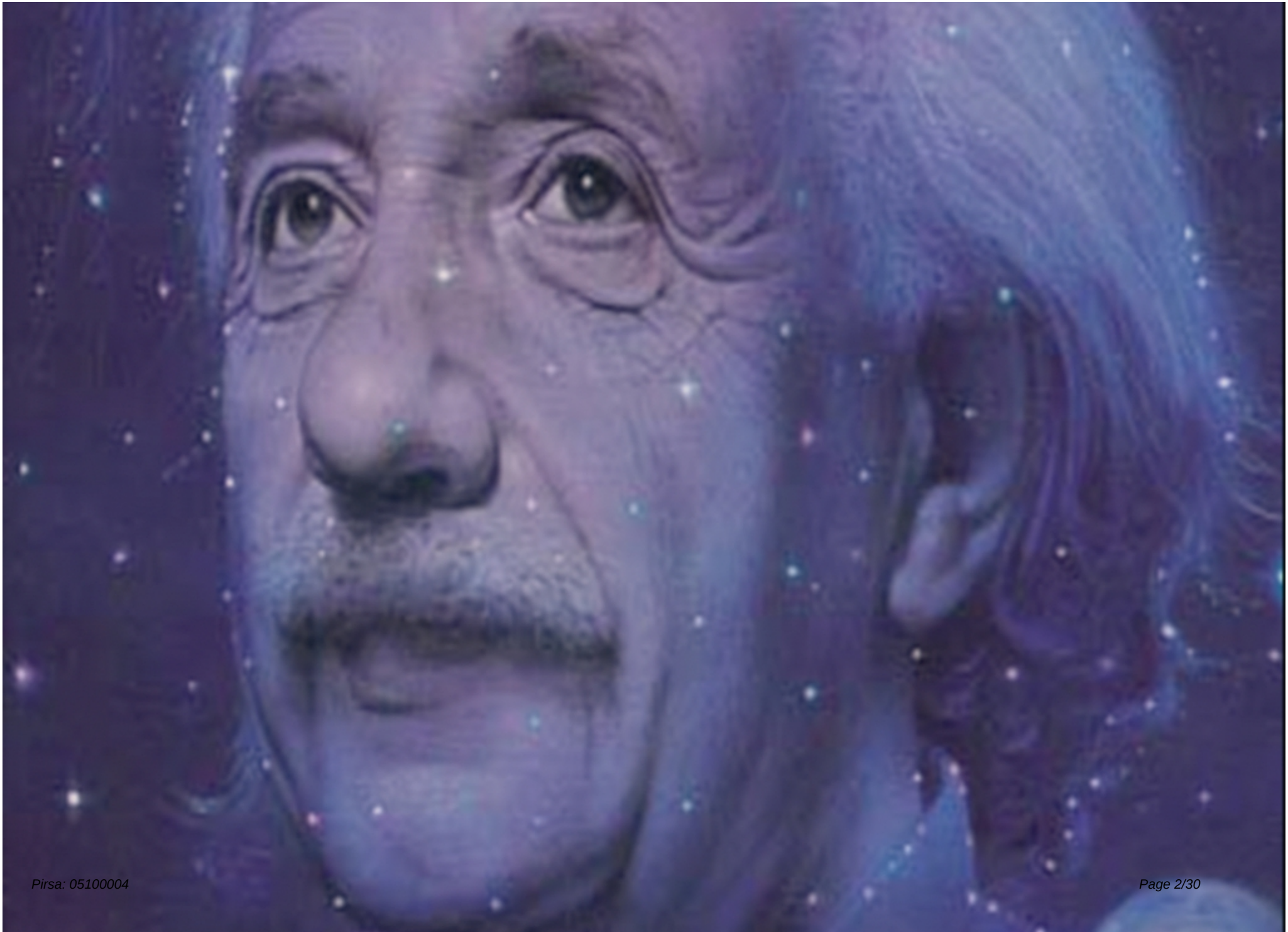
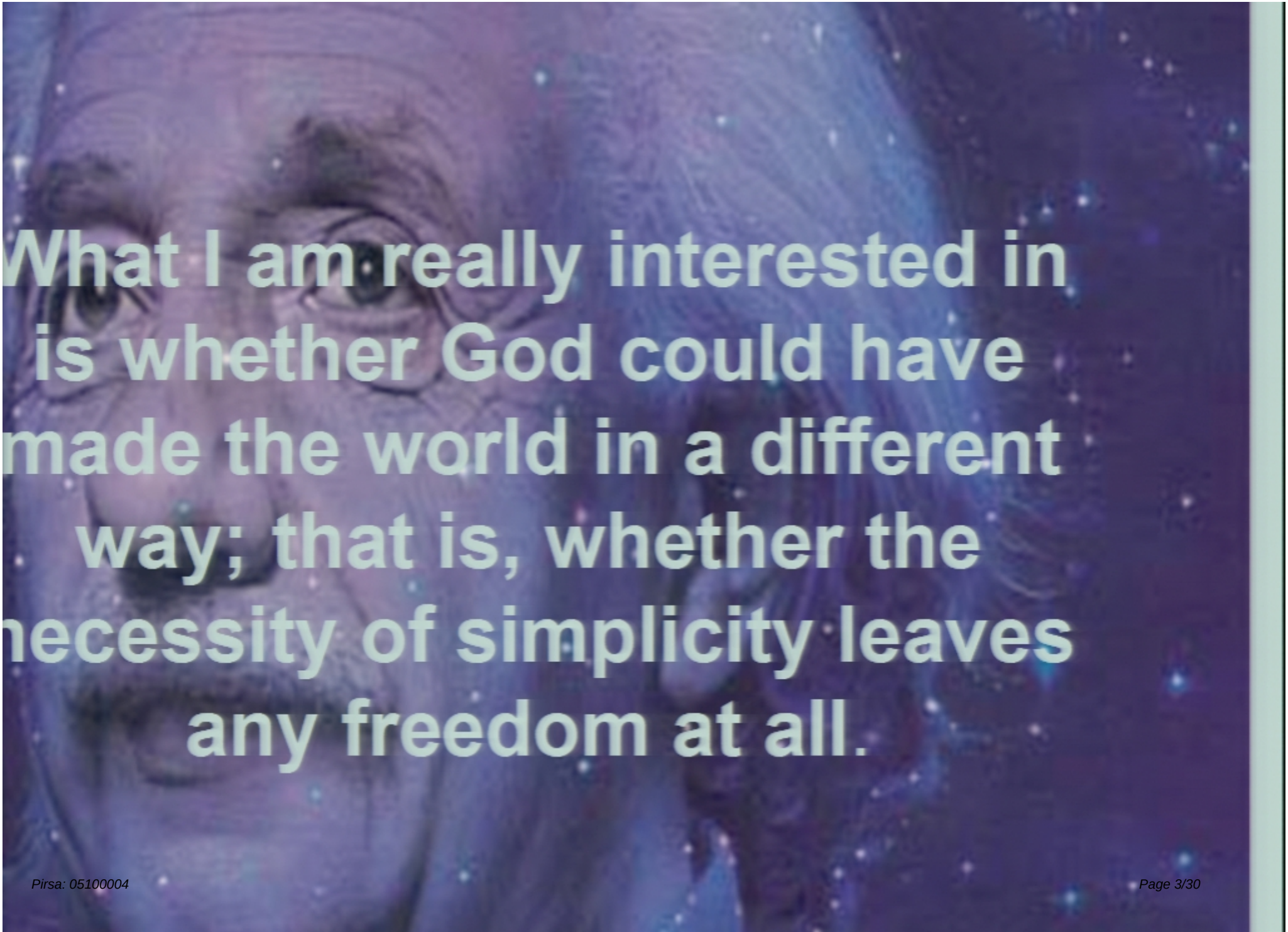
Title: April and May 1905: Witnessing Atoms

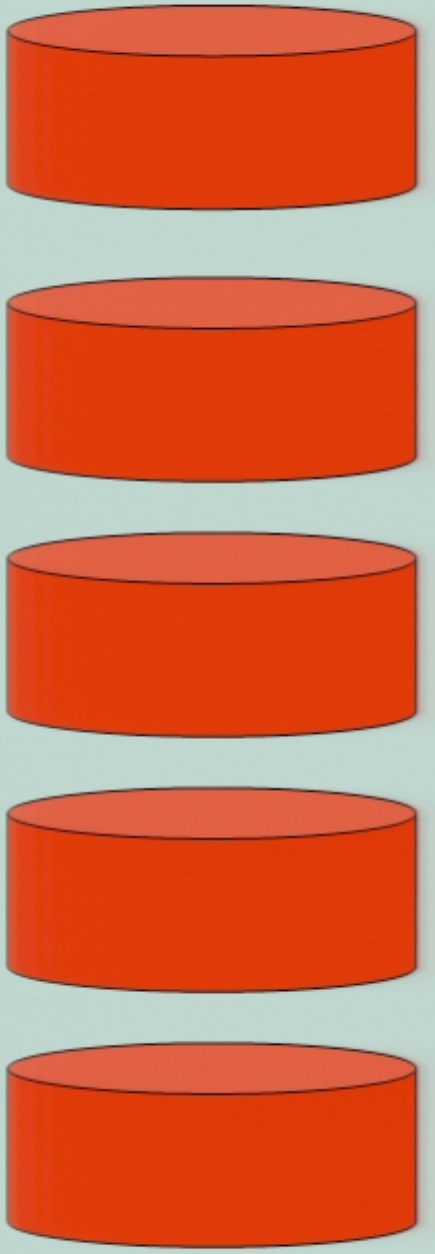
Date: Oct 02, 2005 10:00 AM

URL: http://pirsa.org/05100004

Abstract: In 1905, there were prominent scientists who did not believe in atoms. Einstein did. His April and May papers were motivated in part to support the concept of atoms. The April paper, EinsteinÂ’s dissertation and one of his most cited papers, shows how the dimensions of a sugar molecule, suspended in water, can be determined. His method had many practical applications, hence the citations. In the May paper, a pollen particle took the place of a sugar molecule. For decades, the irregular, zig-zagging motion of pollen particles was a mystery. In a paper that is magic, Einstein showed how, with a simple ruler and a stopwatch, one could witness atoms at work and prove their existence. <kw> John S. Rigden, atoms, thermodynamics, kinetic theory, mechanism, coffee and cream, Brownian motion, </kw>




What I am really interested in
is whether God could have
made the world in a different
way; that is, whether the
necessity of simplicity leaves
any freedom at all.



