

Philosophy of Science I

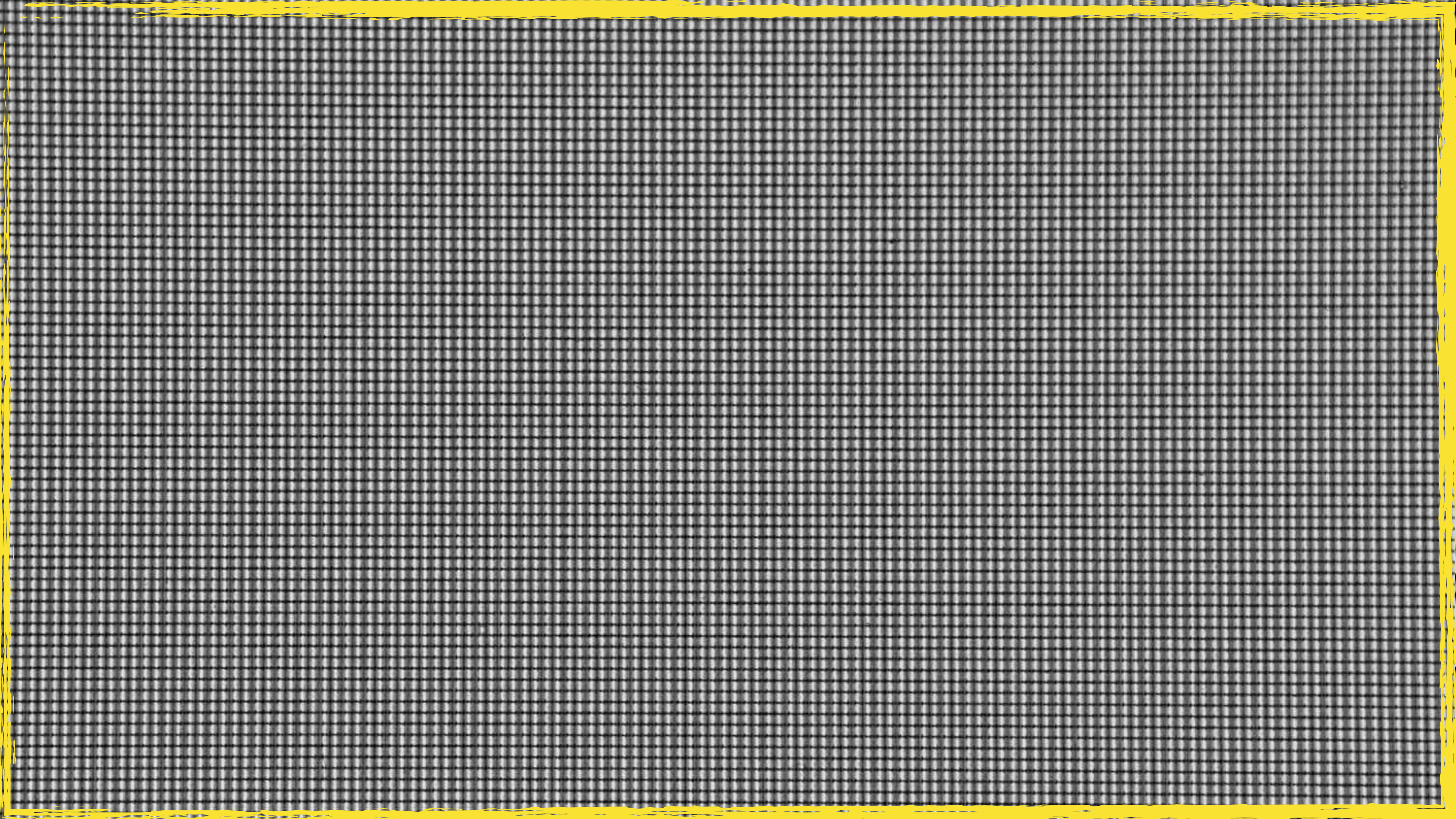
Feb 23rd 2024

Session 5 - Realism

Analogy warning!

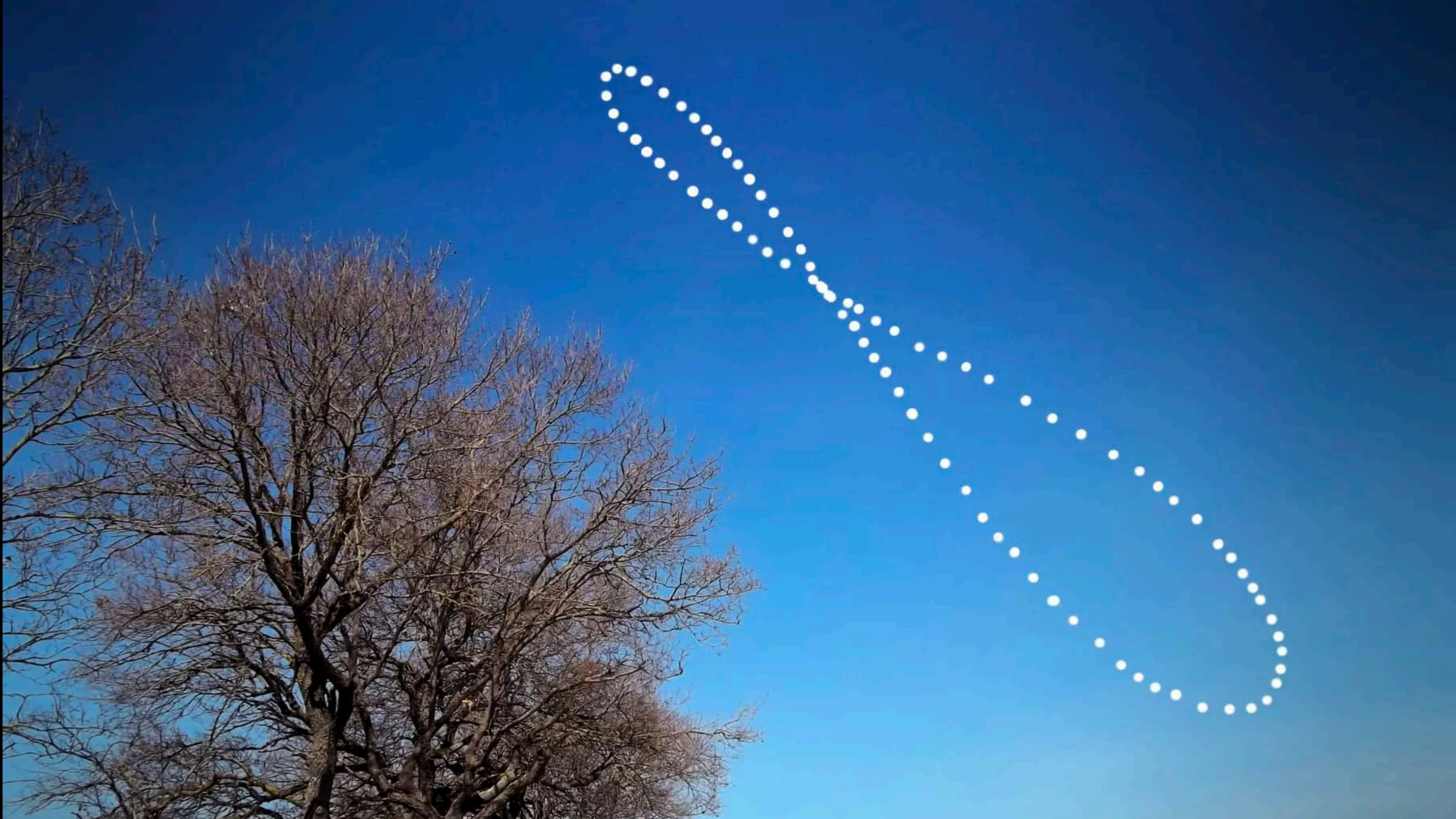






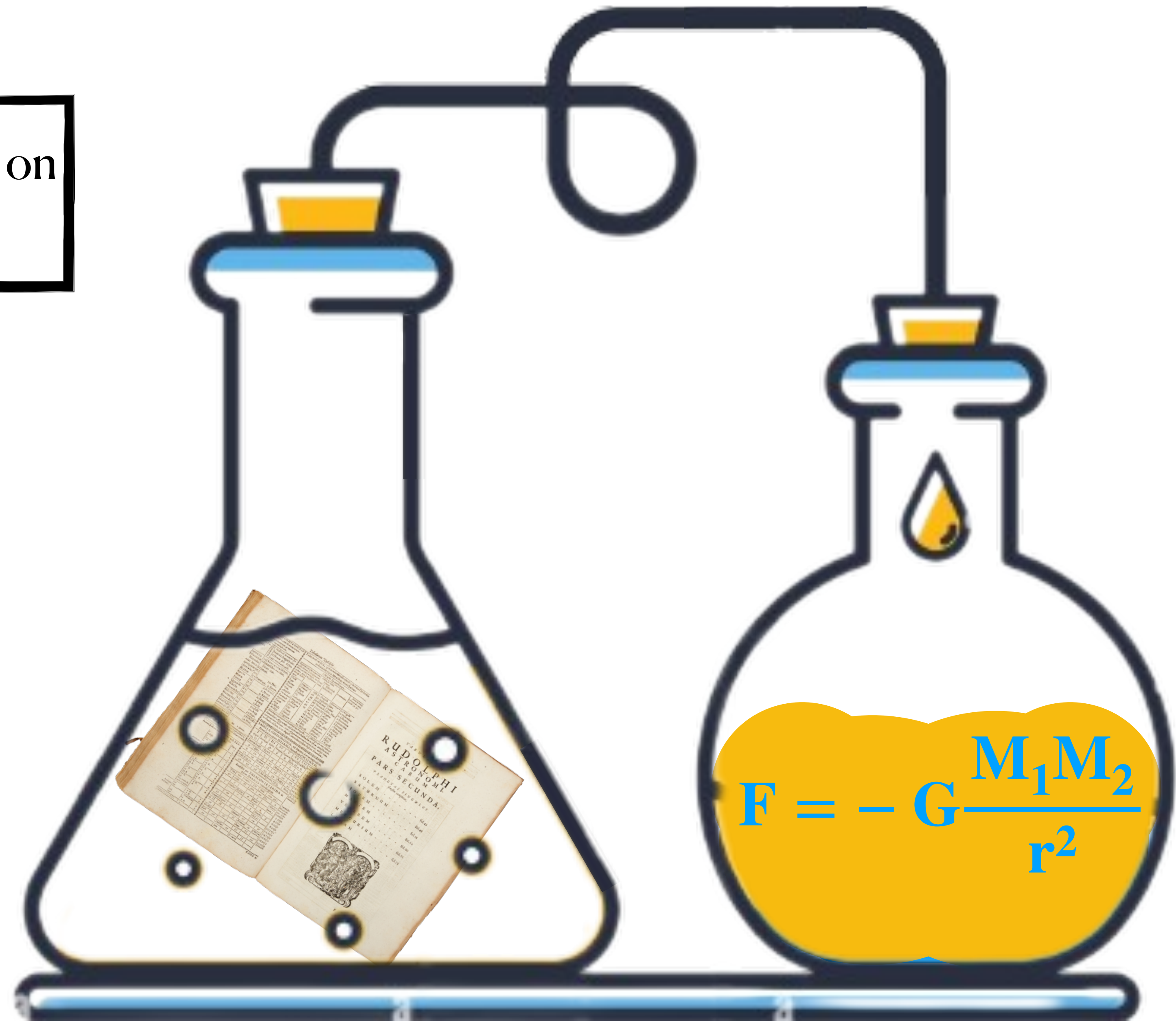
Reality's Rabbit Hole







And not only on
the sky!





