ERC in Our Research

Gia Dvali

ERC-SRNSF meeting
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In this talk I will mainly focus on our experience with ERC

Members of ERC team:

Cesar Gomez (Professor)

Deb Sarkar
Alexis Helou
Kepa Sousa
} Post docs

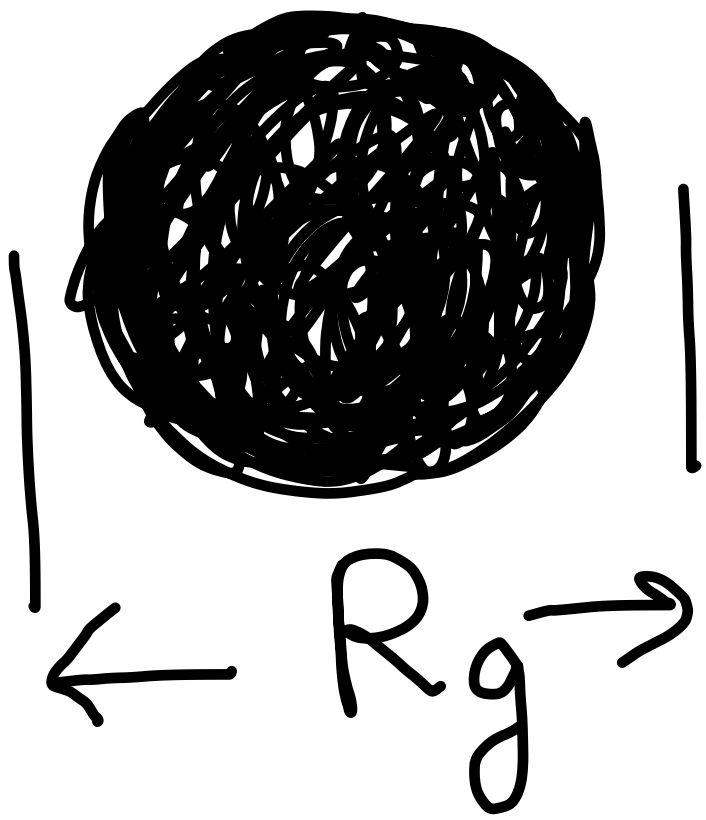
Jaba Chelidze
Misha Panchenko
Raul Letschka
} Ph.D. students

Collaborators:

Cesar Gomez

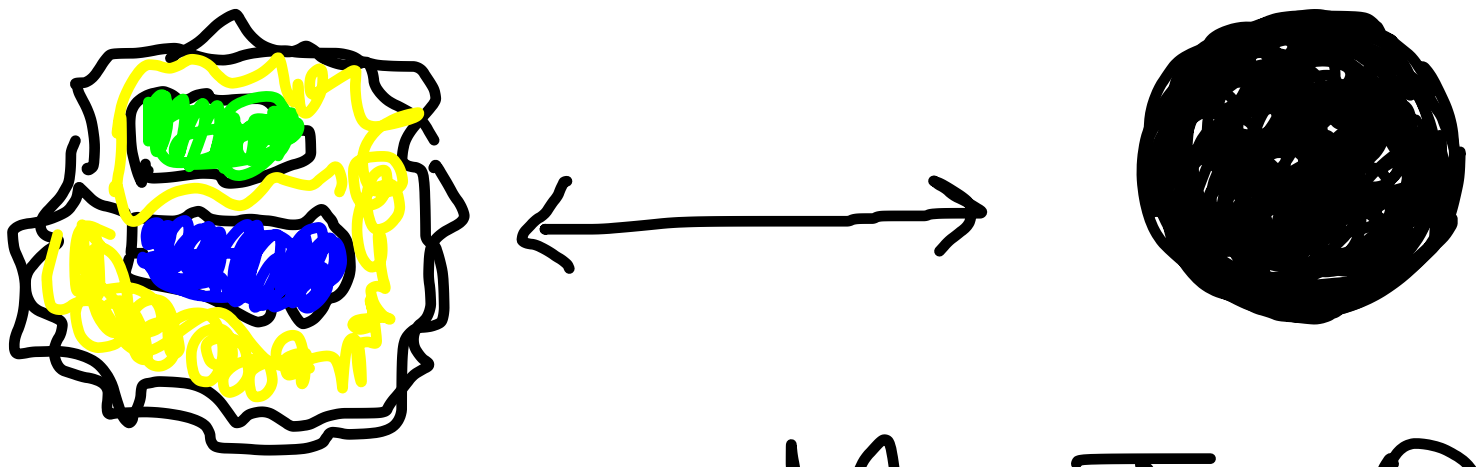
Daniel Flassig
Alex Pritzel
Nico Wintergerst
Andre França
Mischa Panchenko
Pieter Lüst
Alex Gussmann
Artem Averin
Sebastian Zell ...