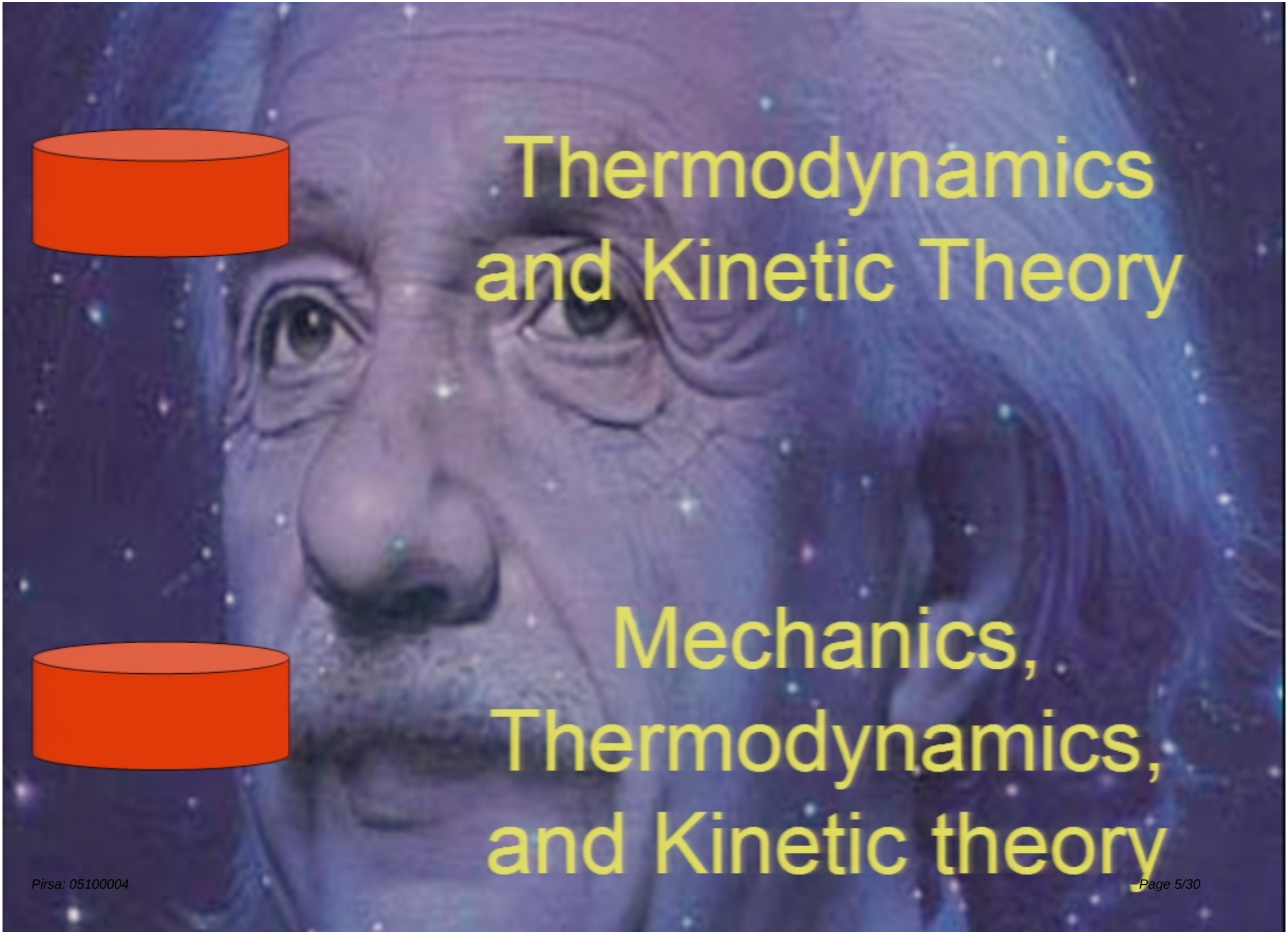
Light and Atoms

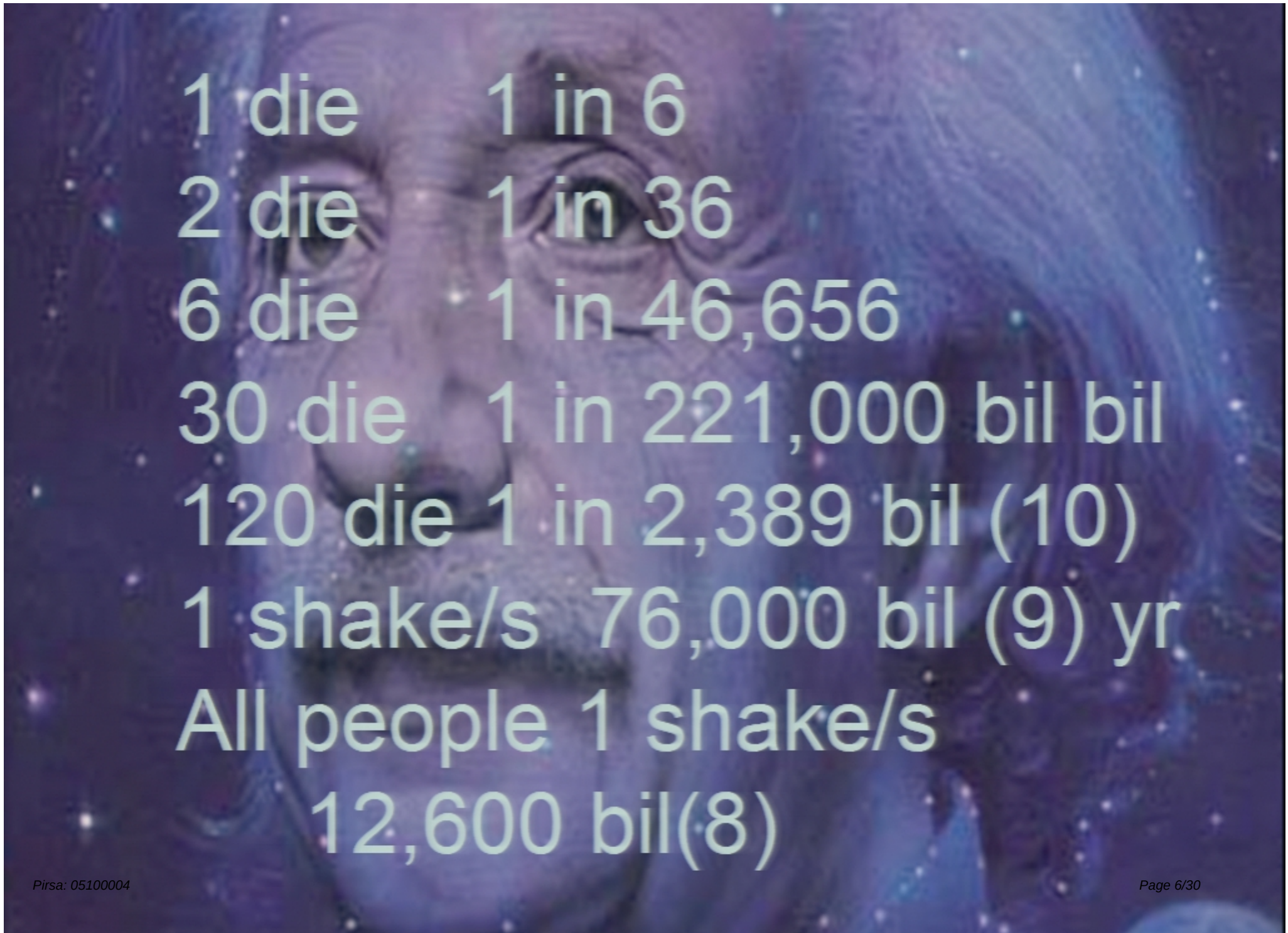
Thermodynamics and Kinetic Theory

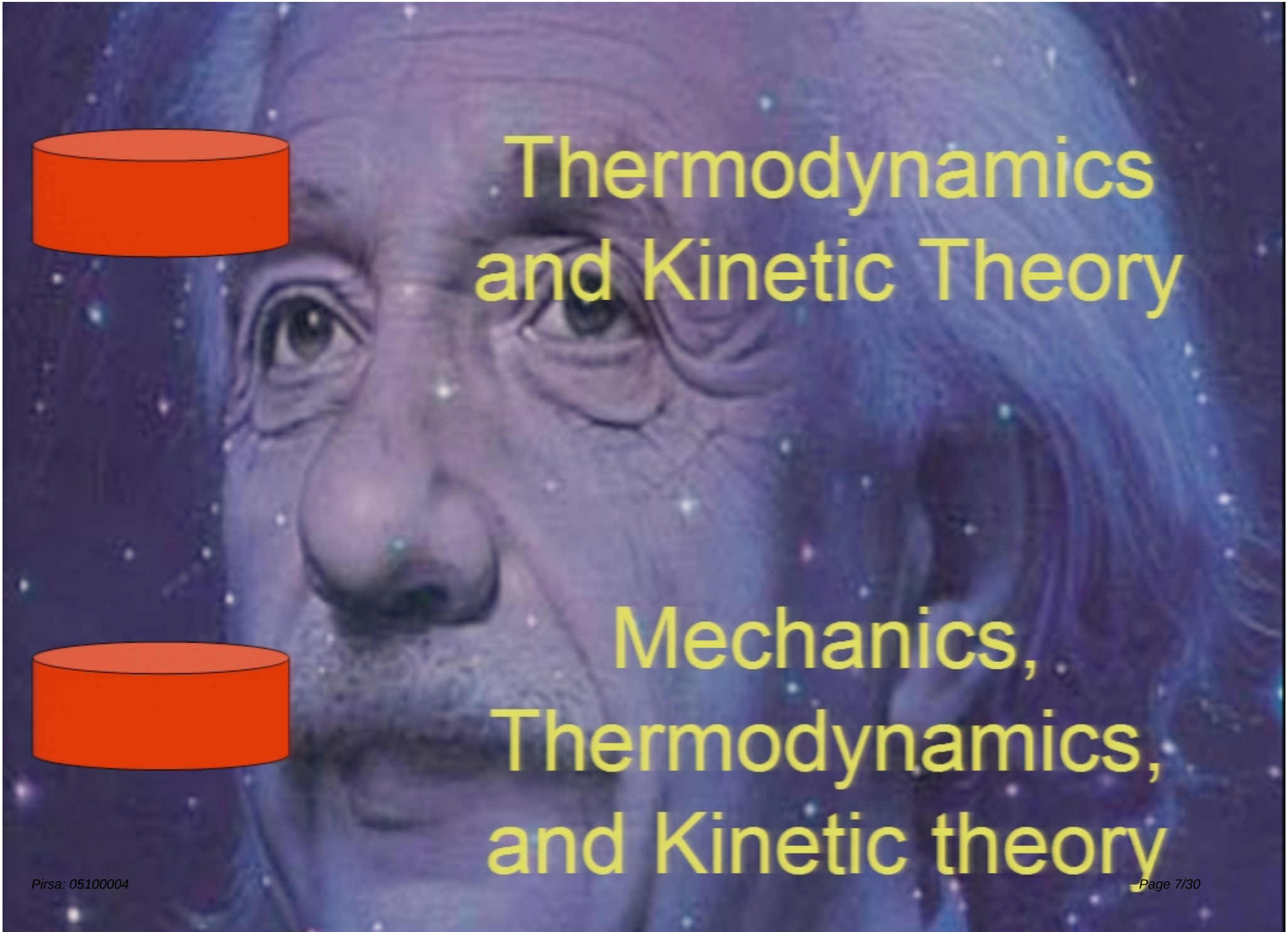
Mechanics, Thermo. and Kinetic Theory

Light and the Ether

Mechanics and Electromagnetism


Thermodynamics
and Kinetic Theory
Mechanics,
Thermodynamics,
and Kinetic theory


1 die 1 in 6
2 die 1 in 36
6 die 1 in 46,656
30 die 1 in 221,000 bil bil
120 die 1 in 2,389 bil (10)
1 shake/s 76,000 bil (9) yr
All people 1 shake/s
12,600 bil(8)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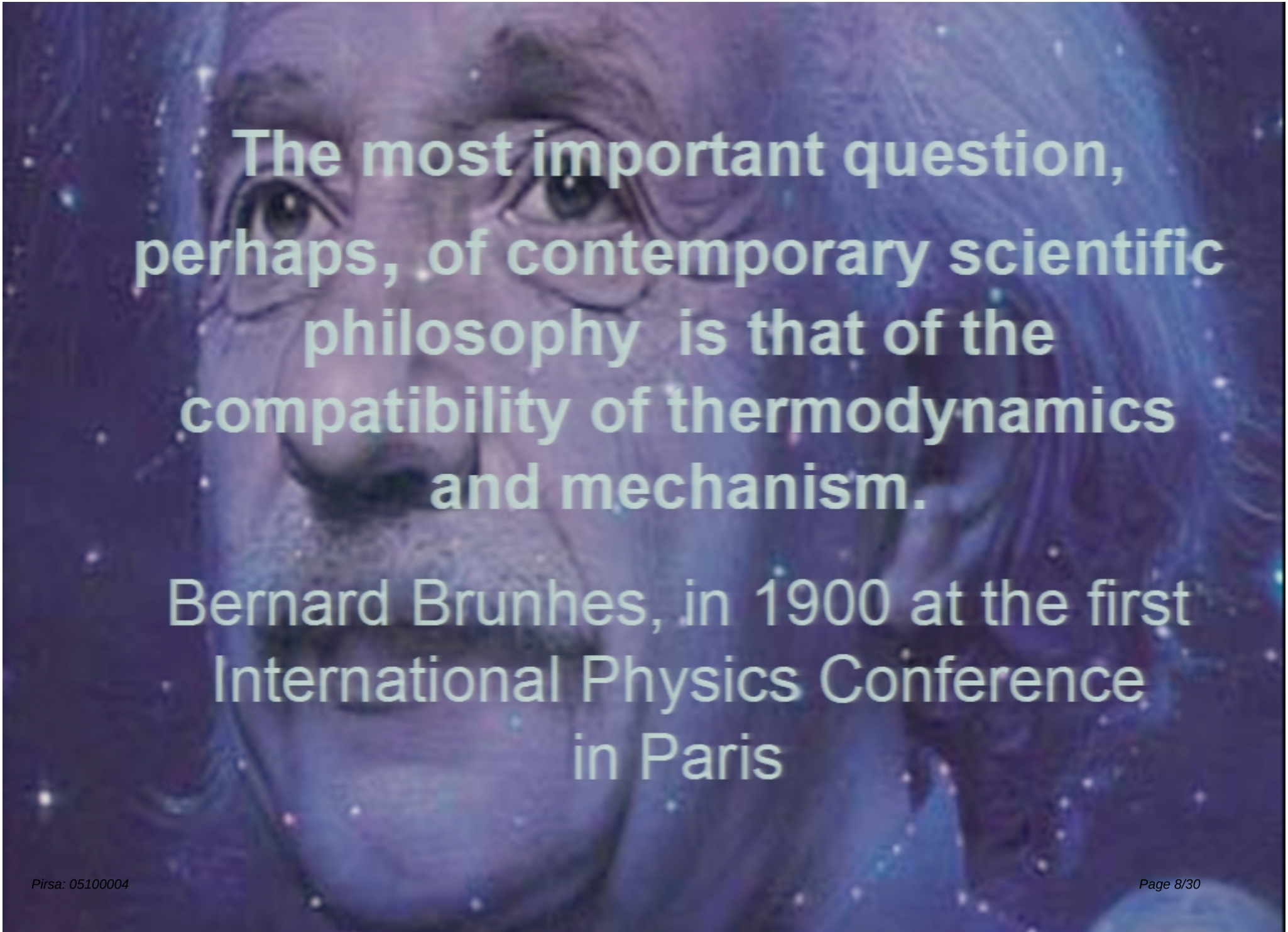
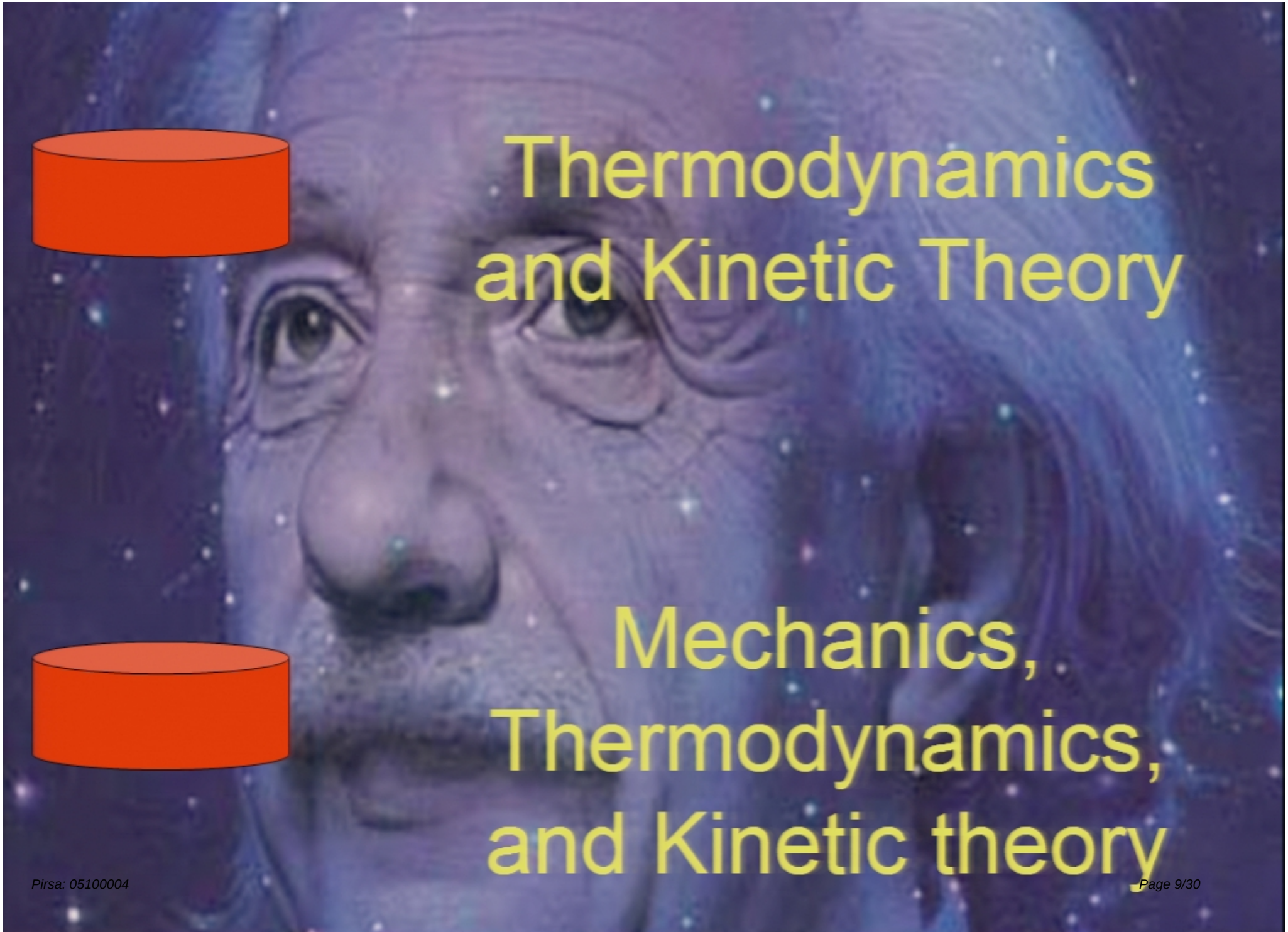