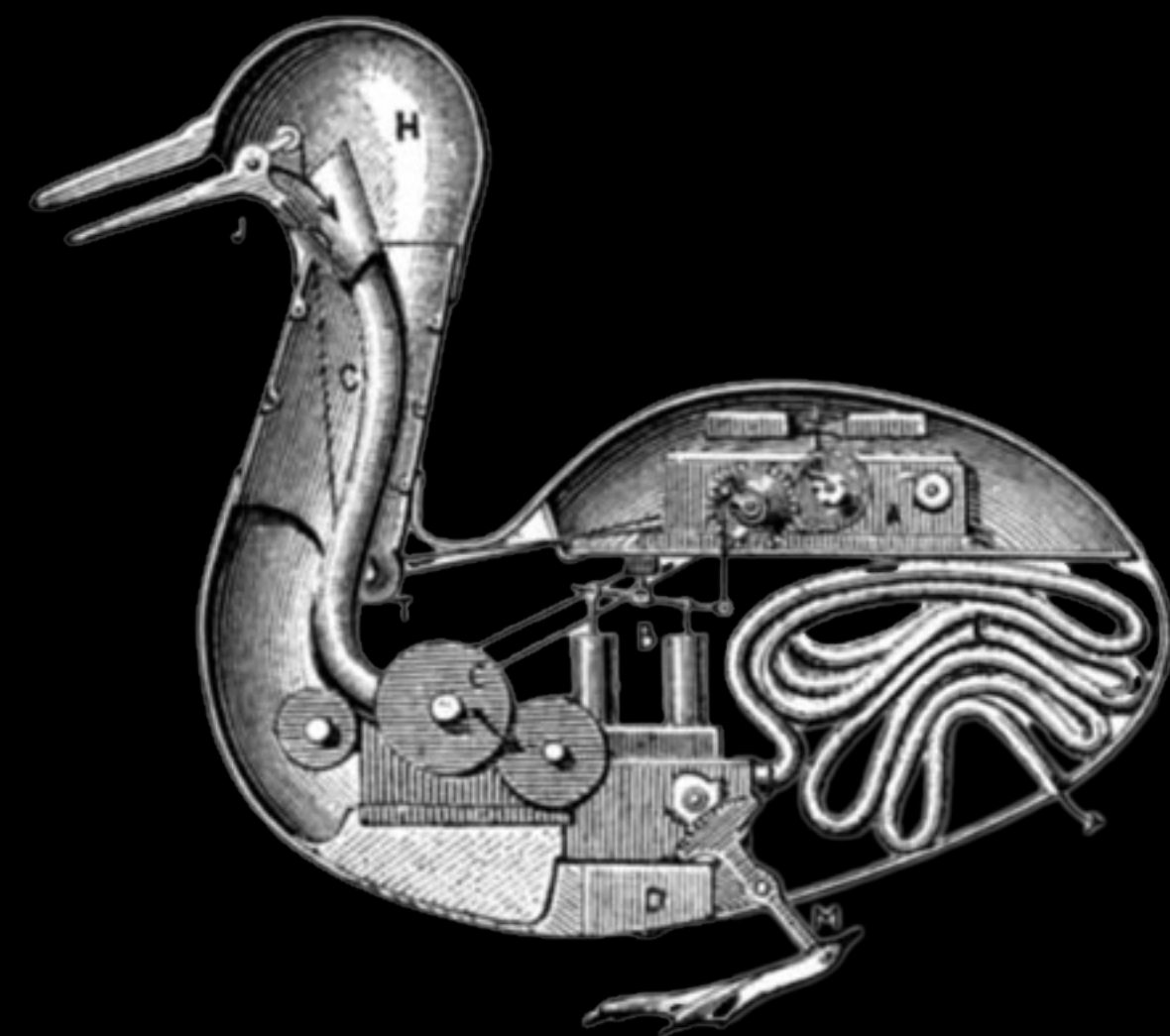
Like a clockwork, but
with invisible kogs!

Reduction:

The axioms of some less basic theory become theorems of a more basic theory.

Nowadays, there is more emphasis on the opposite move: **emergence**, where we aim to recover the reduced theory from the more basic one .

Q: Can you name an emergent theory?
Q: Are all theories derived?



Particles to Gases

From $6N$ degrees of freedom to three variables (P, V, T) satisfying a different equation:

