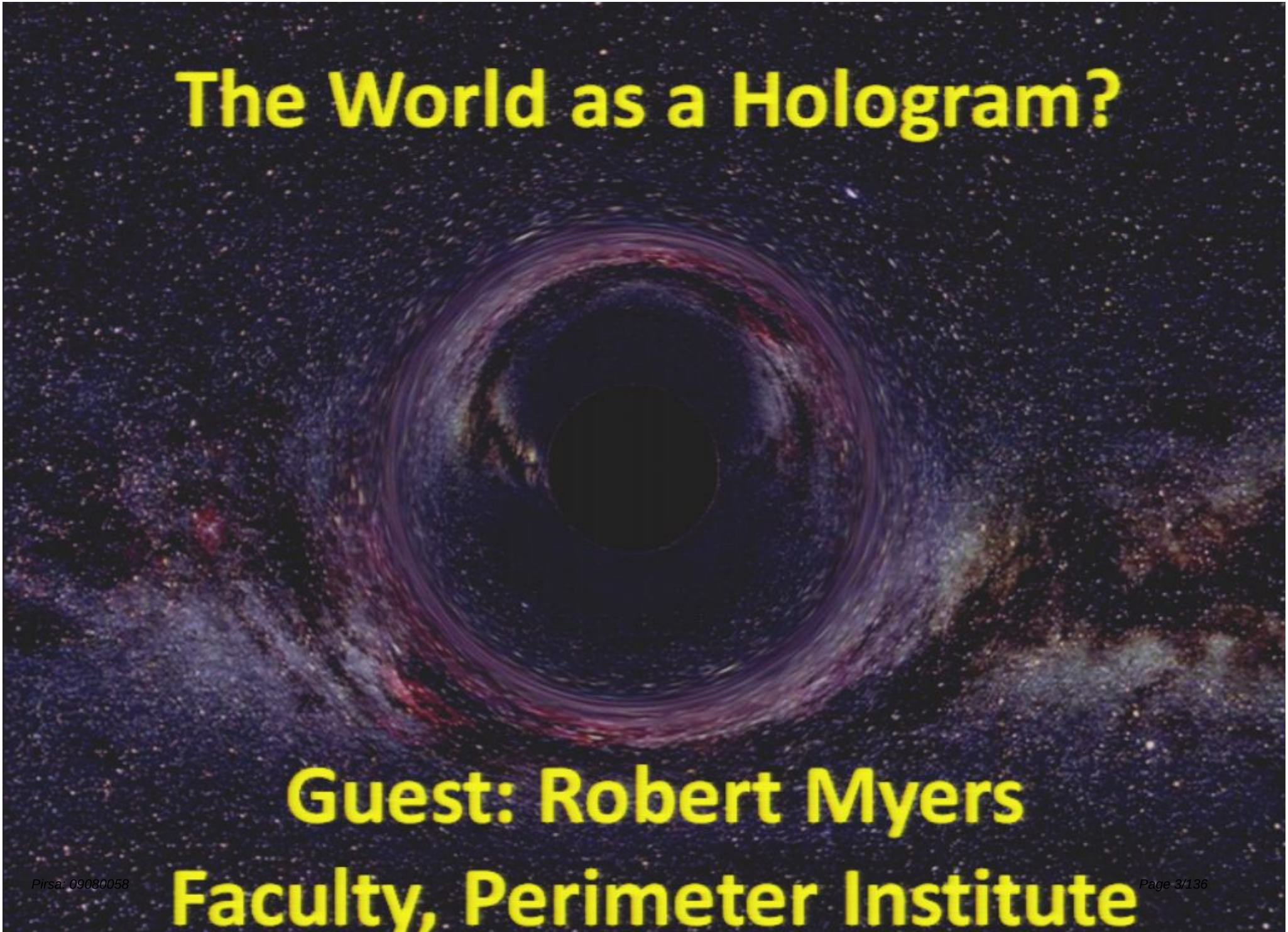
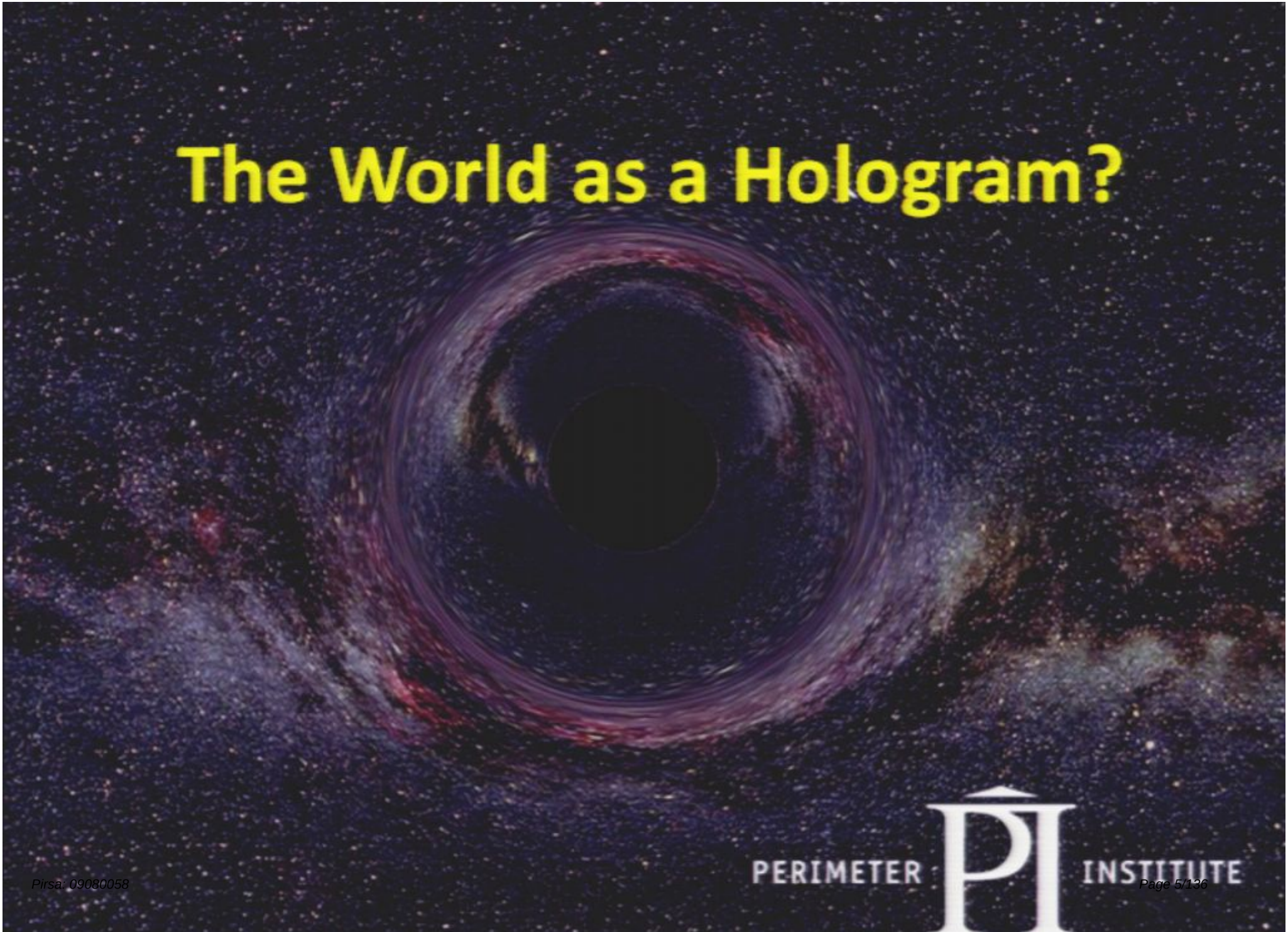
Title: Special Topic: Our World as a Hologram?

Date: Aug 10, 2009 04:00 PM

URL: http://pirsa.org/09080058

Abstract: Our universe has a split personality: quantum and relativity. Understanding how the two can coexist, i.e. how our universe can exist, is one of the greatest challenges facing theoretical physicists in the 21st century. The presentation focuses on a simple but mind-bending thought experiment that hints at some fascinating new ways of thinking that may be required to unravel this mystery. Could the world be like a hologram? The half hour multimedia presentation provides refreshing insight into how science works â€“ how theoretical physicists search for the ultimate nature of reality, and is followed by a half hour question and answer session with PI researcher Sean Gryb.


The World as a Hologram?
Guest: Robert Myers
Faculty, Perimeter Institute


The World as a Hologram?
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What do we know about our Universe?

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Quantum

Relativity

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How atoms can exist

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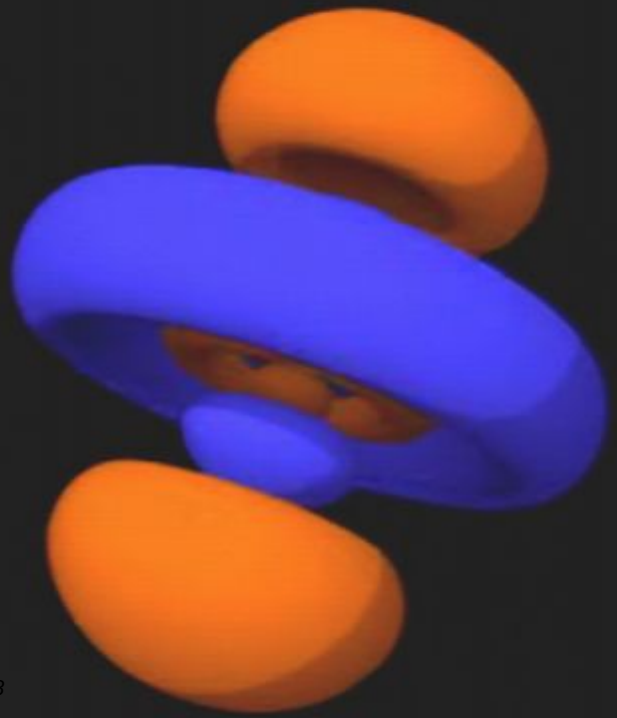

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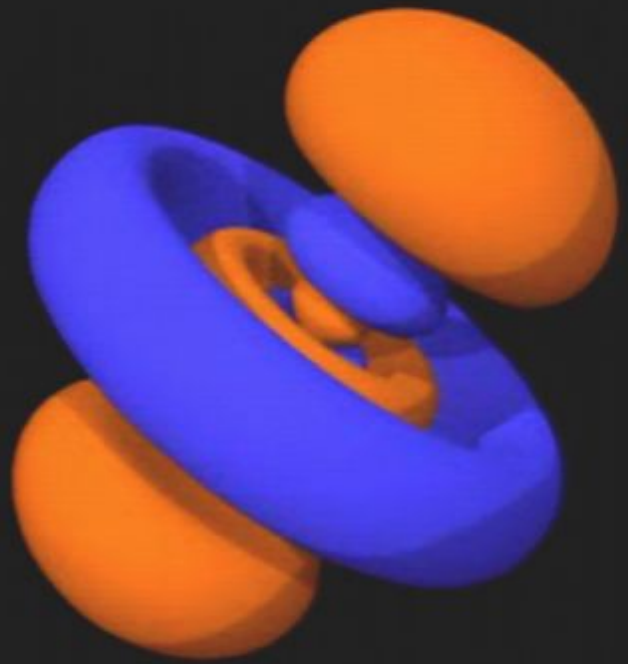

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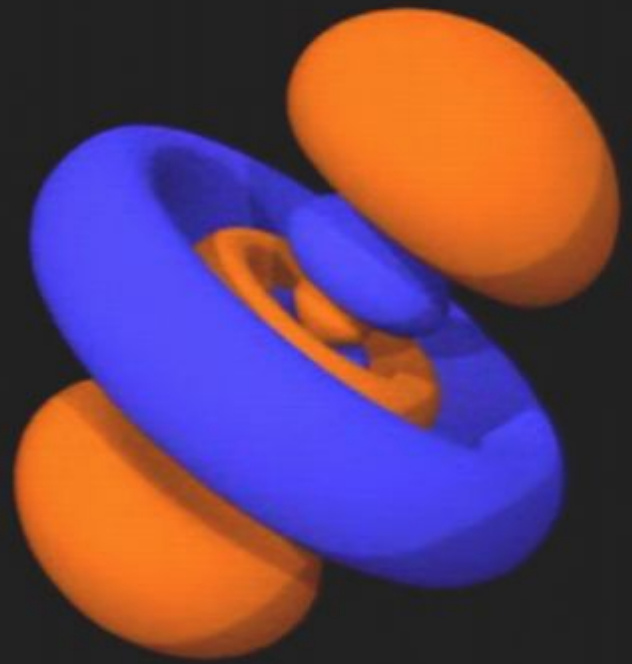

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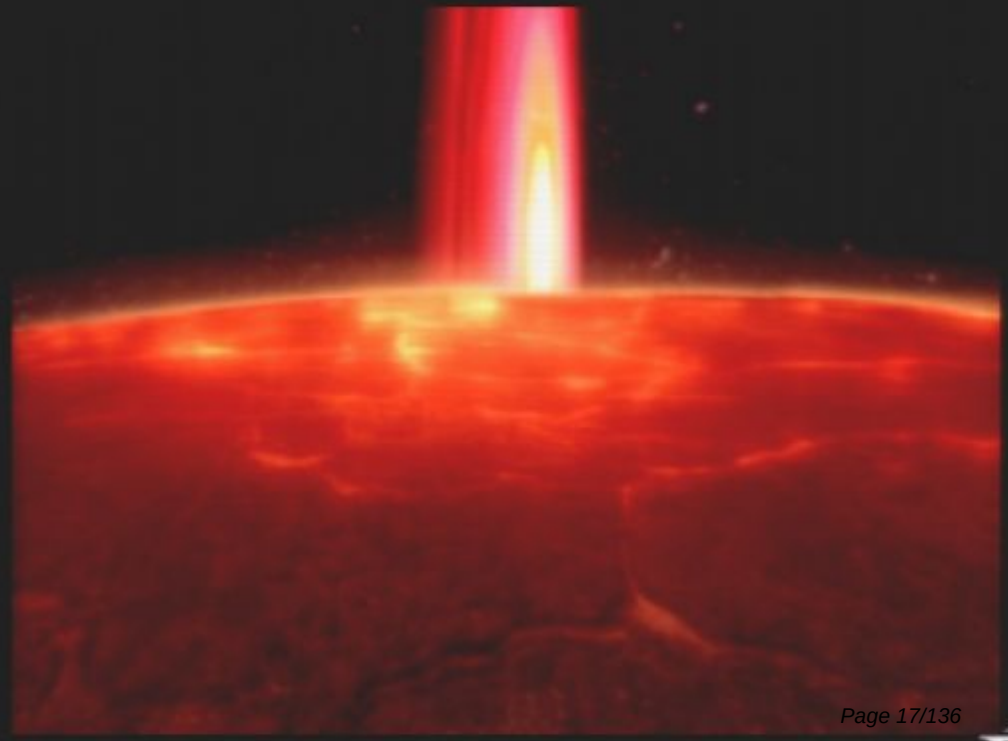

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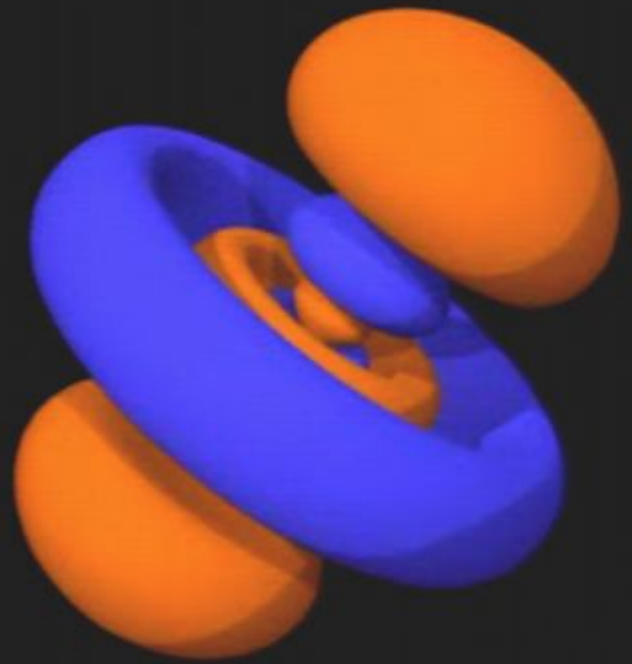