The most important question, perhaps, of contemporary scientific philosophy is that of the compatibility of thermodynamics and mechanism.
Bernard Brunhes, in 1900 at the first International Physics Conference in Paris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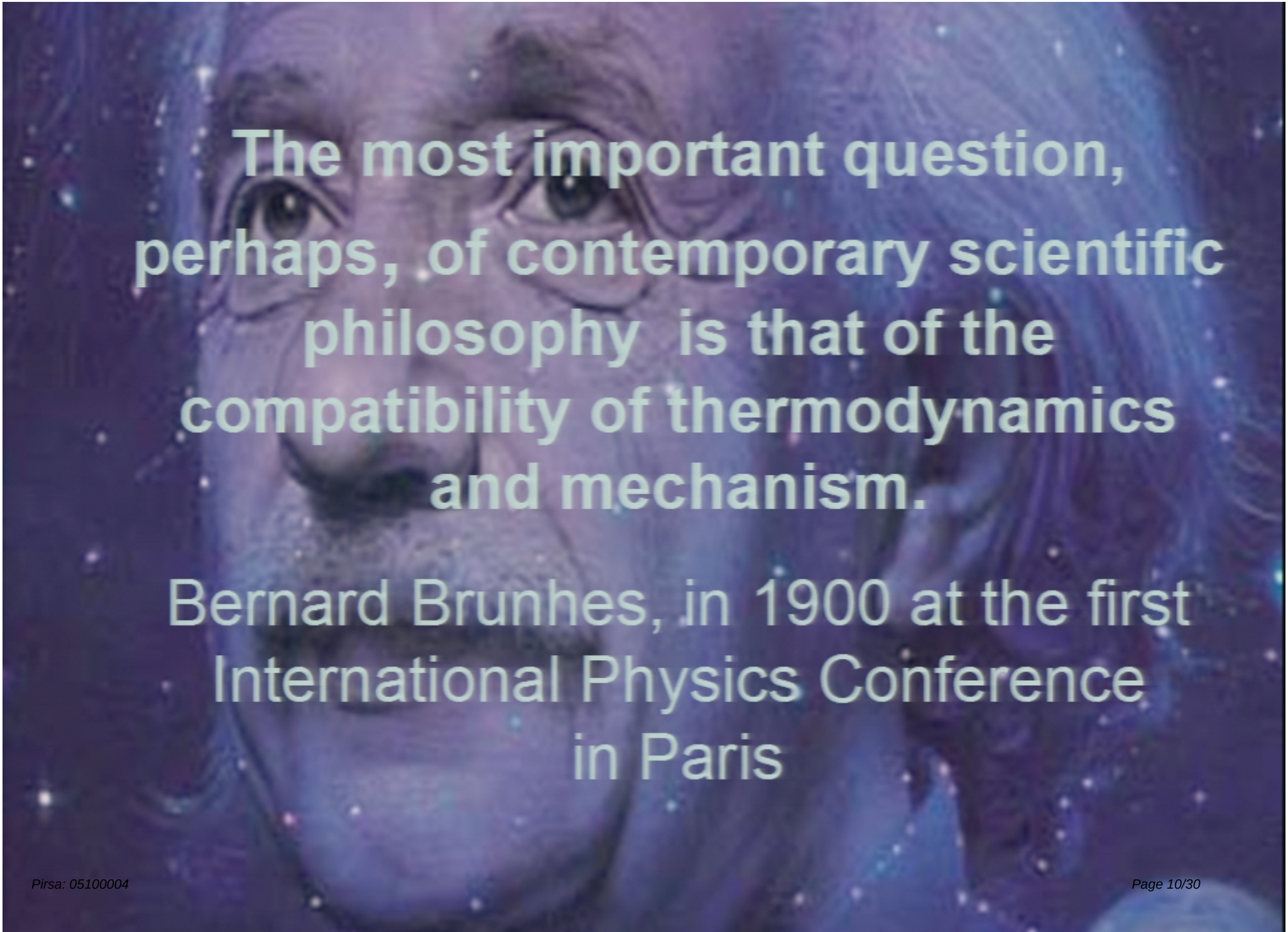
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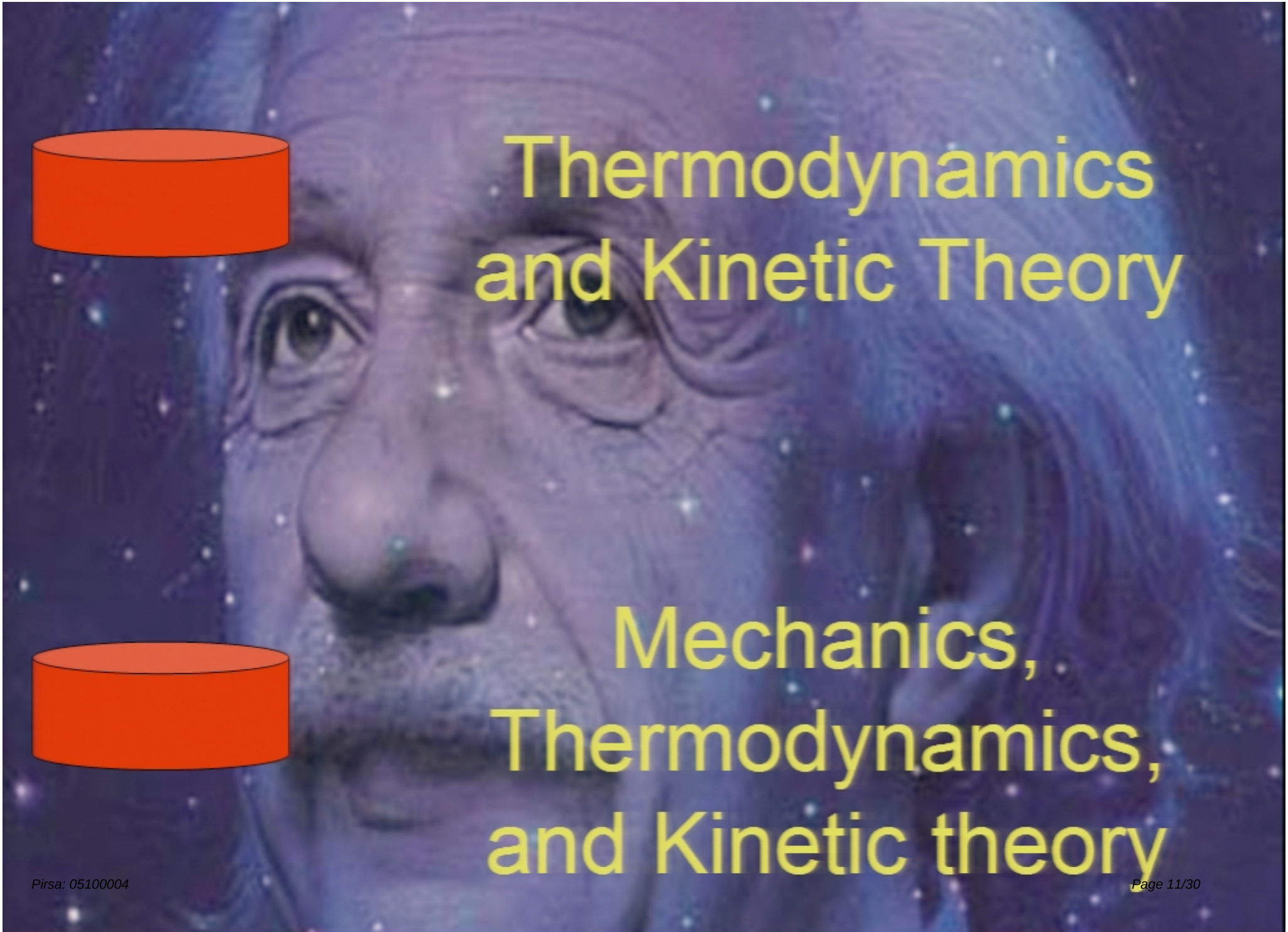
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Mechanics,
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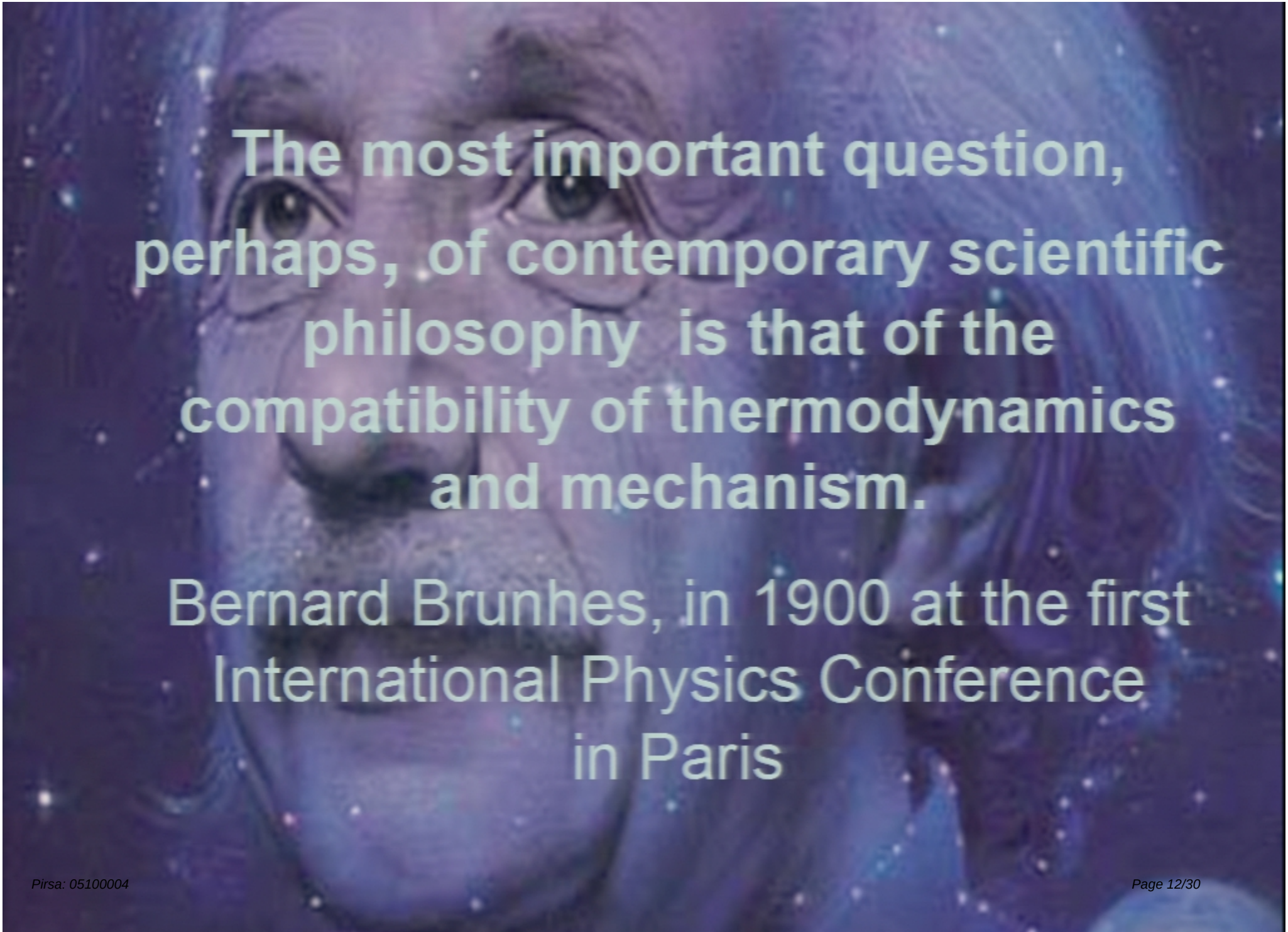
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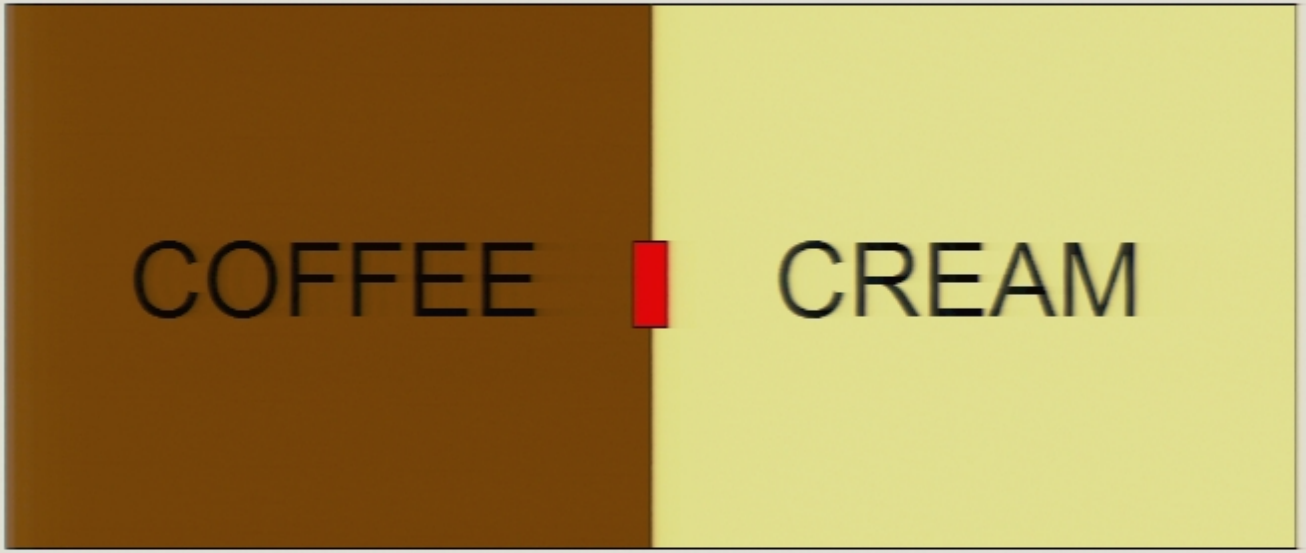
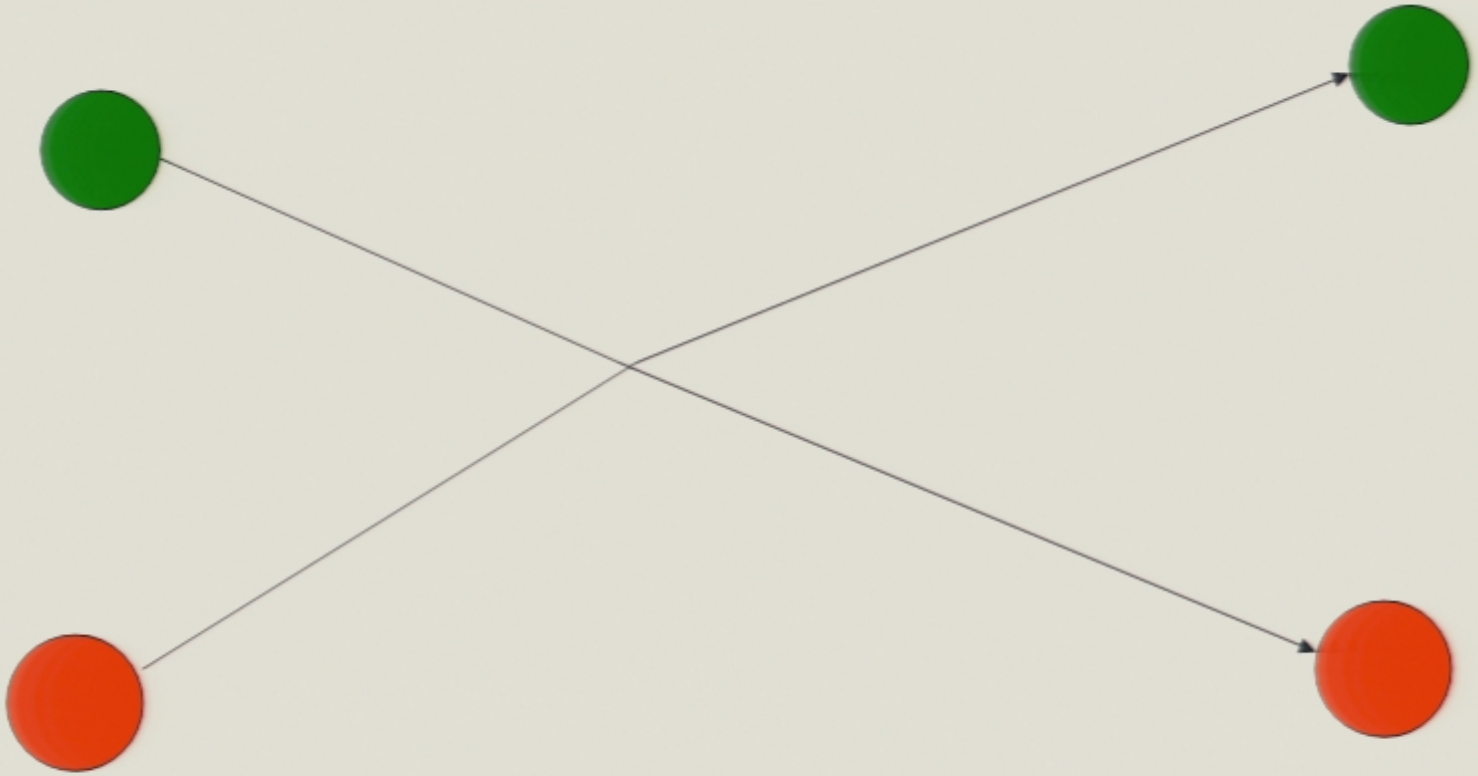
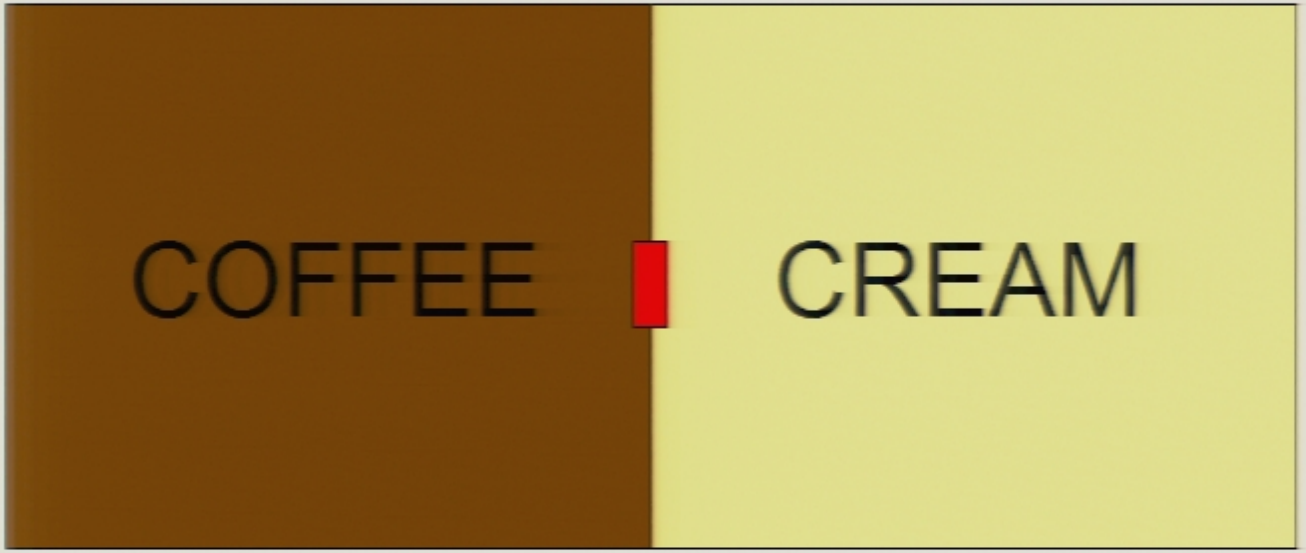

