

FROM PARTICLES TO PEOPLE: THE LAWS OF NATURE AND THE MEANING OF LIFE



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Executive summary:
The laws of nature underlying the everyday world
are completely understood.



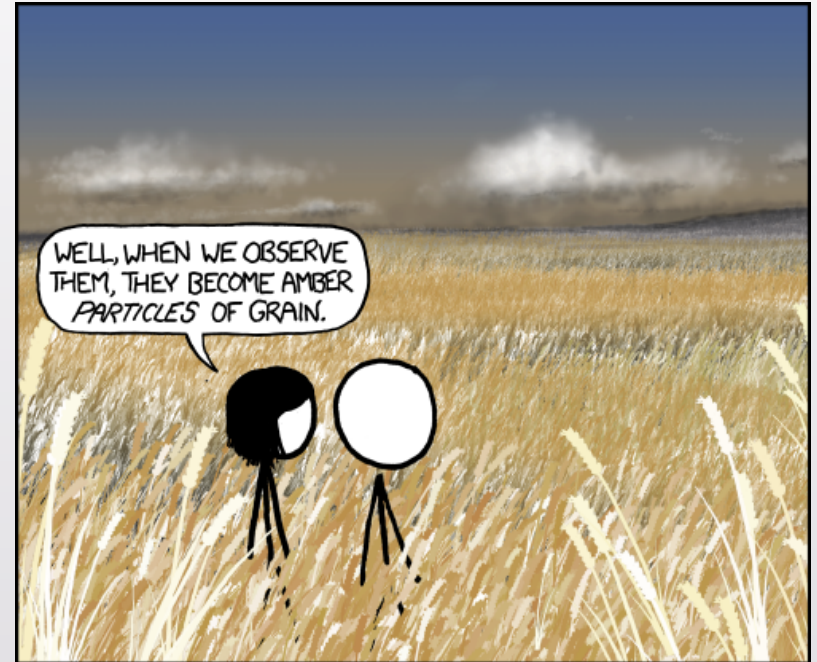
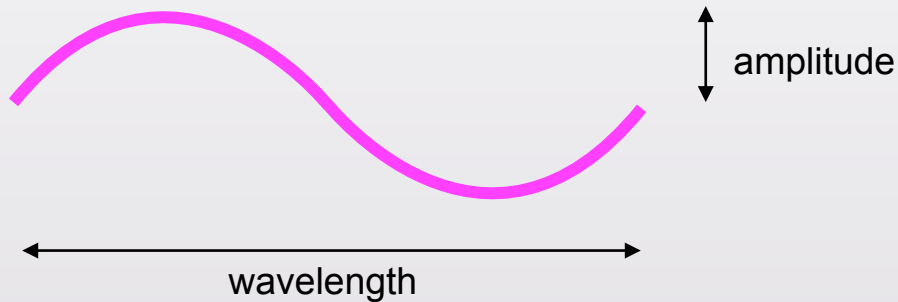
That understanding has consequences for human life.

The way that nature works is **Quantum Field Theory**.



The world is made of **particles** (fermion fields) interacting through **forces** (boson fields).

QFT tells us that everything is a wave in a field.