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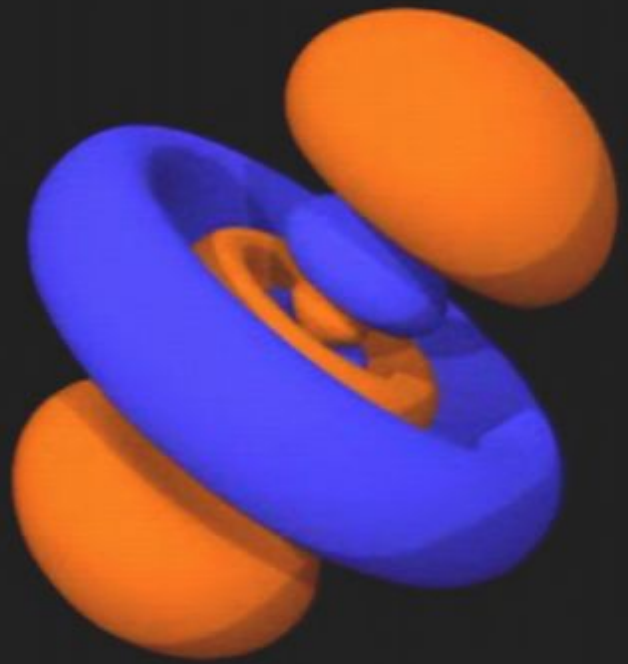

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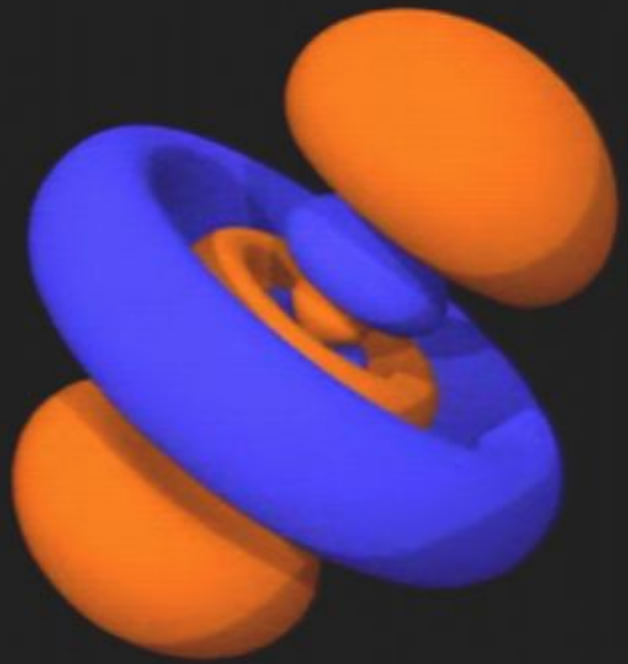

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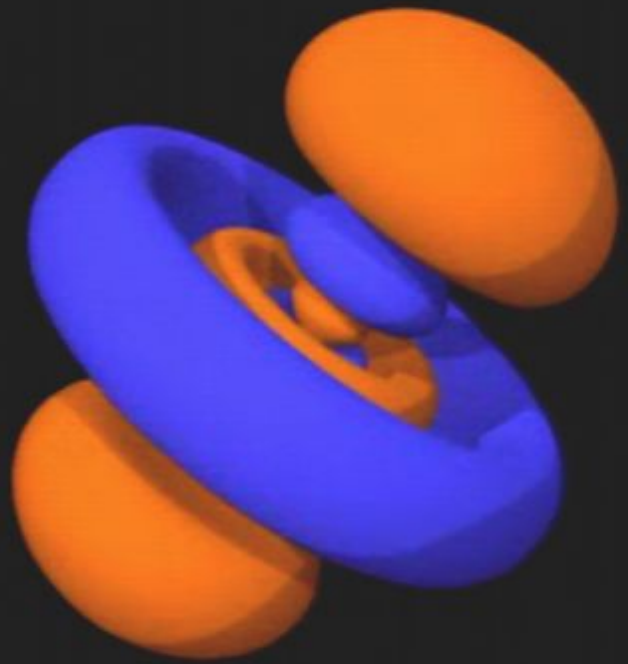

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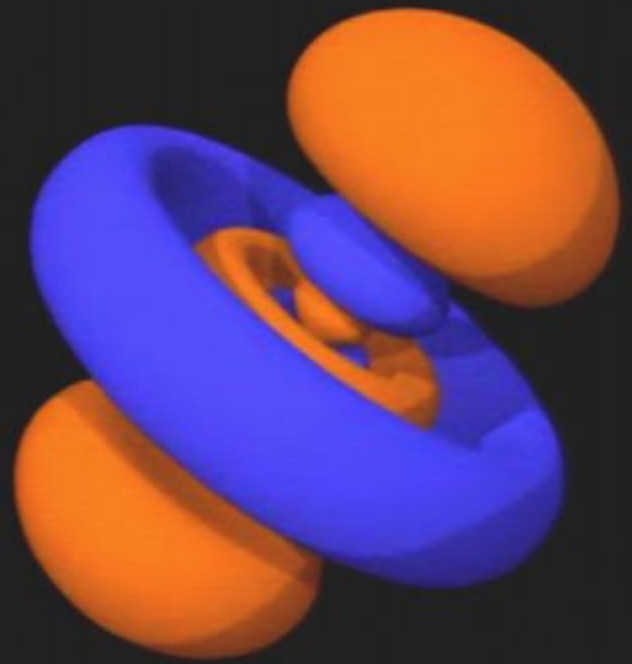

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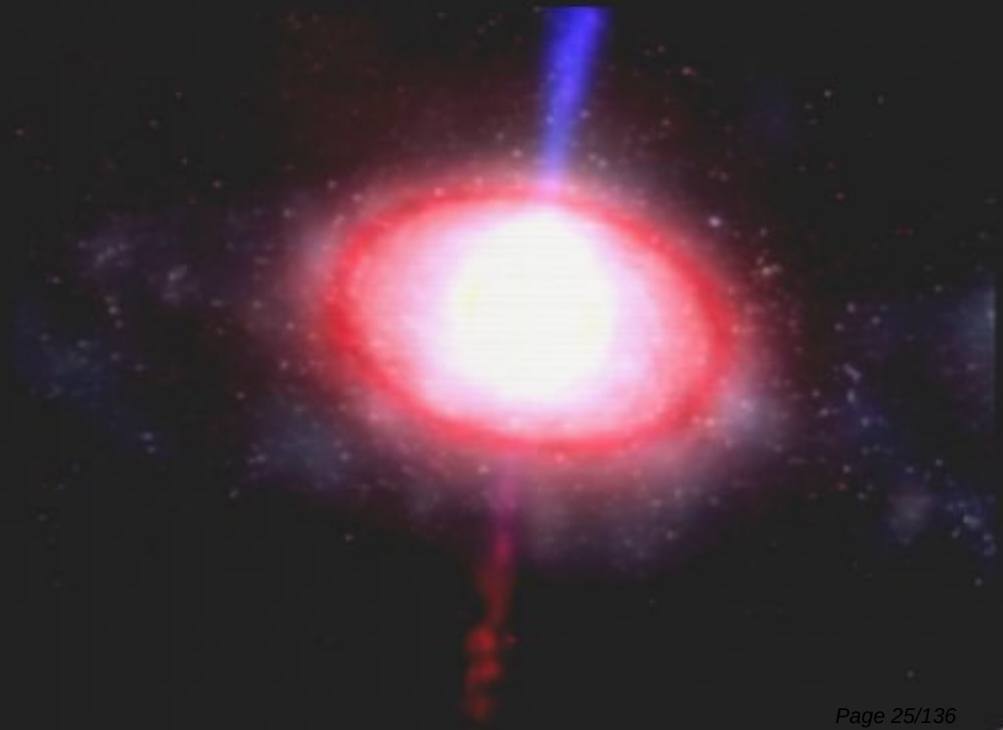

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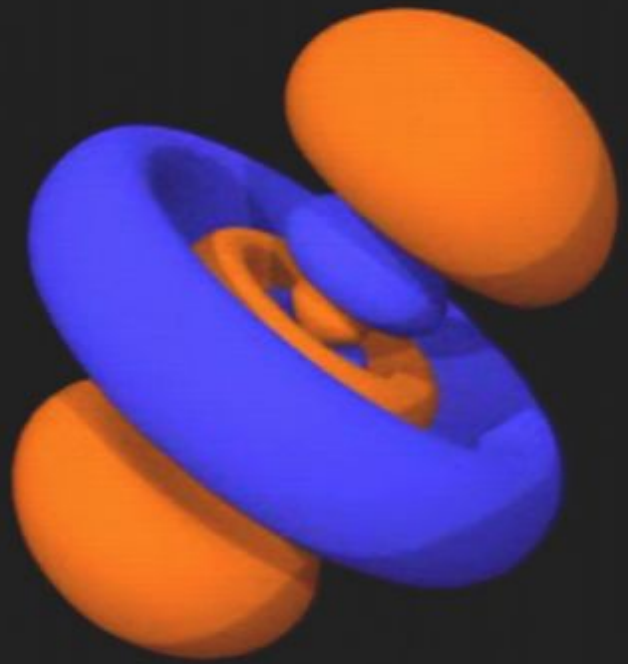

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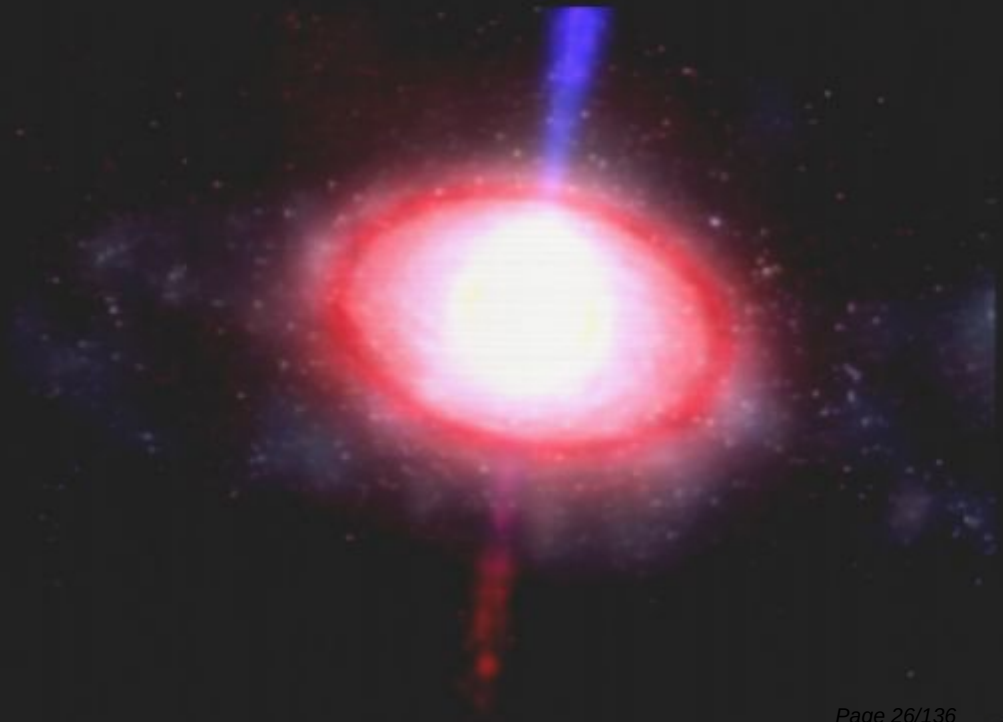

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Problem: Q & R are incompatible

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Probability

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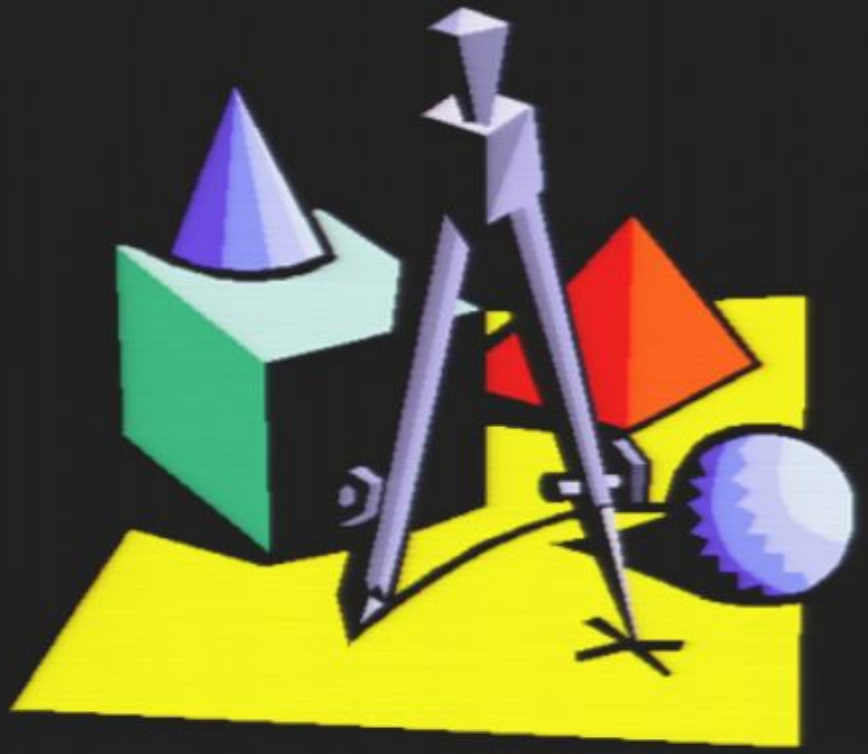

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Question: How

Question: How can our Universe exist?

Question: How can our Universe exist?

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Quantum Gravity?

Your Mission:

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1. Learn: Quantum & Relativity in 60 seconds

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$E = hf$

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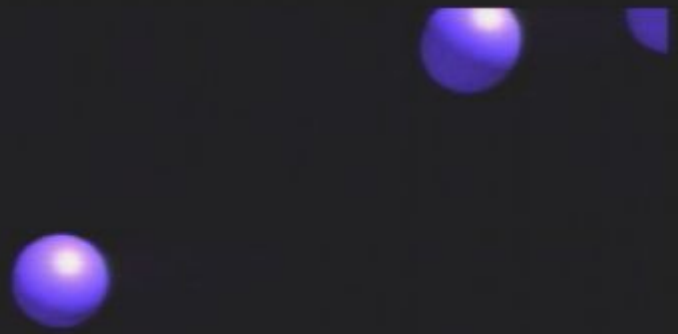

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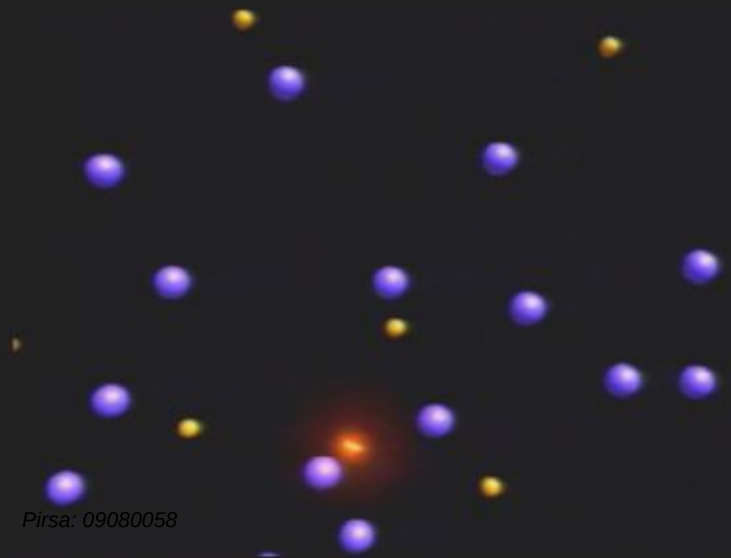

