://www.math-inst.hu/pub/algebraic-logic/loc-mnt04.html>

(5) our e-book on conceptual analysis of SpecRel

<http://www.math-inst.hu/pub/algebraic-logic/olsort.html>

(6) Some papers available, and some recent work

<http://www.renyi.hu/~nemeti/>

Thank you!

THE WAY TO GET THROUGH THE TURING BARRIER