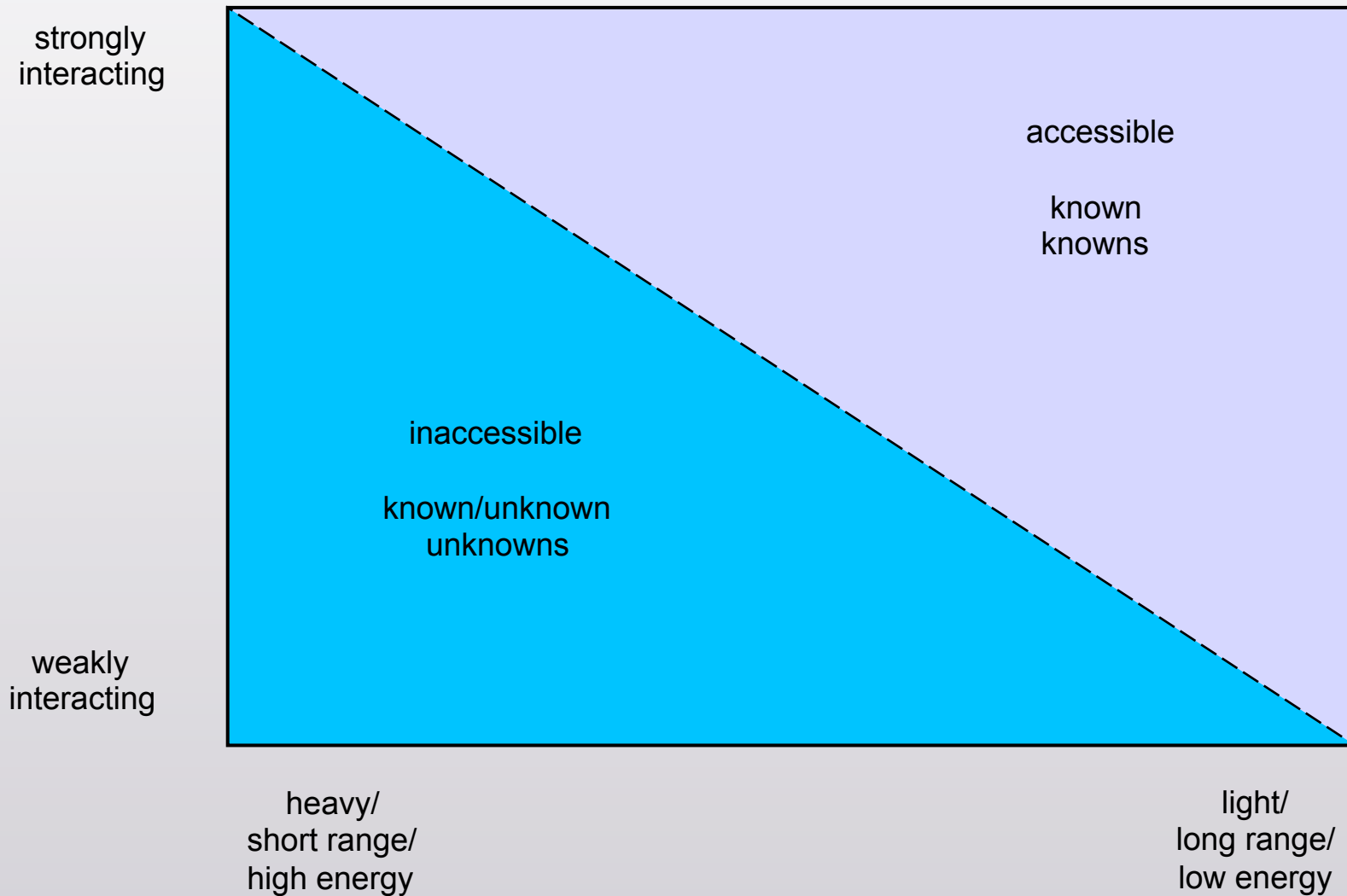
[xkcd]

Amplitude = # of particles or strength of force.
Wavelength = mass of particle or range of force.