COFFEE
CREAM



COLLISION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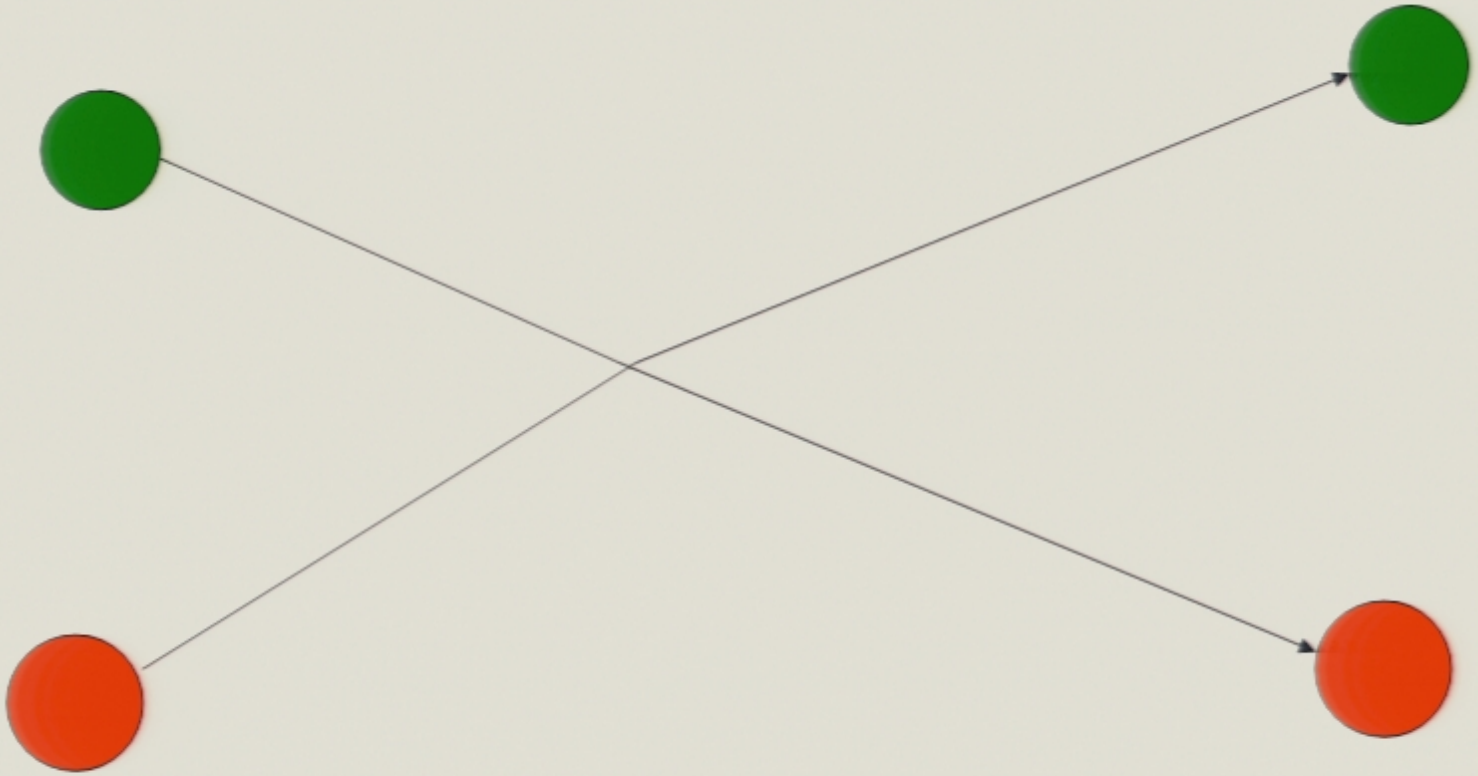

