Title: Anticipating A New Golden Age

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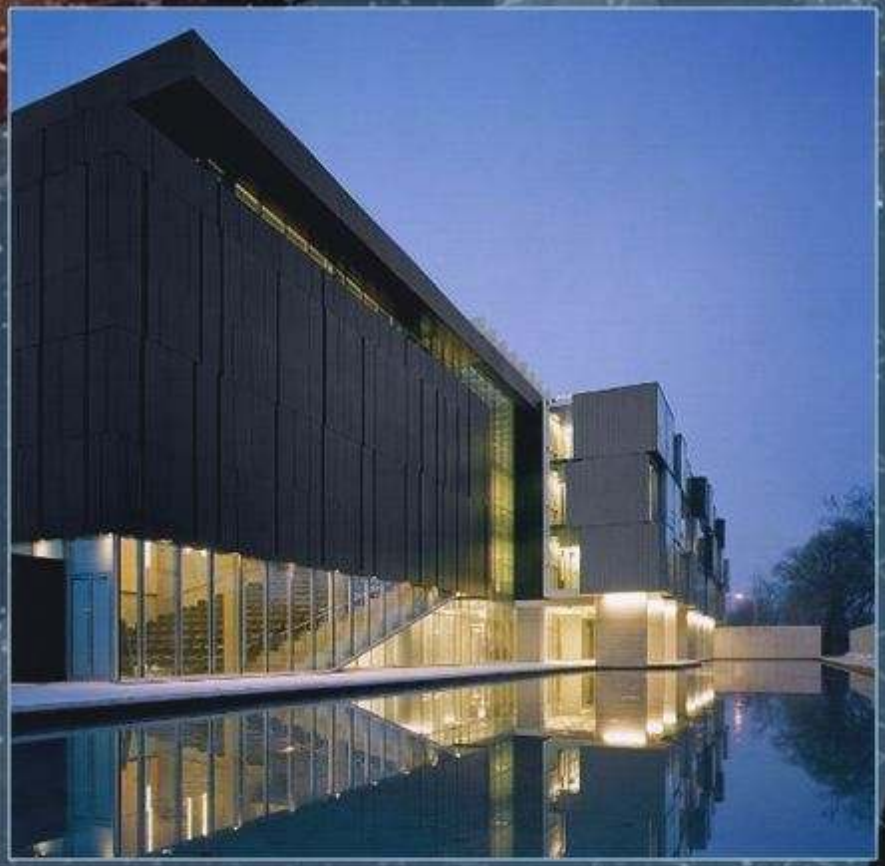
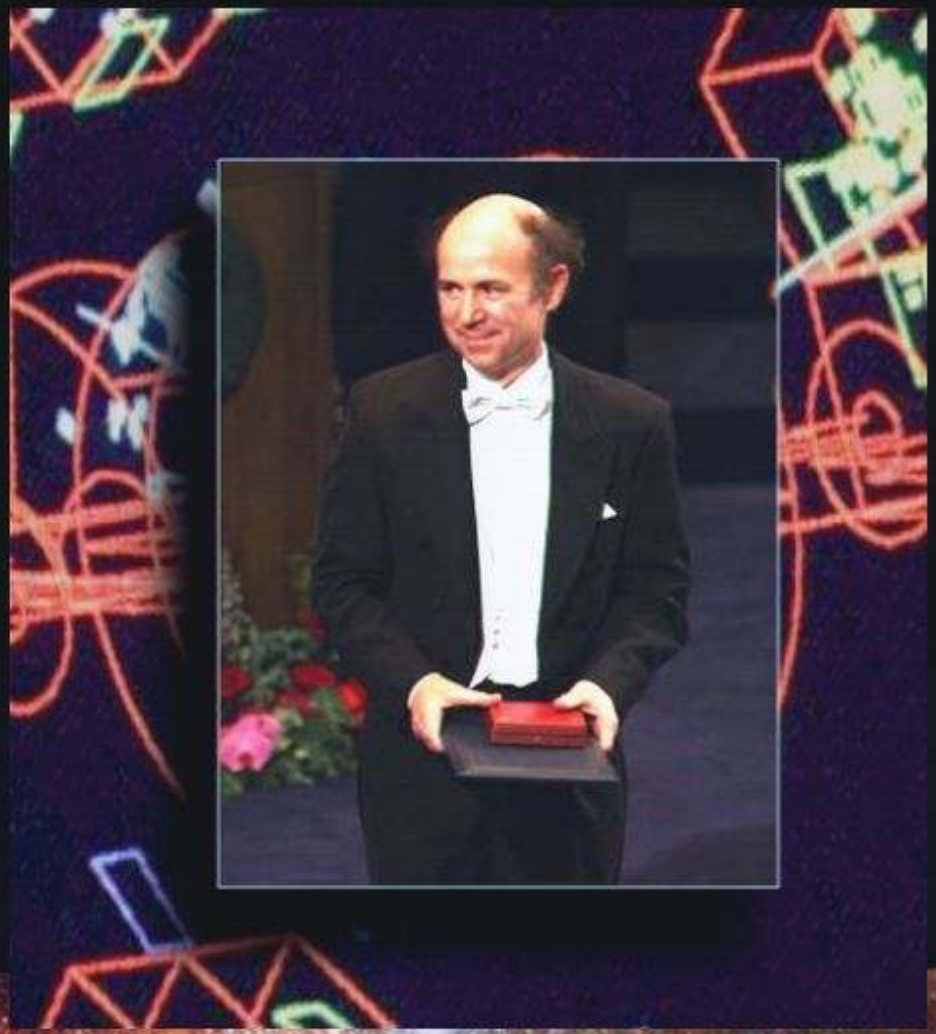
Abstract: Our present Core Theory of matter (aka â€œstandard modelâ€•) was born in the 1970s, a Golden Age for fundamental physics. To date it has passed every experimental test, extending â€“ by many orders of magnitude â€“ to higher energies, shorter distances, and greater precision than were available in the 1970s. Yet we are not satisfied, because the Core Theory postulates four separate interactions and several different kinds of matter, and its equations are lopsided. In this lecture, Prof. Wilczek will describe powerful and extremely beautiful ideas for restoring unity and symmetry to the fundamental laws. These ideas are firmly rooted in empirical reality, but at present the evidence for them is circumstantial. The Large Hadron Collider (LHC) will provide critical tests. If Nature has been teaching, not teasing, discoveries at the LHC will inaugurate a new Golden Age, bringing our fundamental understanding of the physical world to a new level. <kw> Standard model, fundamental physics, experiment, LHC, unification, particle physics, supersymmetry, vacuum fluctuation </kw>