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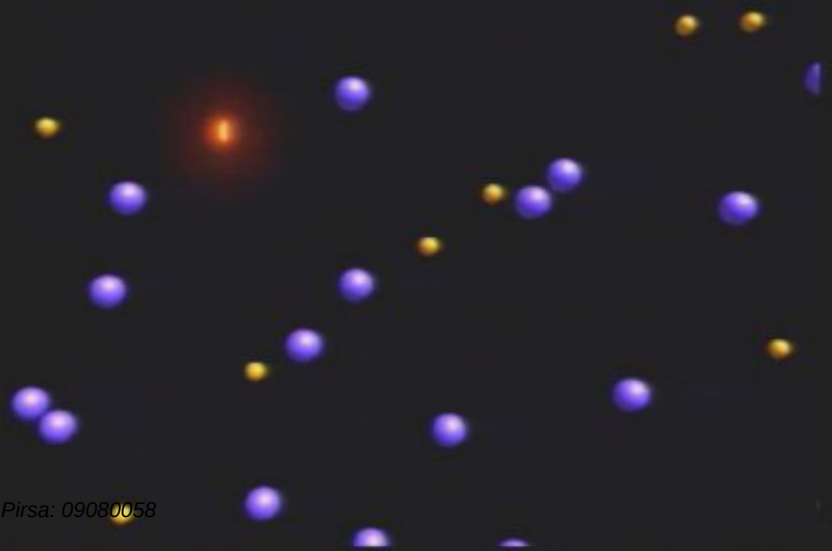

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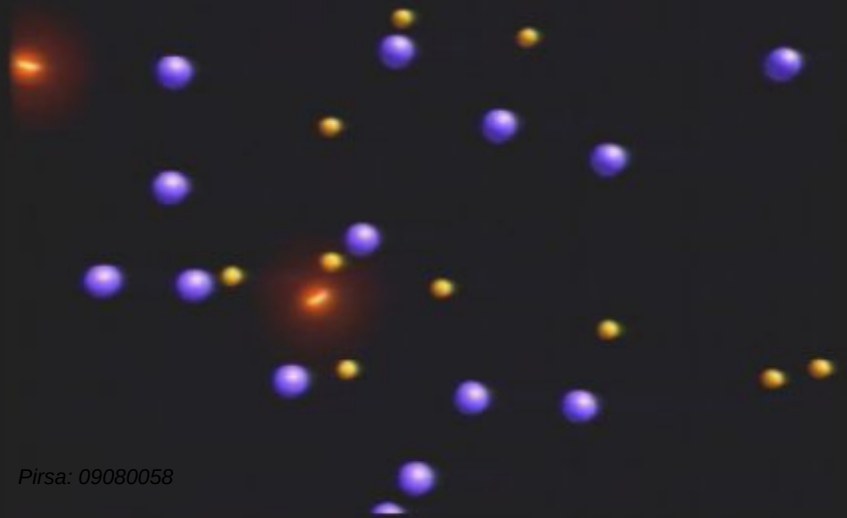

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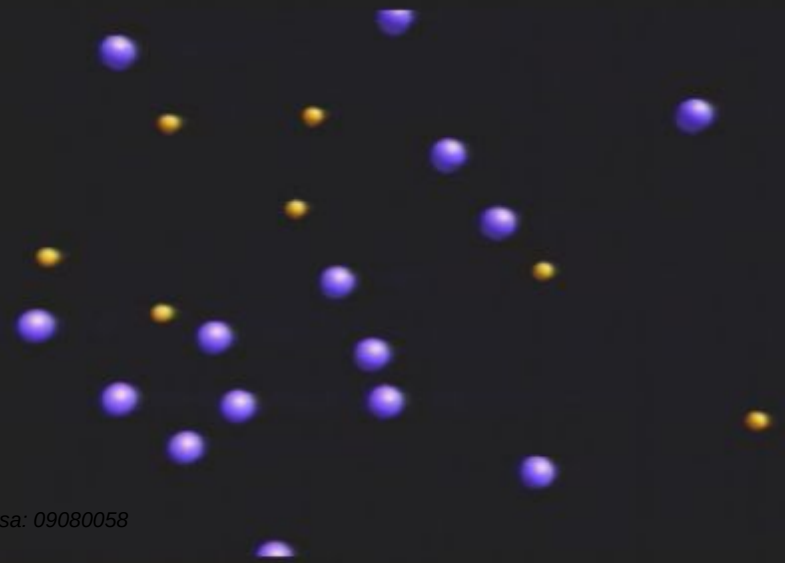

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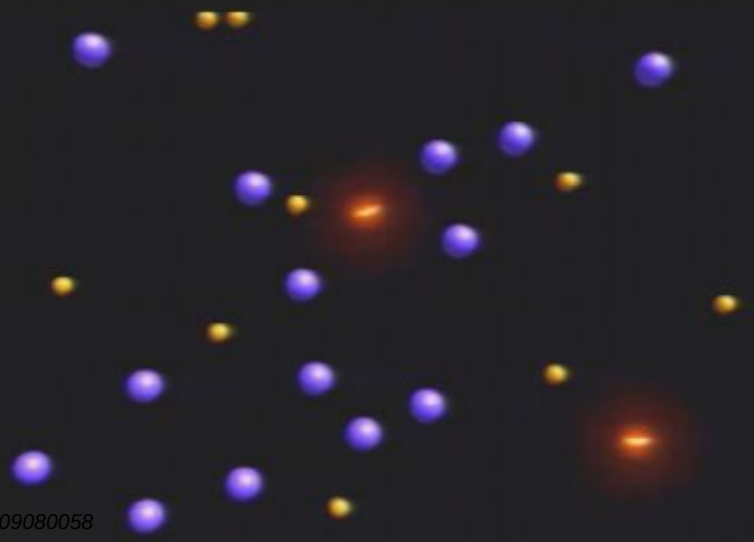

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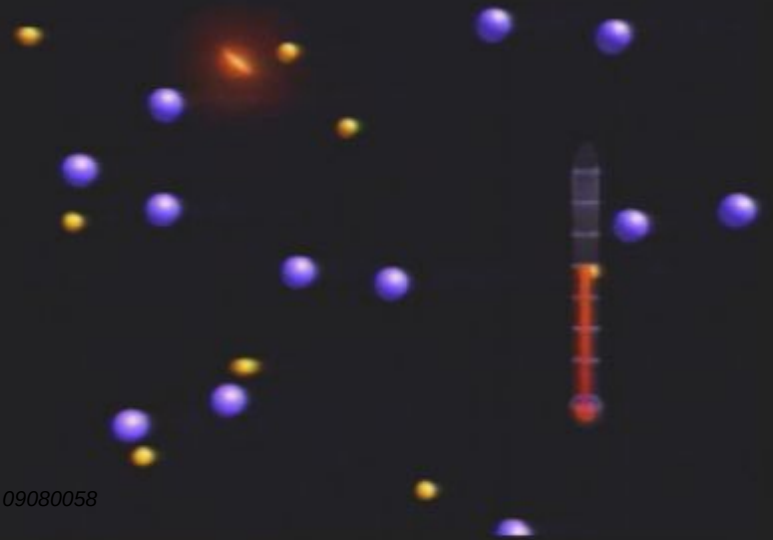

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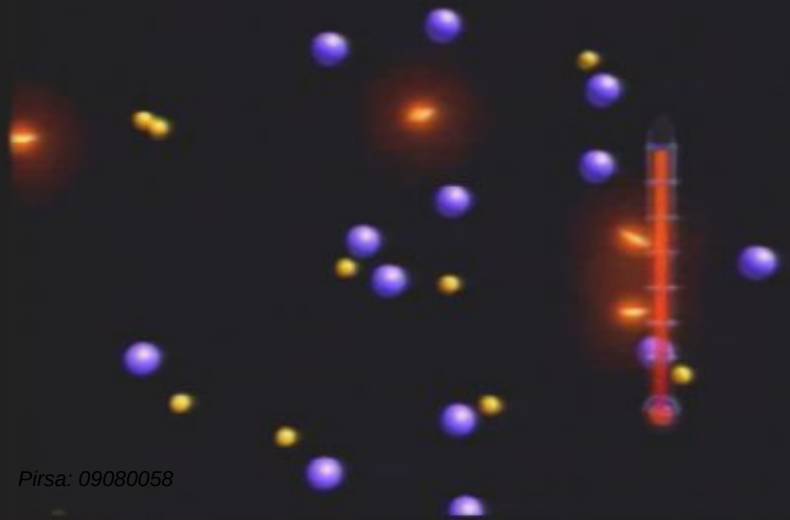

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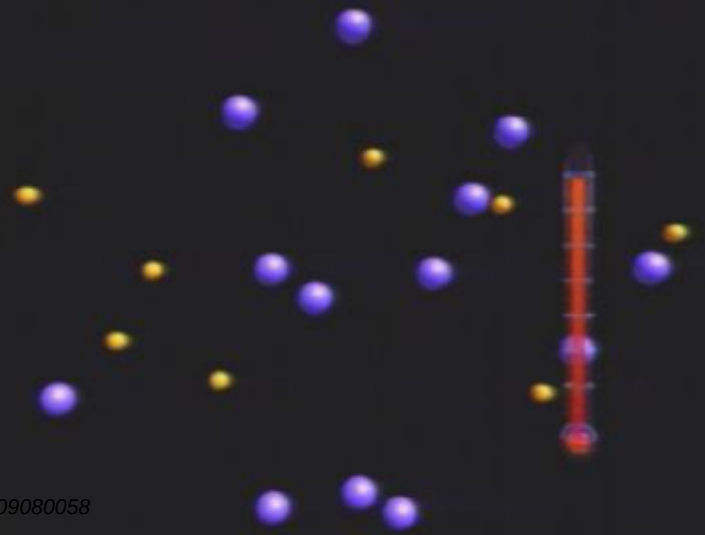

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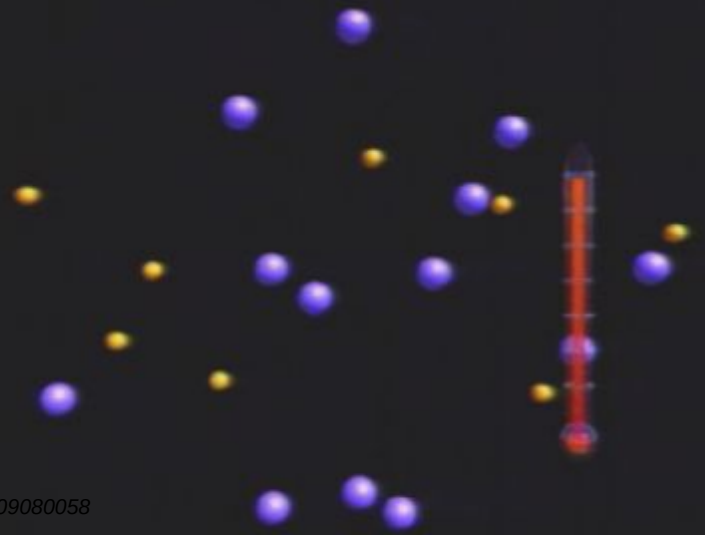
Step 1: Quantum & Relativity in 60 seconds:

Quantum	Relativity
$E = hf$	$E = Mc^2$
Light = Photons Photons have Energy	Energy & Mass Interchangeable



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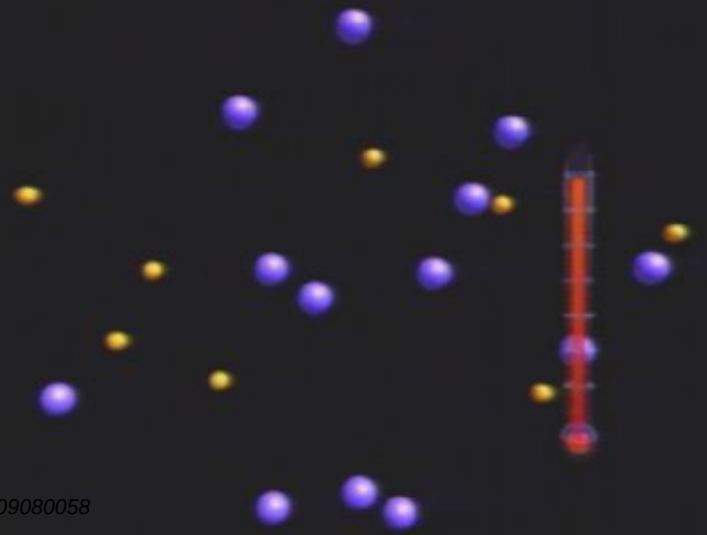

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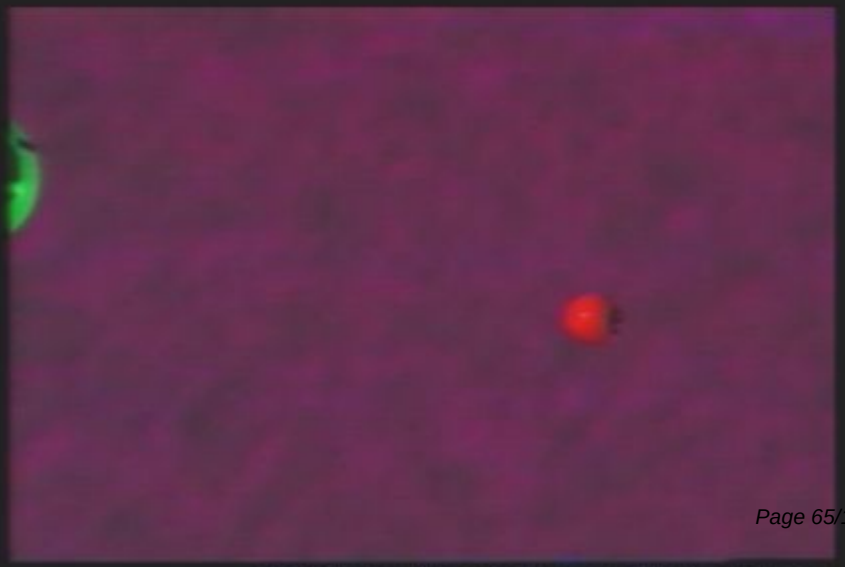

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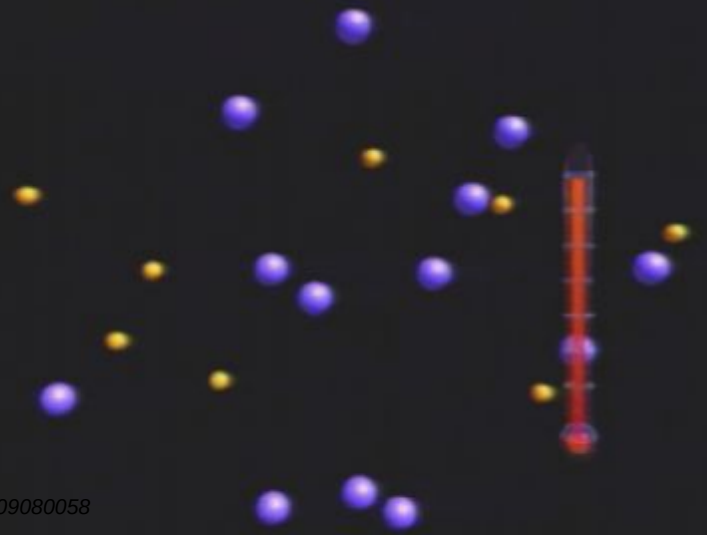

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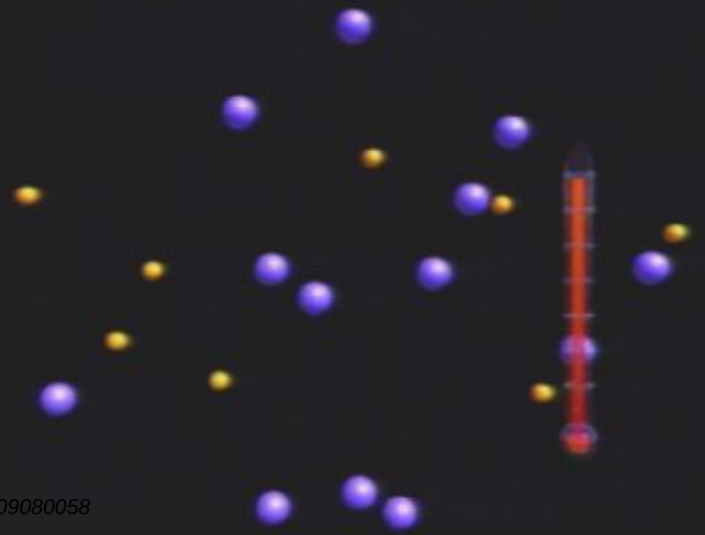