An object contracted beyond Rg becomes a flack hole



Escape velocity = speed of light

Classically black holes are featureless



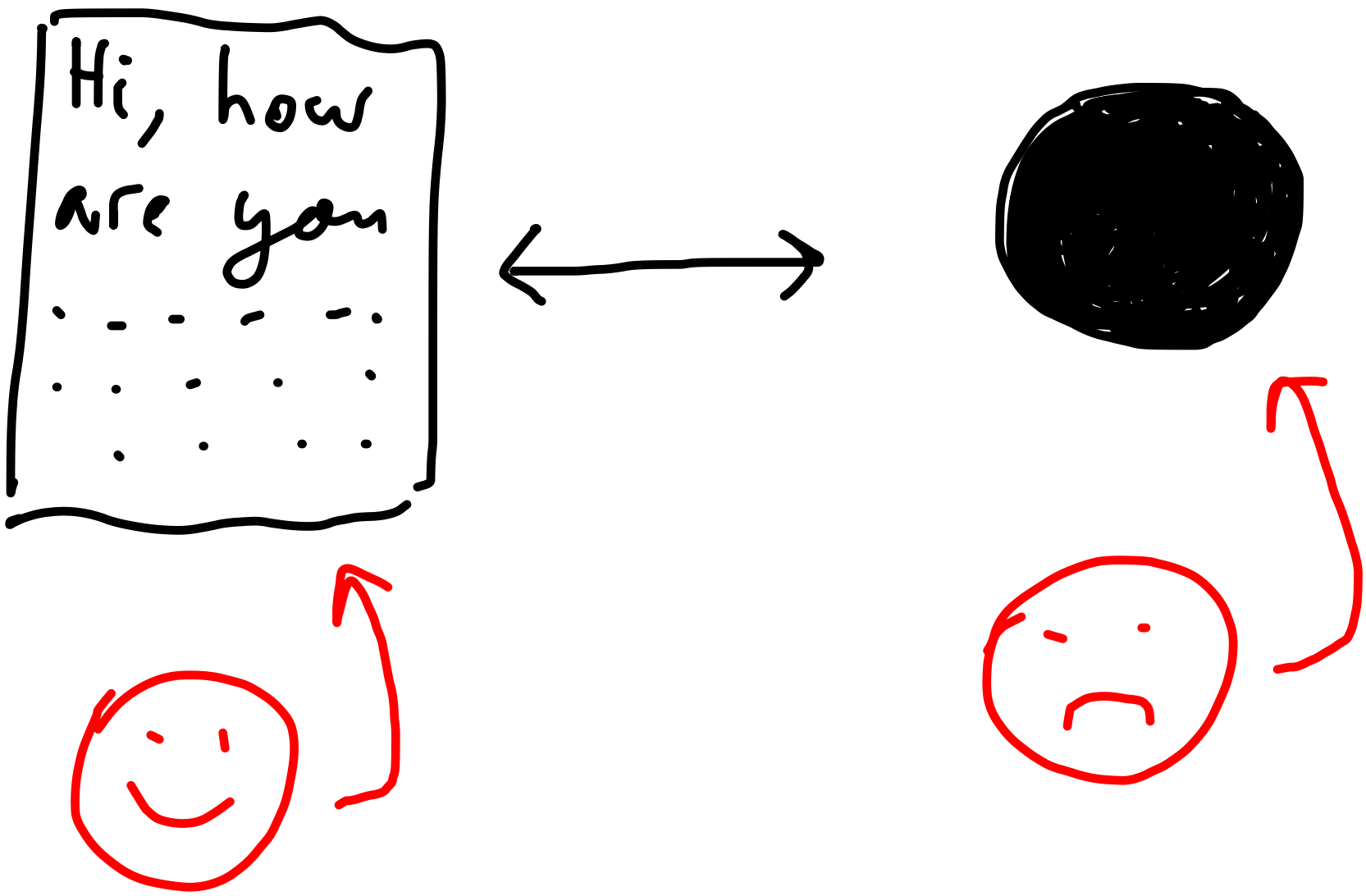
M, J, Q

mass

angular momentum

electric charge

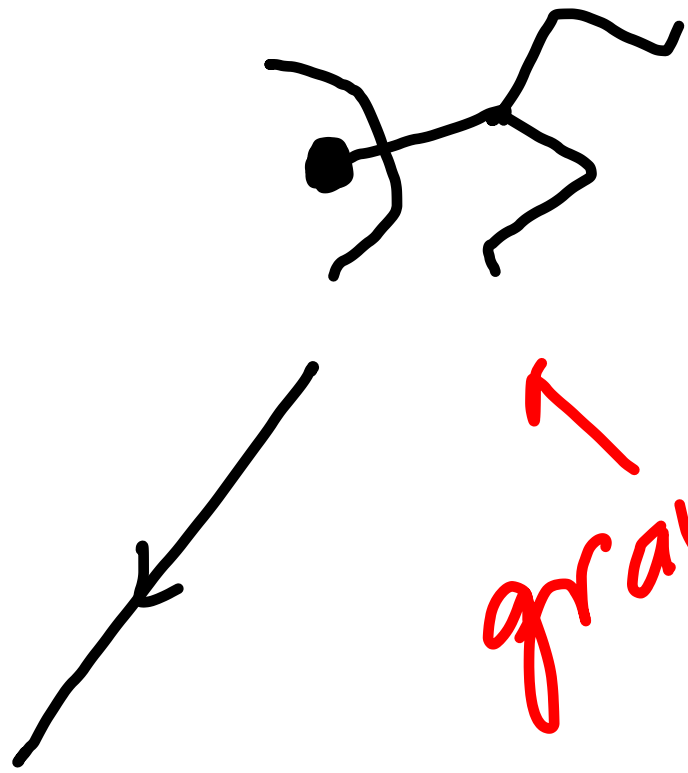
This means I cannot send you a message encoded in black hole features!



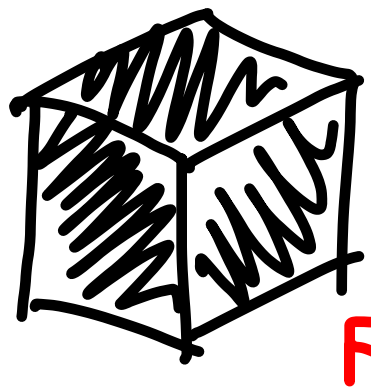
From here one would naively conclude that black holes carry very little information.

$$\text{Info} = 0$$

But, quantum theory tells us a very different story!



gravitational force



Box with information

Consequences:

① The shortest length of nature!