$$\{\vec{x}_i, \vec{v}_i\}$$



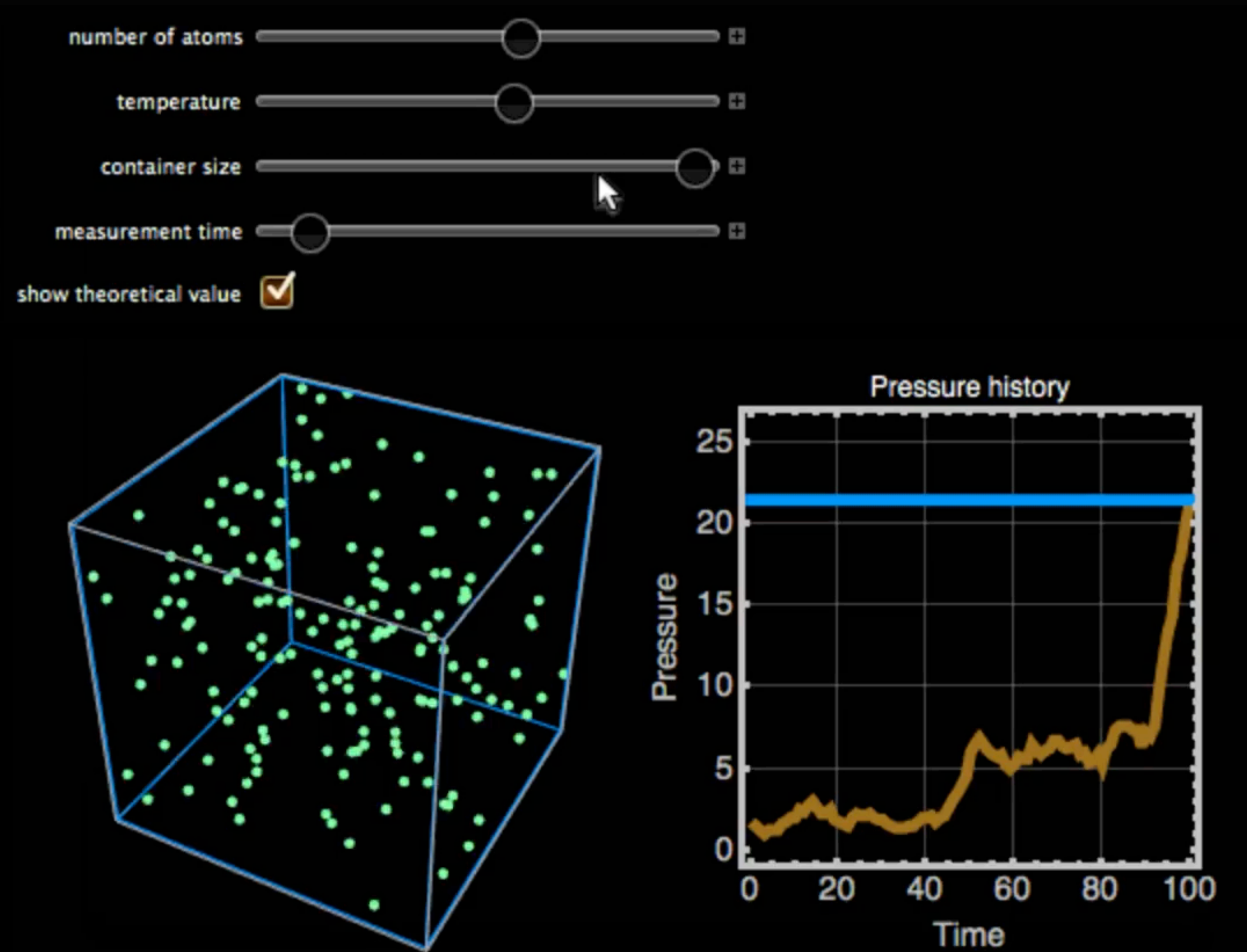
$$T = \frac{m\bar{v}^2}{3k_B}$$

$$P = \frac{Nm\bar{v}^2}{3V}$$

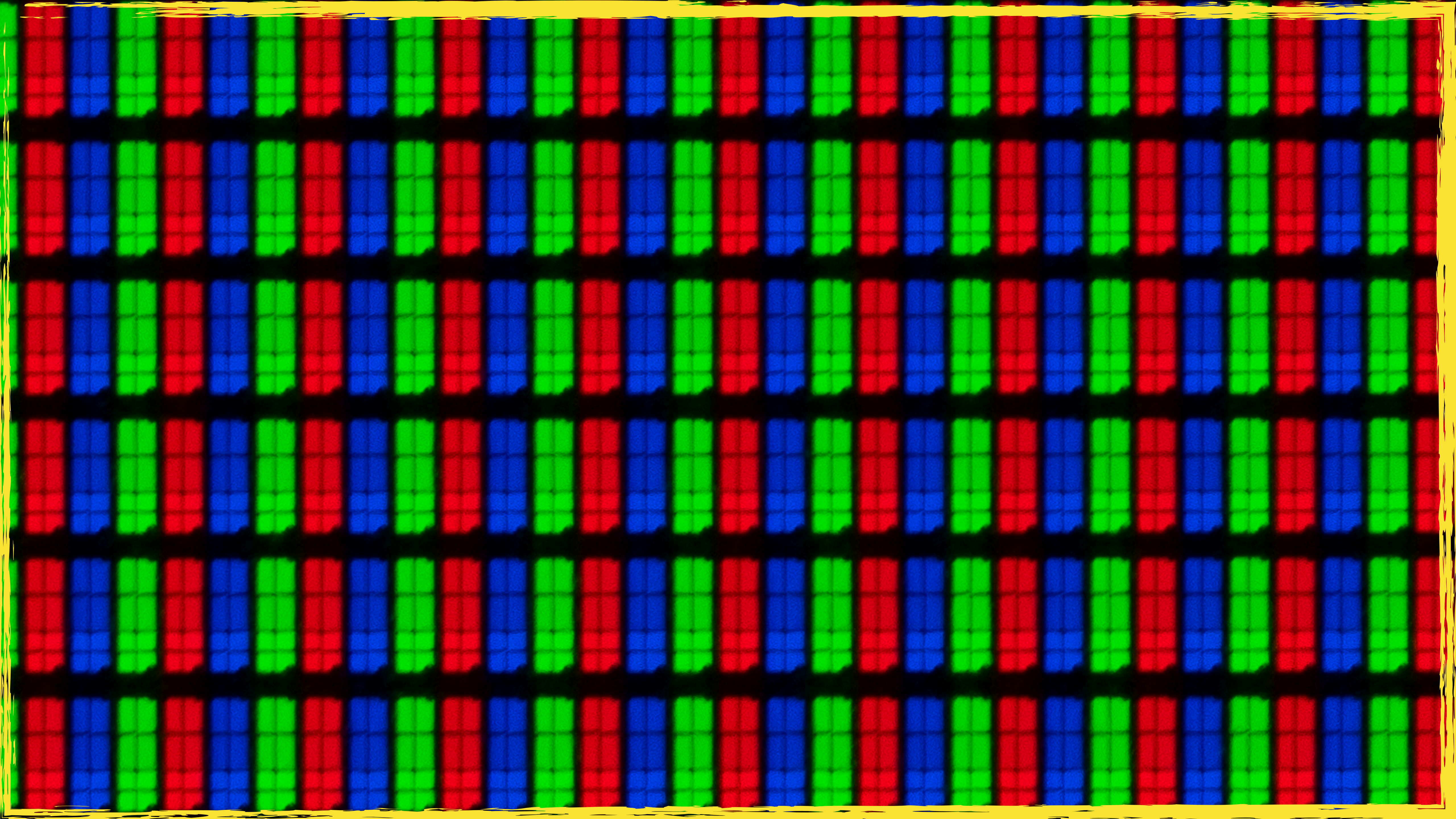
$$m\frac{d\vec{v}_i}{dt} = \vec{F}_i(\vec{x}_i)$$



$$PV = k_B NT$$



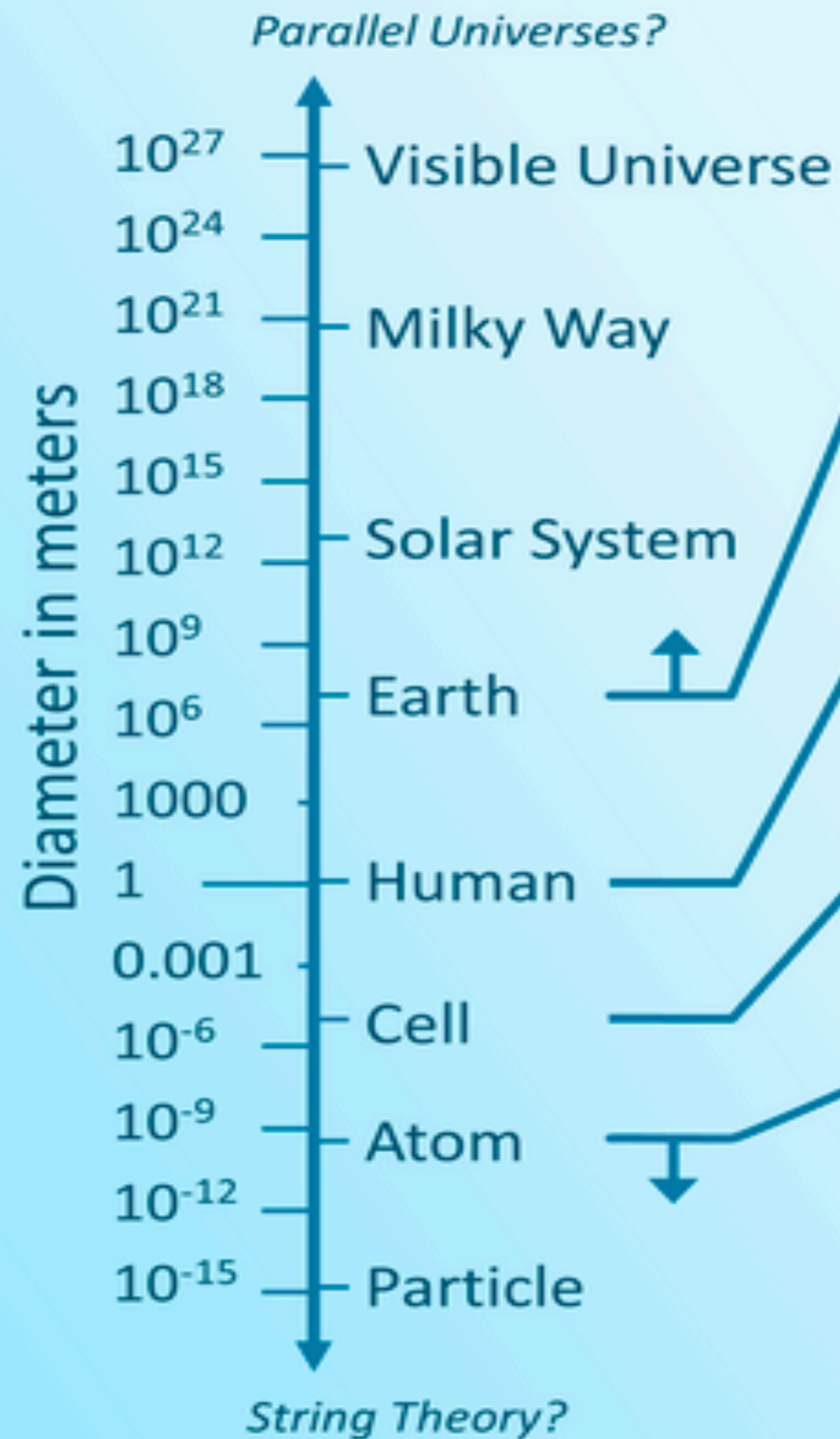




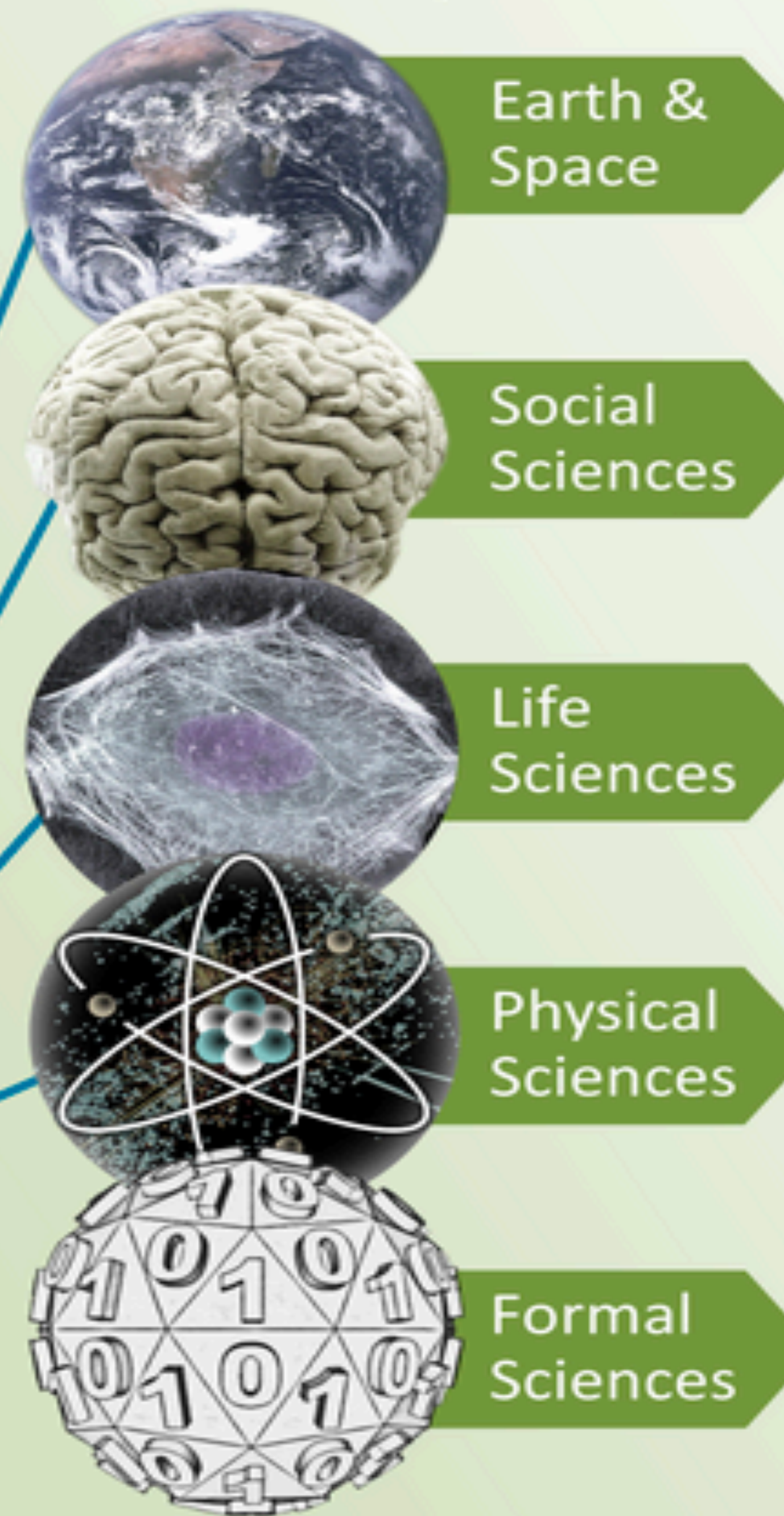
Reduction seems to reflect the fact that science can enlarge its range and depth of explanation, much like the idea of unification.

Q: What does this unity imply?