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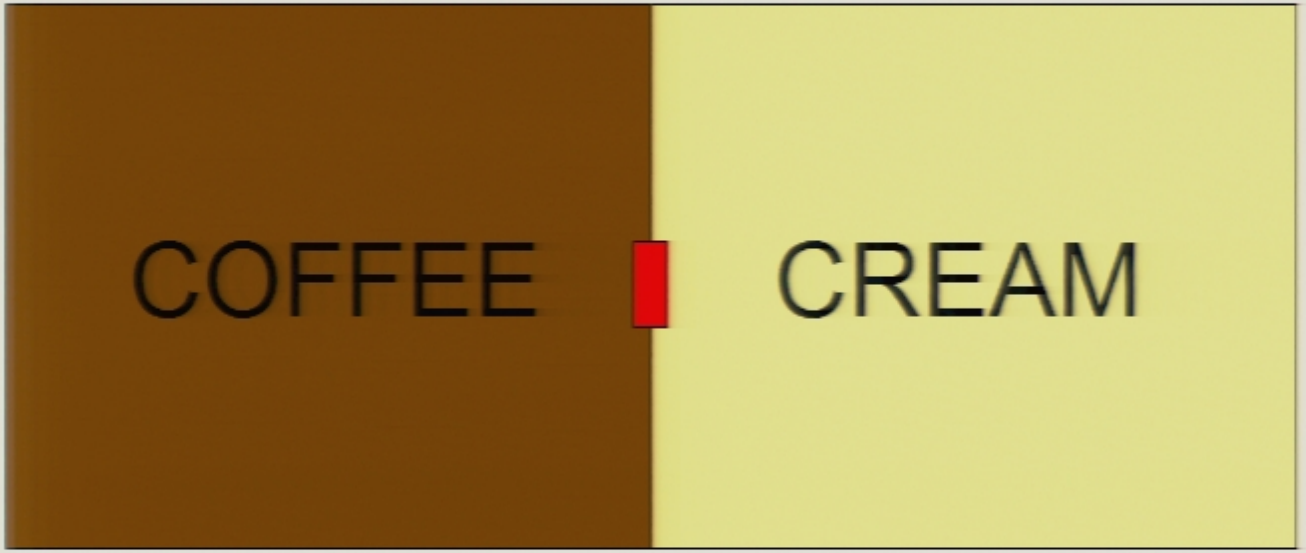
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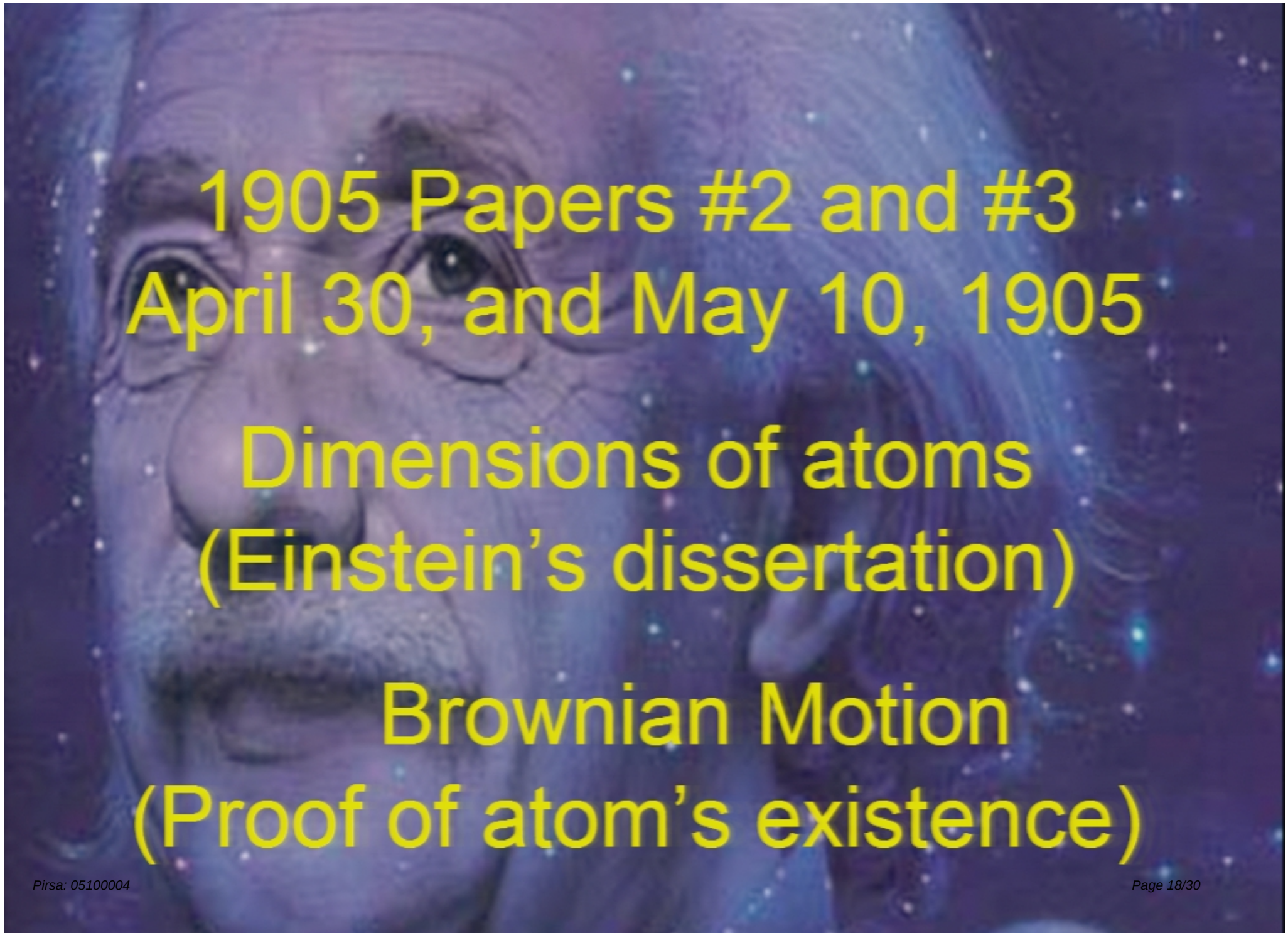
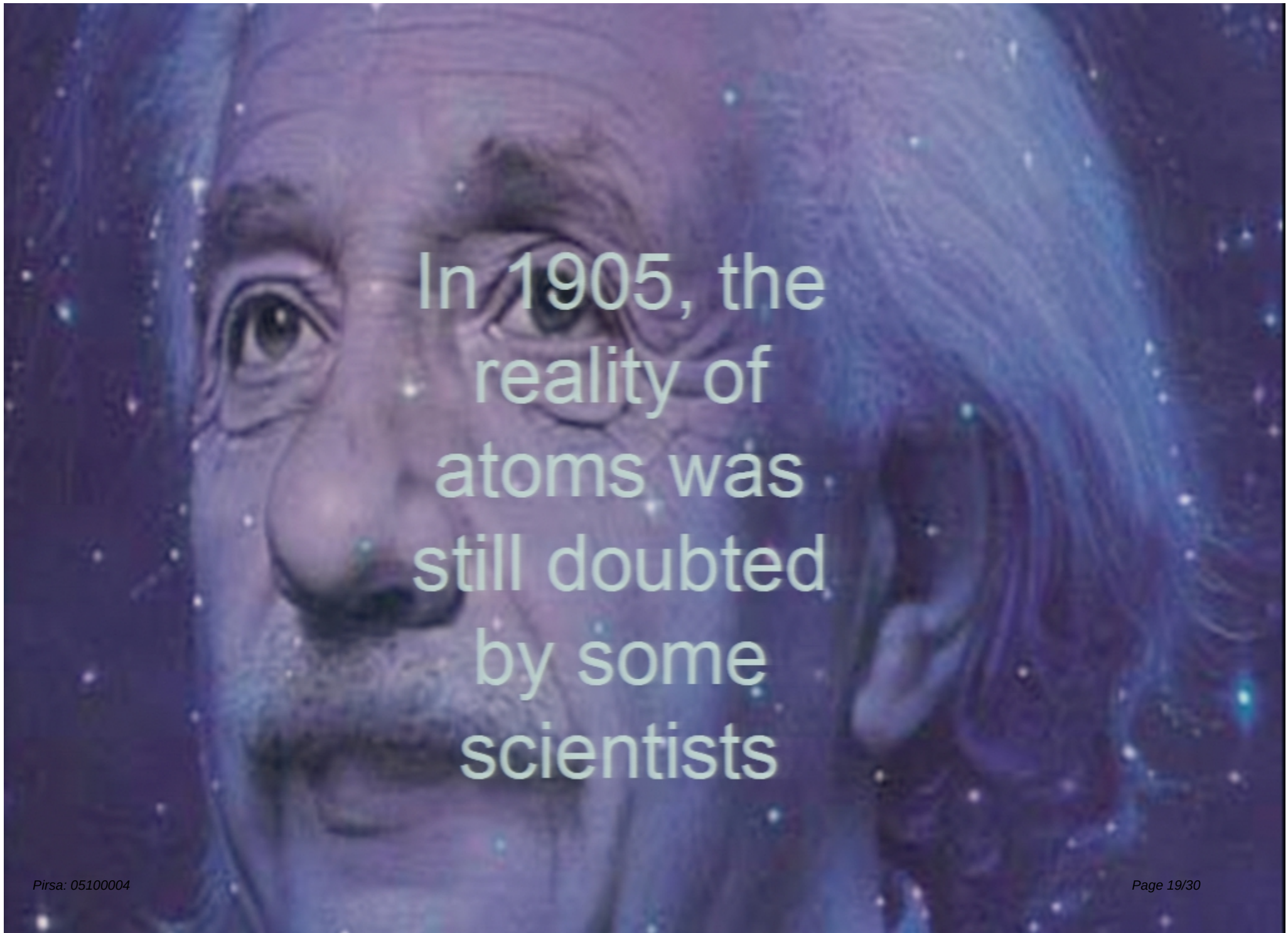
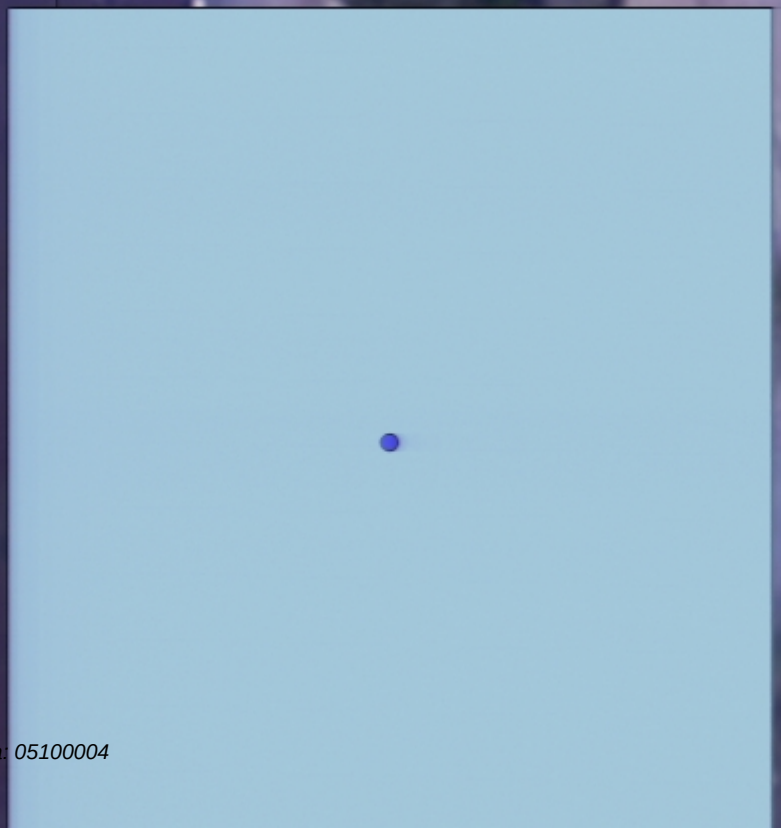

1905 Papers #2 and #3
April 30, and May 10, 1905
Dimensions of atoms
(Einstein's dissertation)
Brownian Motion
(Proof of atom's existence)