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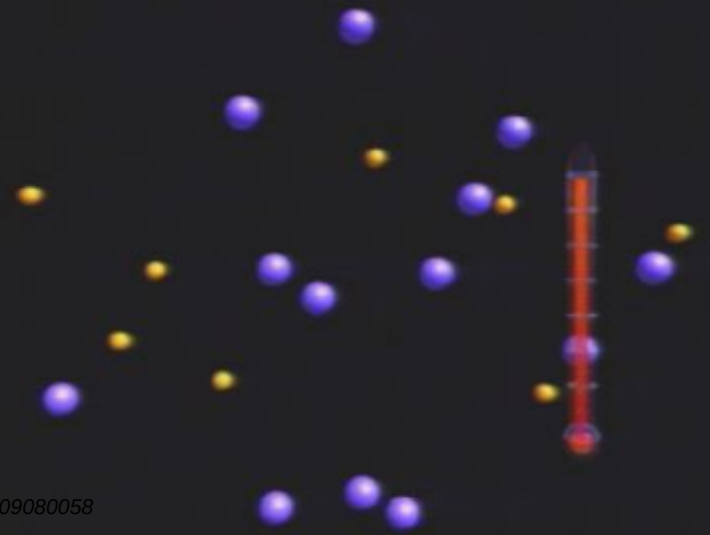

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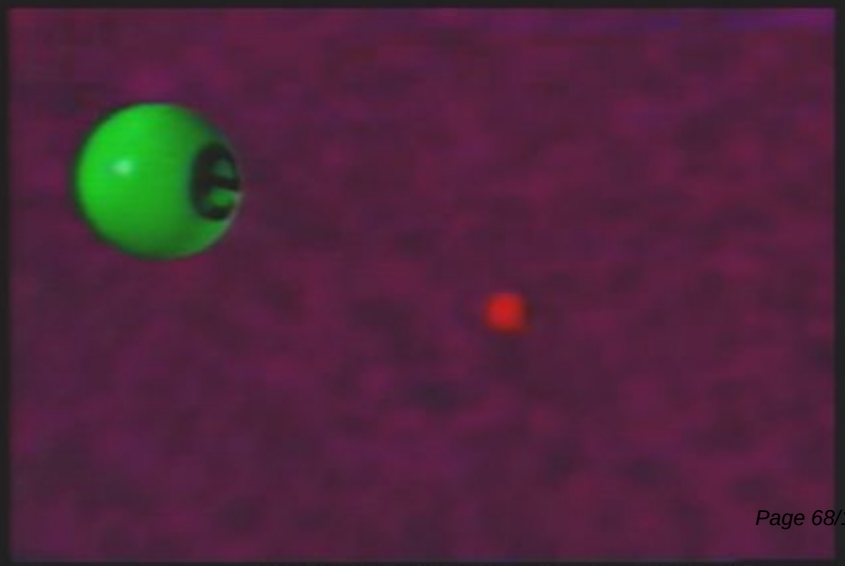

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Also need to know:

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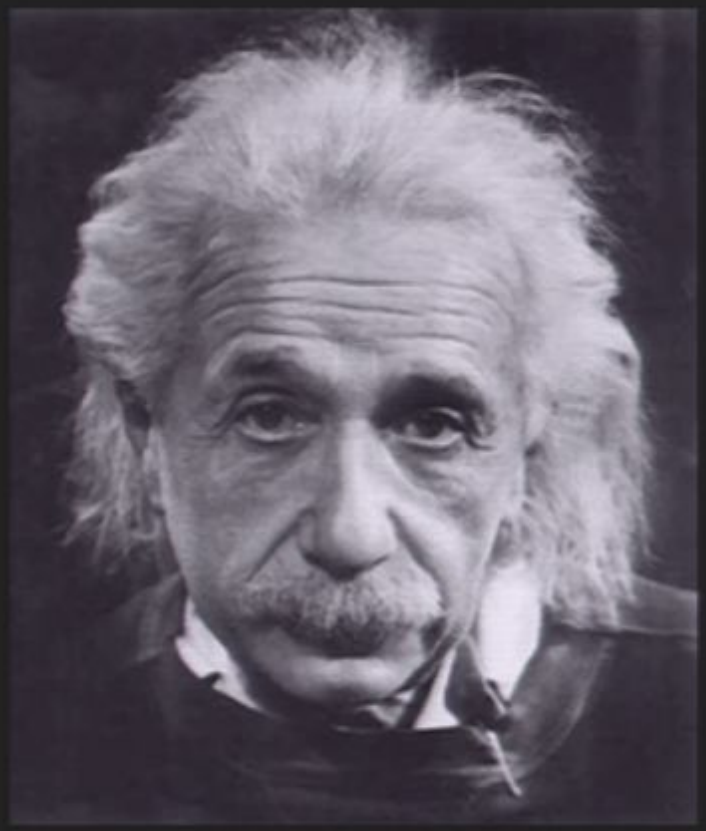

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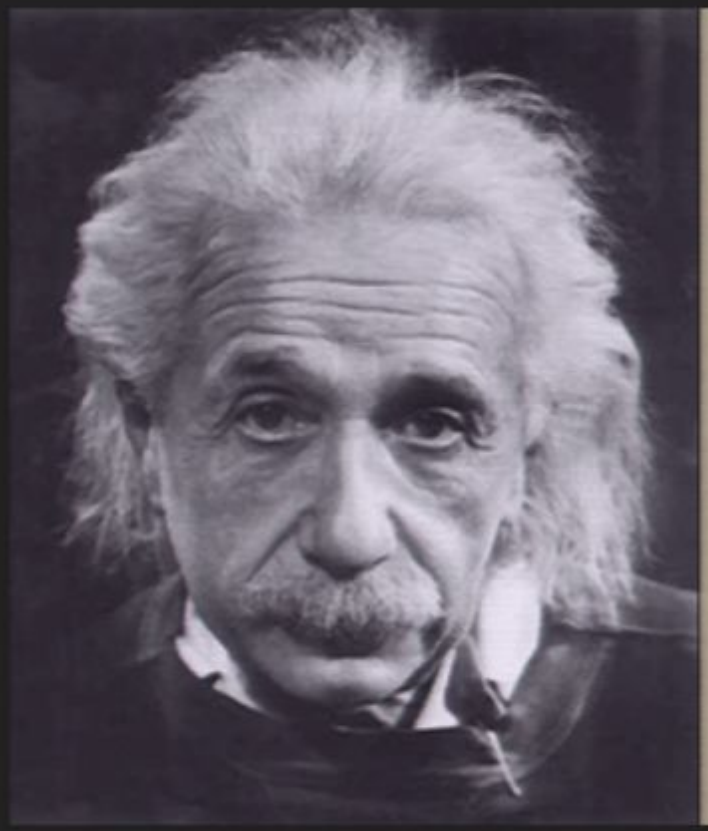

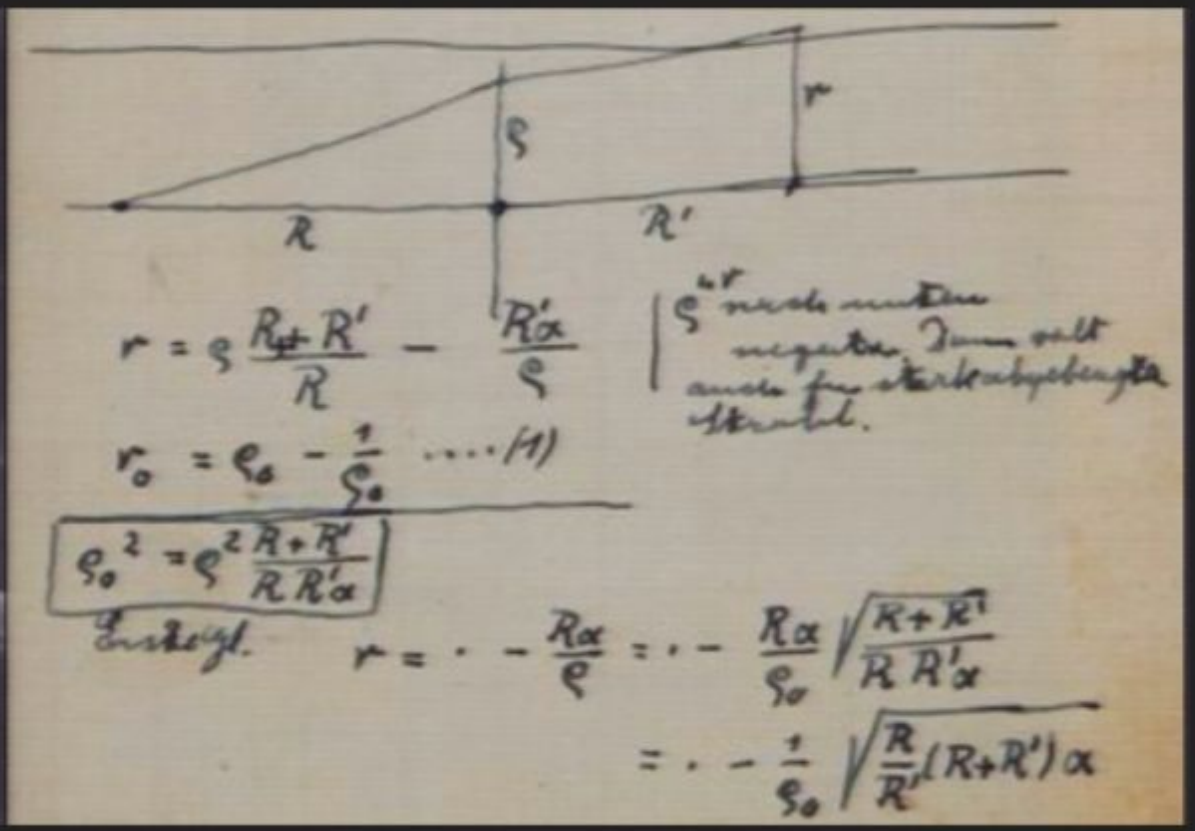

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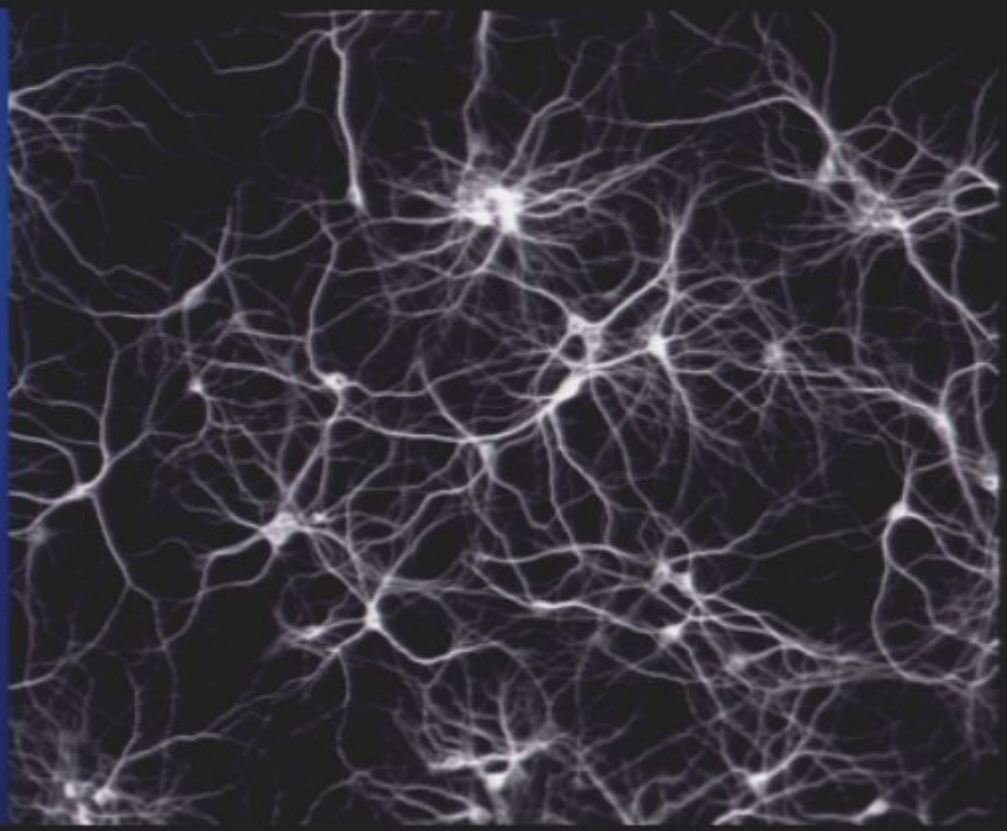

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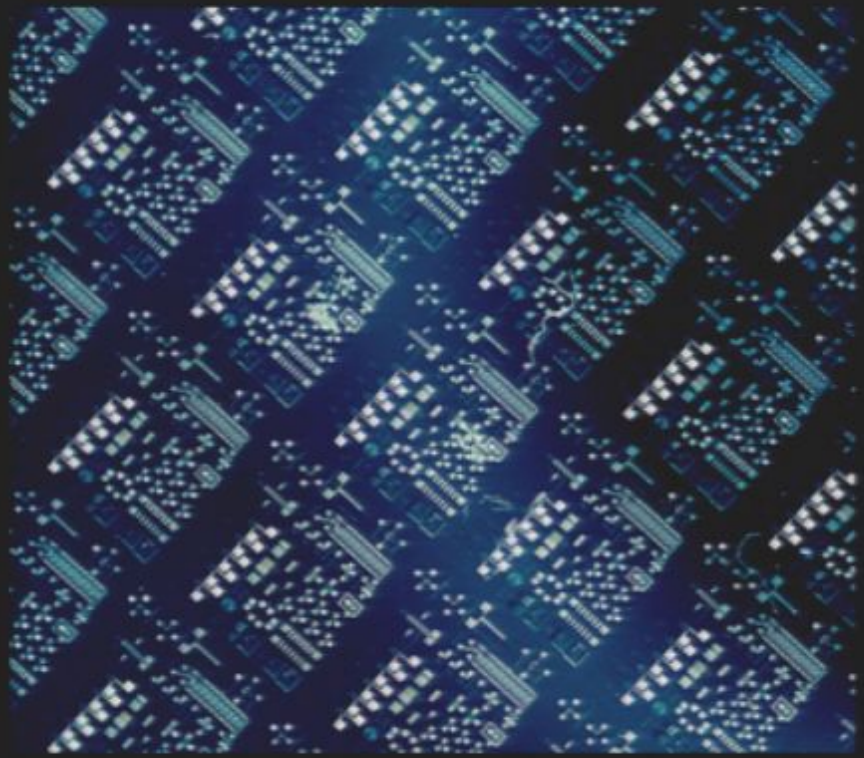

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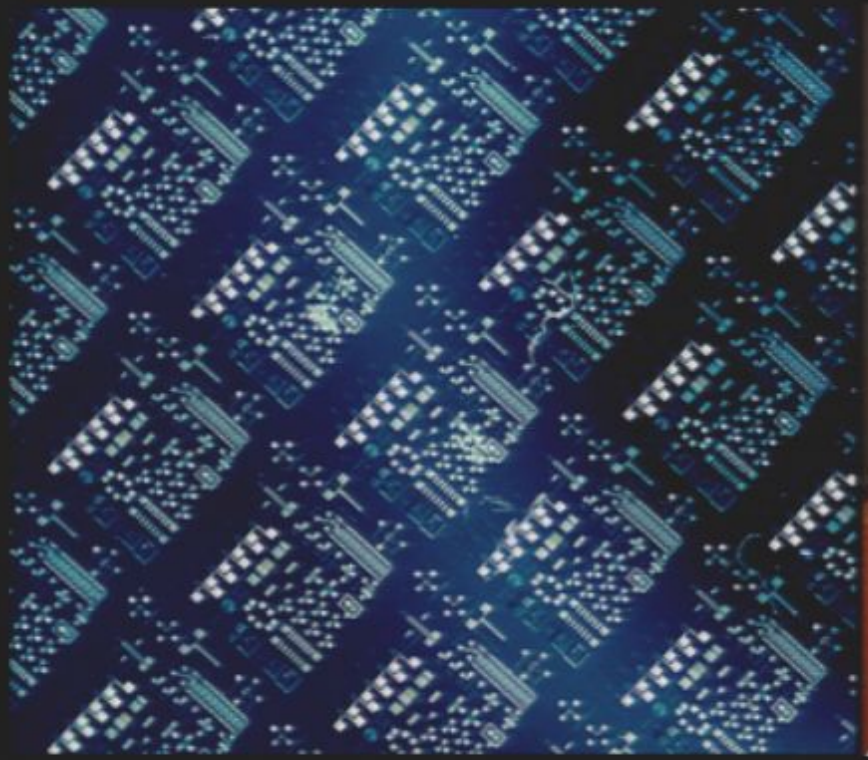