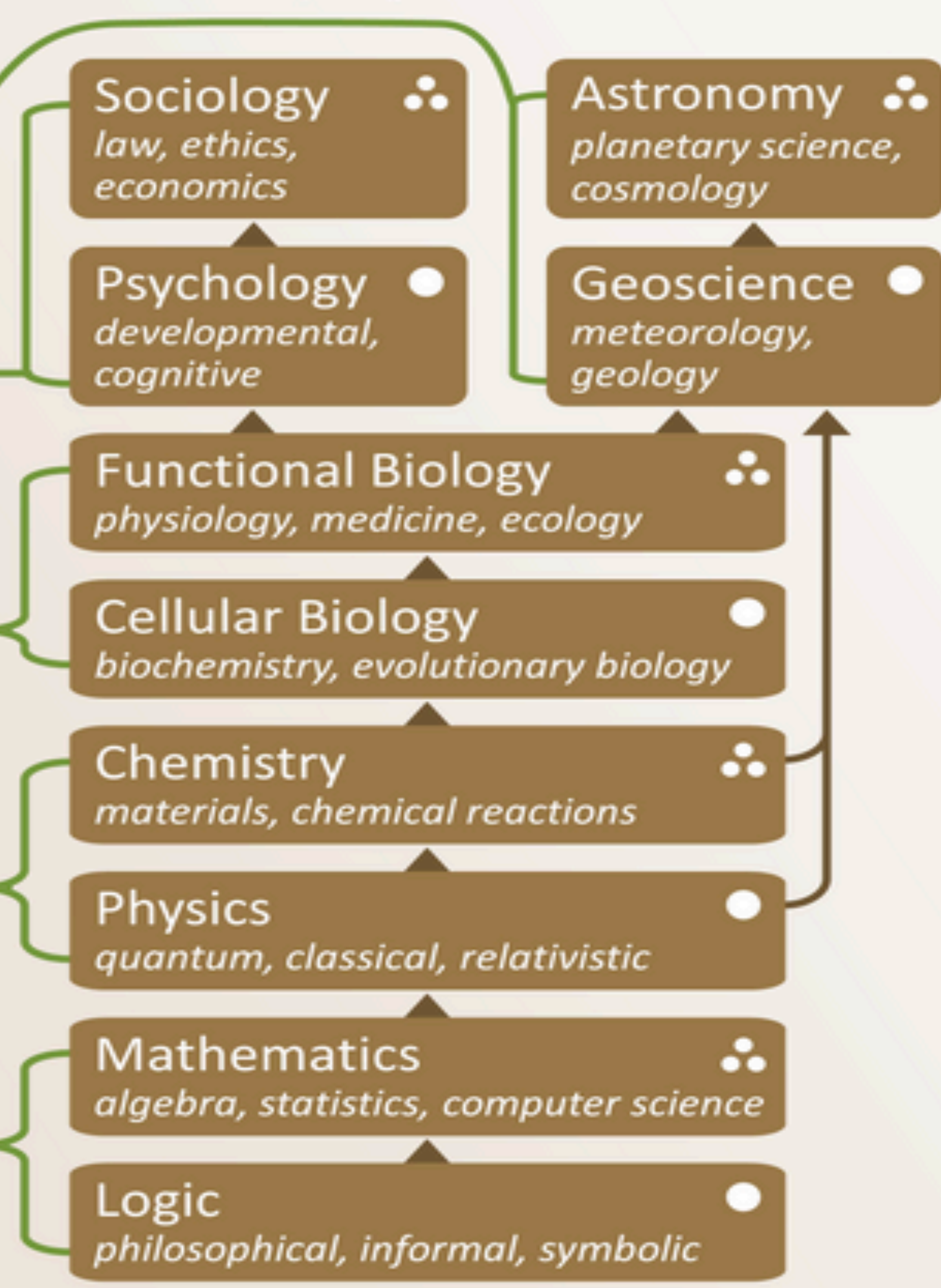
Scale of the Universe



Branches of Science



Hierarchy of the Sciences



Question:

**Do you think there should be a uniquely
correct, final, description of nature?**

Note that **being reduced** doesn't imply **strictly being contained**: more basic theory should not incorporate the less basic theory's limitations (e.g. Galileo vs. Newton).

Reduction is not simply a **theory replacement**, which happens when the theories are not related by any derivation (e.g. different ontology).



Q: Is there an example of a current theory that we don't expect to be reduced?

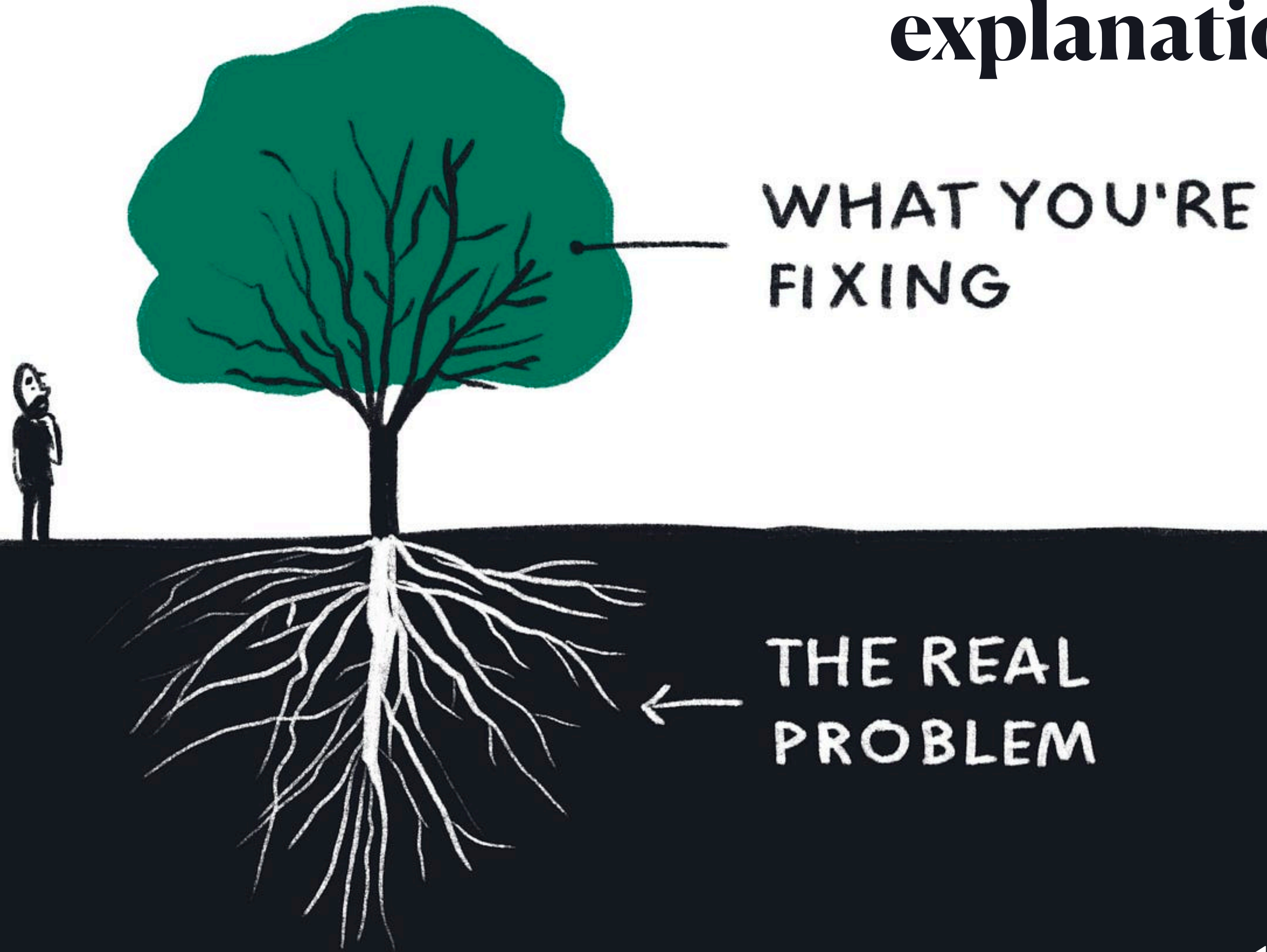
Question:

**How successful has been the reduction/
emergence program?**

Using the epistemological unity of science as a criterion to identify scientific theories, some have argued that some of the theories in the special sciences **cannot be considered scientific** as they still cannot be derived from more fundamental ones, which might point out to methodological errors in their approaches to understanding phenomena.

Moreover, as appealing as reduction is, it has become harder and harder to recover intertheoretical identifications (e.g. genetics).

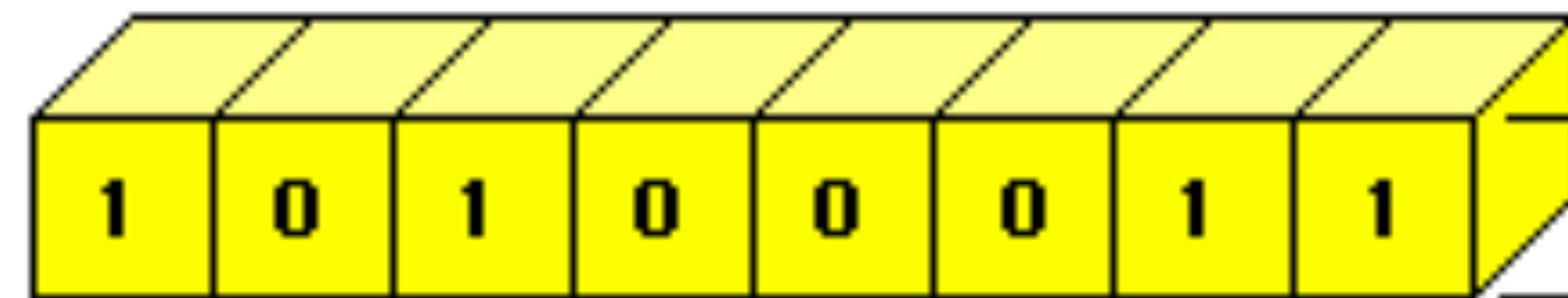
**...undermining autonomous
explanations of higher level
sciences**