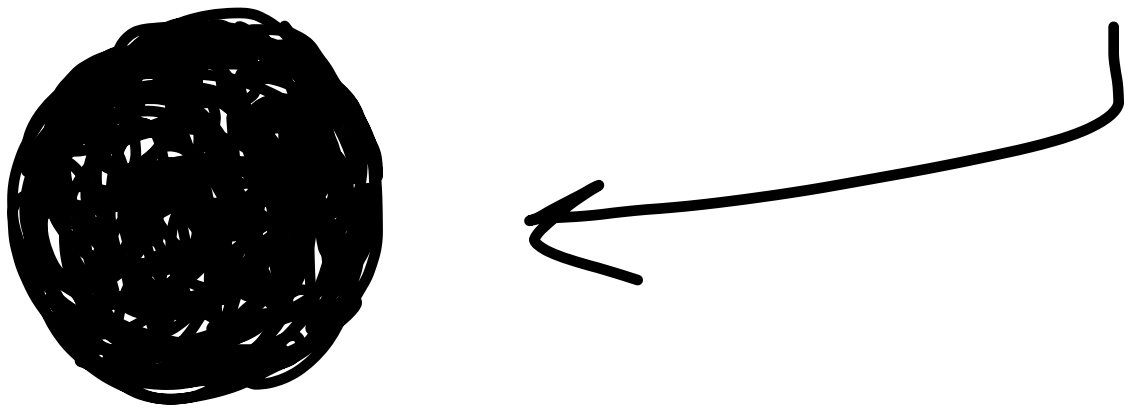
Planck length

$$L_P \equiv \sqrt{\hbar G_N} \sim 10^{-33}\ \text{cm}$$

Bound on Information (Bekenstein)

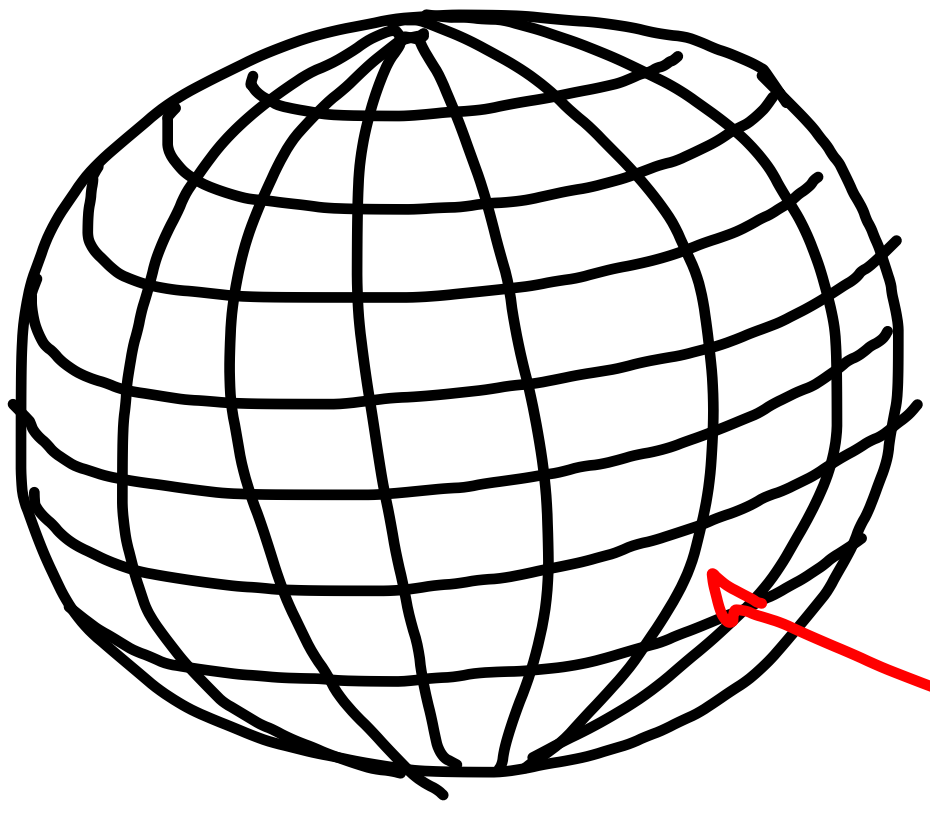
$$N_{max} = \left(\frac{R}{L_P}\right)^2$$

Saturated by black hole!



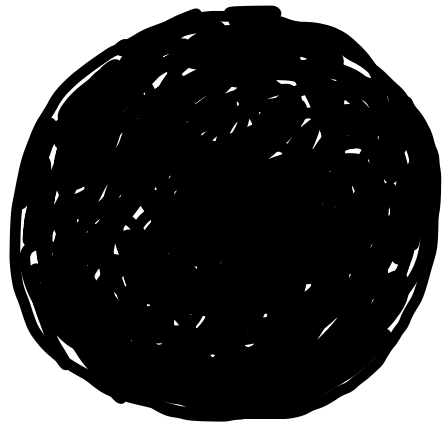
Black hole carries a maximal information (per size) given by Bekenstein entropy

$$N = \left(\frac{R_g}{L_p}\right)^2$$



Plahck area pixels

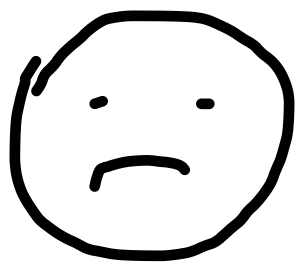
But, I told you minute ago that classical black hole is featureless!