PERIMETER PI INSTITUTE FOR THEORETICAL PHYSICS

Public Lecture Series



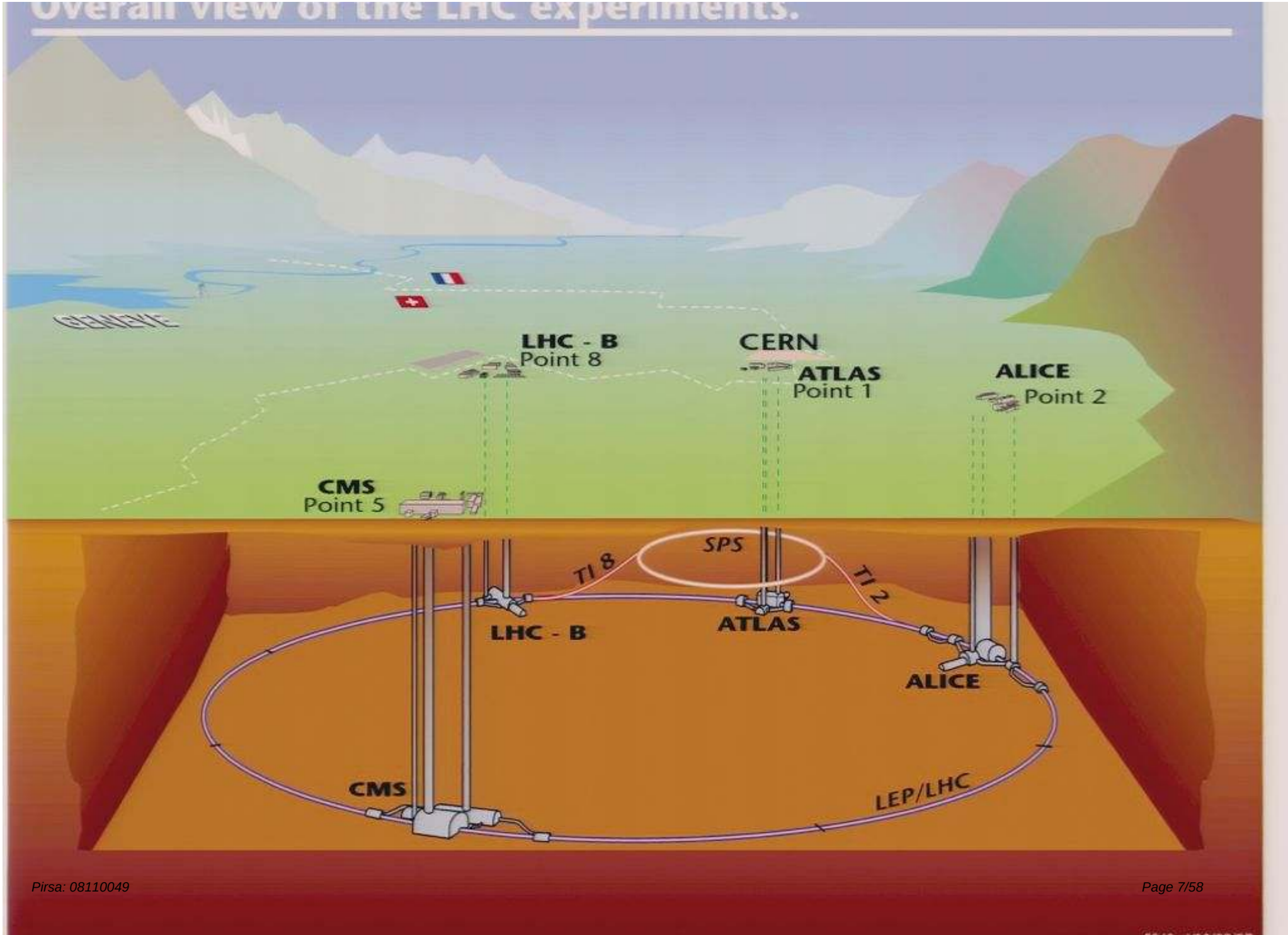
Frank Wilczek

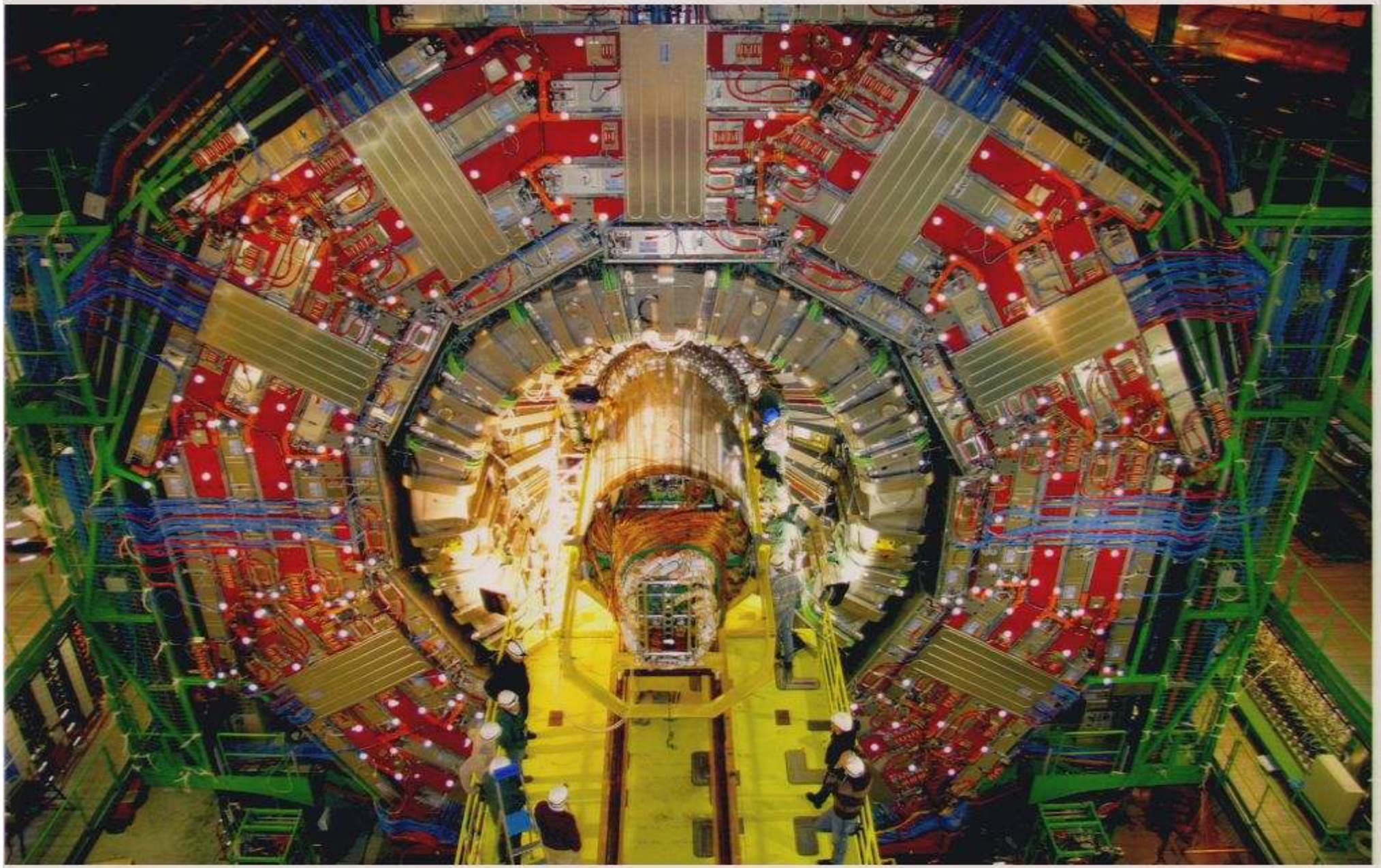
Nobel Laureate

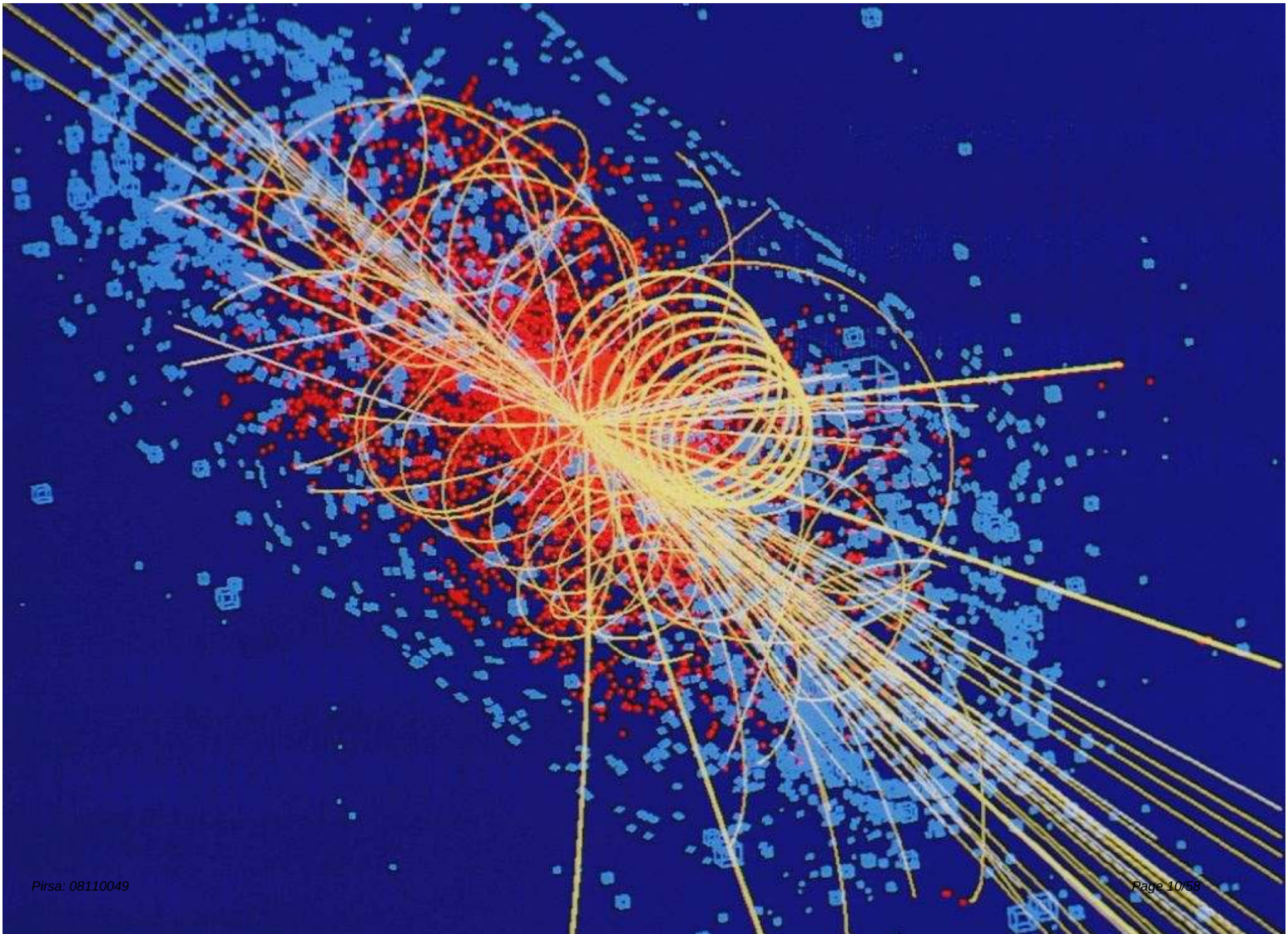
MIT

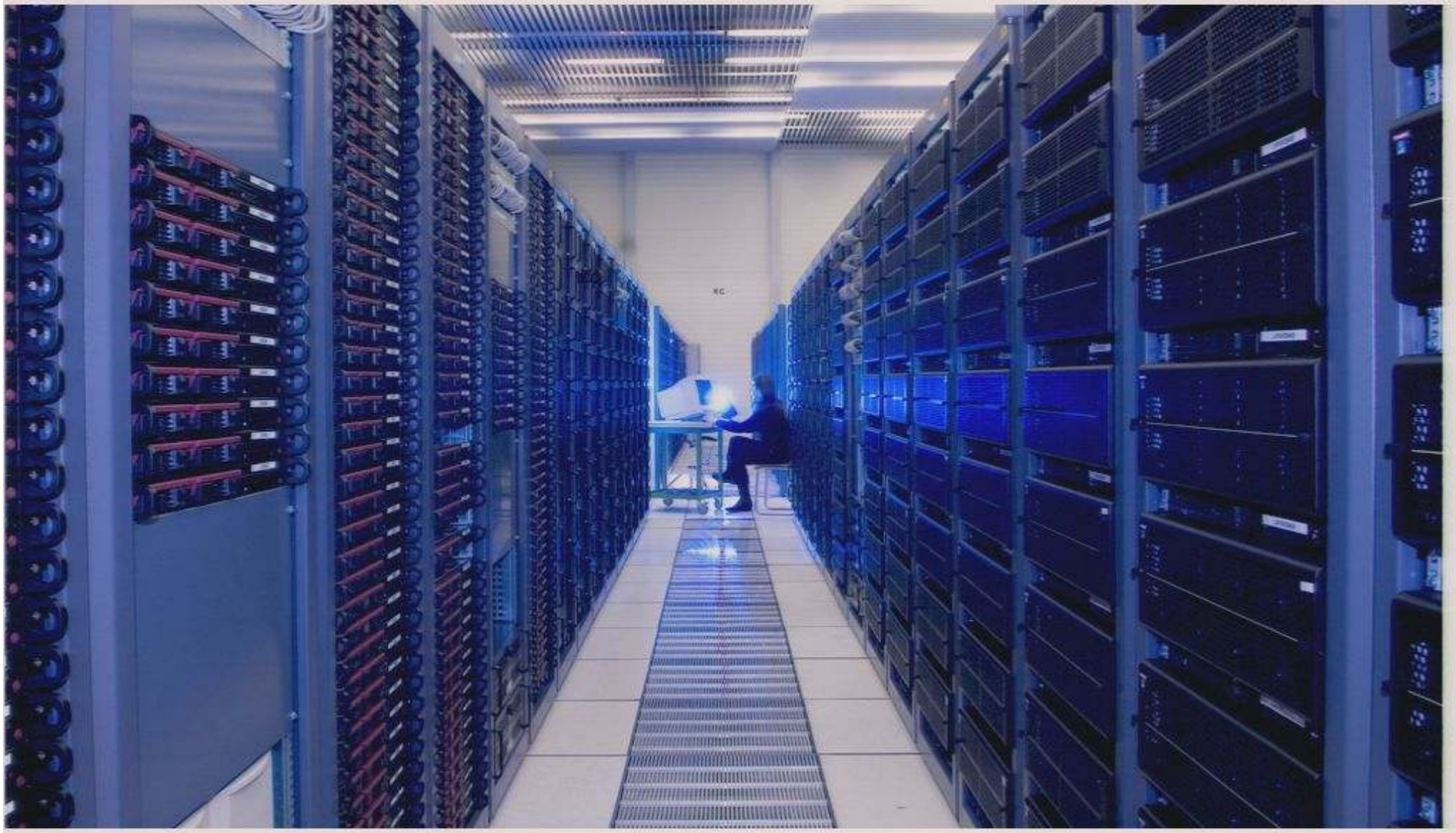
Anticipating a New Golden Age

The Large Hadron Collider (LHC)


Overall view of the LHC experiments.
GENEVE
LHC - B
Point 8
CERN
ATLAS
Point 1
ALICE
Point 2
CMS
Point 5
SPS
TI 8
TI 2
LHC - B
ATLAS
ALICE
CMS
LEP/LHC