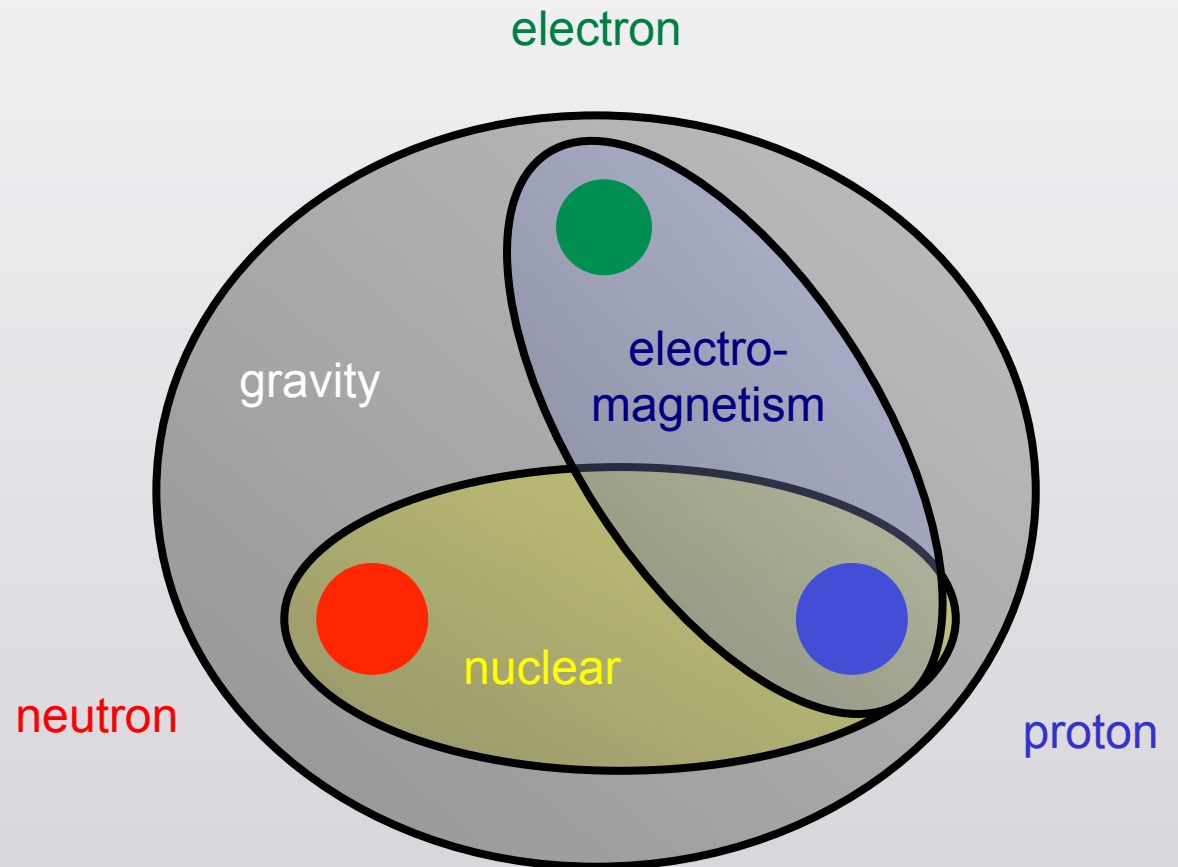
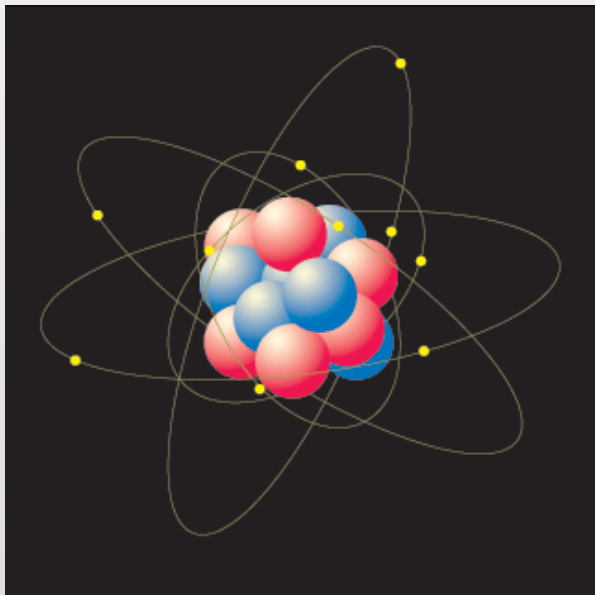
QFT lets us quantify the scope of our understanding.