In 1905, the
reality of
atoms was
still doubted
by some
scientists

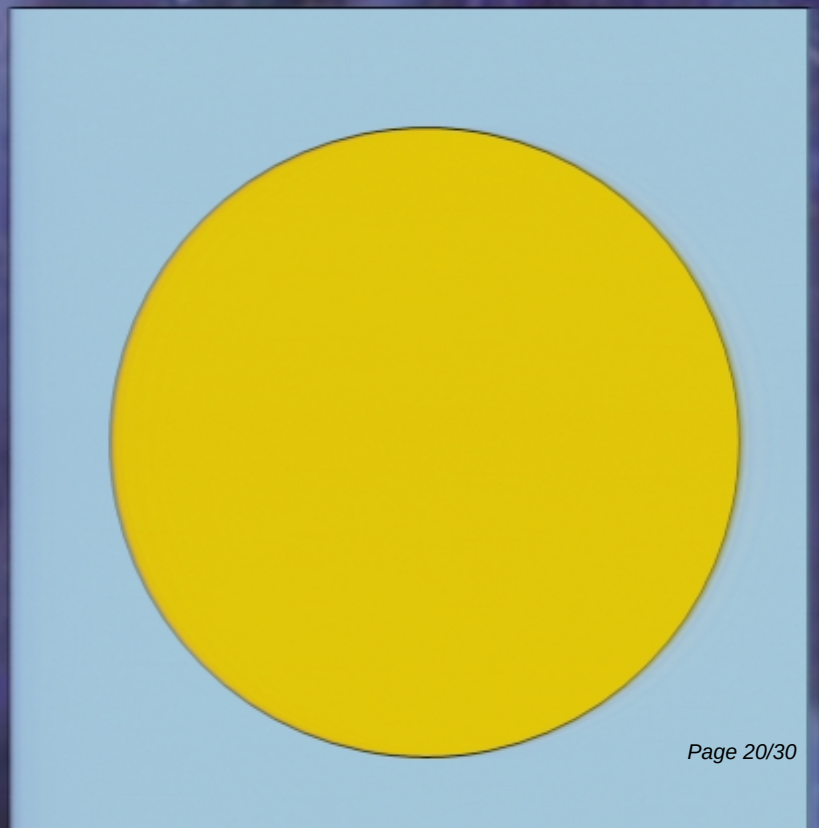
April

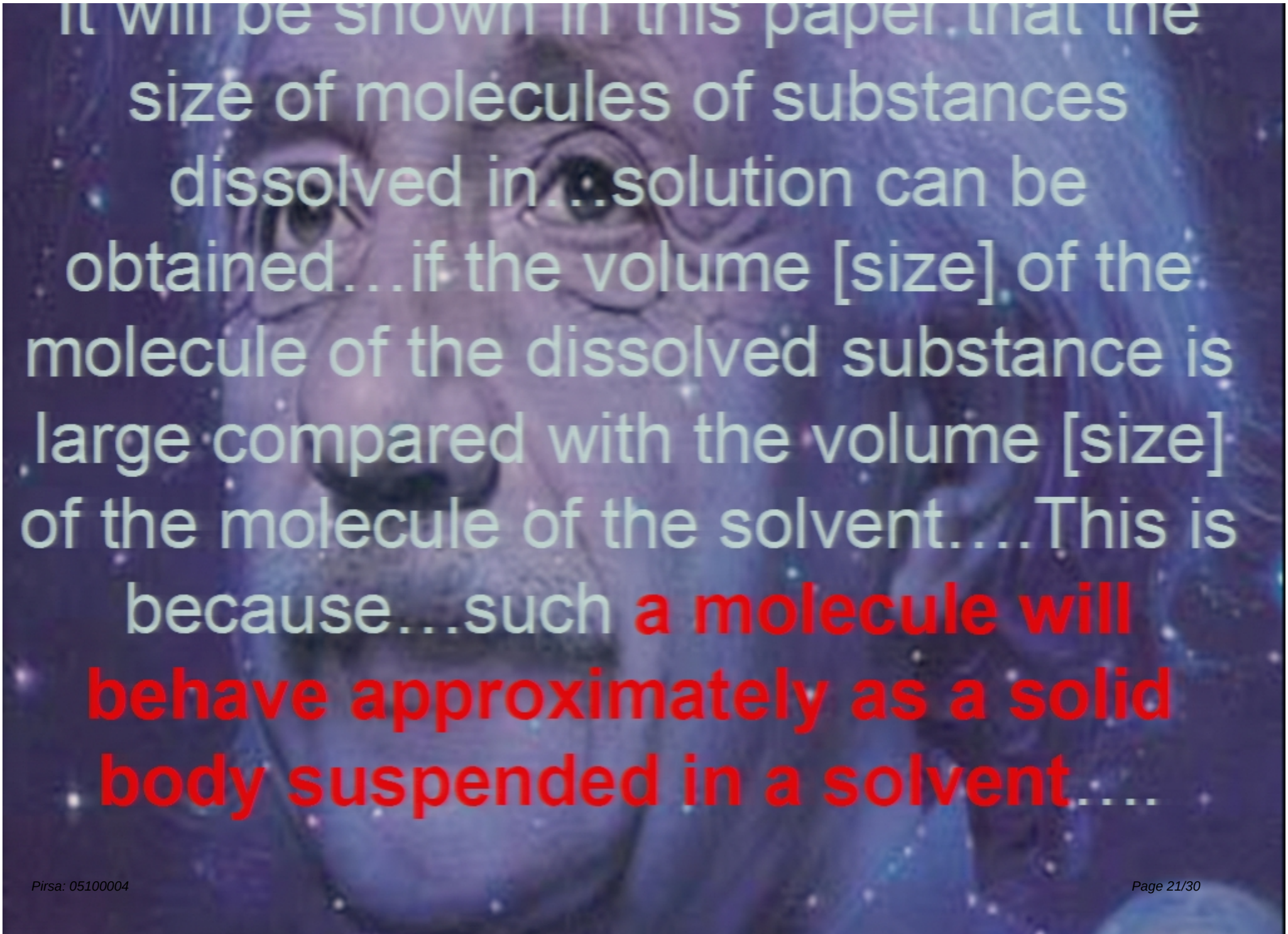
Sugar molecule in water

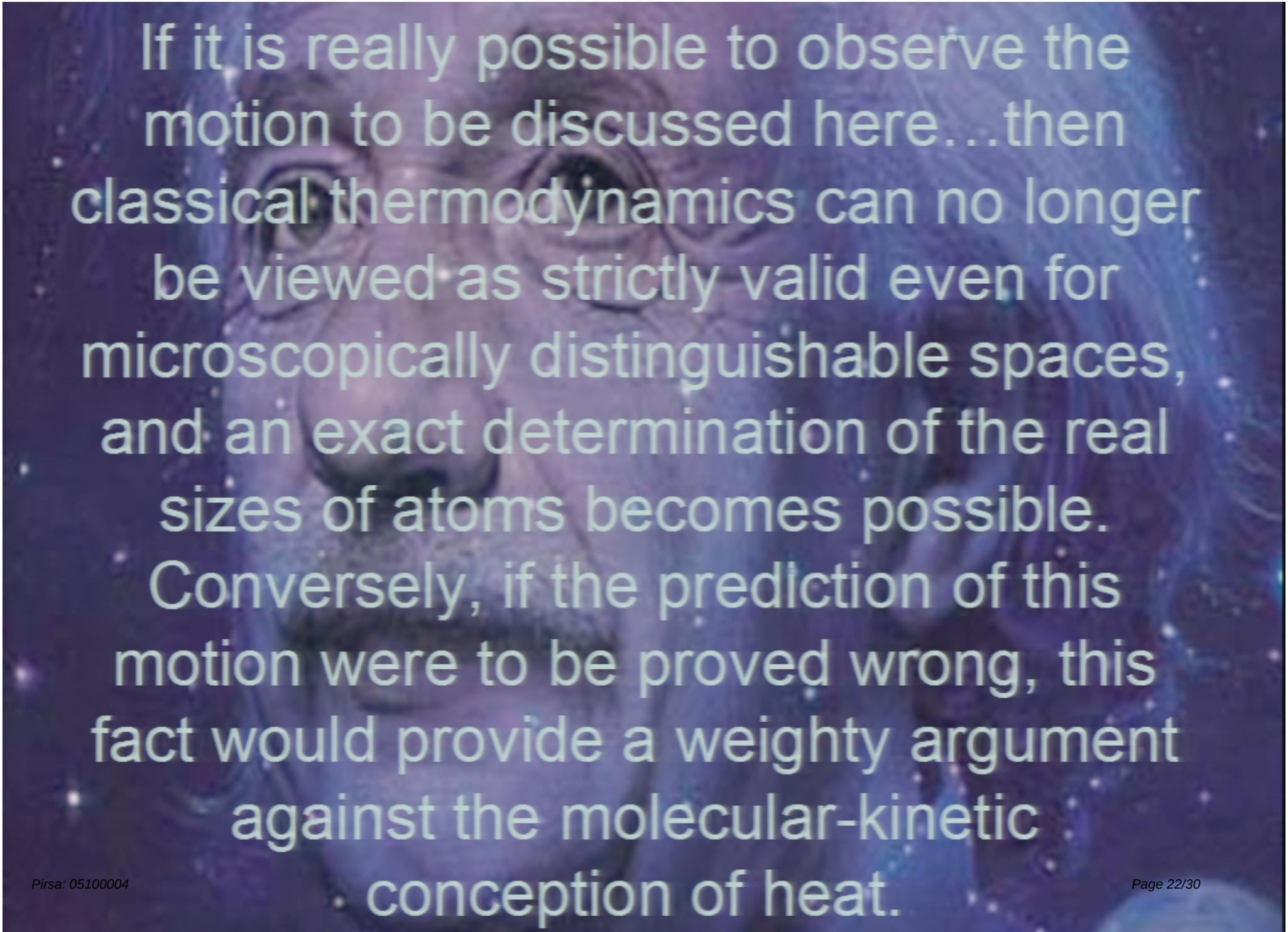


May

Pollen particle in water

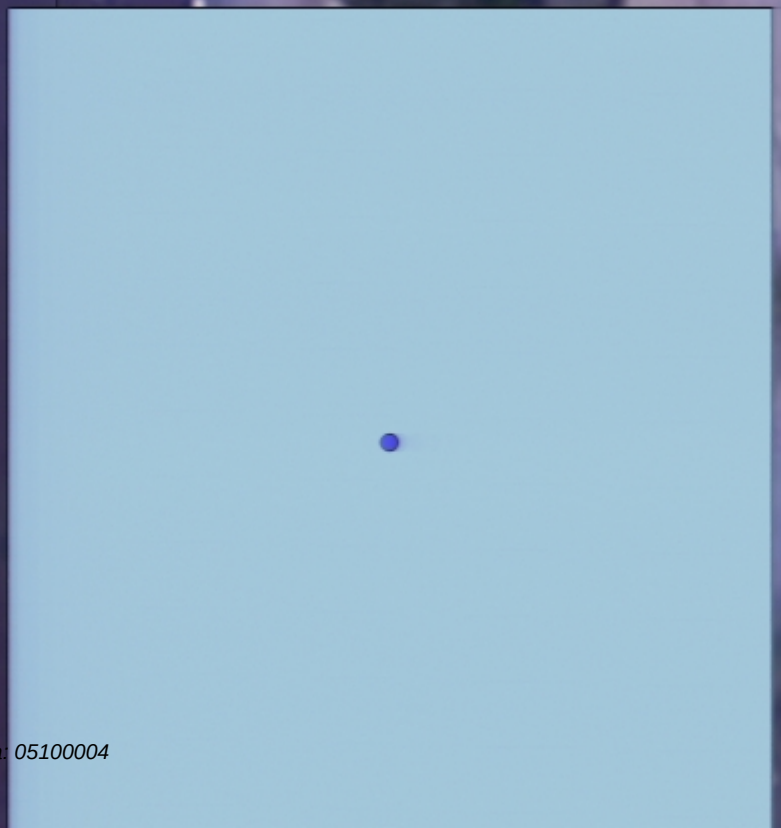



It will be shown in this paper that the size of molecules of substances dissolved in…solution can be obtained…if the volume [size] of the molecule of the dissolved substance is large compared with the volume [size] of the molecule of the solvent….This is because…such a molecule will behave approximately as a solid body suspended in a solvent….


If it is really possible to observe the motion to be discussed here…then classical thermodynamics can no longer be viewed as strictly valid even for microscopically distinguishable spaces, and an exact determination of the real sizes of atoms becomes possible. Conversely, if the prediction of this motion were to be proved wrong, this fact would provide a weighty argument against the molecular-kinetic conception of heat.