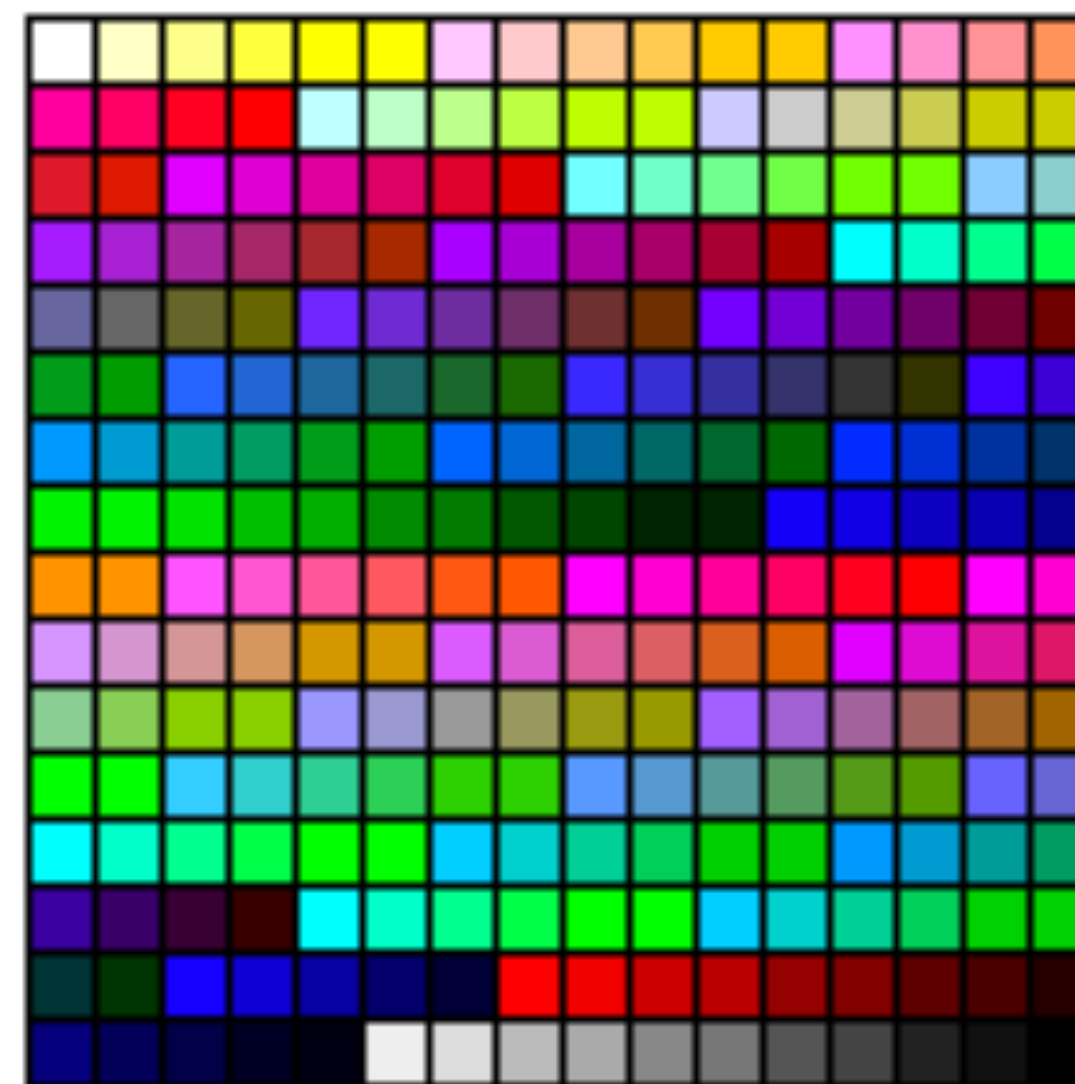
**The problem of
theoretical terms**

8-bit or 256 color displays

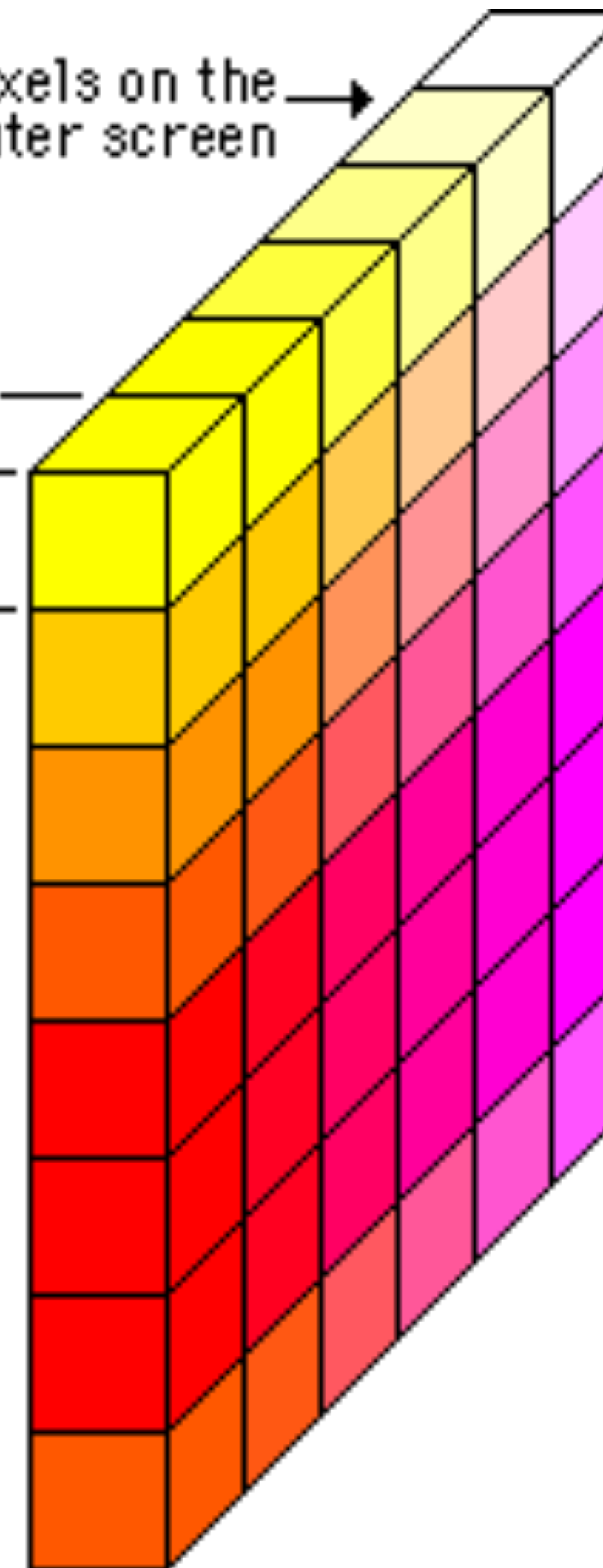
Each screen pixel is represented by eight bits of memory.



256 colors (Color Look Up Table)



Pixels on the computer screen →





ODIN



FRIGG



THOR



BALDER



LOKI



HEL



FREY



FREYA

Theoretical Terms

Challenge the **empiricist epistemology**

Seem necessary for unification of theories

Have **methodological value** (e.g. Einstein trying to define simultaneity)

**Q: Is knowledge ultimately justified by
our experience through our senses?**

What's the meaning of **temperature**?

According to which thermometer?

According to which kind of thermometer?

What about the temperature of the sun?

What about all the objects that never had their temperature measured?



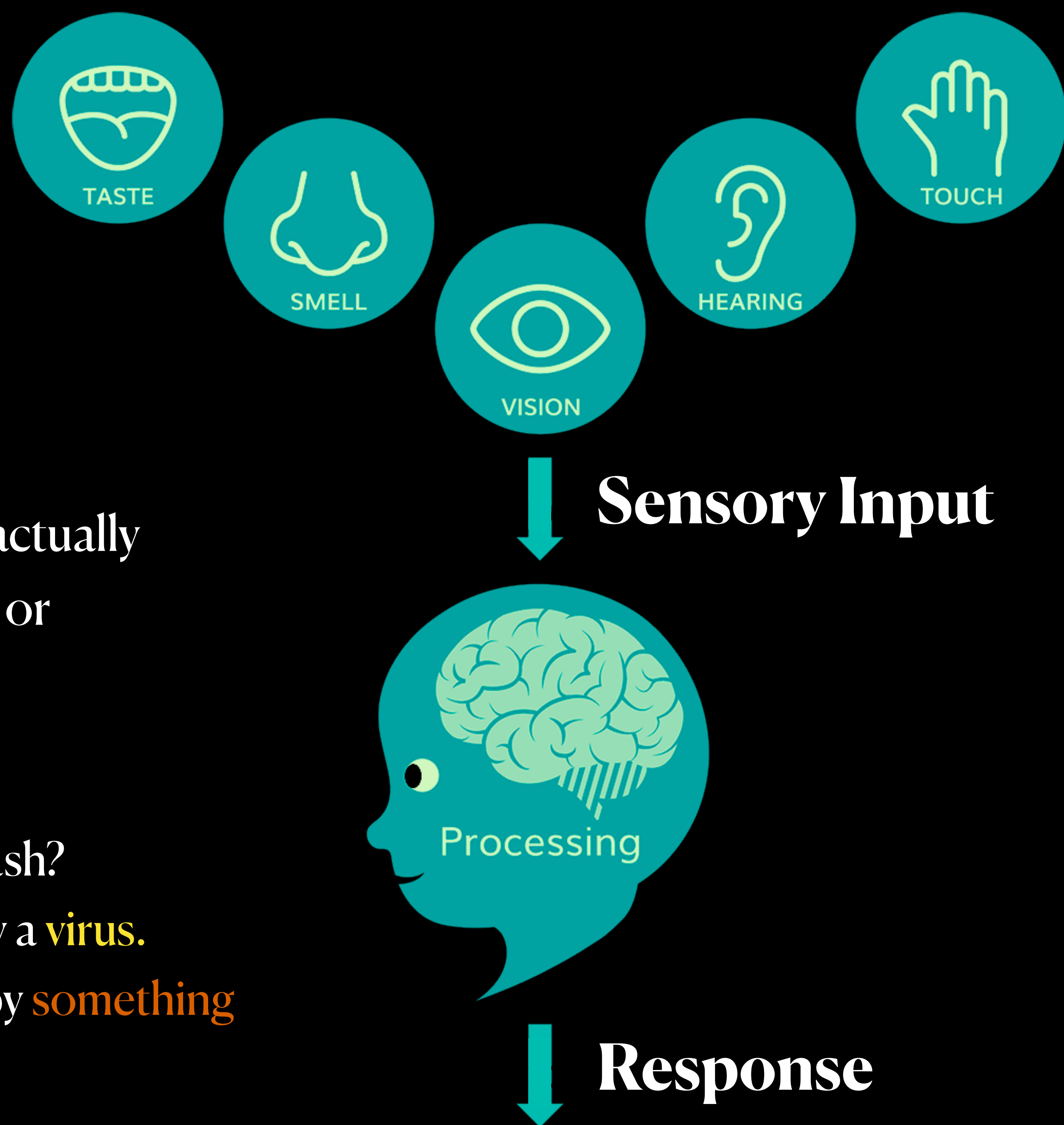
The usage of language

Perhaps the issue arises from our usage of language. Everything that is unobservable actually is directly connected to observable objects or properties thereof.