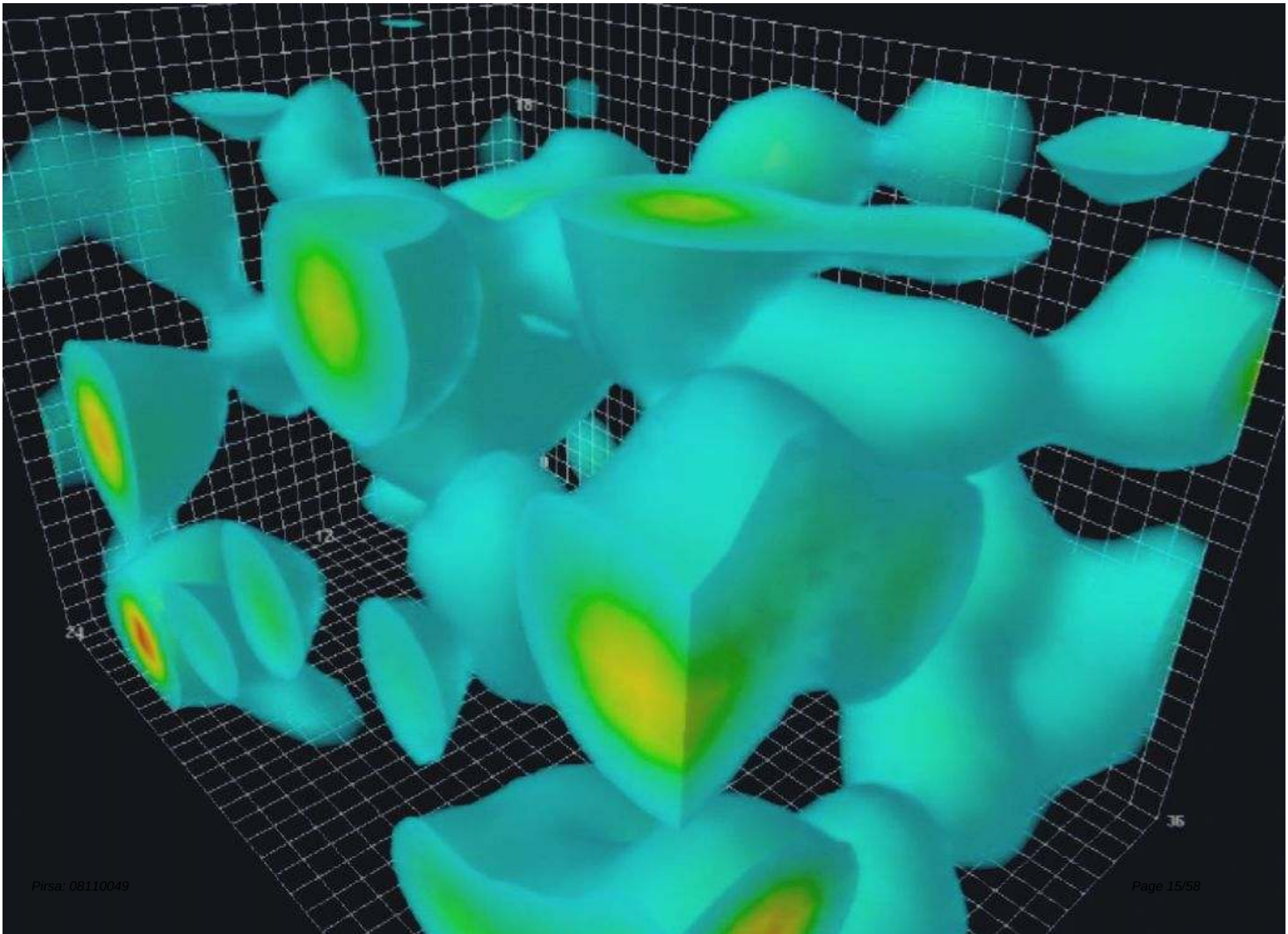


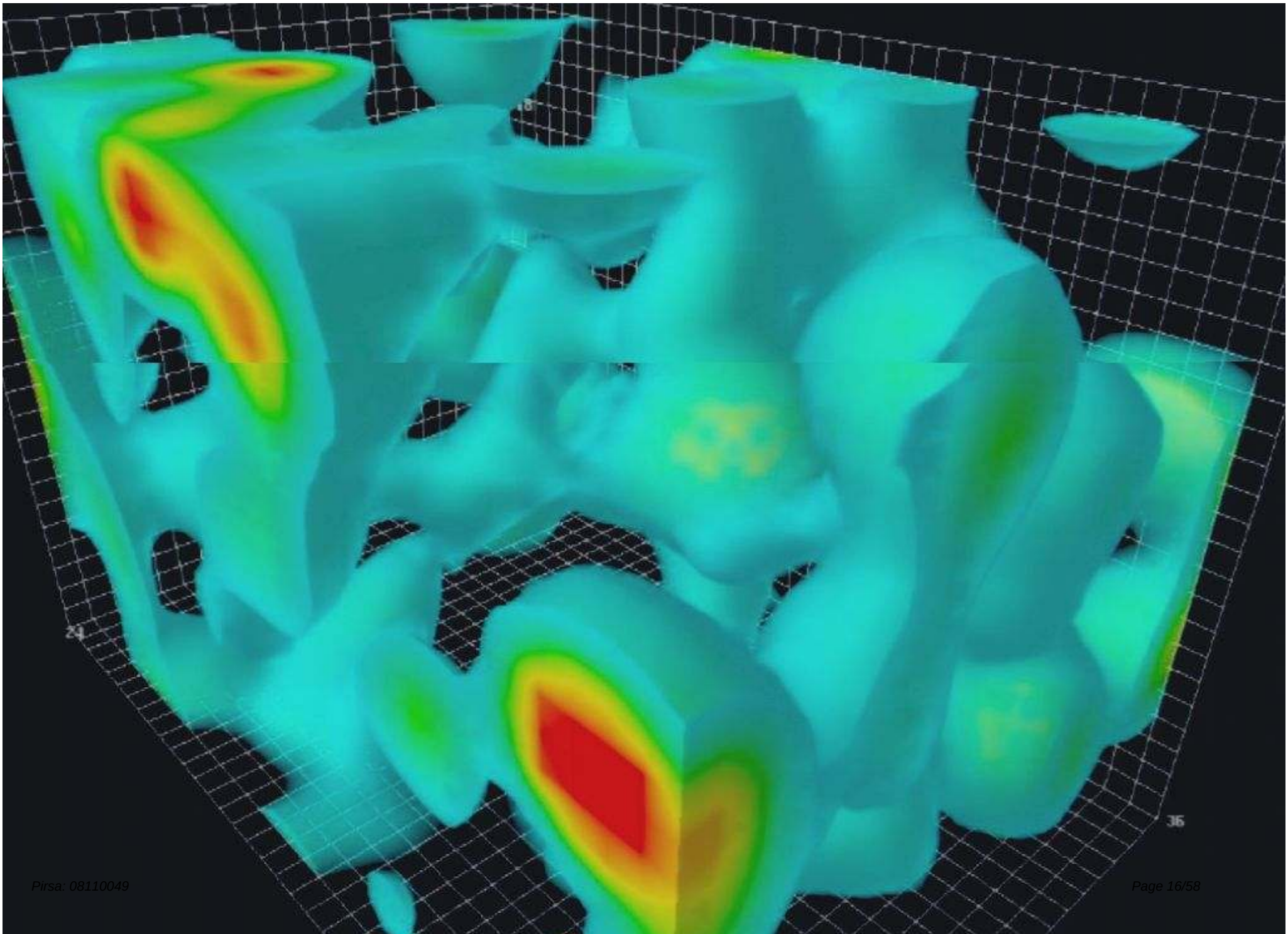


What It Does

LHC is an ultrastroboscopic nanomicroscope for studying deep inner space.

This is what our equations tell us we'd see, everywhere and everywhen, if we had nimbler eyes:


18
12
24
36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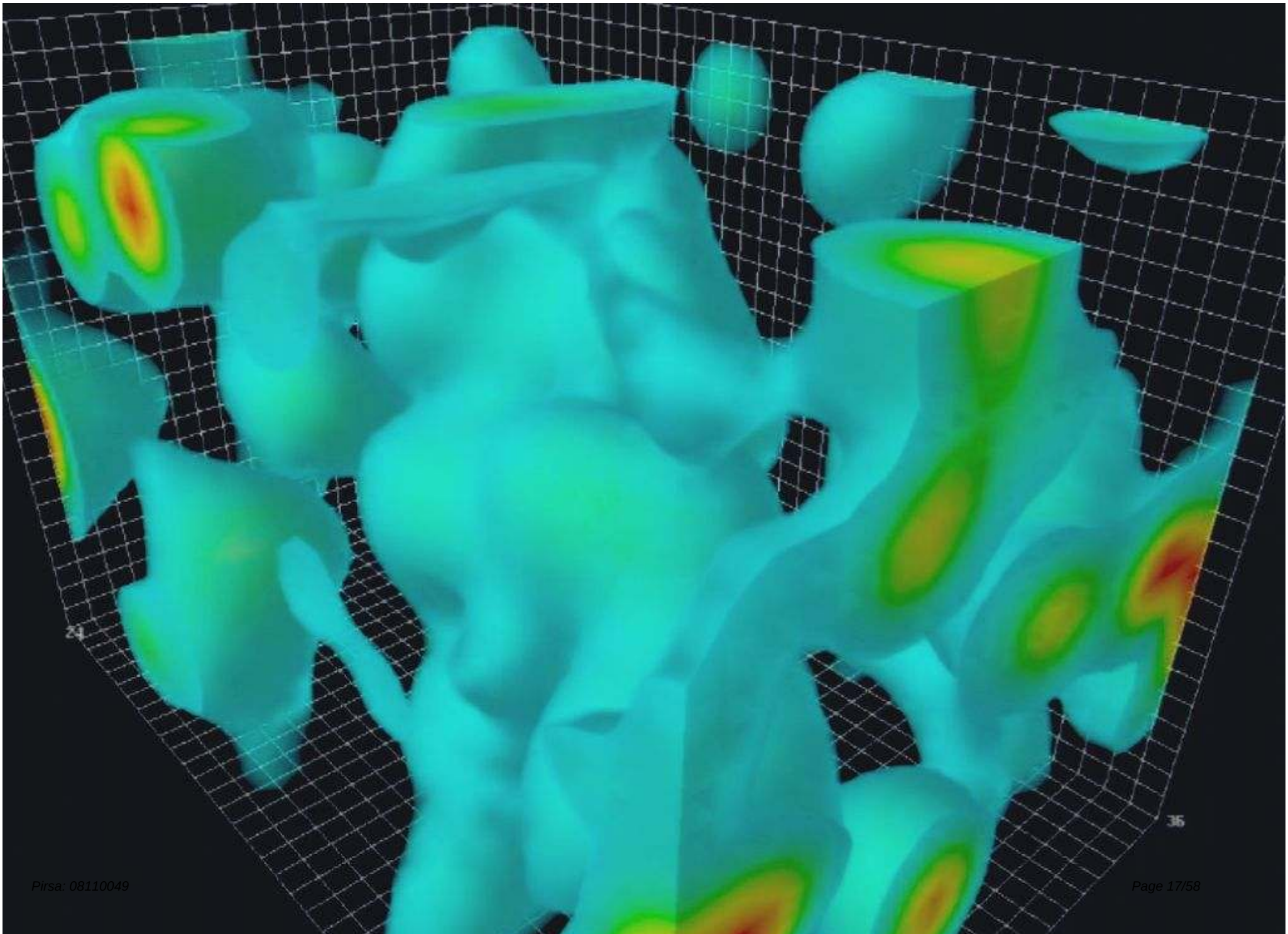
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36

"Empty" space (= ~~ether~~ Grid) has it all, *virtually*.

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BUT

In the quantum world, to see something you must *disturb* it.

In the quantum world, to see something you must *disturb* it.