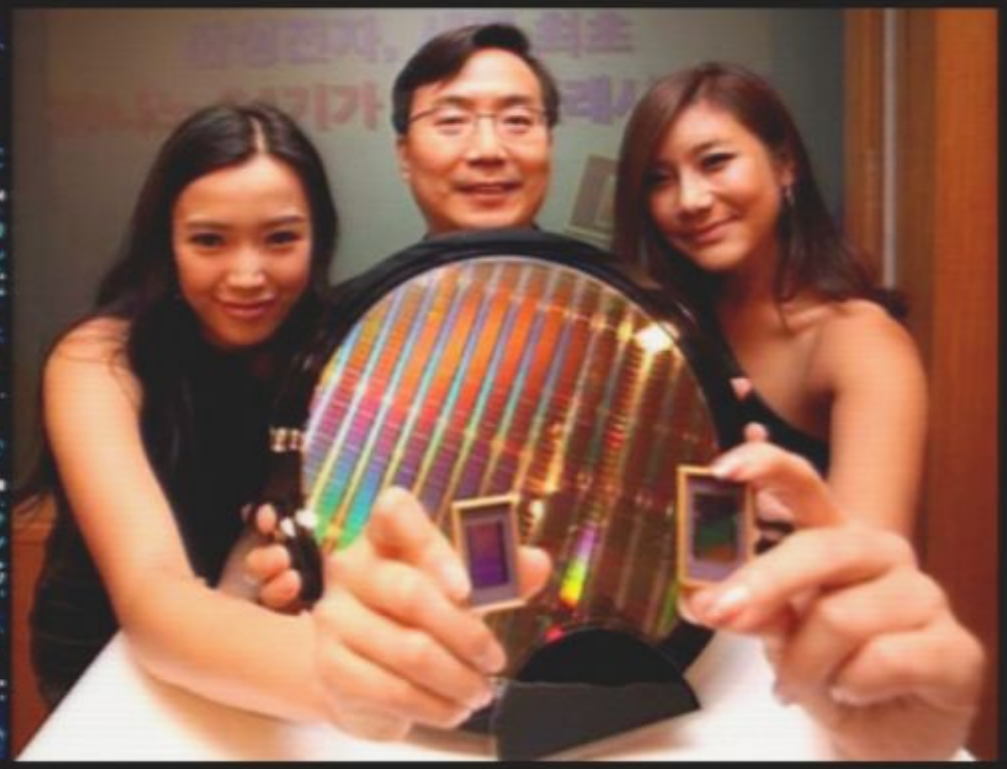

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Summary So Far:

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Quantum: $E = hf$

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Relativity: $E = Mc^2$

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Information needs to be embodied in a physical form

Step 2: What are Q & R trying to tell us?

trying to tell us?

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Question:

How much information can we cram into this sphere?

Maximum Info?

Maximum Info?

Info = 101101001001…

Maximum Info?

Info = 101101001001…

1 photon = 1 bit of info

Maximum Info?

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Use E = hf (and f = c/λ)

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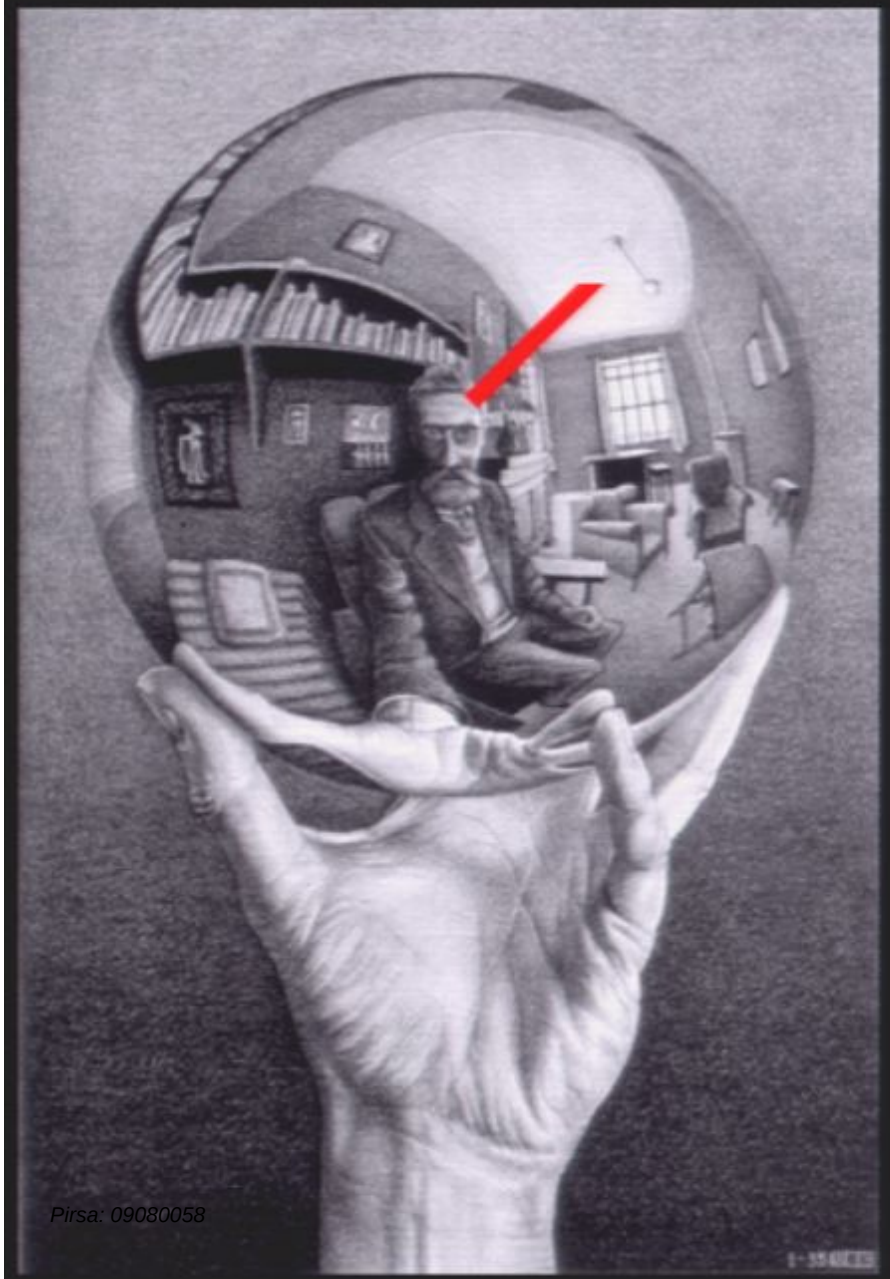
Use E = hf (and f = c/λ)

Energy cost: E = hf = hc/λ

Maximum Info?



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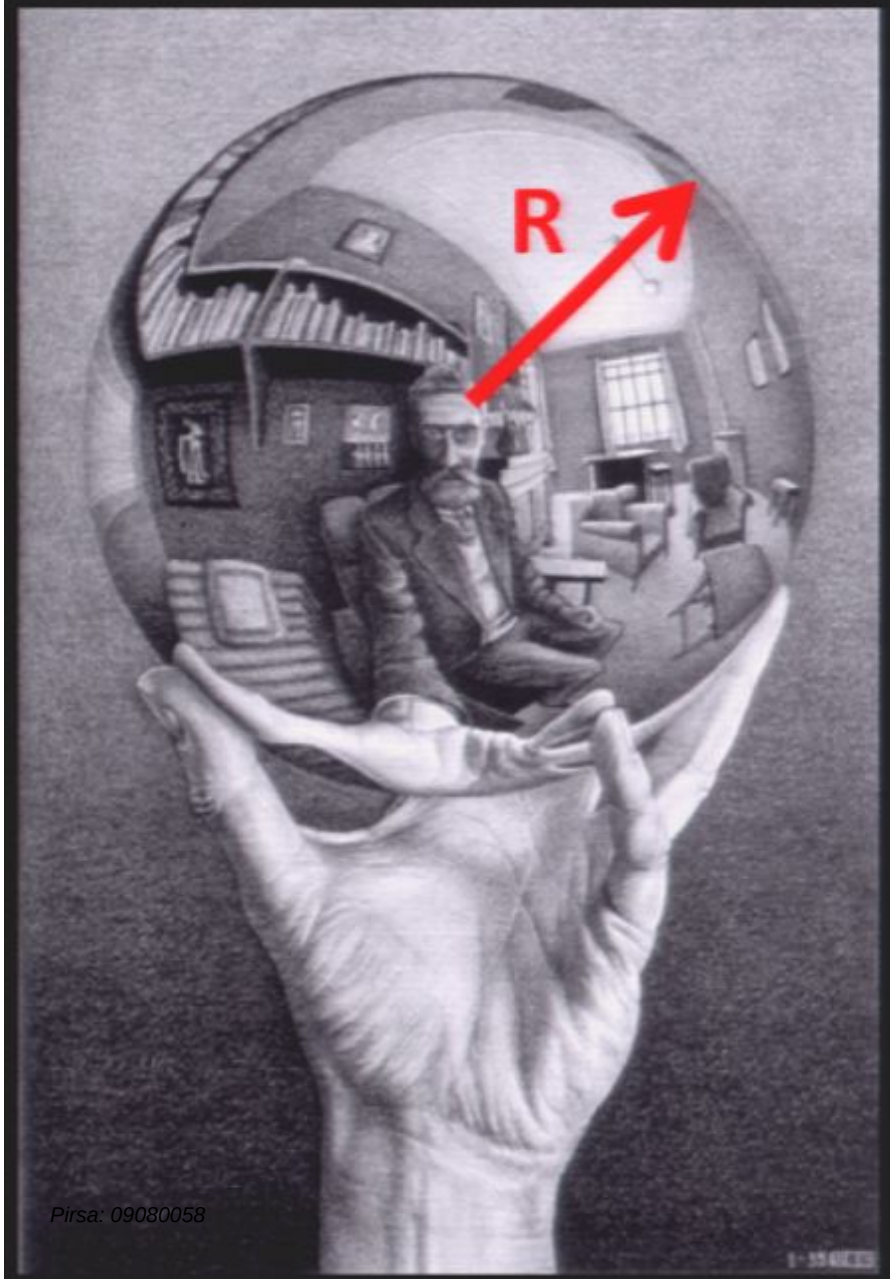
Energy cost: E = hf = hc/λ

Minimum cost: E = hc/R

Maximum Info?



Info = 101101001001…

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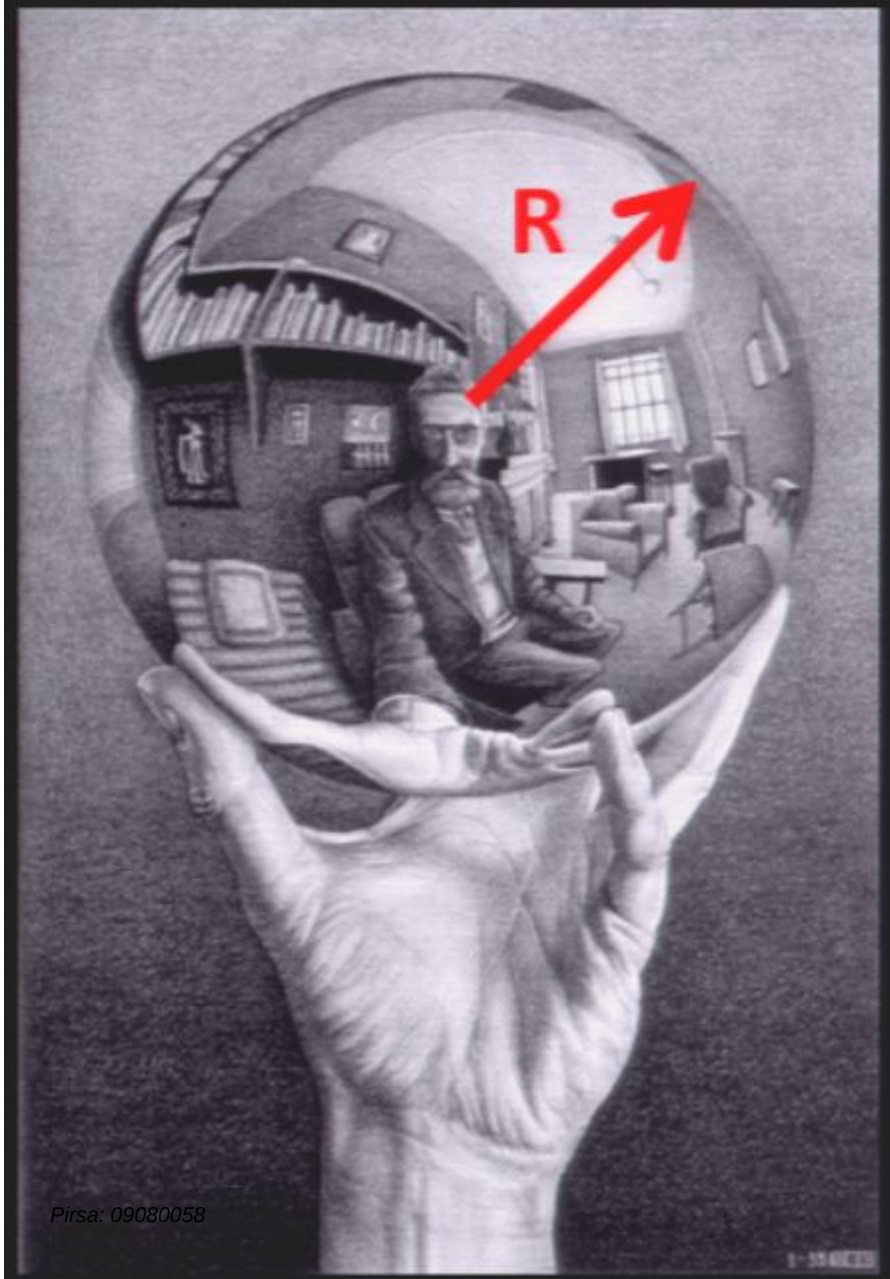
Use E = hf (and f = c/λ)

Energy cost: E = hf = hc/λ

Minimum cost: E = hc/R

Maximum Info?



Info = 101101001001…

1 photon = 1 bit of info

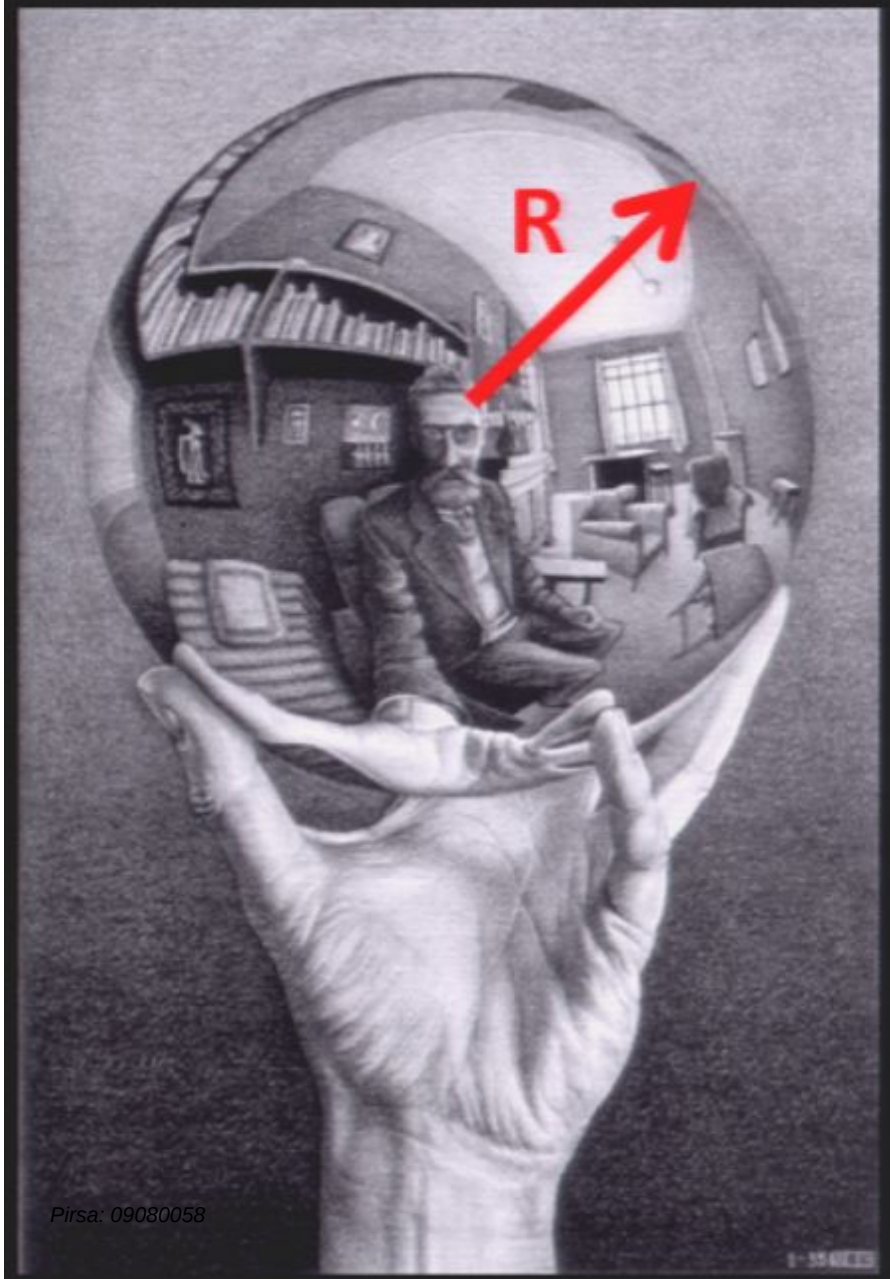
Use E = hf (and f = c/λ)

Energy cost: E = hf = hc/λ

Minimum cost: E = hc/R

Cost for N bits: E = Nhc/R

Maximum Info?