Ken Wilson
Nobel 1982



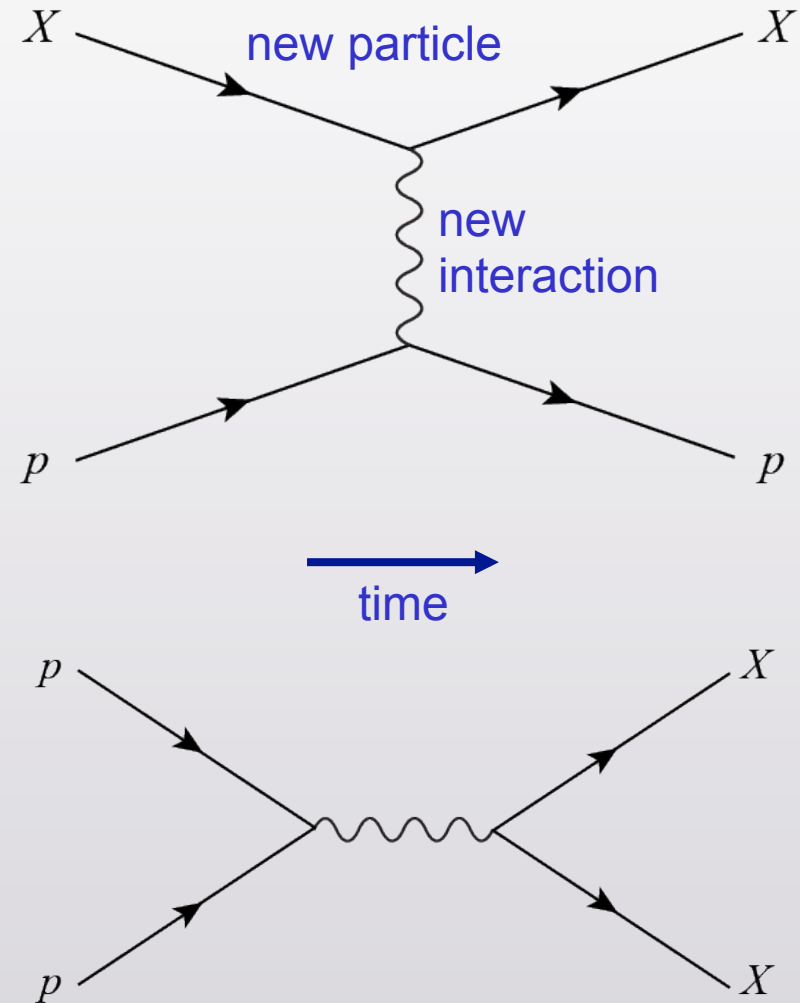
All of everyday life consists of three particles
-- electrons, protons, and neutrons --
interacting via three forces
-- gravity, electromagnetism, the nuclear force.



Quantum field theory puts very tight constraints on new particles.

If a new particle can interact with ordinary particles:

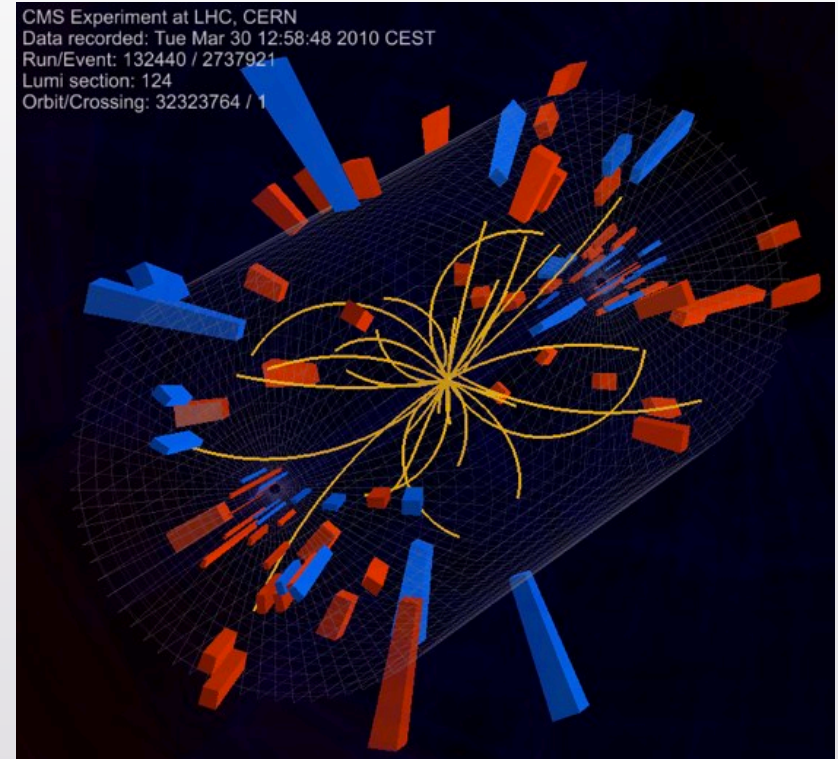
Then that particle can be created in high-energy collisions.



Could new particles hide from our view?

Sure, if either:

1. very weakly interacting,
2. too heavy to create, or
3. too short-lived to detect.



In any of those cases, the new particle would be irrelevant to our everyday lives.