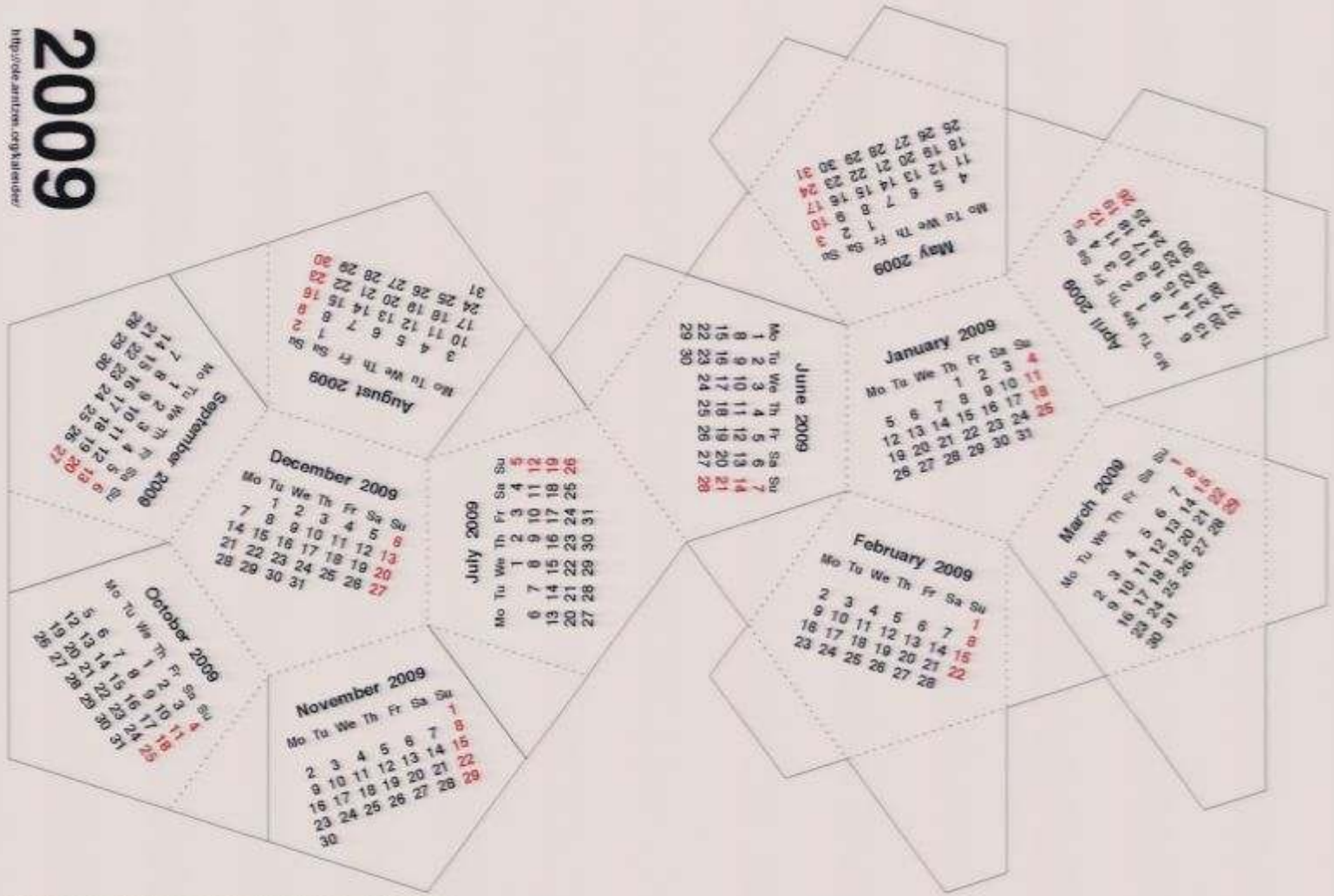
In the deep quantum world, to see something you must *create* it.

Specifically:

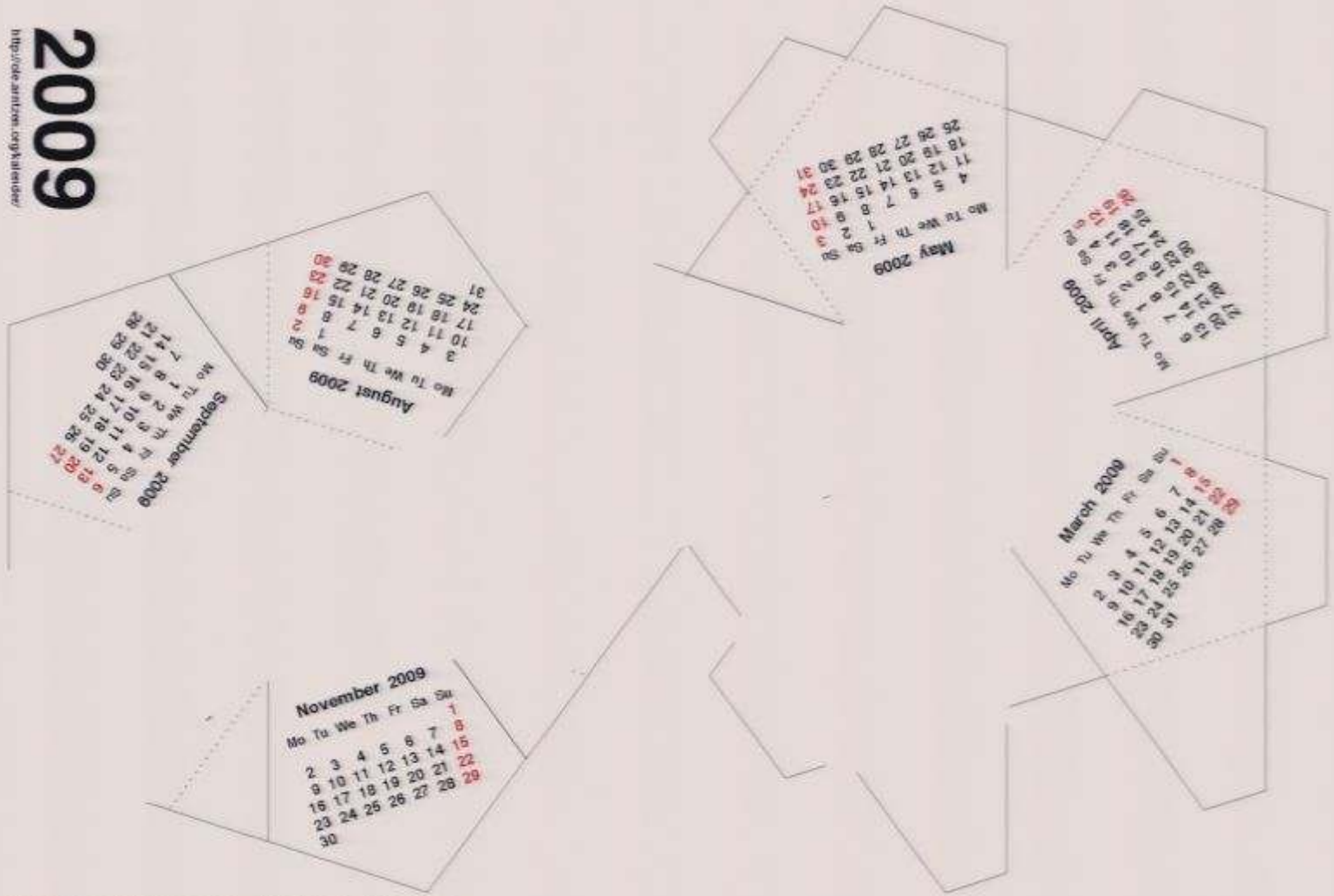
To produce a particle of mass m, you must supply at least the minimum energy E which that particle can have, namely $E = mc^2$.

My Vision


1月 2006
月 火 水 木 金 土 日
1
2 3 4 5 6 7 8
9 10 11 12 13 14 15
16 17 18 19 20 21 22
23 24 25 26 27 28 29
30 31



Cut along solid line; score and fold along dotted lines.