Example:

Why did Michael develop a rash?

- Because he was infected by a **virus**.
- (Because he was infected by **something which gives rise to rashes**)



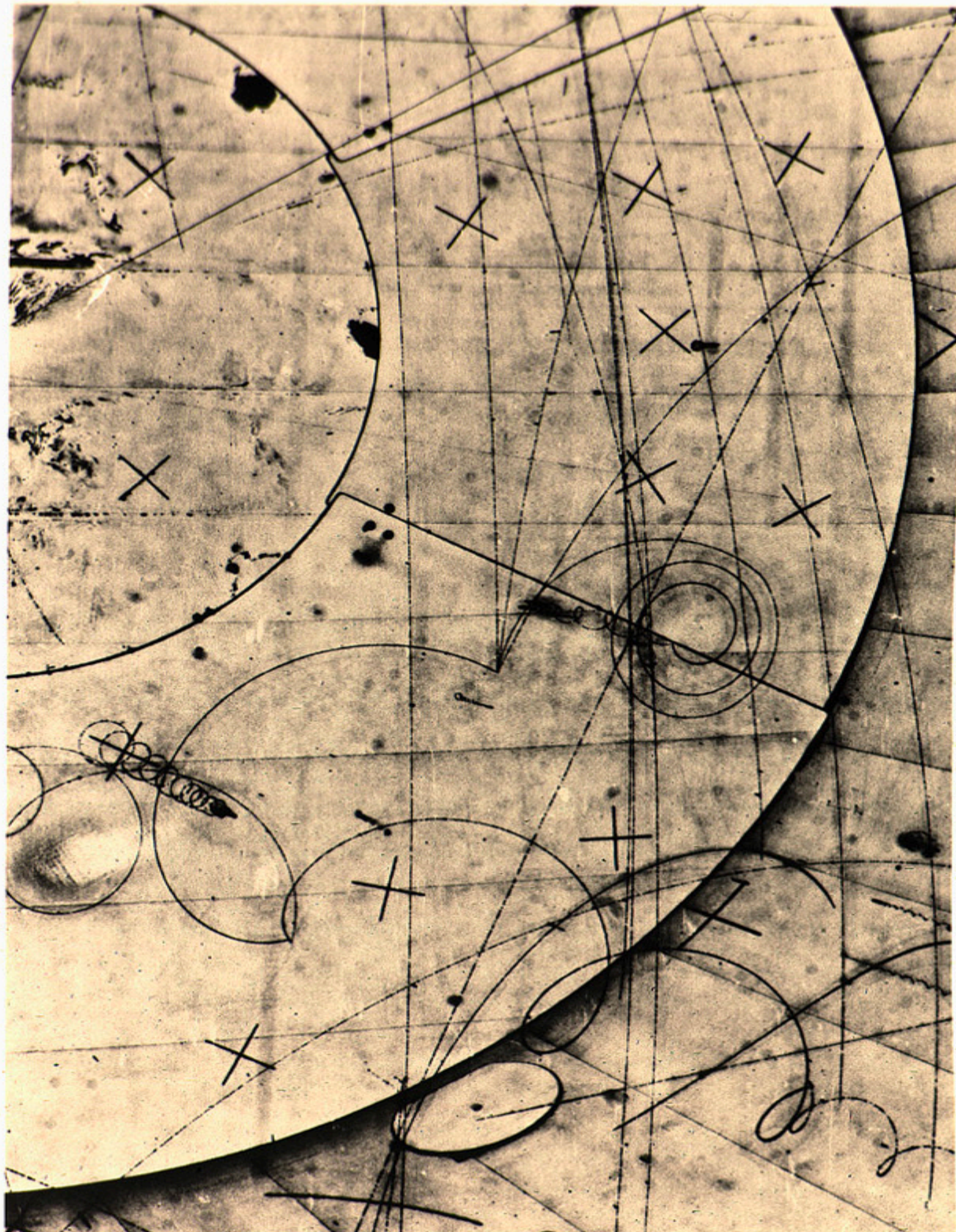
Empiricists like Hume and Berkeley were comfortable with the idea of keeping theoretical terms as long as they could be related to observable terms. The theoretical terms would work as abbreviations, summaries, compositions of observable terms (e.g. density).

Theoretical terms that did not satisfy such requirement would be deemed meaningless (e.g. gravity, atoms, etc).

Q: How successful is this project?

How to reconcile
the demands of explanation
with
the demands of empiricism?





AACHEN-BONN-CERN-MUNICH-OXFORD COLLABORATION

WA 21

EVENT 294/0995

$$\nu p \rightarrow D^* p \mu^-$$

$$D^* \rightarrow D^0 \pi^+$$

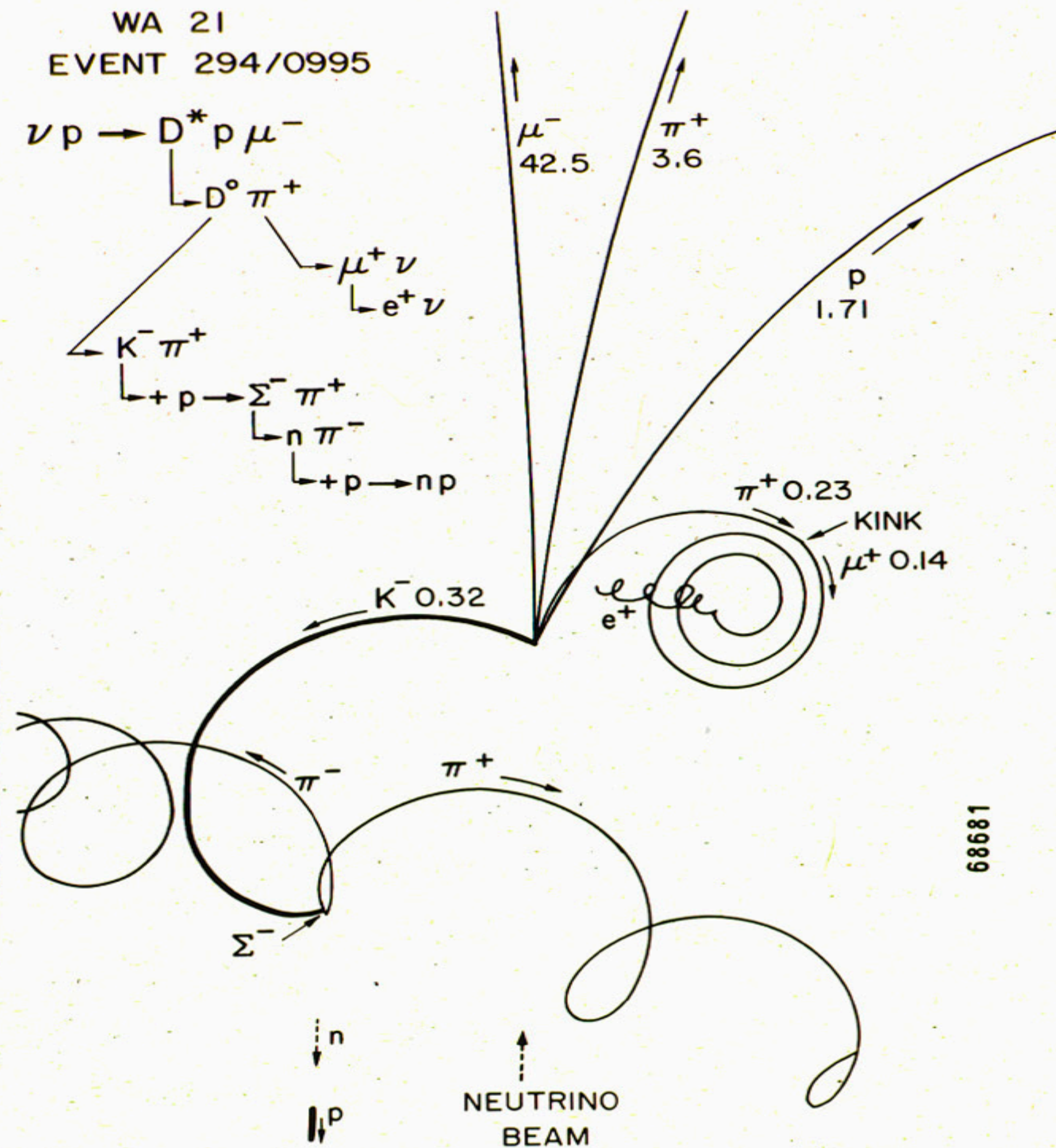
$$\mu^+ \nu \rightarrow e^+ \nu$$

$$K^- \pi^+$$

$$+ p \rightarrow \Sigma^- \pi^+$$

$$n \pi^-$$

$$+ p \rightarrow n p$$



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MOMENTUM IN GeV/c



Scientific Realism

Do we **trust** in science? If so, does that mean that scientific theories are **true**? Does it mean that the theoretical terms contained in our scientific theories refer to ***real*** unobservable aspects of the world?



Realistic Commitments

Semantical

- our scientific claims about this reality have a determinate **truth-value** when they are interpreted “literally”

Ontological - There **exists** a mind-independent world or reality (w/ unobservable aspects)

Epistemological

- scientific claims give us **knowledge** about that unobservable reality



No Miracles Argument

*Realism is the only philosophy that does
not make the success of science a miracle.*

Putnam 1975 –

Science's great and ever-increasing predictive power, its “instrumental success” allows ever-increasing technological interventions in the world, and this begs for explanation.
Why does science work? The realist will obviously say: because it is (approximately) true.

It'd be a miracle if its success and tech applications were just a matter of luck. By “inference to the best explanation”, where the success of science is that its theoretical terms are real and have their attributes given by their theoretical framework, realists make use of an abductive argument.

Q: Thoughts?



No Miracles Argument

Realism is the only philosophy that does not make the success of science a miracle.