Info = 101101001001…

1 photon = 1 bit of info

Use E = hf (and f = c/λ)

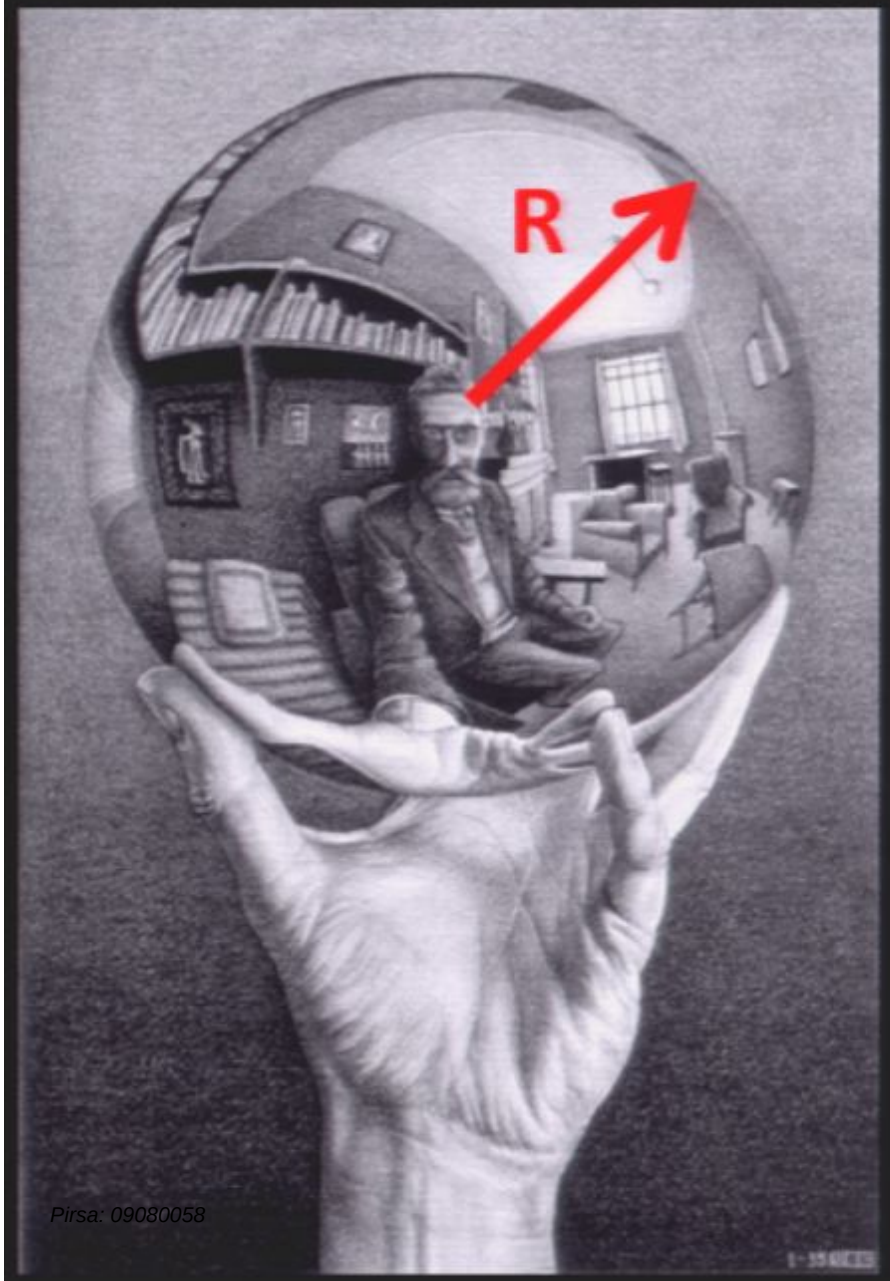
Energy cost: E = hf = hc/λ

Minimum cost: E = hc/R

Cost for N bits: E = Nhc/R

Use E = Mc^2

Maximum Info?



Info = 101101001001…

1 photon = 1 bit of info

Use $E = hf$ (and $f = c/\lambda$)

Energy cost: $E = hf = hc/\lambda$

Minimum cost: $E = hc/R$

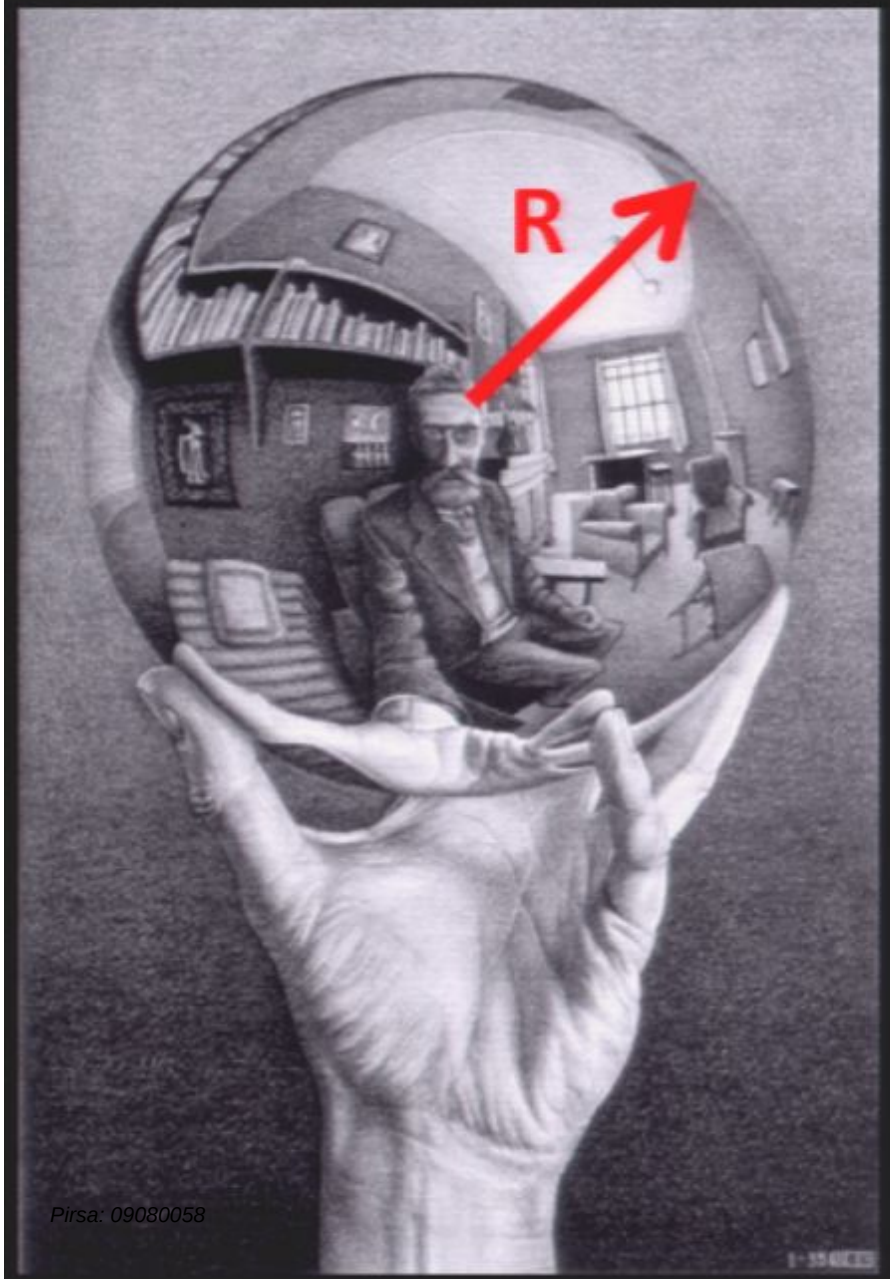
Cost for N bits: $E = Nhc/R$

Use $E = Mc^2$

Gravitating mass of N bits:

$M = Nh/cR$

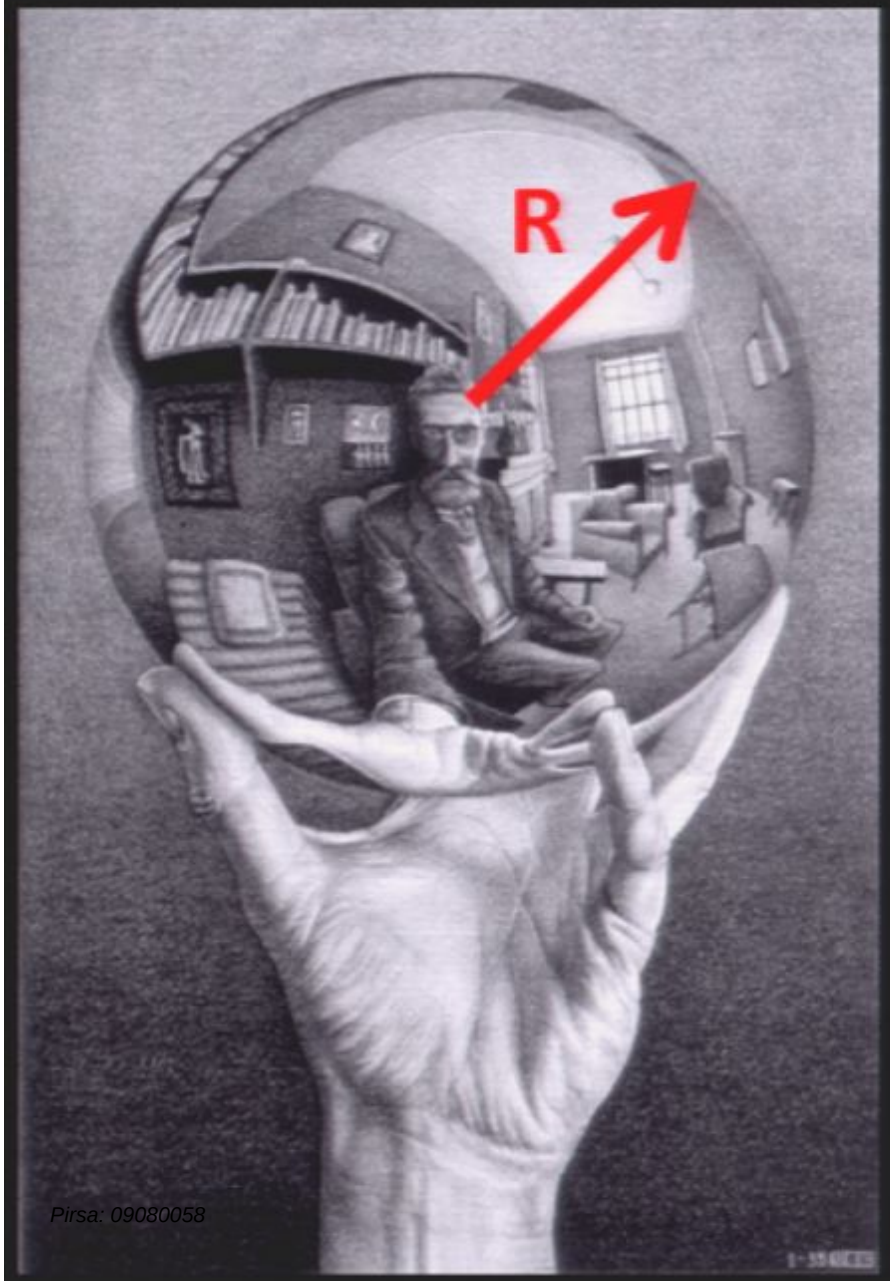
Maximum Info?



Gravitating mass of N bits:

$M = Nh/cR$

Maximum Info?

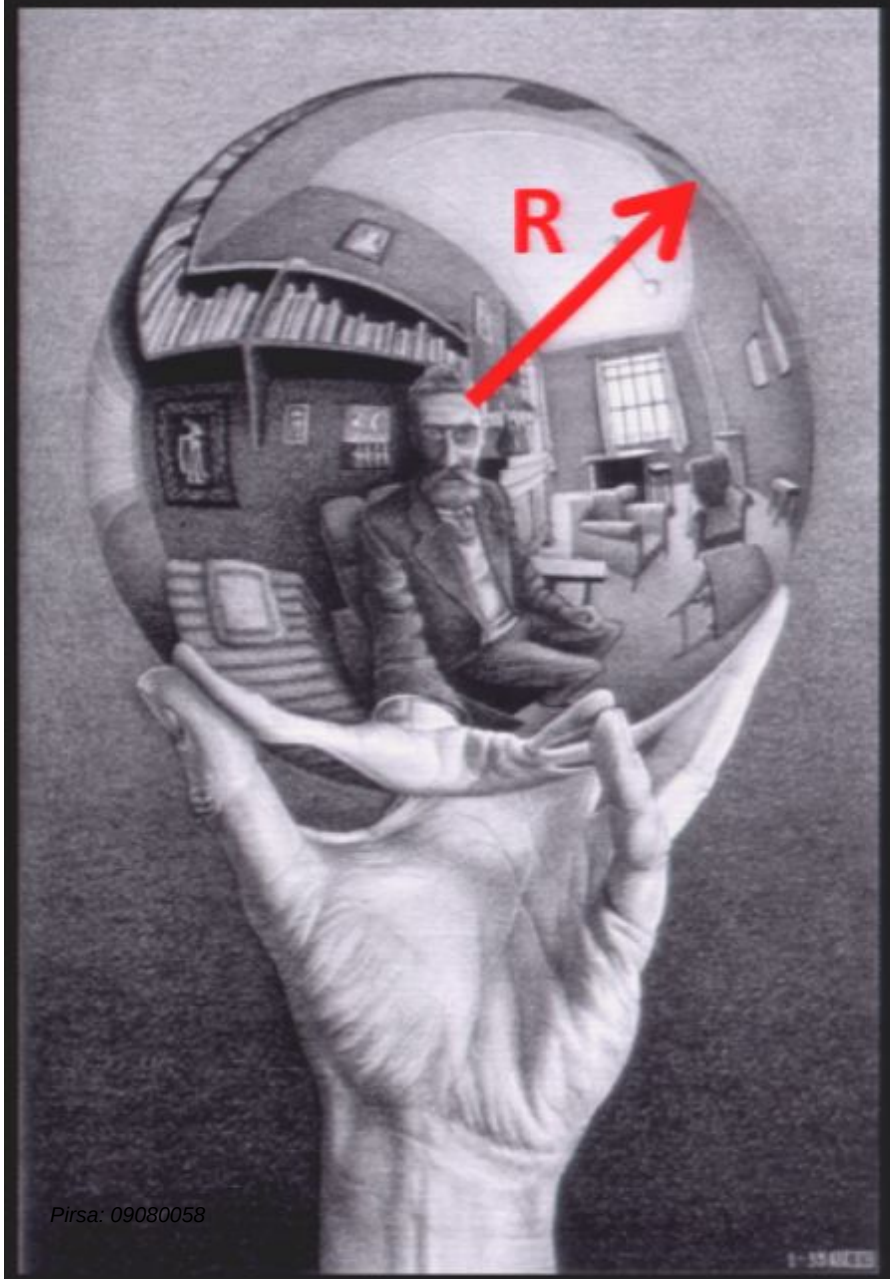


Gravitating mass of N bits:

$M = Nh/cR$

Is there a maximum N?