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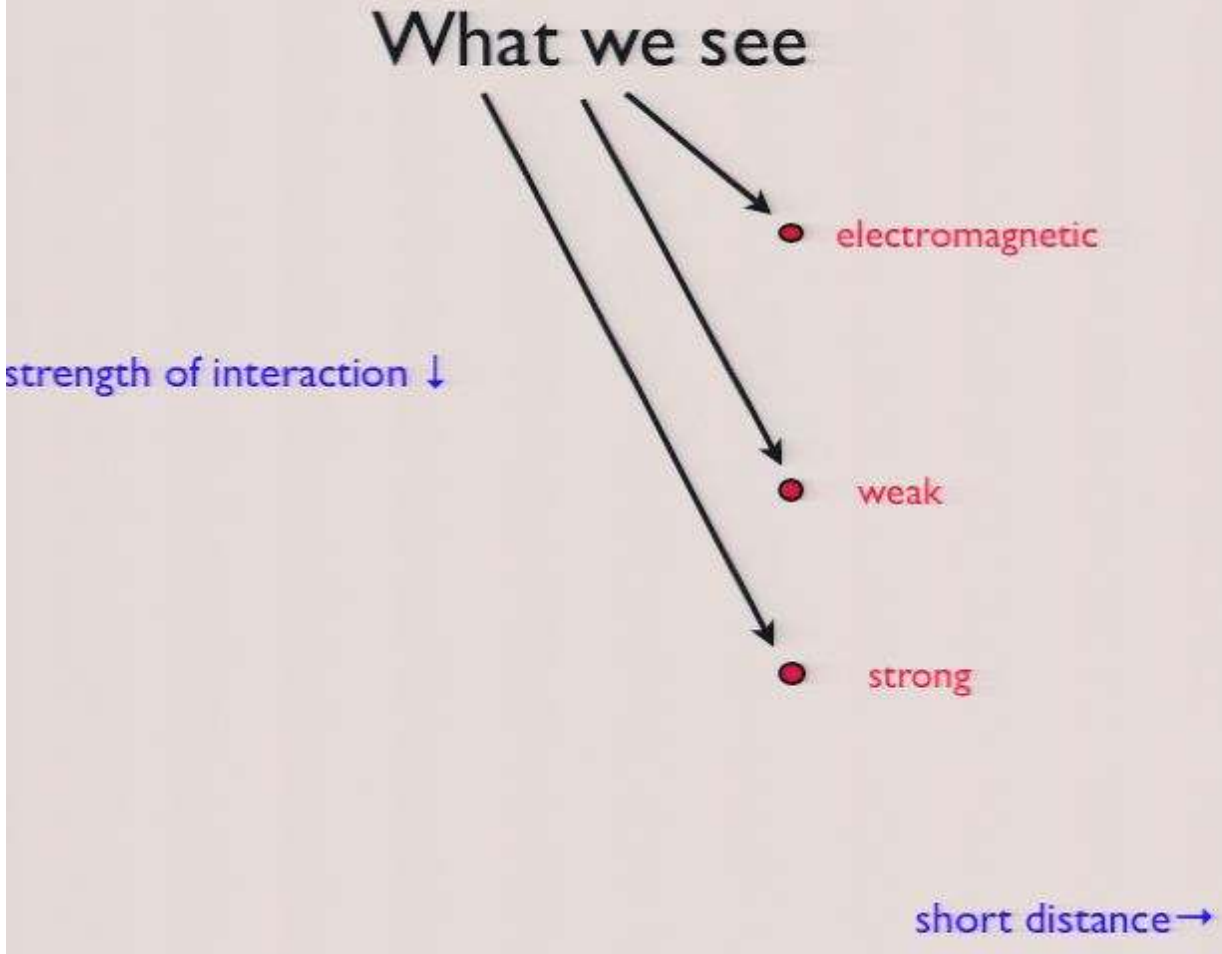
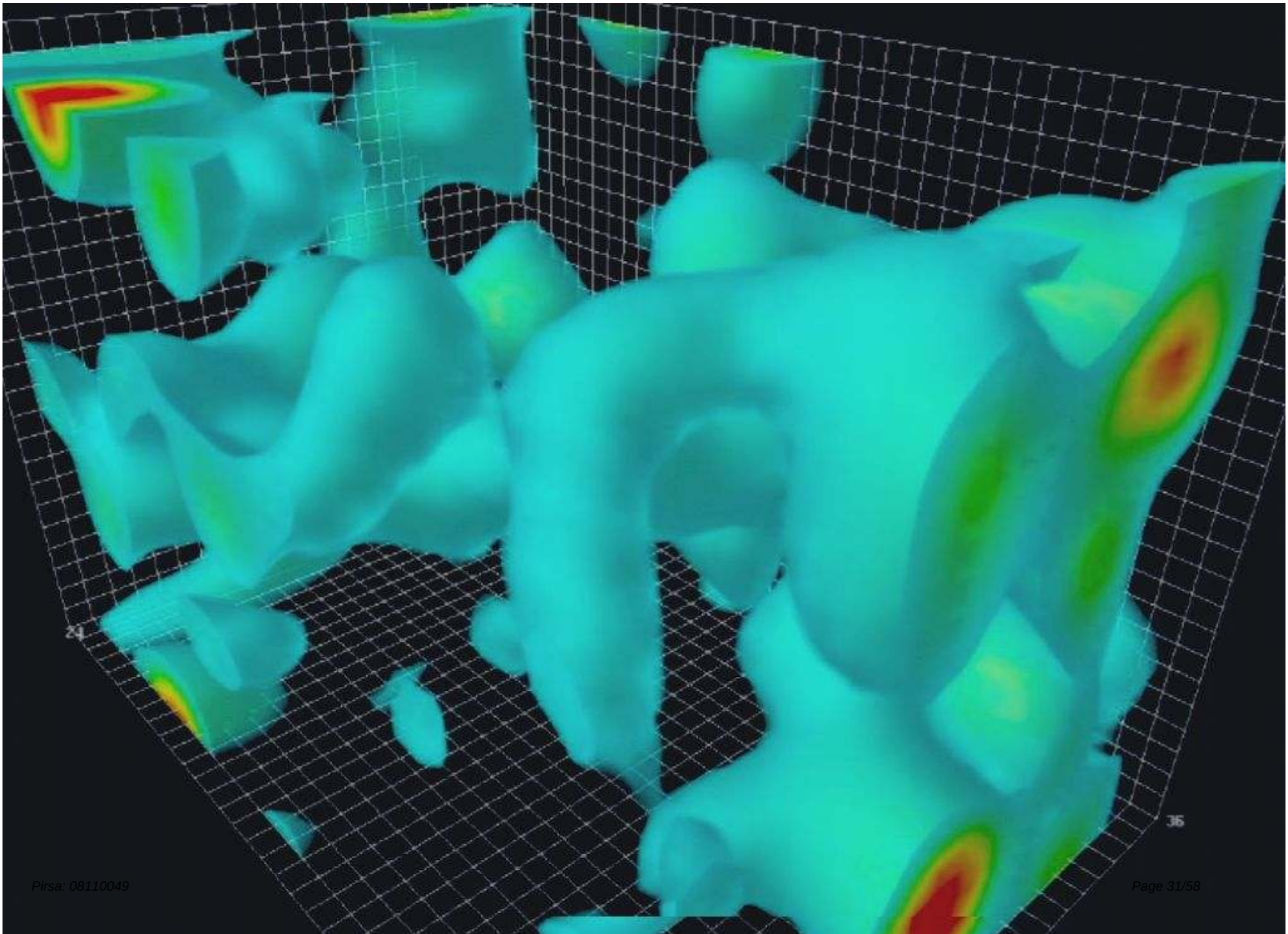

What we see
electromagnetic
strength of interaction ↓
weak
strong
short distance→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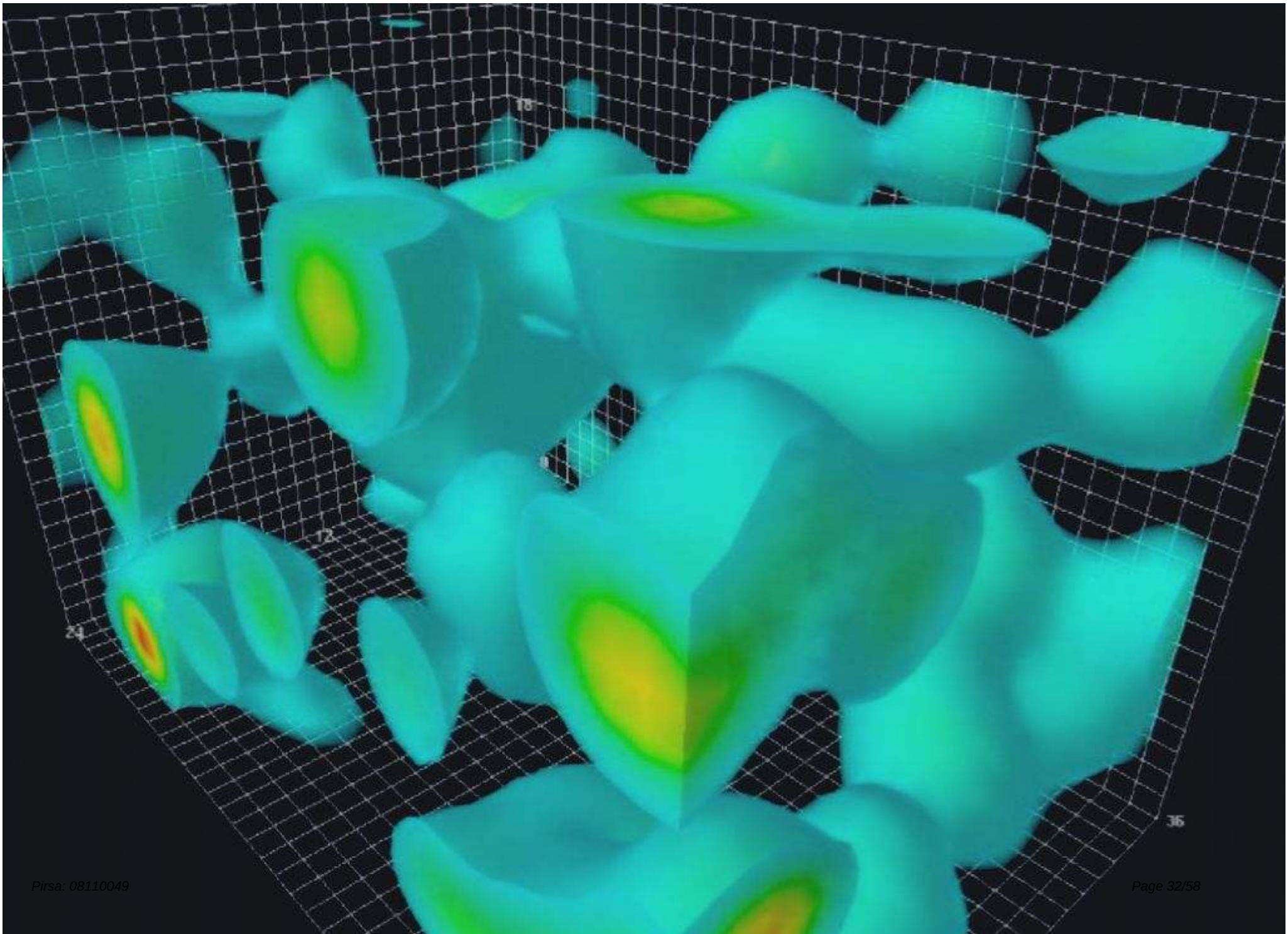
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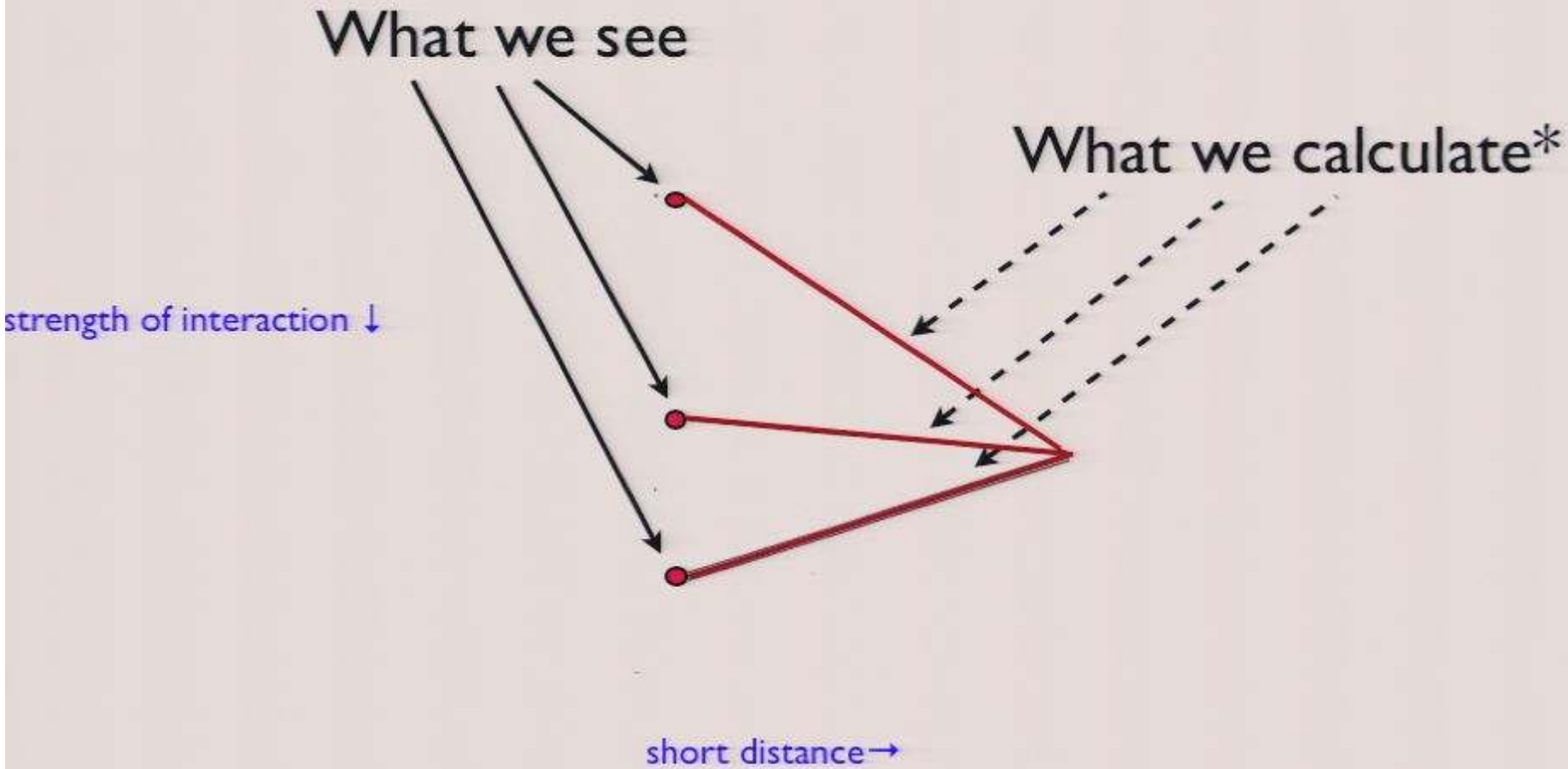
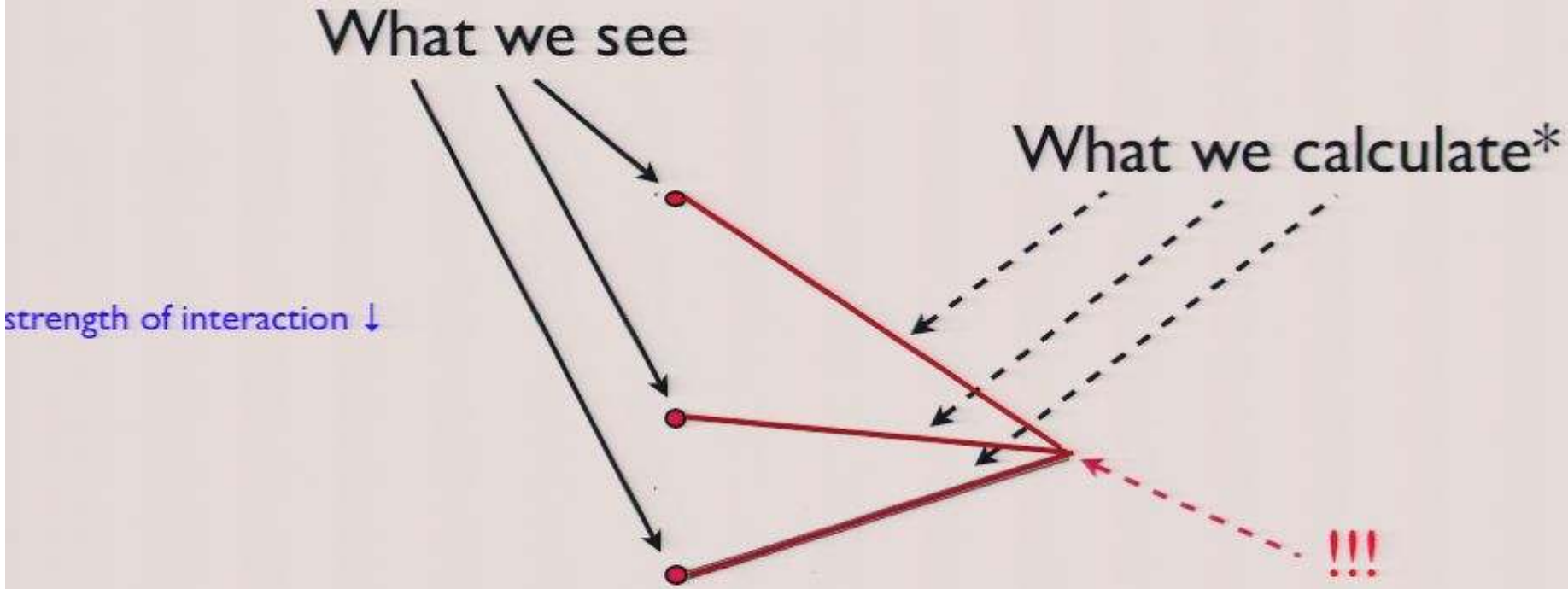
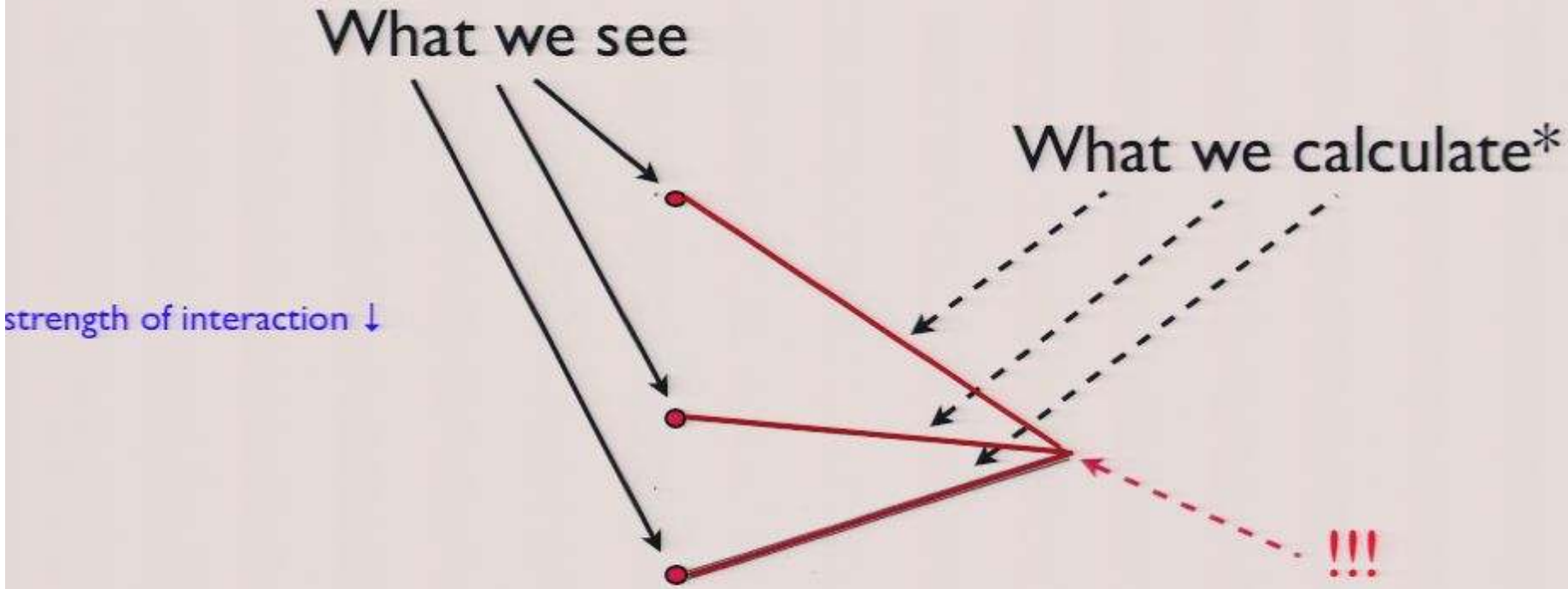