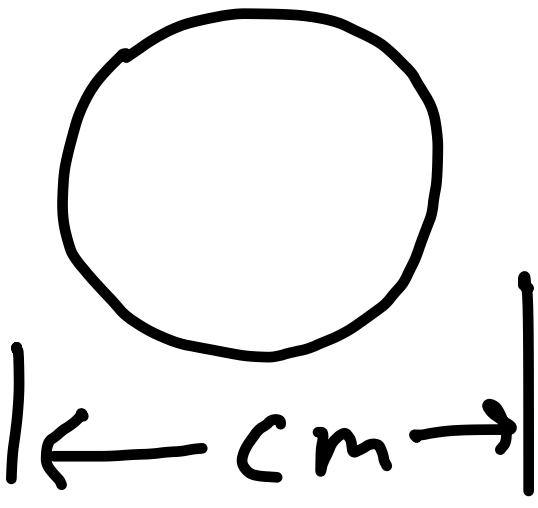
info = 0

$0 = \infty$

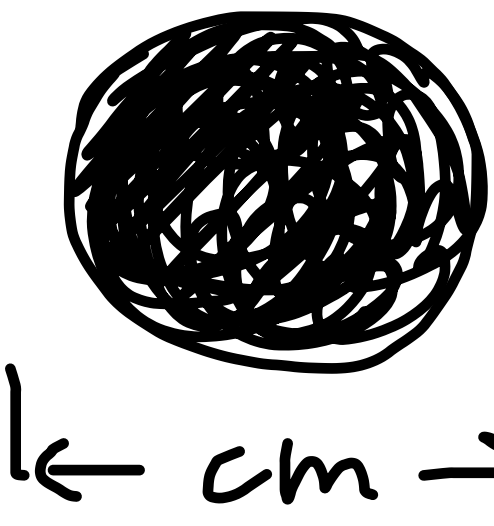
?



Example



$\Delta E \sim 10^{-4}\ eV$



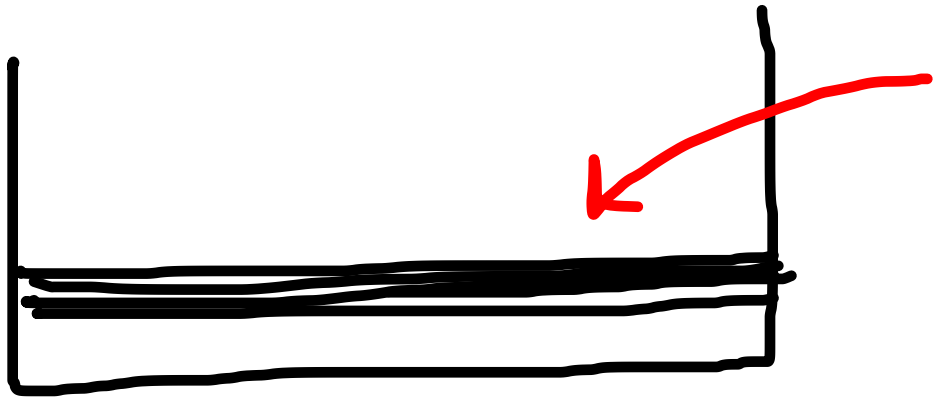
$\Delta E \sim 10^{-70}\ eV$!

Black hole

Black hole has the cheapest qufits!

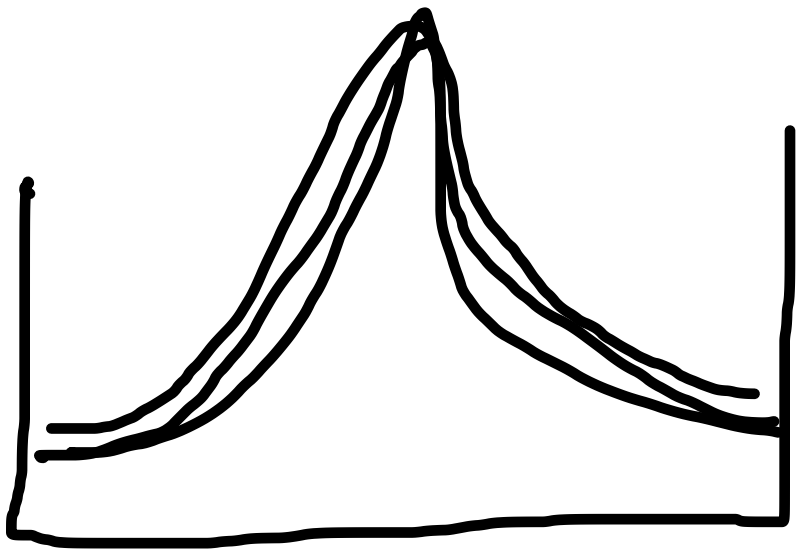
Understanding black holes in terms of universal phenomenon of quantum criticality of attractive cold bosons (gravitons)