Maximum Info?



Gravitating mass of N bits:

$M = Nh/cR$

Is there a maximum N?

$M = c^2R/2G$ (black hole)

Maximum Information?

A

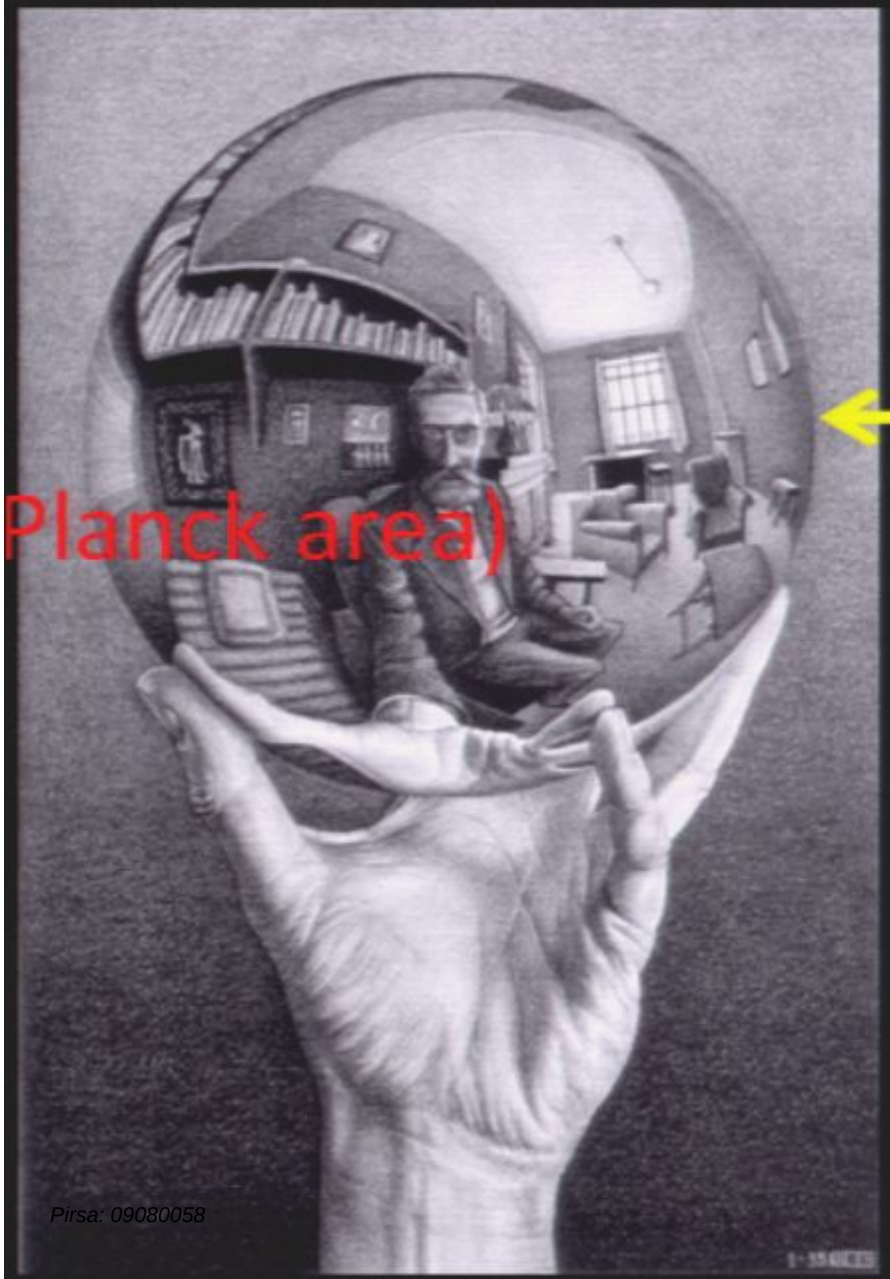
Maximum Information?

A black hole will form when $n \propto m d^3$

Maximum Information?

A black hole will form when number of bits of info = Area / 4$\mathcal{A}$

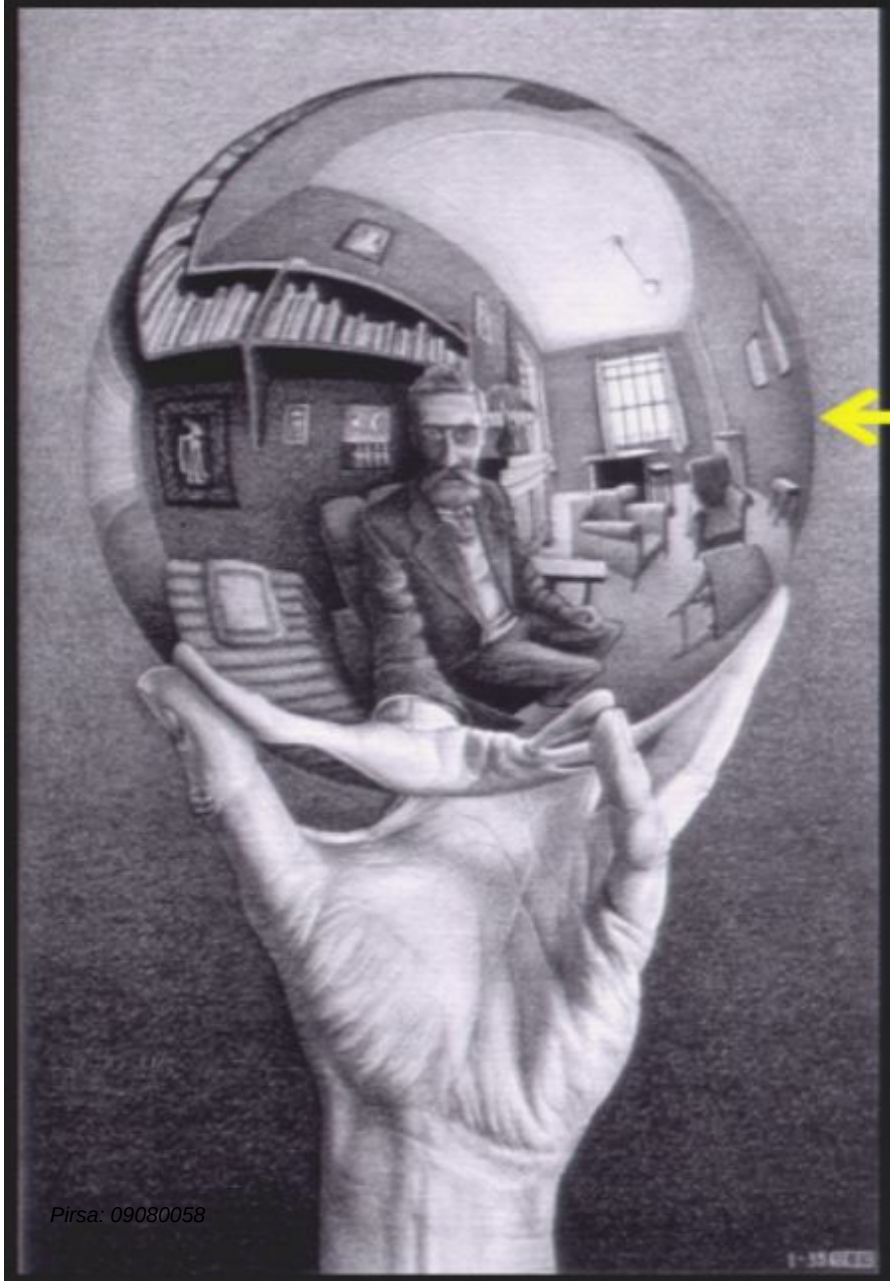
Maximum Information?



A black hole will form when number of bits of info = Area / 4$\mathcal{A}$

Planck area)

Maximum Information?

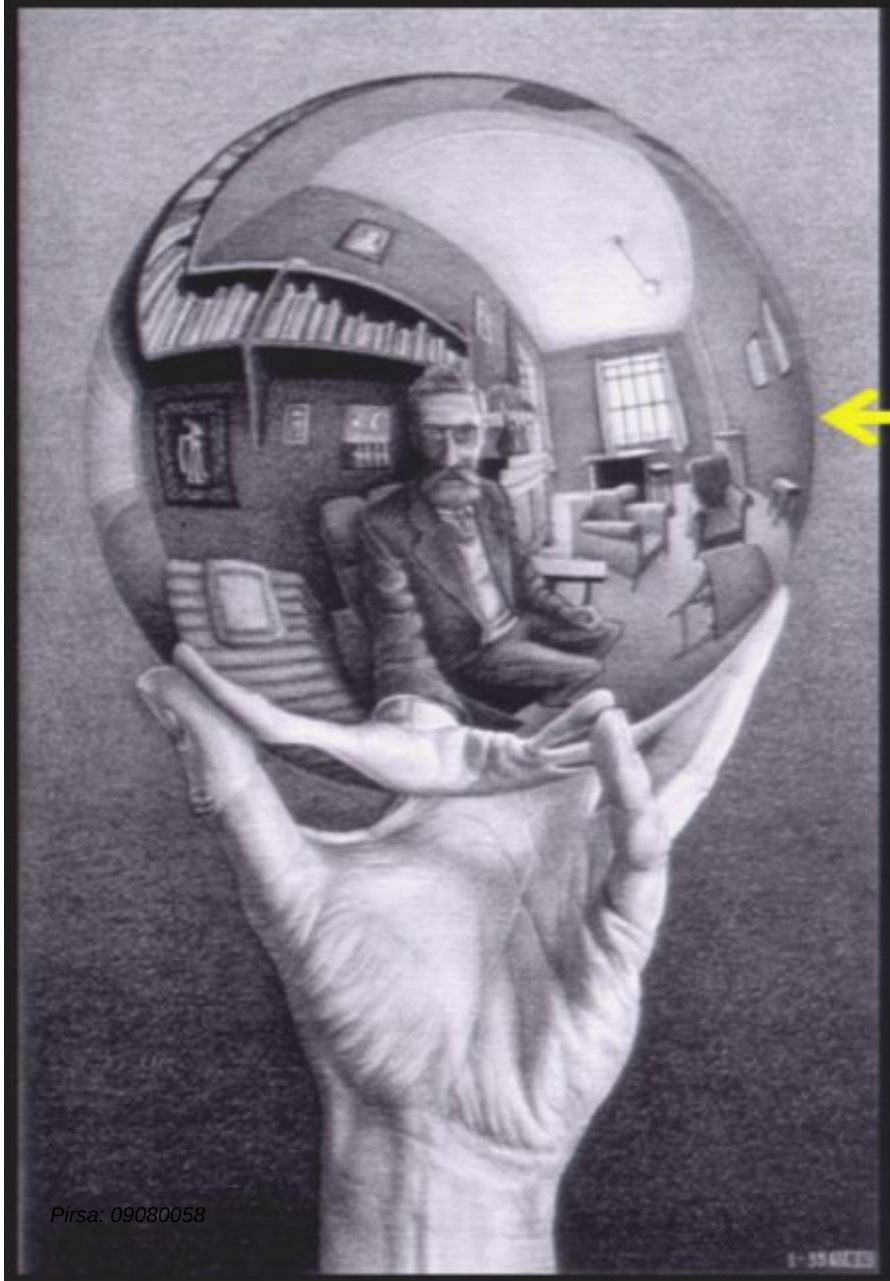


A black hole will form when number of bits of info = Area / 4$\mathcal{A}$

$\mathcal{A}$ = 10^{-70} m^2 (Planck area)

Bizarre: Max Info…

Maximum Information?



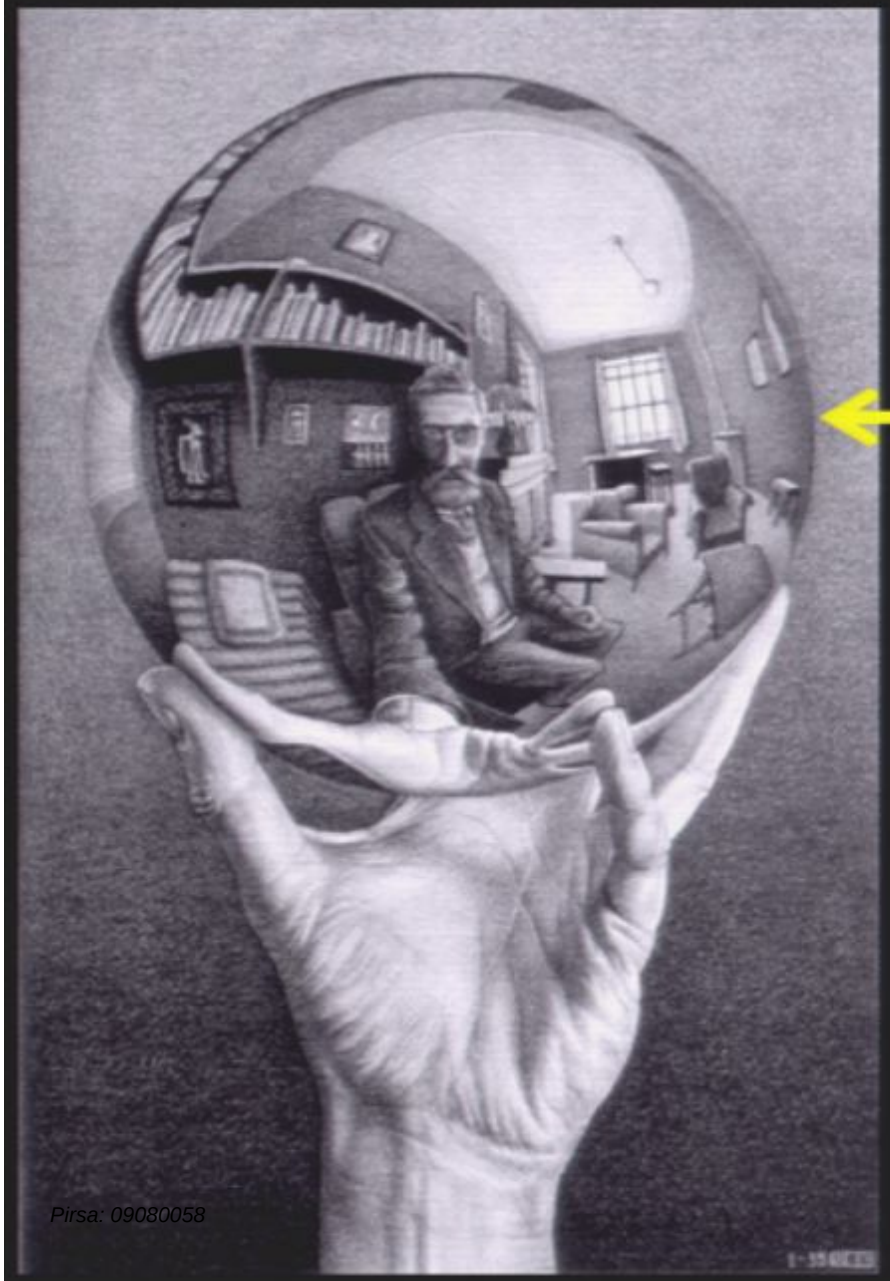
A black hole will form when number of bits of info = Area / 4$\mathcal{A}$

$\mathcal{A}$ = 10^{-70} m^2 (Planck area)

Bizarre: Max Info…

1. Finite

Maximum Information?



A black hole will form when number of bits of info = Area / 4$\mathcal{A}$

$\mathcal{A} = 10^{-70}$ m^2 (Planck area)

Bizarre: Max Info...

1. Finite
2. Depends on Area not Vol

Our deep

Our deepest hi

Our deepest hint at the nat

Our deepest hint at the nature of 1961

Our deepest hint at the nature of reality?

Our deepest hint at the nature of reality?

Our deepest hint at the nature of reality?