Putnam 1975 –

On one hand,

Explanatory Power: the truth of the theories is the best explanation for their empirical successes

Progress and Continuity: acknowledging past theories' truth elements allows for a conception of scientific progress where newer theories often build upon, rather than replacing old ones

On the other hand,

Underdetermination: empirical success doesn't necessarily imply truth. There might be multiple incompatible theories that can account for the same empirical data

Simplicity: Sometimes, the simpler, less-accurate model is chosen over a more complex, more accurate one because it's easier to work with, indicating that empirical success doesn't always track truth



Pessimistic Meta Induction

On one hand,

Historical Precedence: History is filled with examples of empirically successful theories later replaced (e.g., the phlogiston theory, the caloric theory) - empirical success $\neq$ guaranteed truth

Flexibility: entities posited by theories can be seen as useful fictions, allowing for conceptual change without the metaphysical commitment

On the other hand,

Selectivity: PMI might be cherry-picking examples. Not all discarded theories were genuinely successful, or they are replaced by theories that retained much of their core content

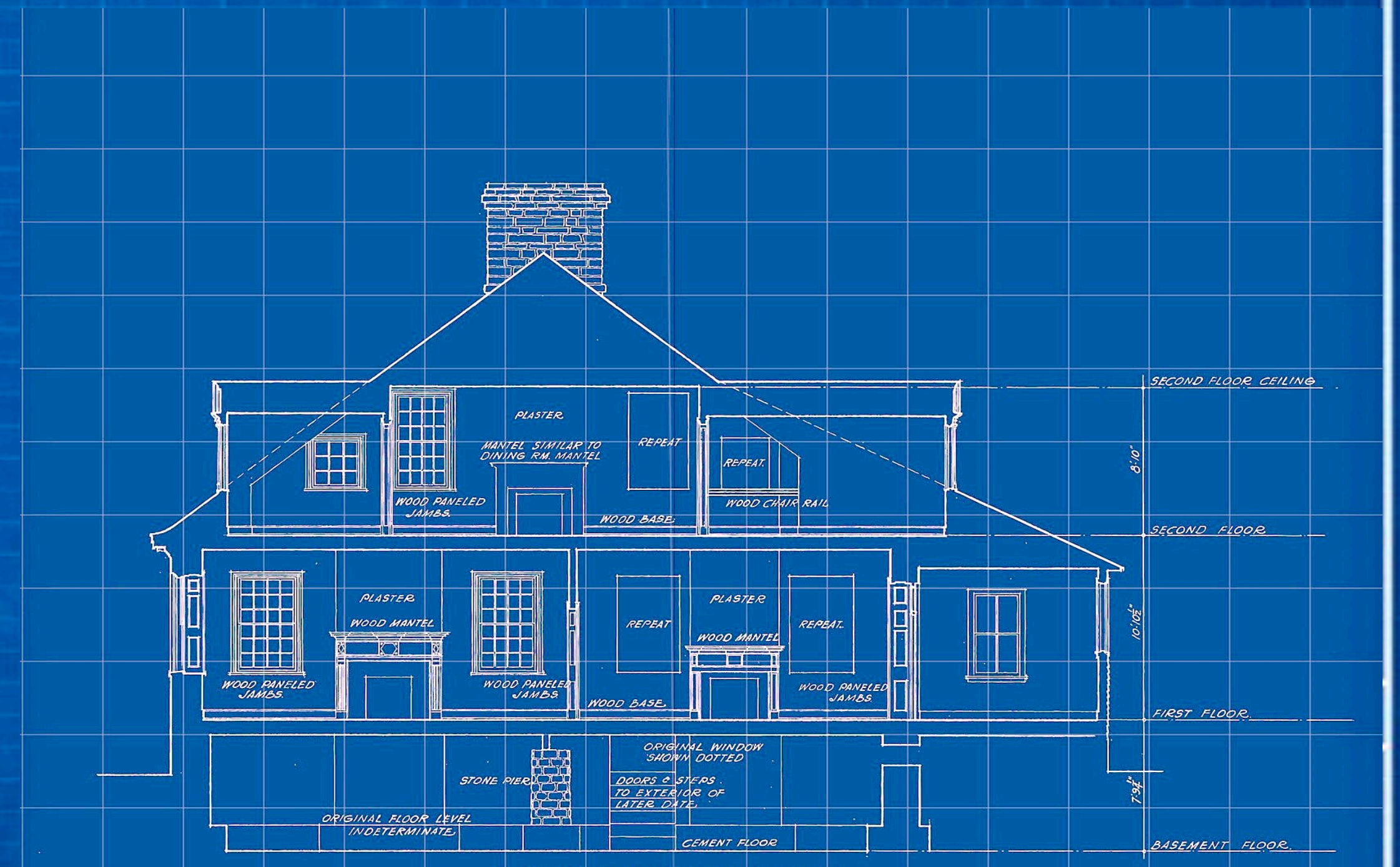
Progress: PMI seems to deny the idea of scientific progress by suggesting that current successful theories aren't necessarily closer to the truth than their predecessors

Q: Thoughts?

Structural Realism

Structural realists will claim that what scientific theories get right is the mathematical structure of reality, without making claims about the nature of things that behave in accordance with these mathematical formulations .

However, how to distinguish the mathematical structures of a theory from its content? What to do when theories have more than one mathematical formulation that are equivalent? And what about theories that are not mathematical by themselves?



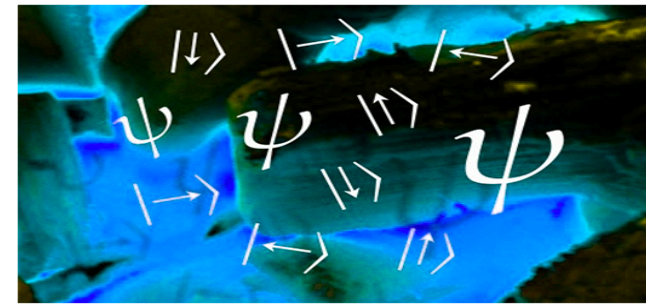
Instrumentalism

Scientific theories are useful instruments, tools we employ for organizing our experience, but not literal claims about the world that are either true or false. Berkeley was a champion of this idea.



Interpretations of Quantum Mechanics

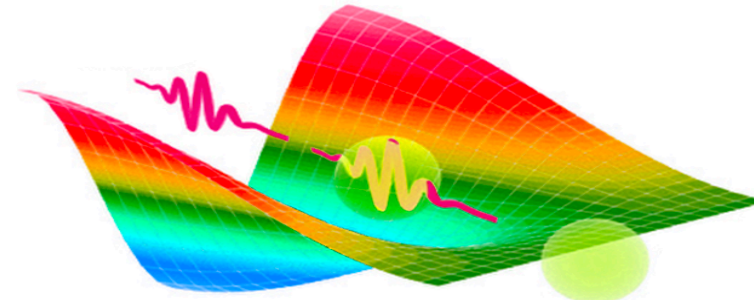
Hidden-Variable Theory



we just don't know (yet)
deterministic
God does not play dice!

Lawful Good

Pilot Wave Theory



wave function & actual state
deterministic
explicitly non-local

Lawful Neutral

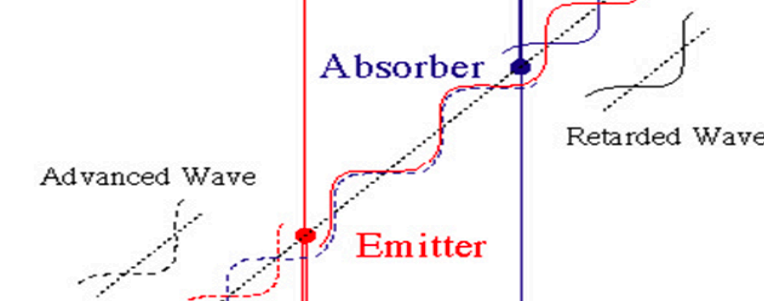
Superdeterminism



everything is predetermined
Bell's theorem loophole
quantum fuzziness is not real

Lawful Evil

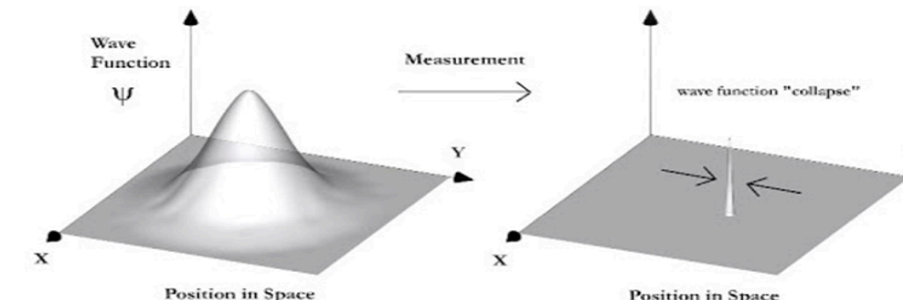
Transactional Interpretation



waves through time
quantum handshakes
explicitly non-local

Neutral Good

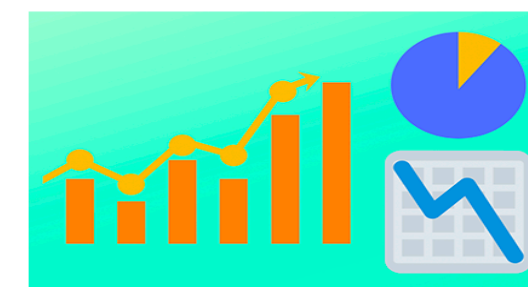
Copenhagen Interpretation



probability wave → collapse
indeterministic
playing dice, but that's okay

True Neutral

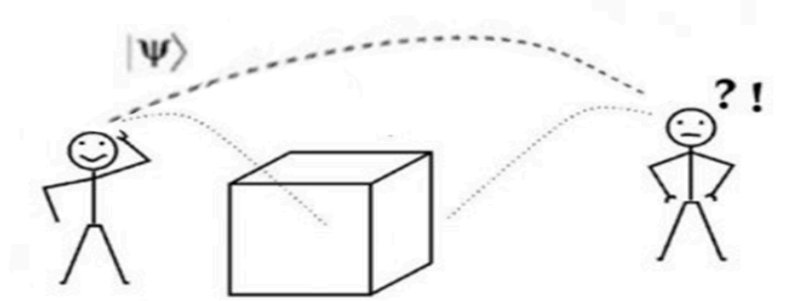
Ensamble Interpretation



probabilities in groups
minimalist
statistics go brrr

Neutral Evil

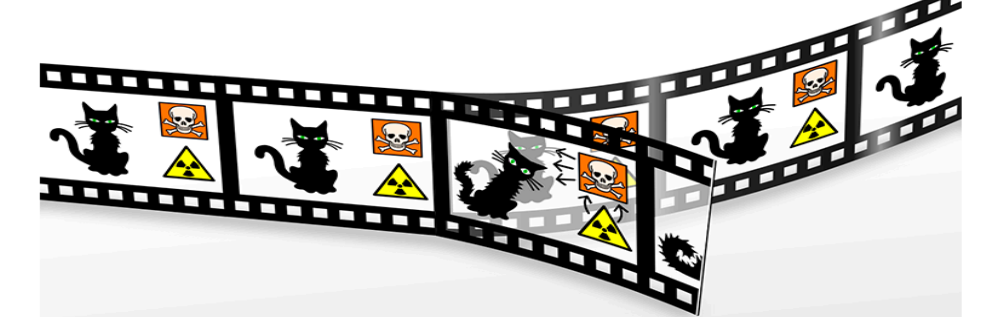
QBism



reality is observation
participatory realism
subjective Bayesianism

Chaotic Good

Many Worlds Interpretation



every state a new world
decoherent
infinite universes

Chaotic Neutral

Quantum Mysticism



consciousness causes collapse
spooky
Philosophy > Physics

Chaotic Evil

Constructive Empiricism

**Just don't commit and deny the
whole project!**

A compromise: take an agnostic stance on theoretical terms, and state that the objective of science is only **systematizing experience**. Thus, as long as theories are **empirically adequate (over truth)**, no need to agree with realists and their ontological commitments, but neither do need to agree with the instrumentalist that the theories are convenient fictions.