N bosons (gravitons) in a box



wave function

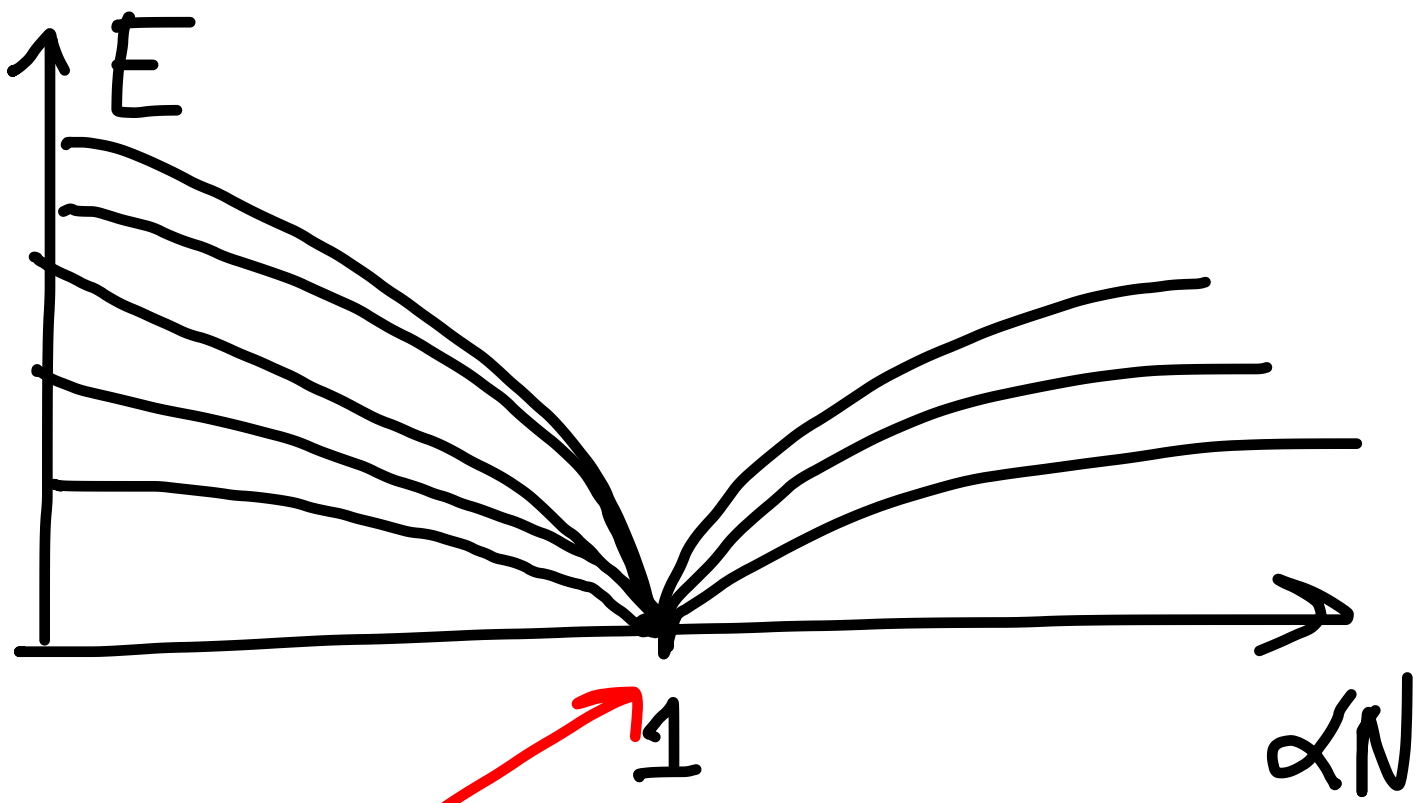
$\alpha N < 1$



$\alpha N > 1$

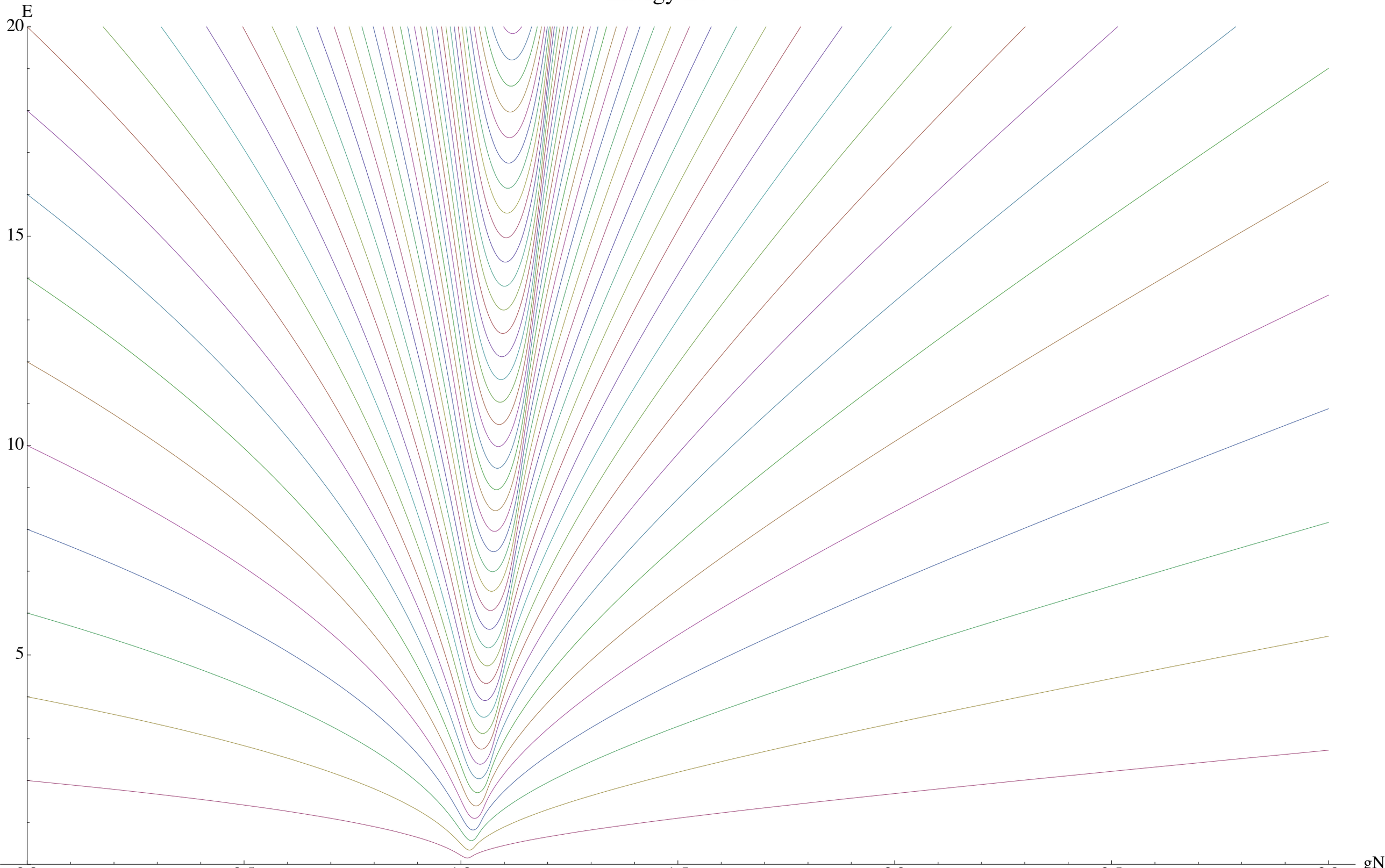
↑ collapse

$\alpha N = 1$ ← Critical point of quantum phase transition



Many cheap (gapless) qubits!

Energy Levels



One particle Entanglement Entropy