What we see
What we calculate*
strength of interaction ↓
short distance→



*Assuming SUSY

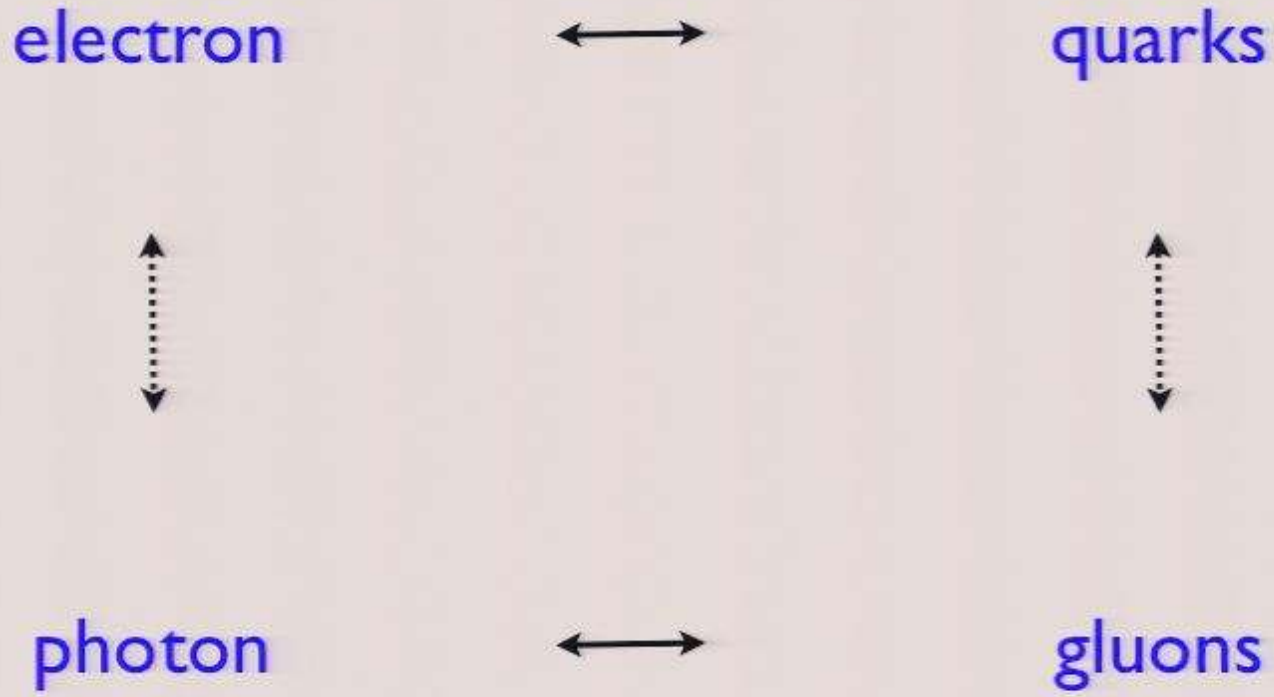
electron ⟷ quarks

photon ⟷ gluons



*Assuming SUSY

It only works if we expand our model of the world to include another powerful unifying idea: supersymmetry.

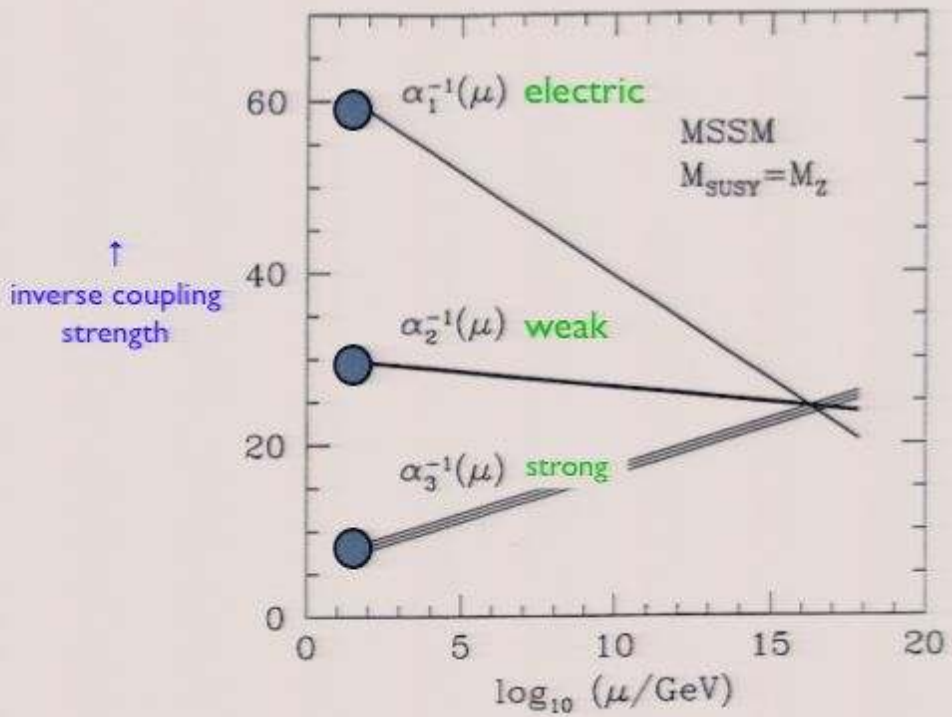

electron
quarks
photon
gluons

Supersymmetry brings in new fluctuations, new corrections ...