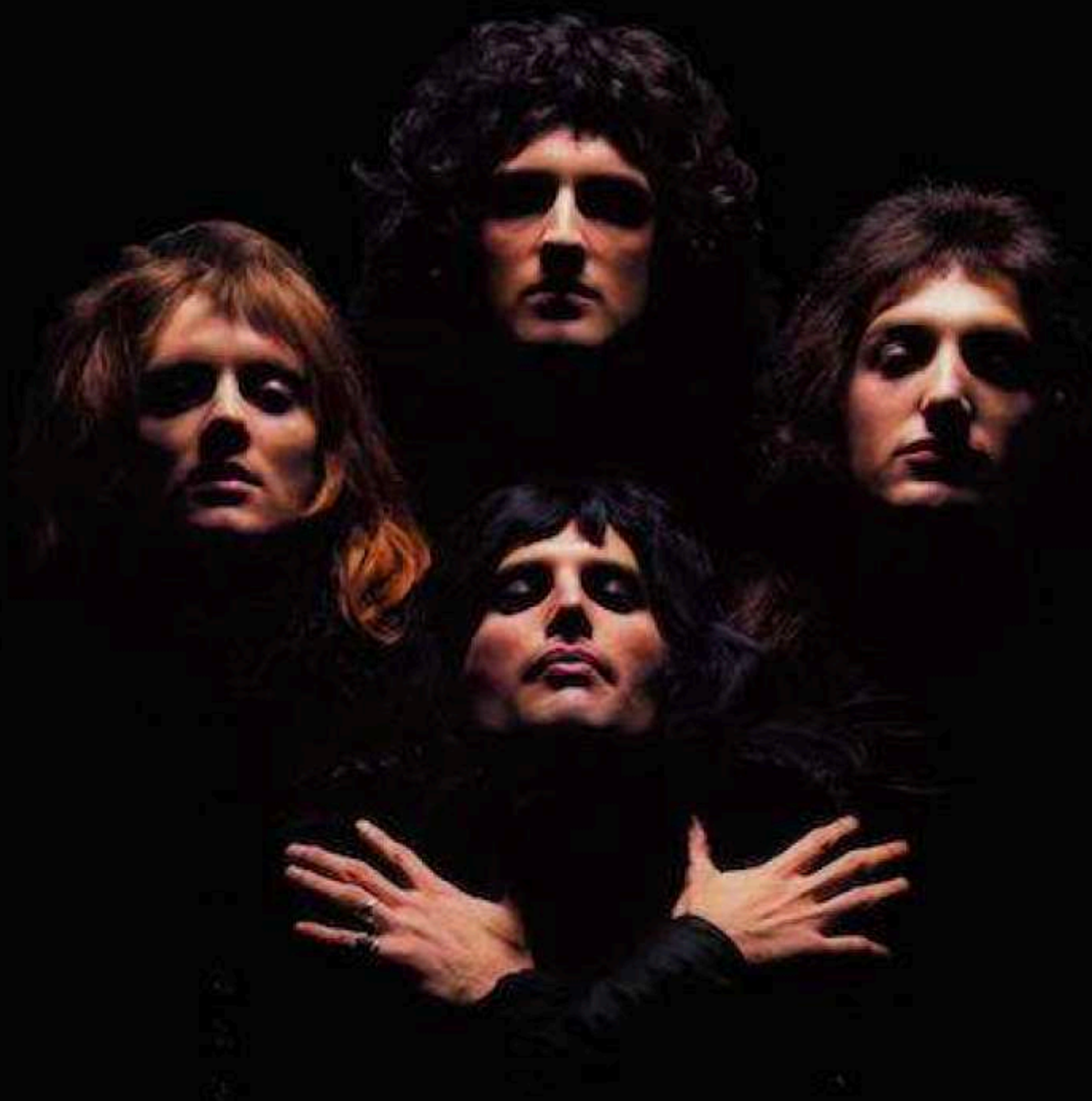
(Bas Van Fraassen)

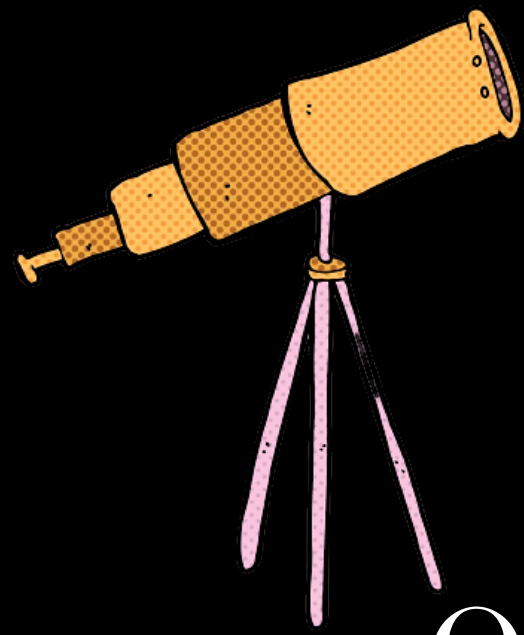


IS THIS THE *Real* life?
IS THIS JUST *Fantasy*?

Anyone who wants to be a realist about observable claims, but denies wholesale scientific realism, relies on a strict distinction between observable and unobservable vocabulary.

Q: Where should we draw the line?



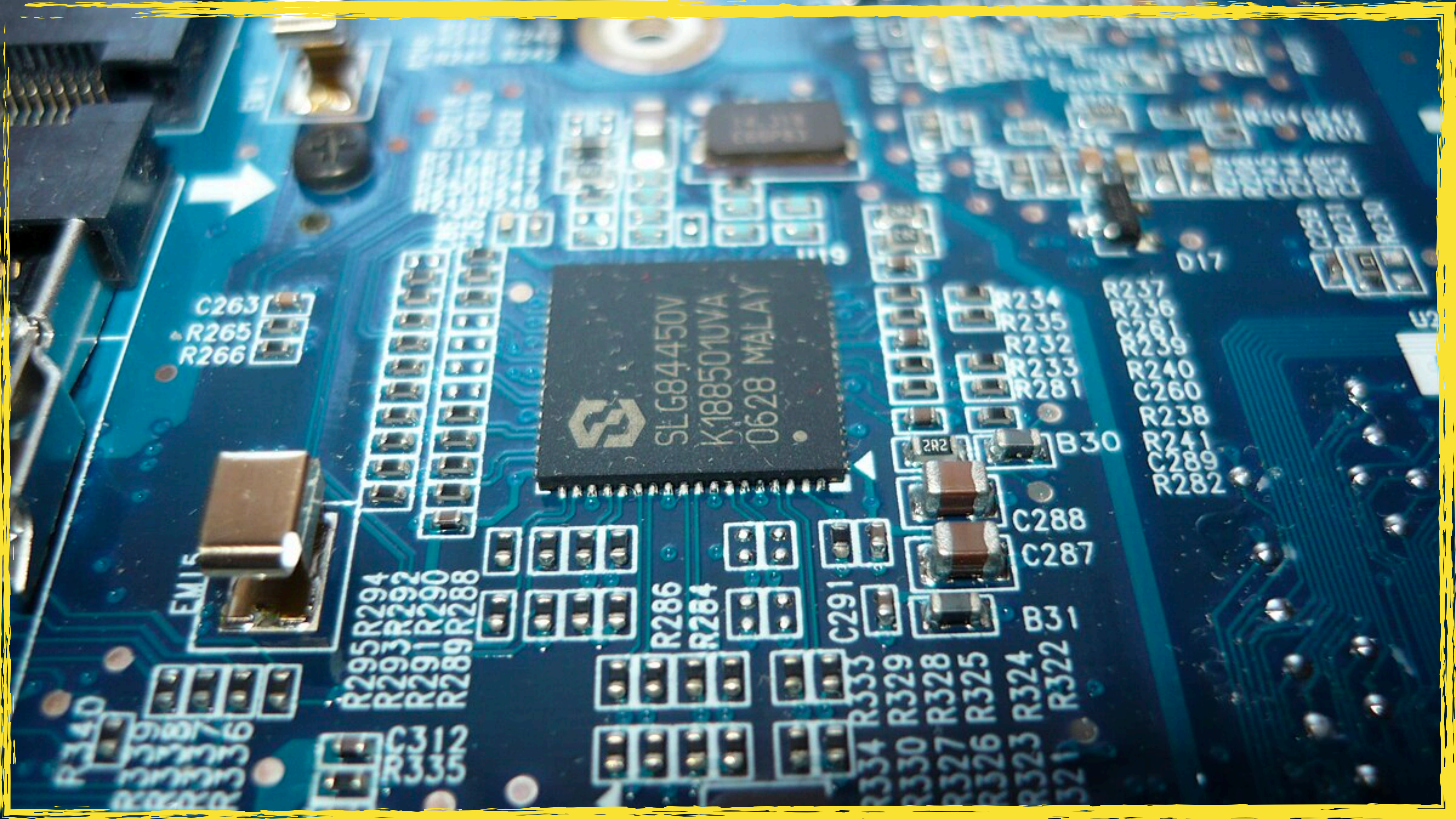


- Observations with the naked senses
- Through glasses
- Through an optical microscope
- Through an electron microscope
- Through particle detectors

If no such distinction can be drawn then a dilemma arises: one should either be skeptical about all knowledge, or one should be a scientific realist.







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R265
R266

EMIR

R295
R294
R293
R292
R291
R288
R289

R286
R284

C291

C288
C287

B30

R234
R235
R232
R233
R281
R237
R236
C261
R239
R240
C260
R238
R241
C289
R282

B31

R334
R333
R329
R328
R327
R326
R325
R324
R323
R322

C312
R335

Next Time (Mar 1st) - Induction and Evidence

- To read (all on Athena):
 - Chapter 10 and 11 of Rosenberg & McIntyre
- Come prepared for class discussion
- Other announcements

IS THIS THE *Real* life?
IS THIS JUST *Fantasy*?