S_{ent}

1.0

0.8

0.6

0.4

0.2

0.0

0

2

4

6

8

10

gN

N=10

N=2000

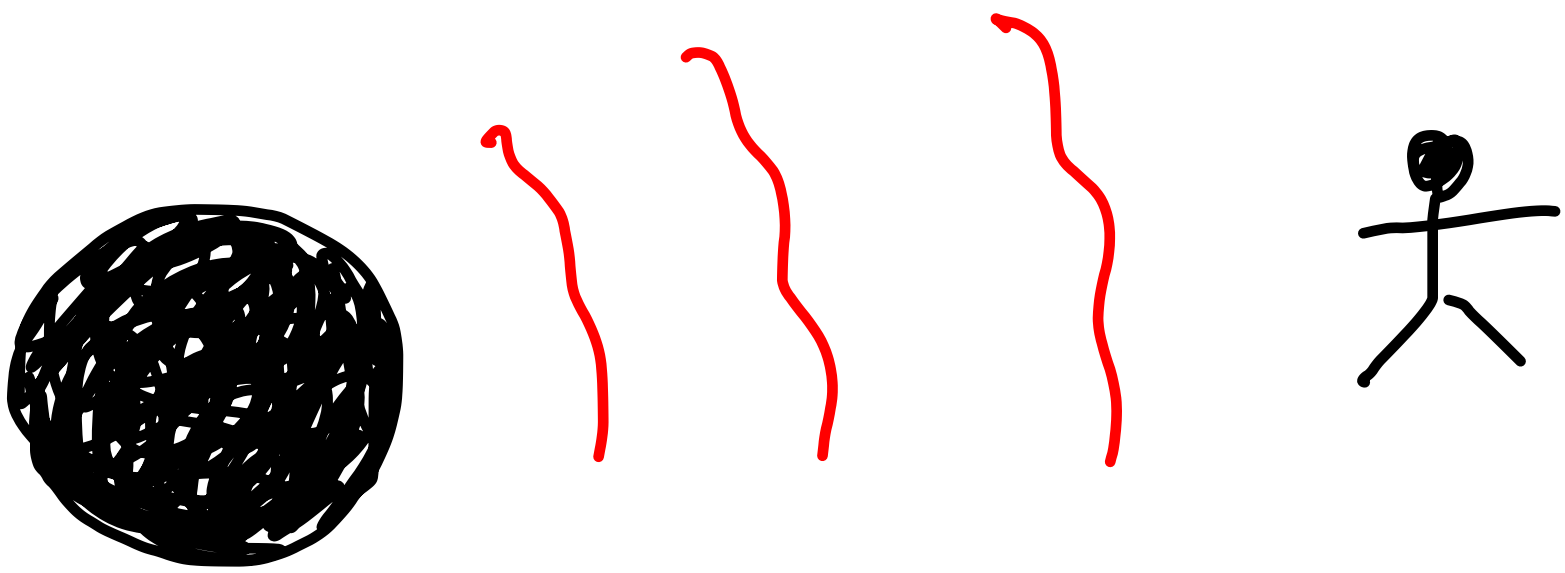
ln(3)

Black hole = Many gravitons at quantum critical point!

Self-sustained quantum criticality.

There is no paradox:

$\hbar \to 0$ black hole indeed carries $\underline{\underline{\infty}}$ information.