Supersymmetry brings in new fluctuations, new corrections ...

... and new particles, which must be produced at the LHC.

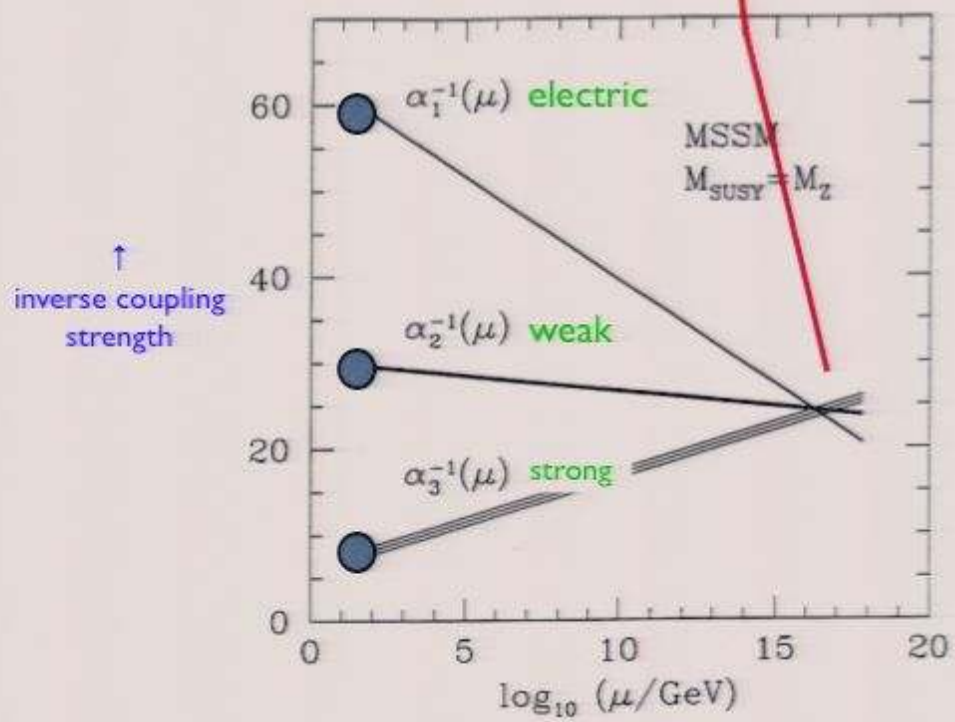
Unification ♥ SUSY



↑
inverse coupling strength

large energy, short distance →

Unification ♥ SUSY



↑
inverse coupling strength

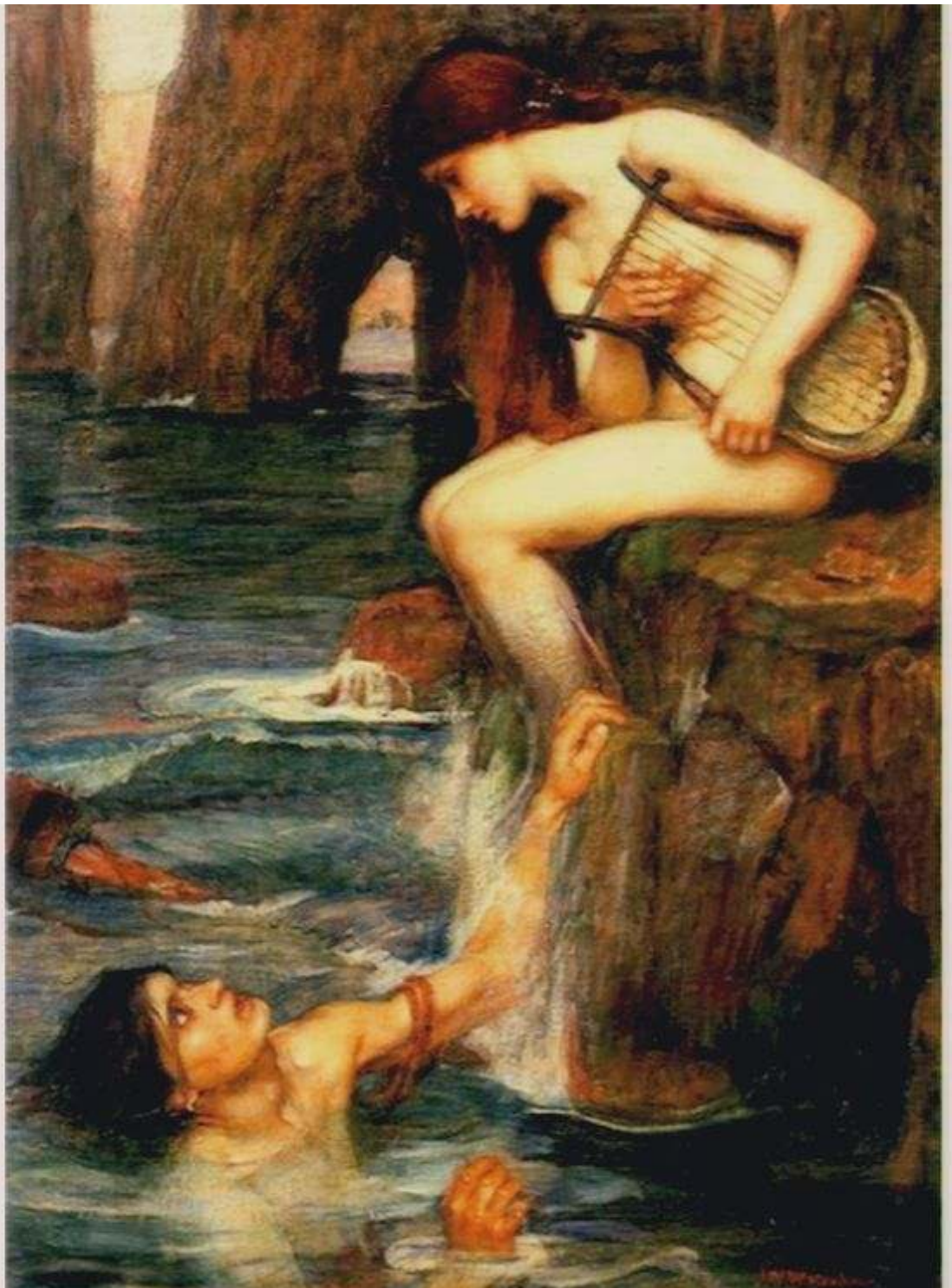
short distance→

Gravity fits too!
(roughly)

Nature is singing a Siren's song.

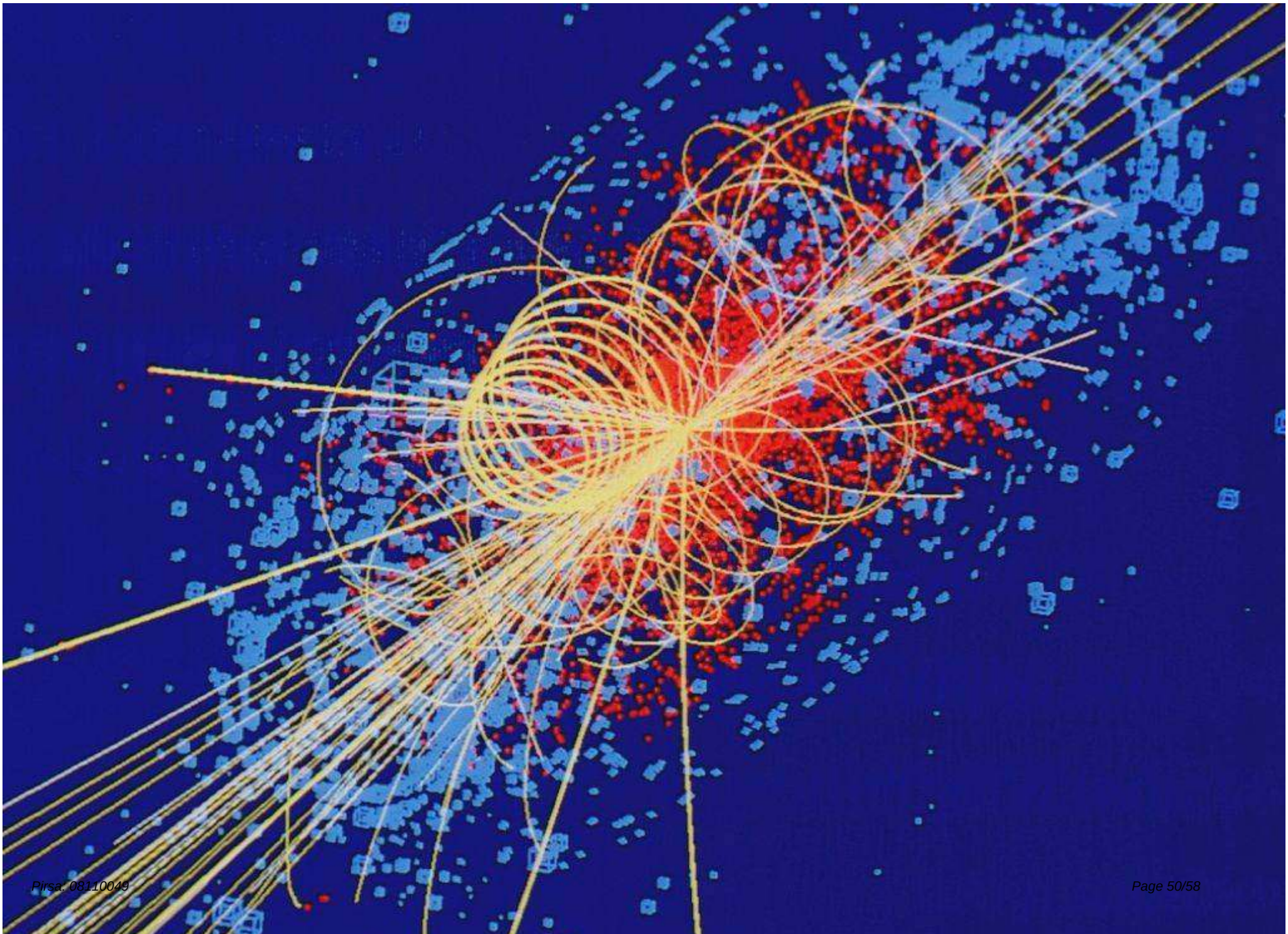
Nature is singing a Siren's song.