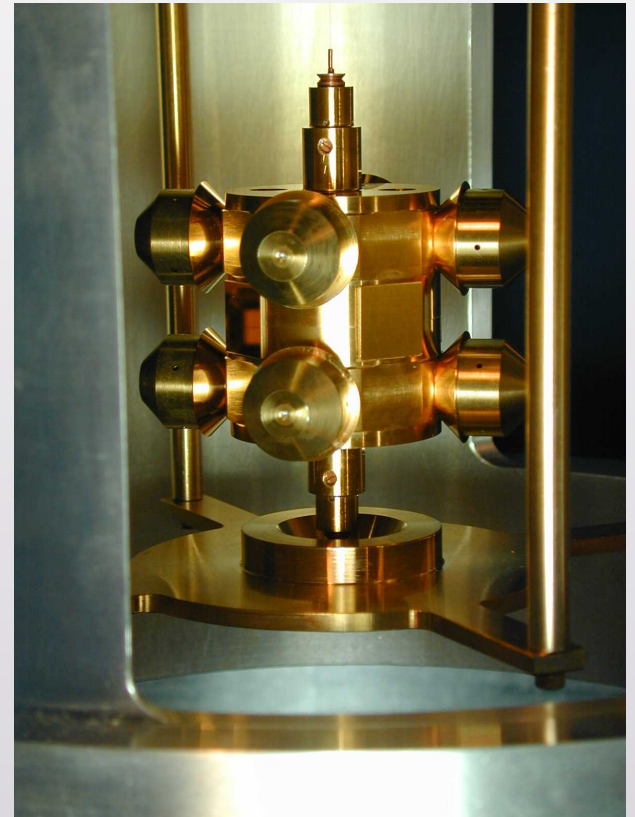
Could there be new forces of nature?

Sure, but they must interact with protons, neutrons, and electrons.

Two ways to hide:

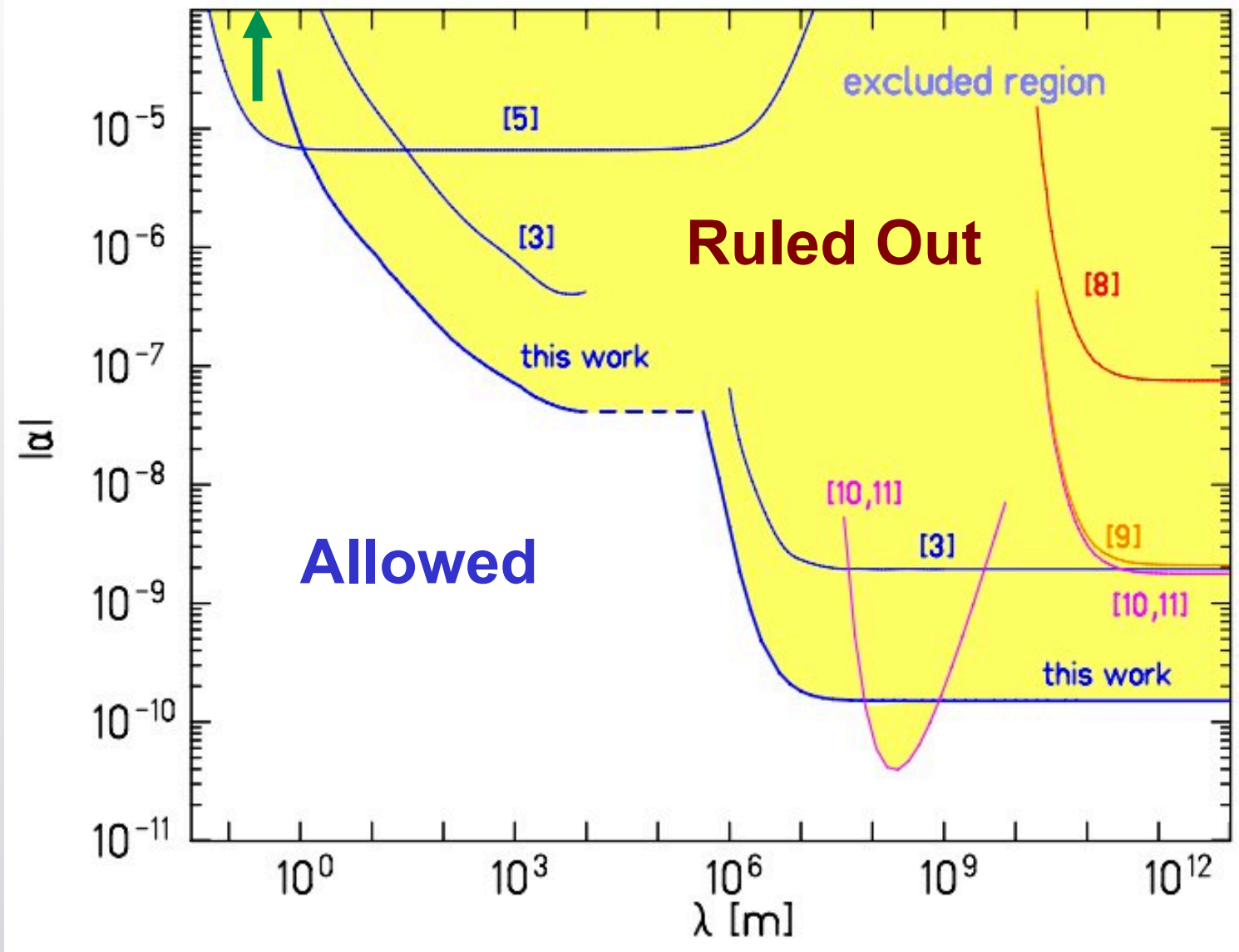
1. weak interactions, or
2. very short ranges.