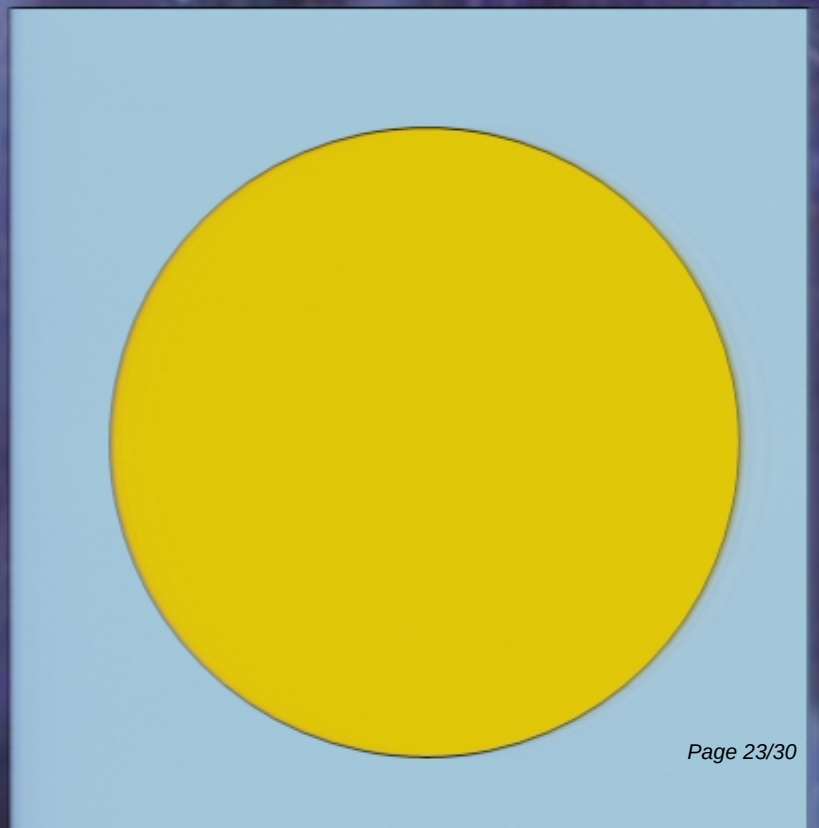
April

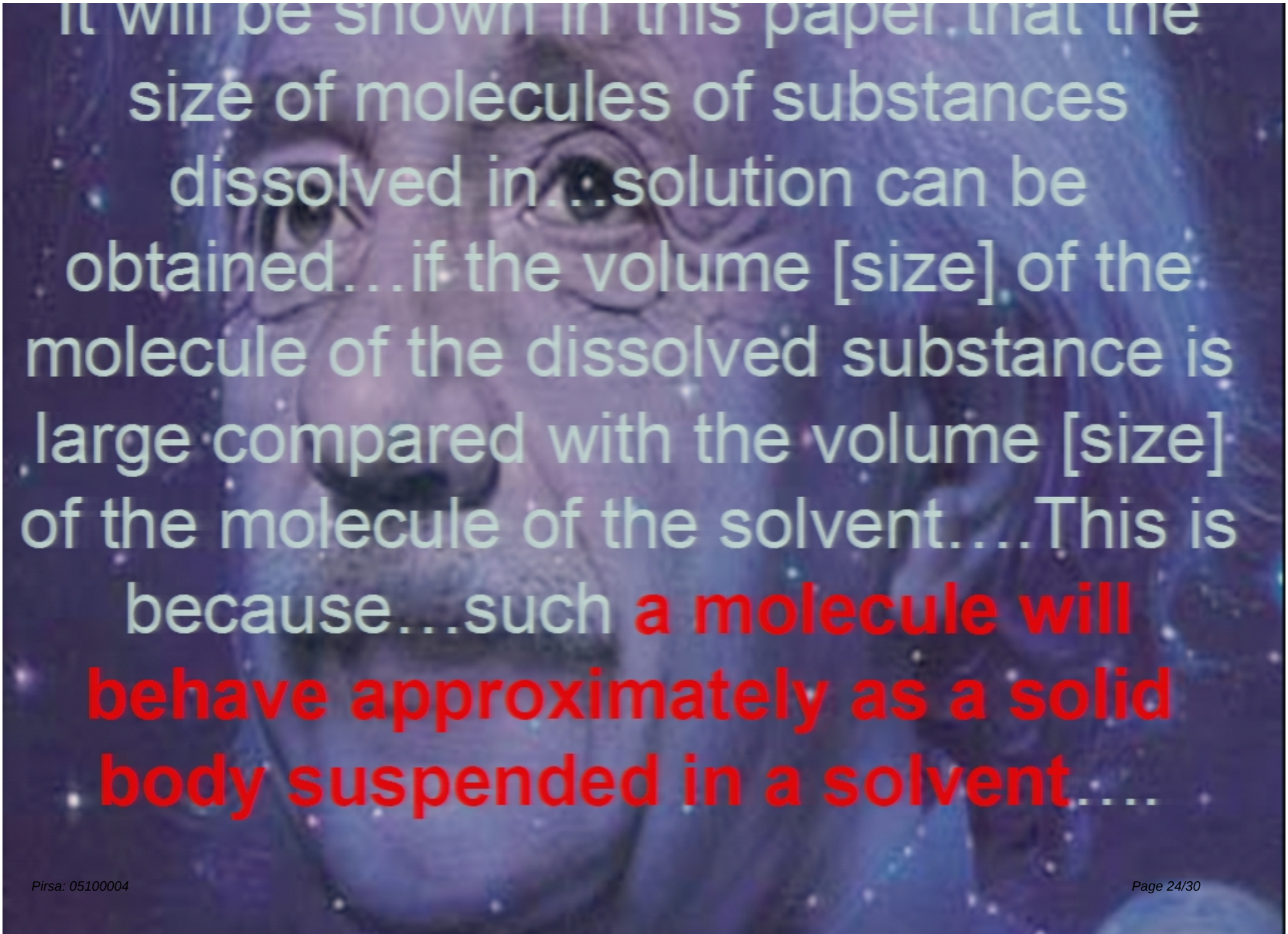
Sugar molecule in water



May

Pollen particle in water

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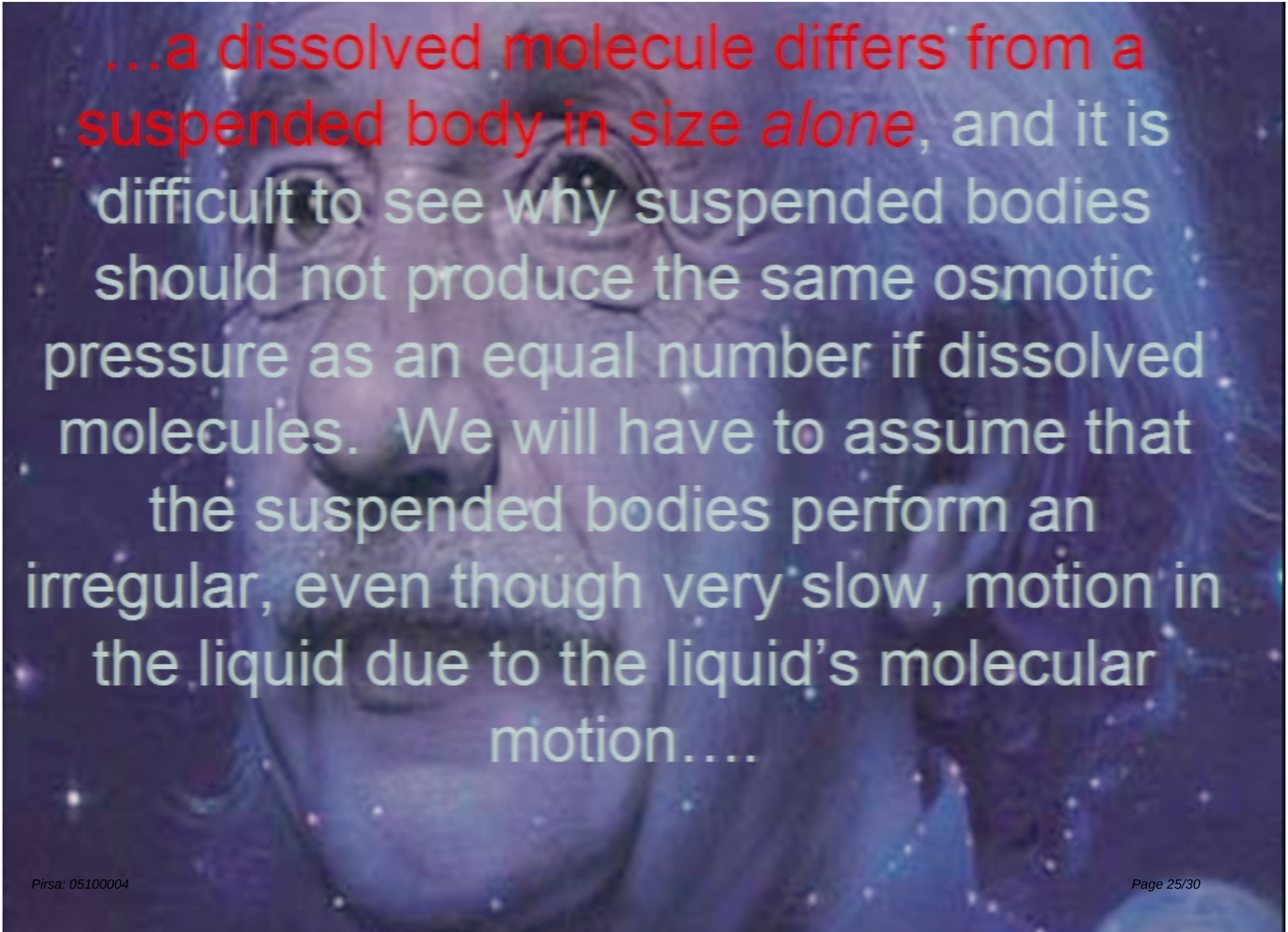
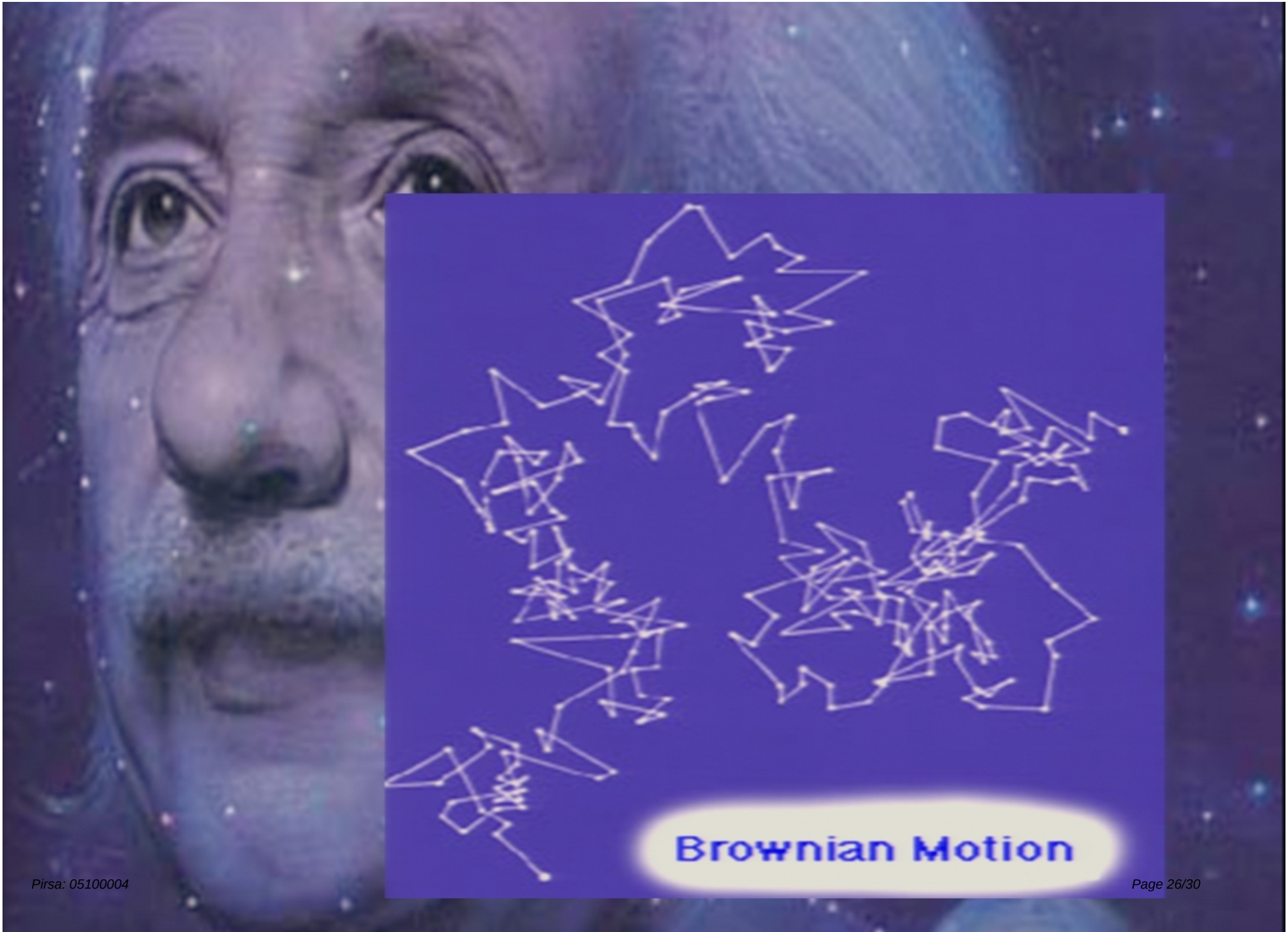
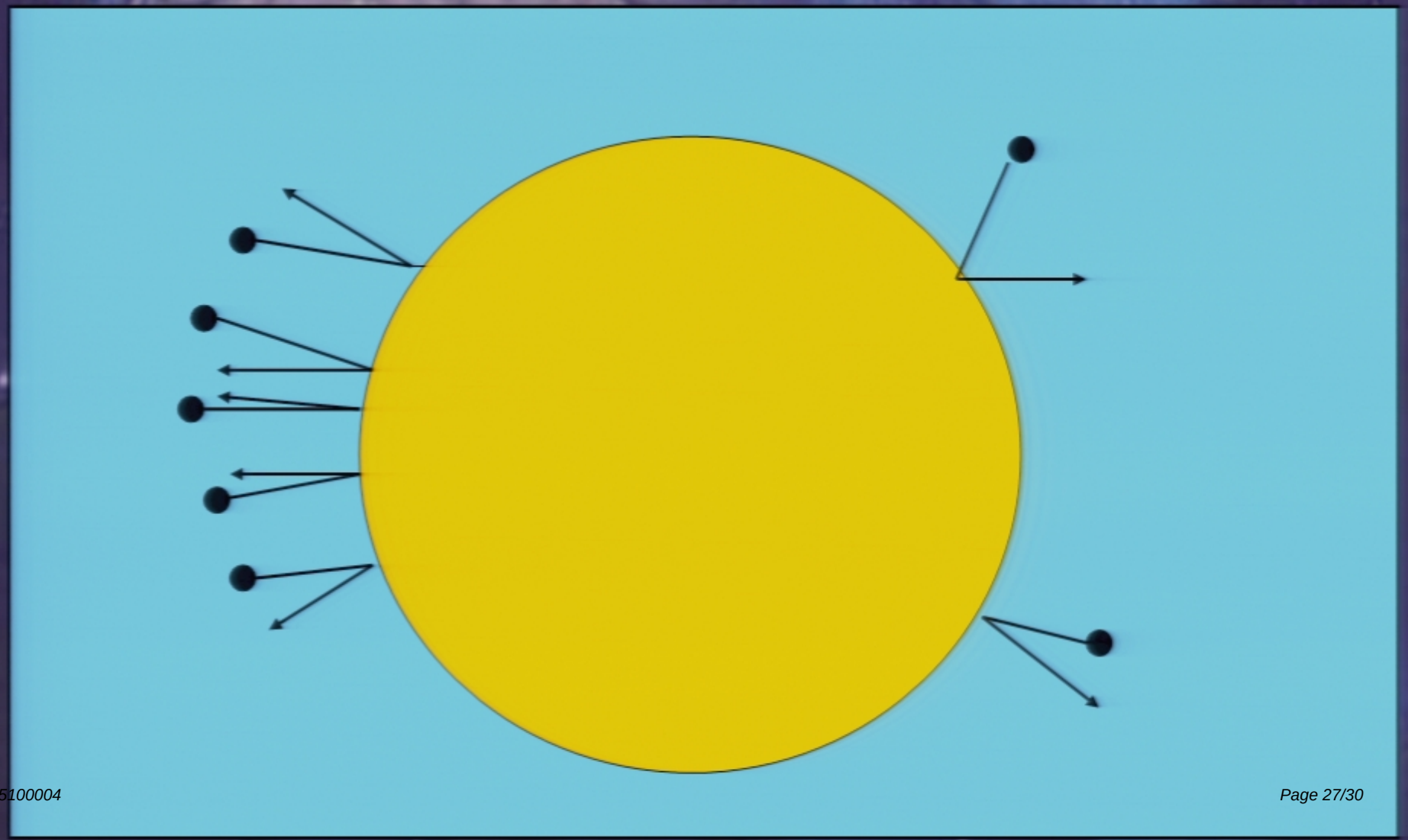
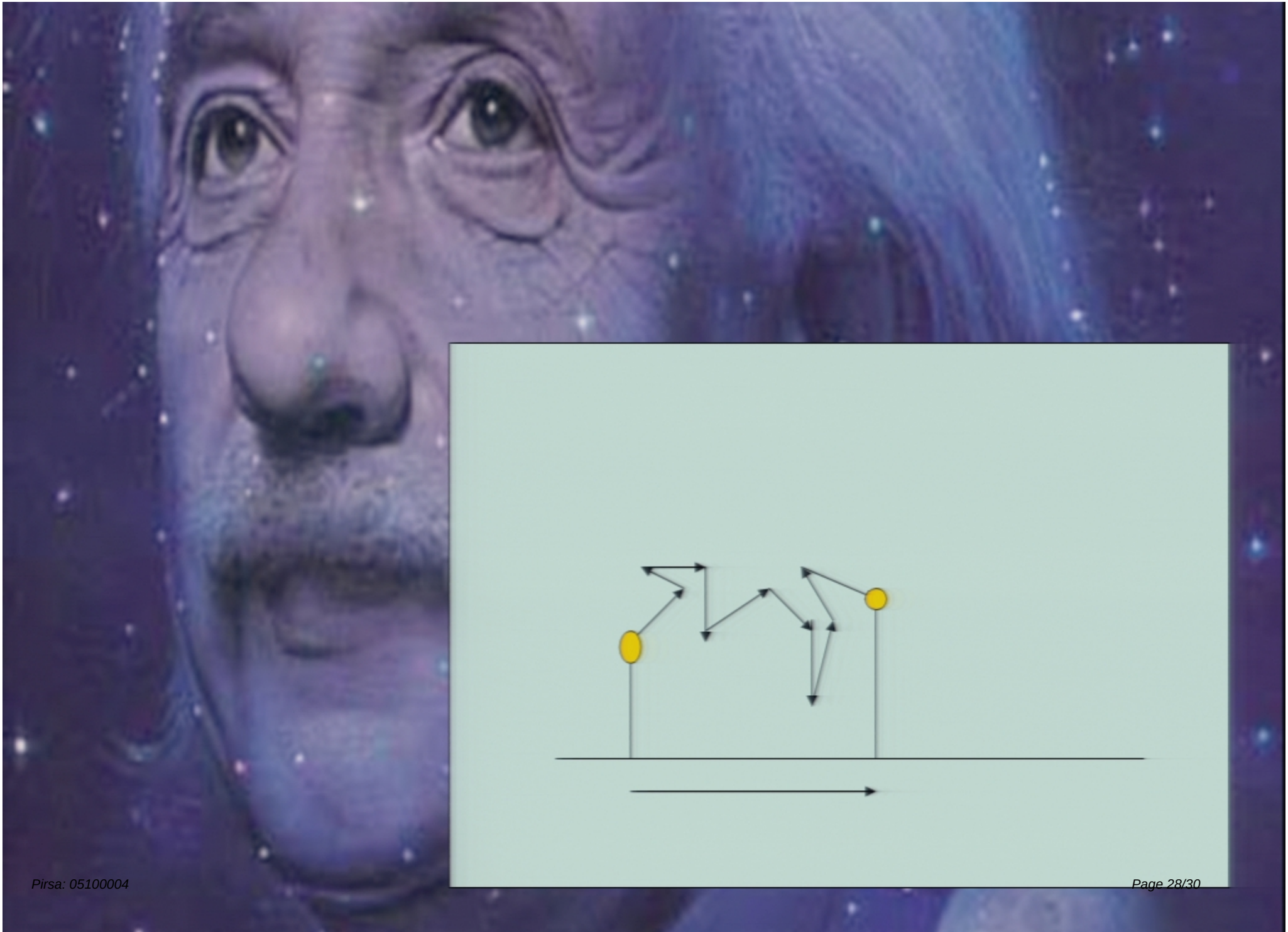
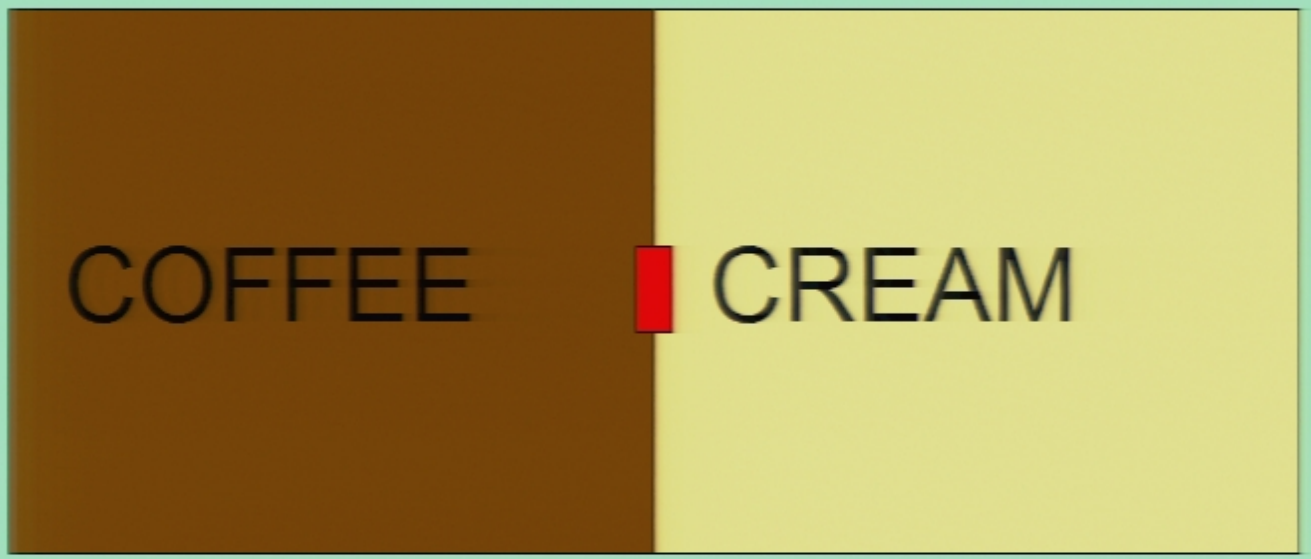

…a dissolved molecule differs from a suspended body in size *alone*, and it is difficult to