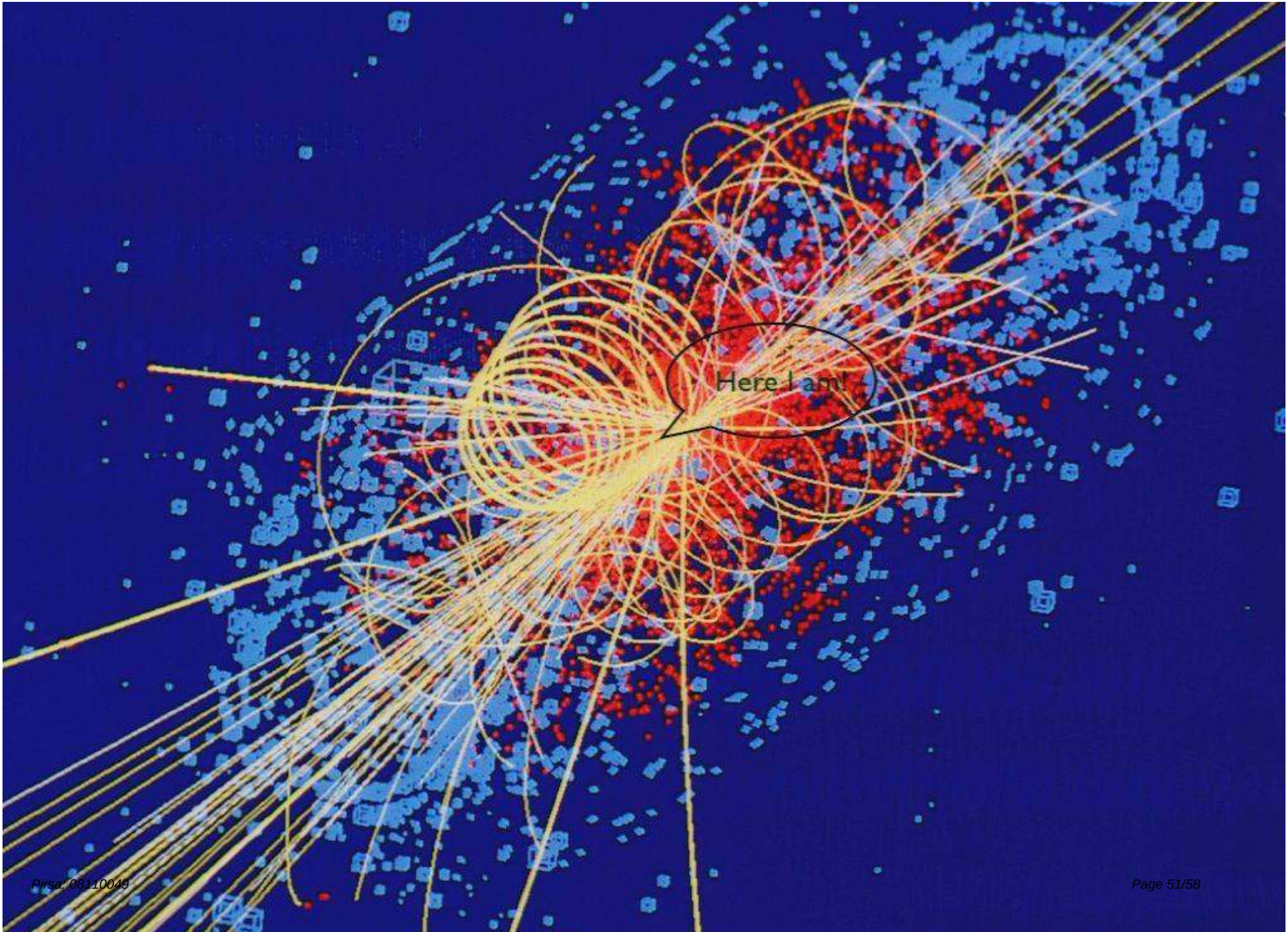
Is she teaching, or teasing?

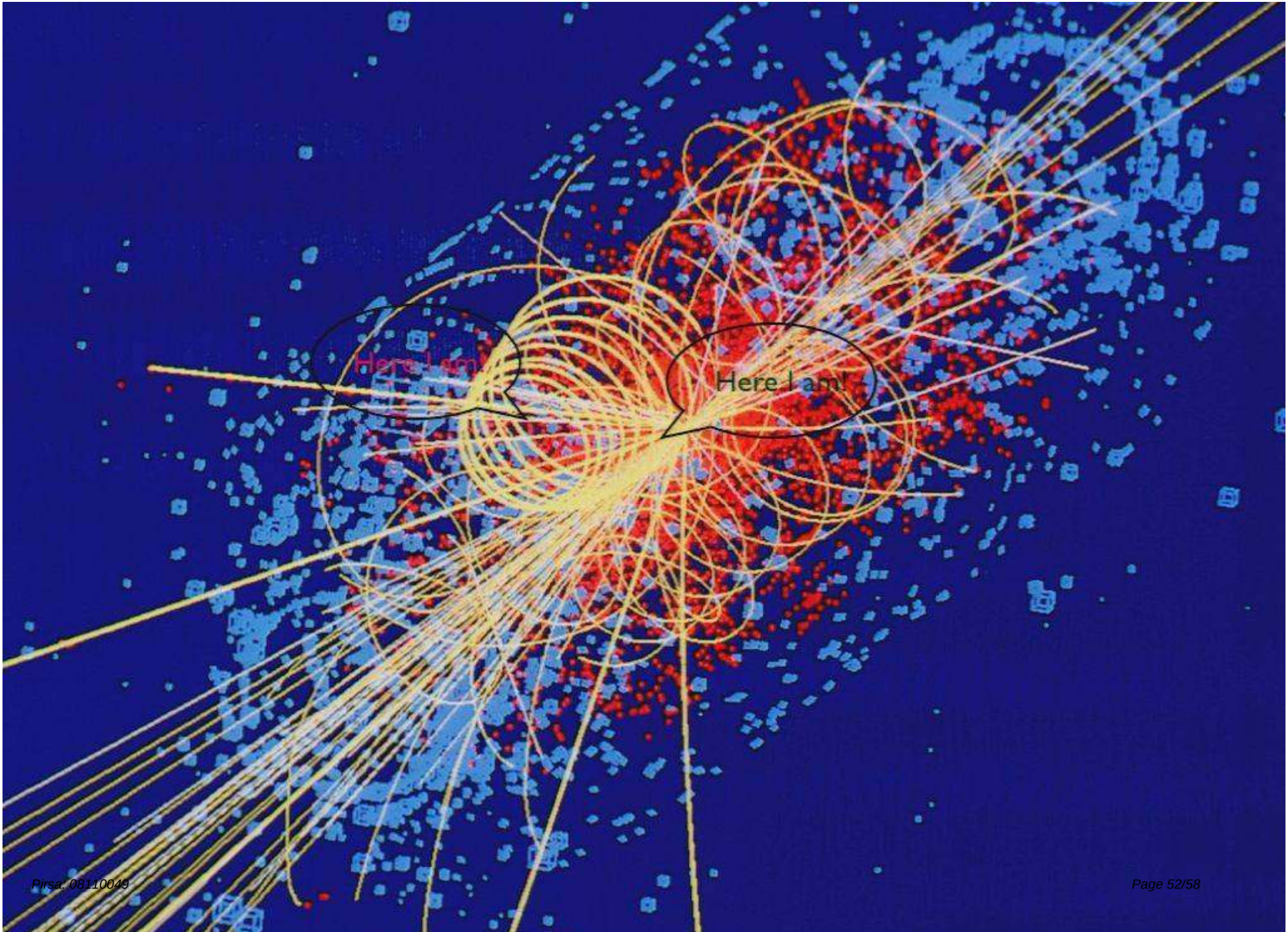


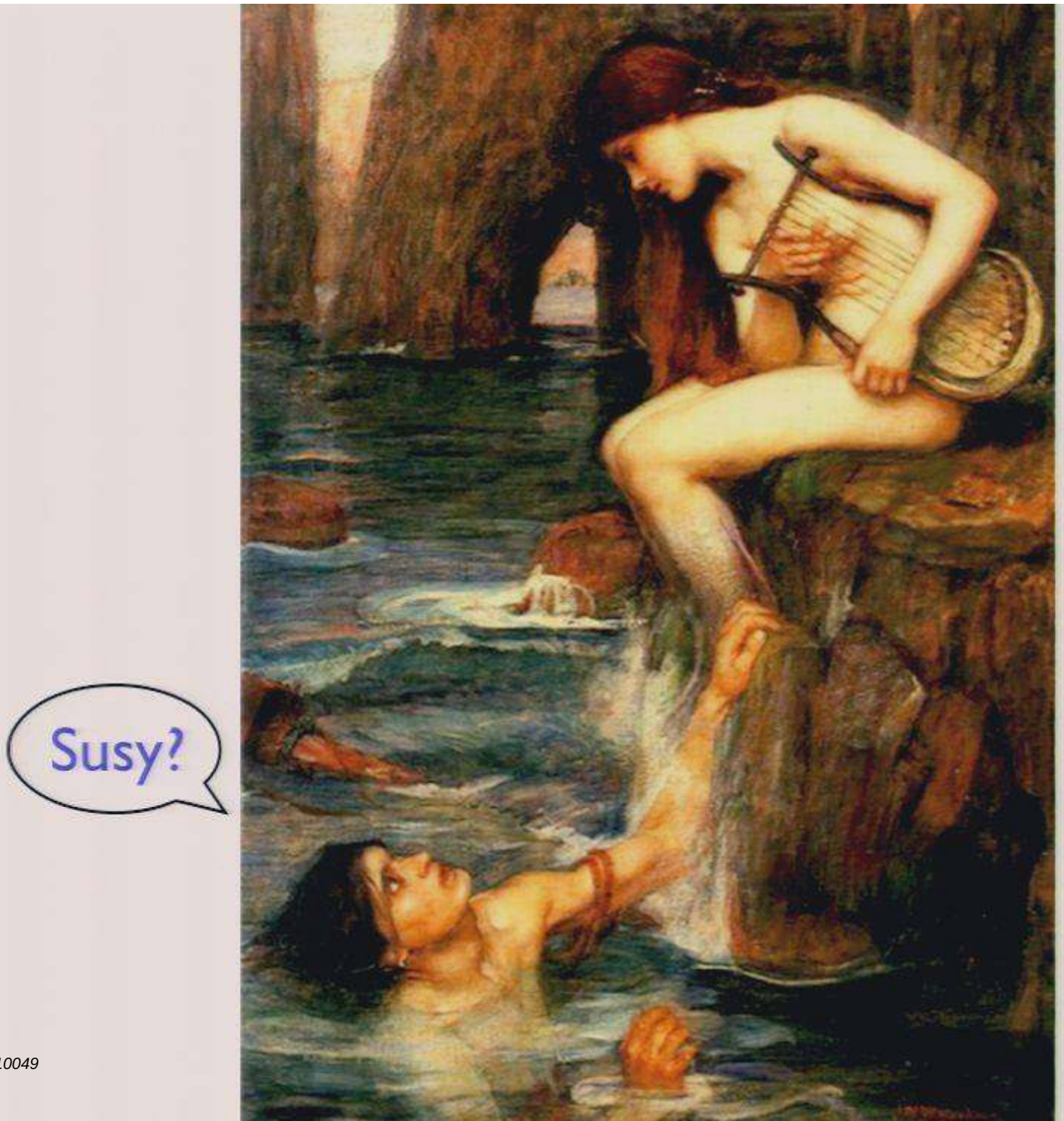
The trial by fire:

Do SUSY's new particles show up at LHC??




Here I am!


Here I am!
Here I am!


Susy?

It's an exciting time to be a physicist!

It's an exciting time to be a physicist!

It's an exciting time to be a thinking being!

Suggested Questions

What about dark matter and dark energy?

Will LHC destroy the world?

What about dark matter and dark energy?

Will LHC destroy the world?

What's it like to win a Nobel Prize?