Max Info

=

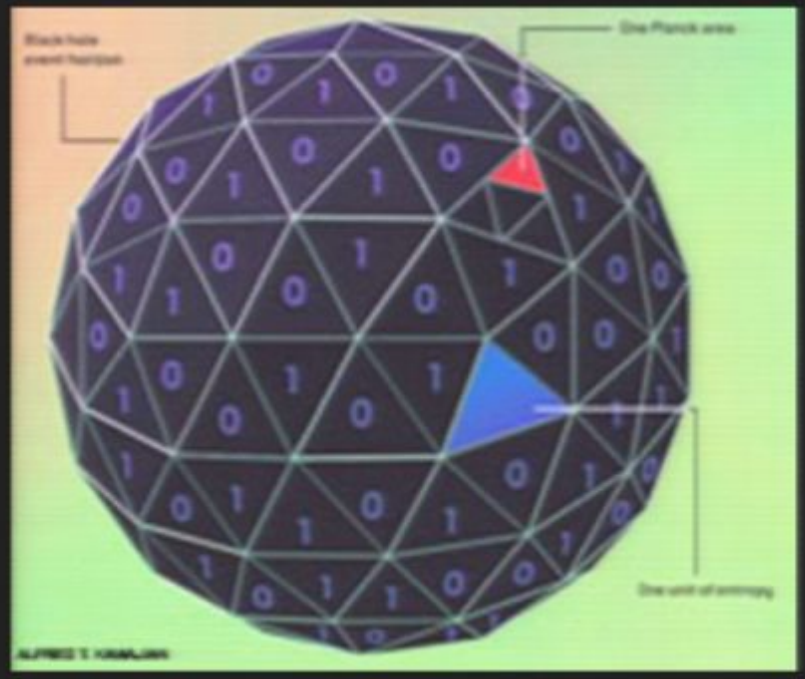
Area / 4$\mathcal{A}$

Our deepest hint at the nature of reality?

Max Info

=

Area / 4$\mathcal{A}$



The World as a Hologram?

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The World as a Hologram?

2-D hologram...

The World as a Hologram?

2-D hologram...

...contains 3-D info

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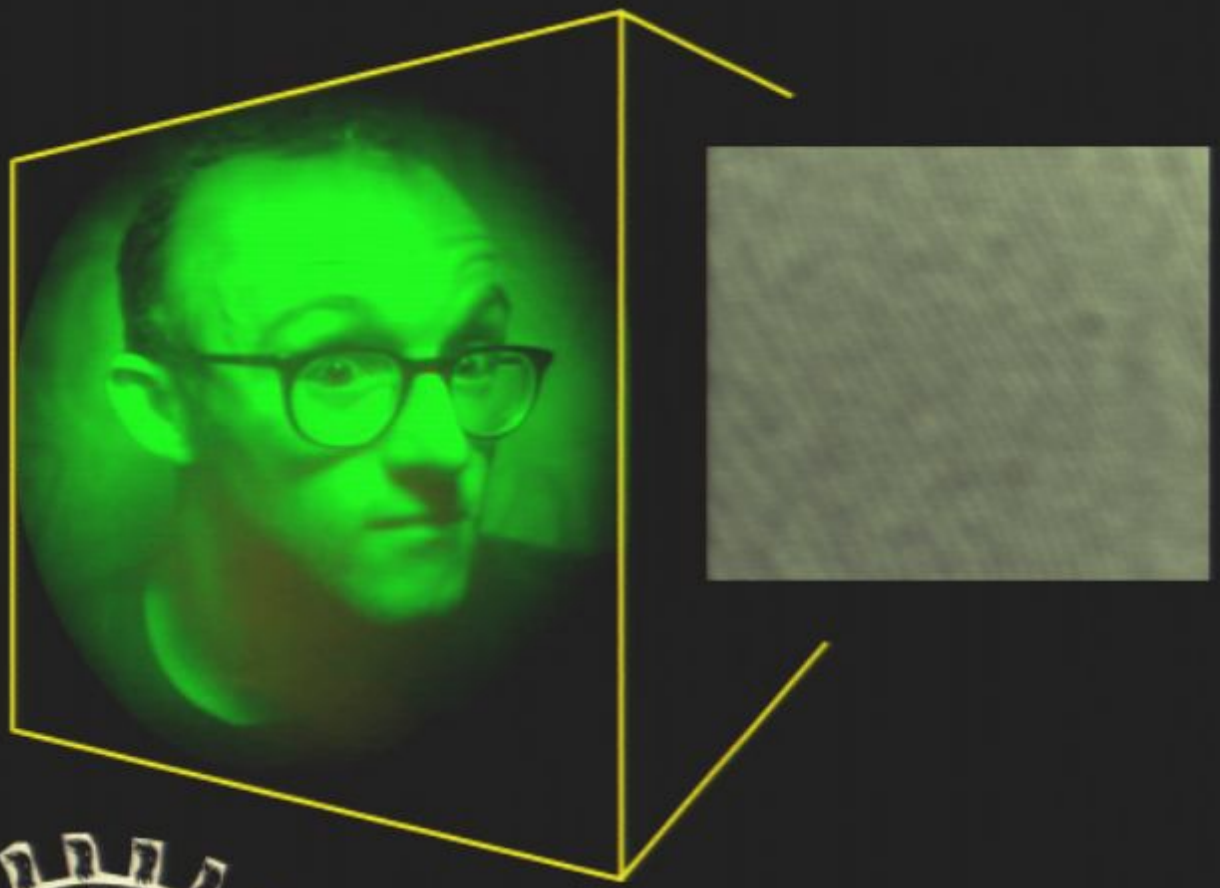
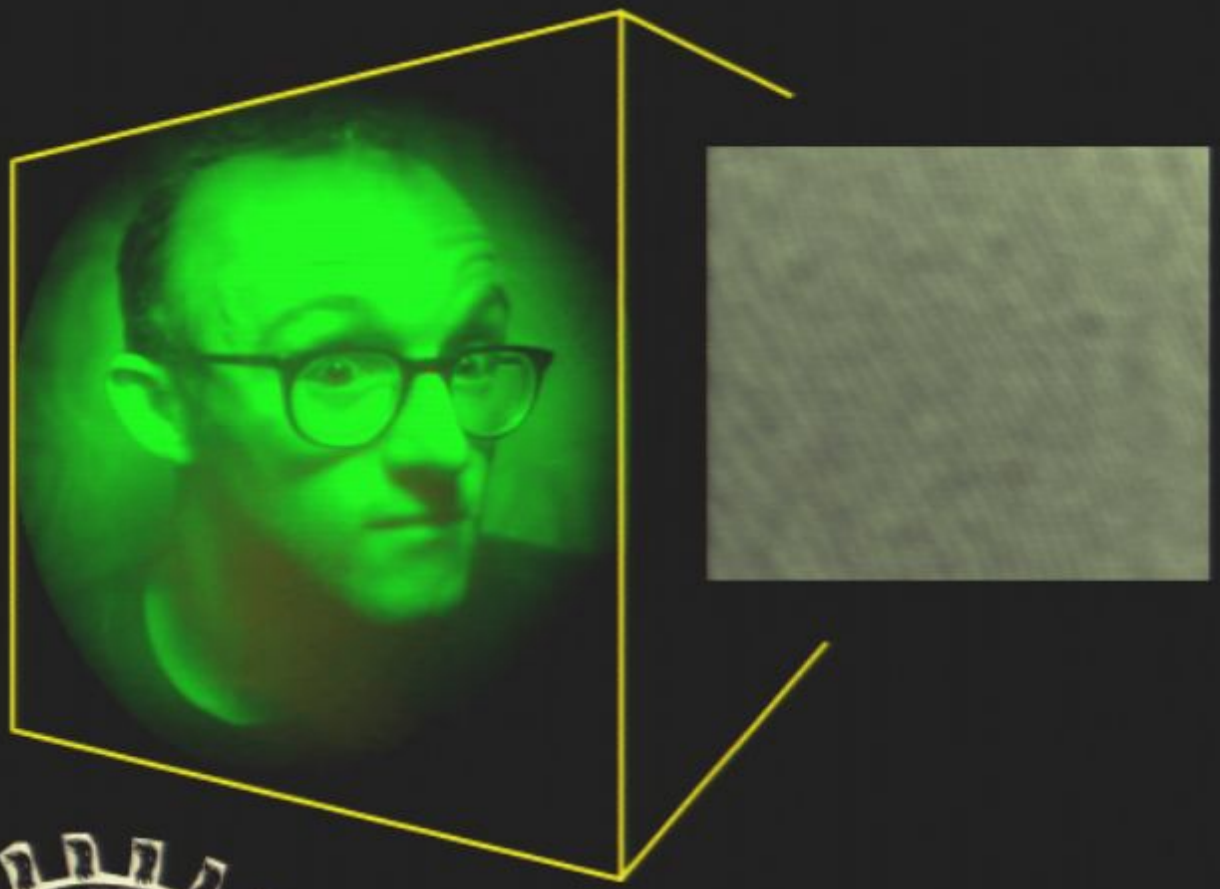


...contains 3-D info

The World as a Hologram?

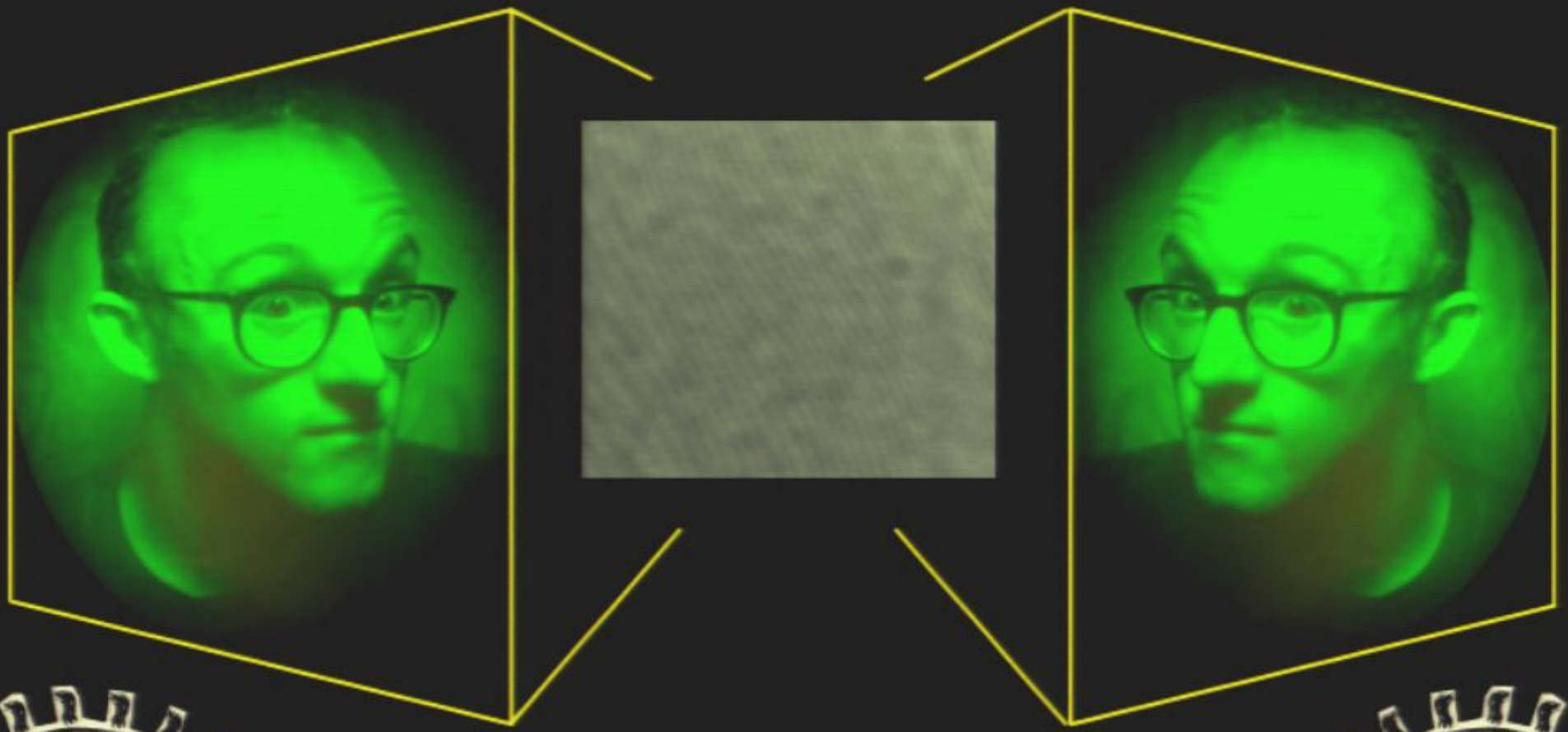
2-D hologram…



…contains 3-D info

The World as a Hologram?

2-D hologram...

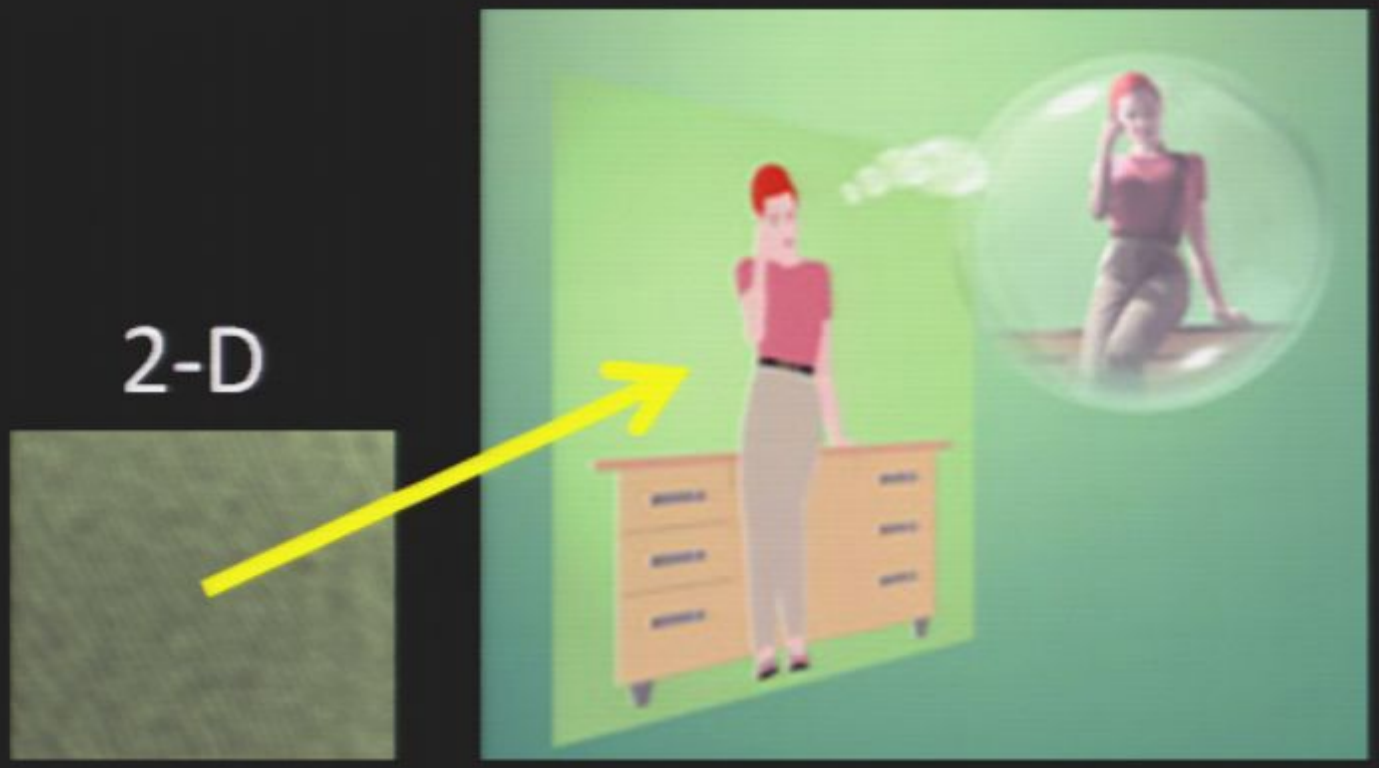


...contains 3-D info

The World as a Hologram?

The World as a Hologram?

The World as a Hologram?



The World as a Hologram?

The World as a Hologram?

"Our everyday perceptions of the world as 3-D would then be either a profound illusion or merely one of two alternative ways of viewing reality." – Jacob Bekenstein