see why suspended bodies should not produce the same osmotic pressure as an equal number if dissolved molecules. We will have to assume that the suspended bodies perform an irregular, even though very slow, motion in the liquid due to the liquid's molecular motion….


Brownian Motion

Water molecules colliding with pollen a pollen particle






COFFEE
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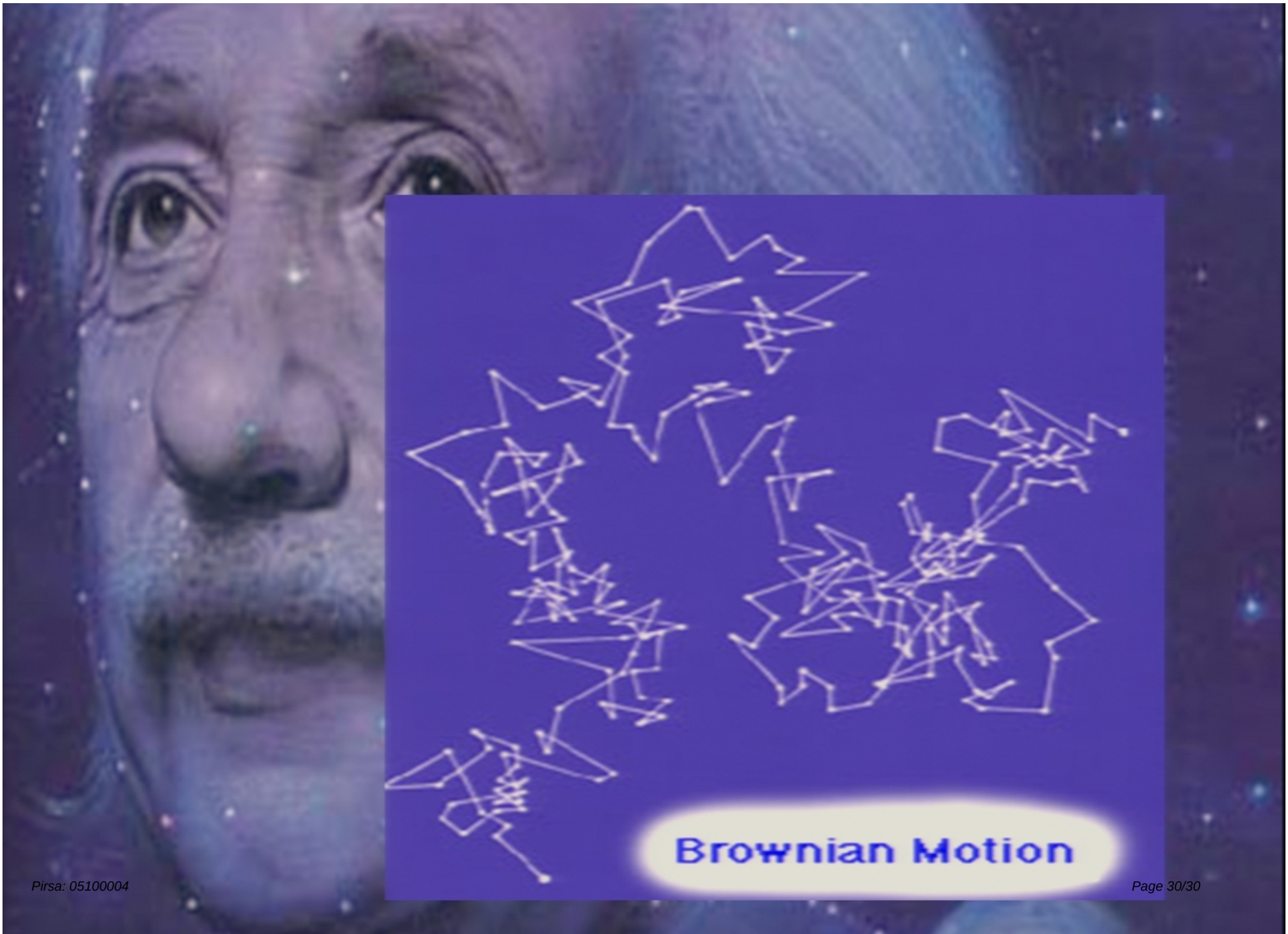
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