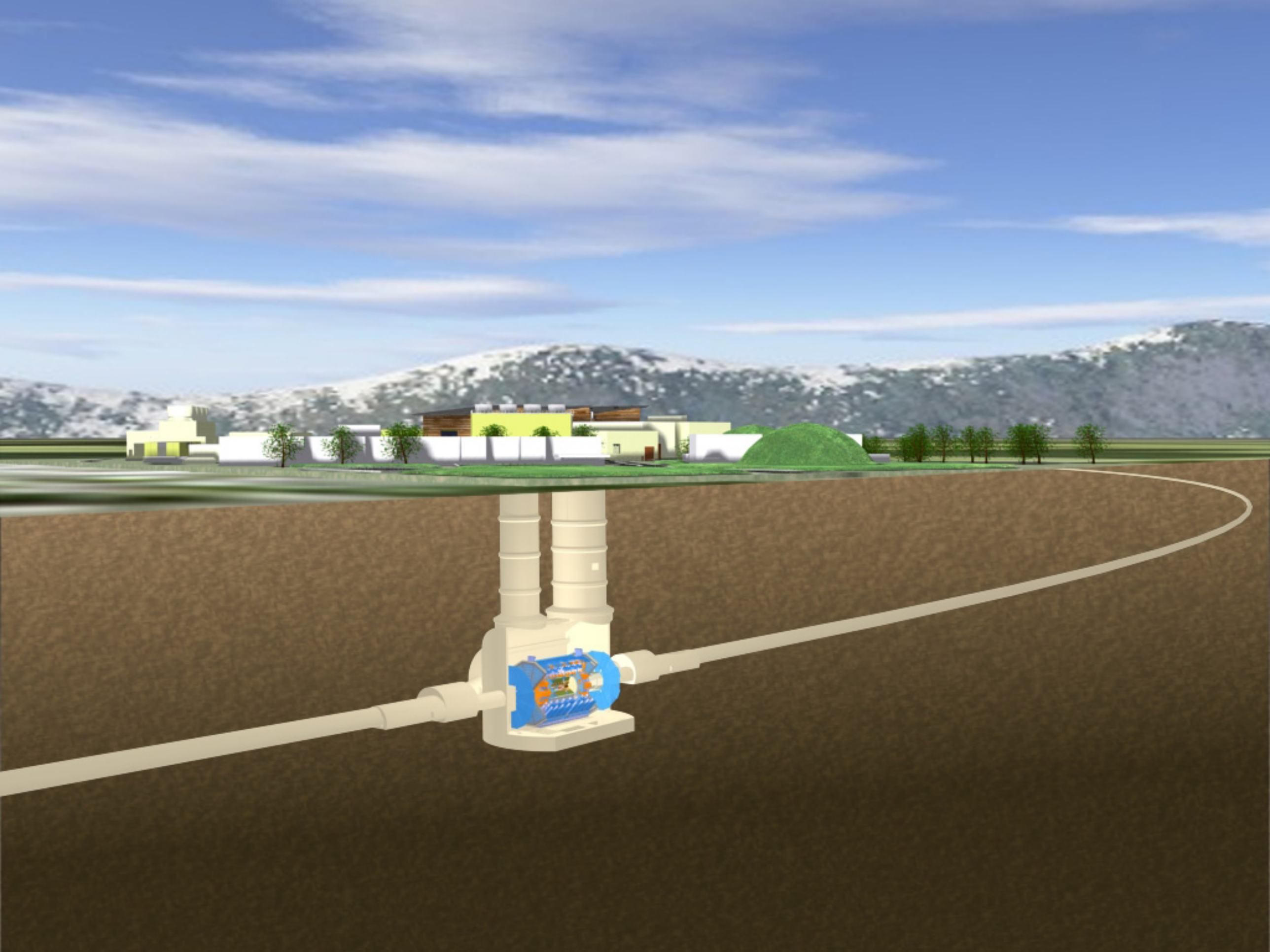
However it takes

$t = \infty$ to read it!

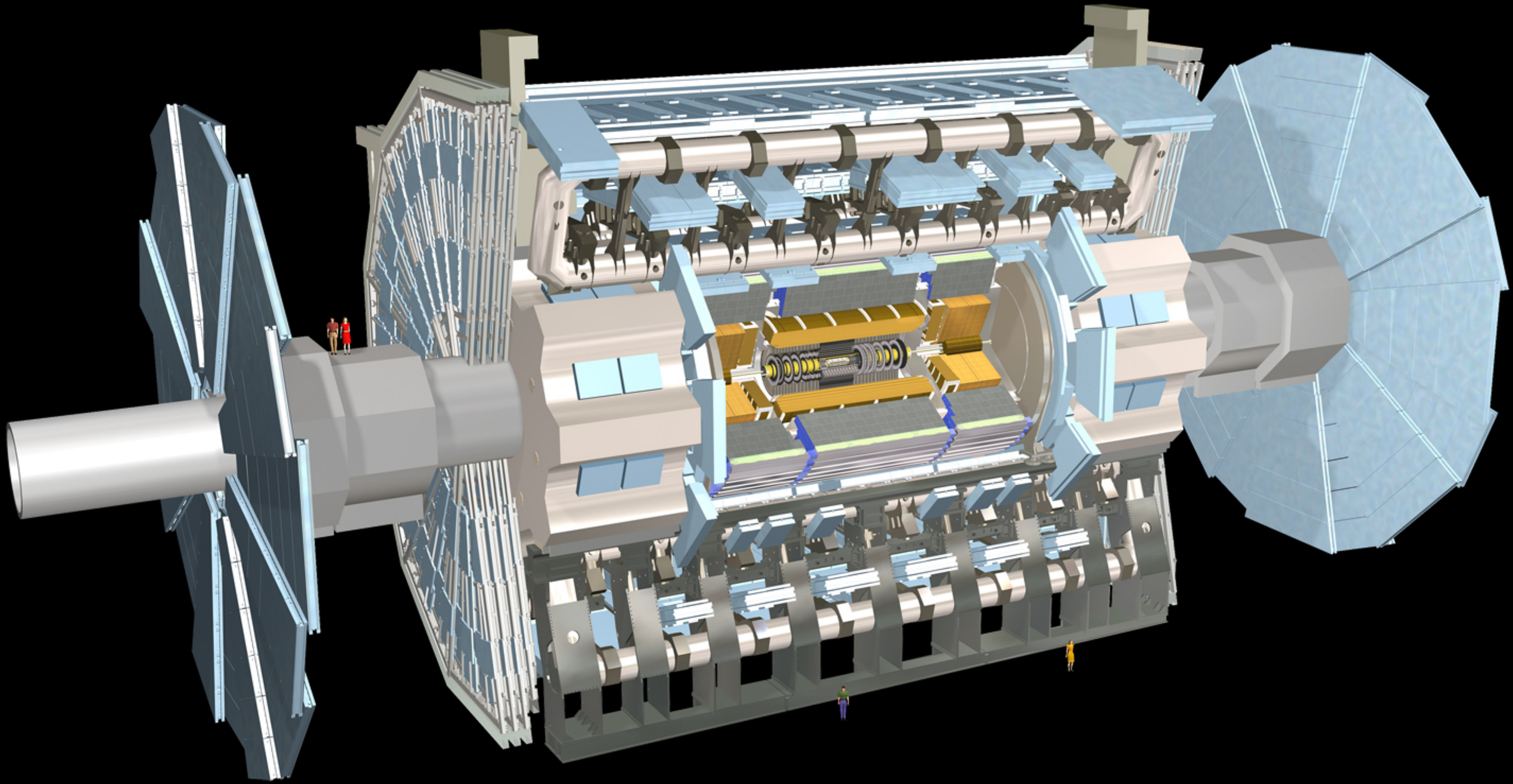
Experimental prospects:

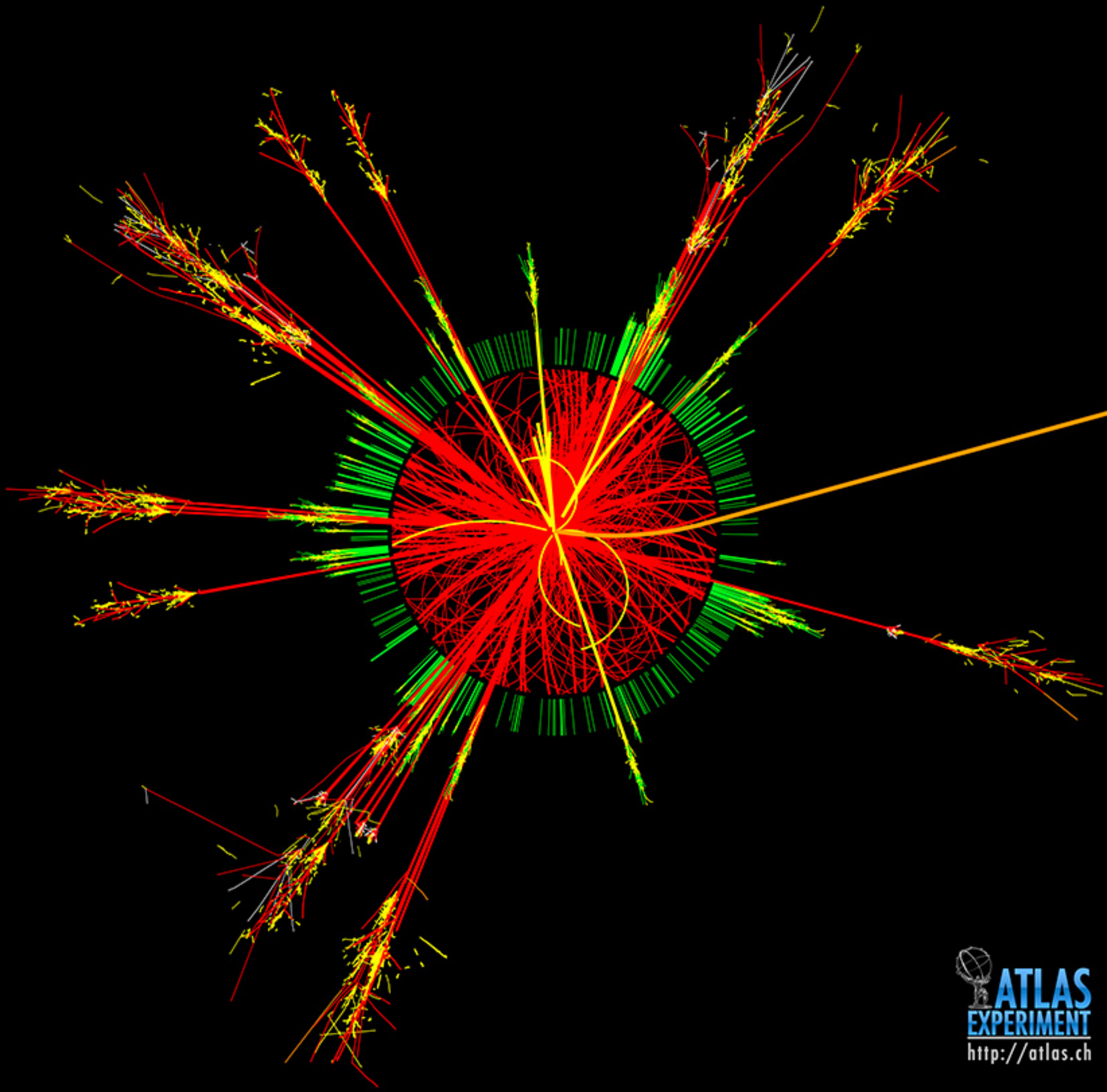
* Simulating black holes;

* Black hole based quantum computing in labs!




ALICE
CMS
ATLAS
LHCb




ATLAS
EXPERIMENT
http://atlas.ch

Applications:

- Understanding Quantum criticality.
- Understanding black holes (in the sky and in Labs).
- Building black hole based quantum computers.
- Understanding UV-completion