Look for new forces using torsion-balance experiments.



Experimental constraints on new forces.

Strength (relative to gravity)



Range

[Schlamminger et al. 2008]

Any new force on macroscopic scales must be less than $1/100,000^{\text{th}}$ the strength of gravity.

Gravity is a weak force.



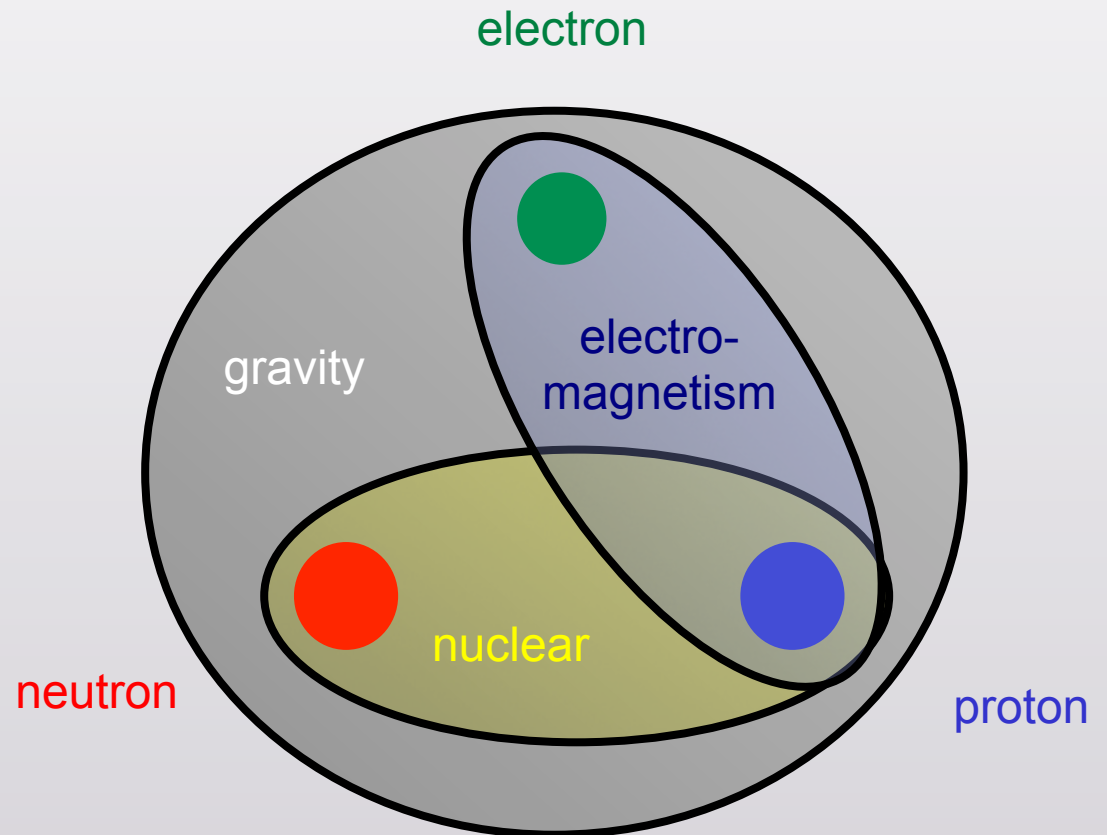
New forces relevant to everyday life are ruled out by experiment.

Conclusion:

when it comes to the laws of physics underlying everyday life -- baseballs, tables, viruses, human beings -- we are done.

It's all just electrons, protons, and neutrons, interacting via gravity, electromagnetism, and the nuclear force.

That's all.



Of course there is plenty we don't understand.

non-everyday physics



dark matter, dark energy,
origin of the universe,
grand unification,
quantum gravity...

complicated systems



[litlquest.com]

turbulence, weather, high-
temperature superconductivity,
cancer, consciousness,
economics...

Knowing the underlying laws of physics is like knowing the rules of chess -- doesn't make you a grandmaster.



But it does constrain the kinds of games you can play.

All questions of everyday life must fit into the three-particles/three-forces paradigm.

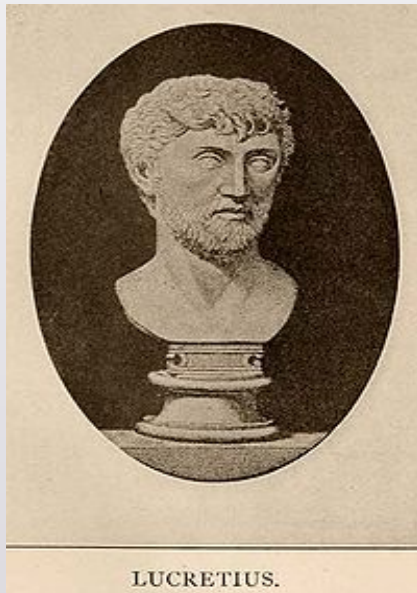
Immediate consequences:

- No spoon-bending (or other telekinesis)
- No precognition
- No clairvoyance
- No astrology
- No homeopathy
- etc.

More profound consequences as well.

Deeper consequences of the laws of physics:

- There is no soul/spirit independent of the body.
- There is no life after death.



Titus Lucretius Carus
On the Nature of Things, 50 BCE

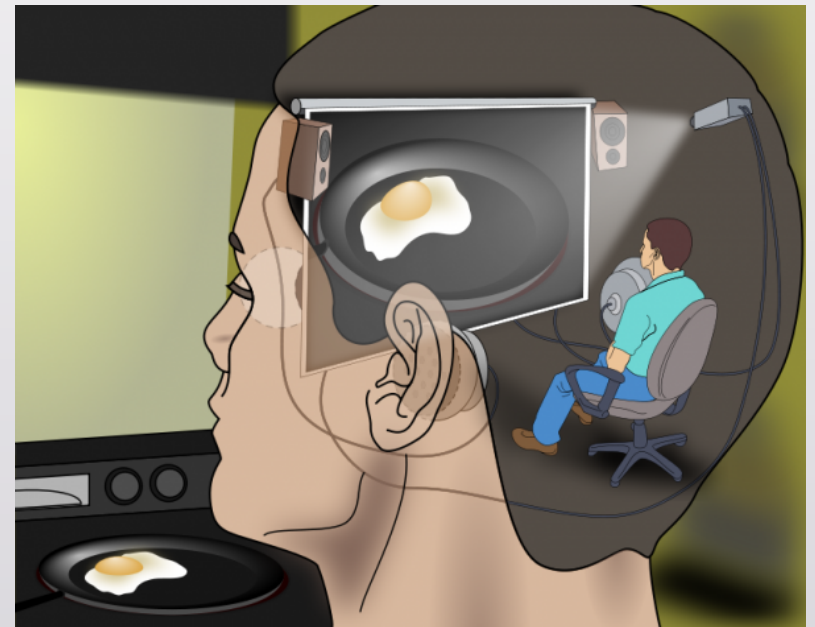


Julien Offroy de la Mettrie
Man a Machine, 1748

Of course there is much we don't understand about, for example, consciousness.

But there is zero evidence that consciousness requires more than the known laws of physics.

If there were a “spirit” that played a role -- a mind independent of the brain -- how would it interact with the electrons/protons/neutrons of our brain? Through what new force?



How do we *know*?

Science doesn't *prove* things about the world.

It judges claims based on evidence, including other things we think are understood.



Saying “maybe consciousness requires new physics” isn't a prudent conjecture about consciousness; it's a wholesale rejection of everything we think we know about quantum field theory.

Even deeper consequences of the laws of physics:

- There is no strong sense of free will, “a law unto one’s self.”
- There is no designated purpose to human life.



Pierre-Simon Laplace, 1814:
“Laplace’s Demon.”

If we knew everything about the universe, and had unlimited computing power, we could predict the future exactly.

“Free will” must be compatible with the laws of physics.

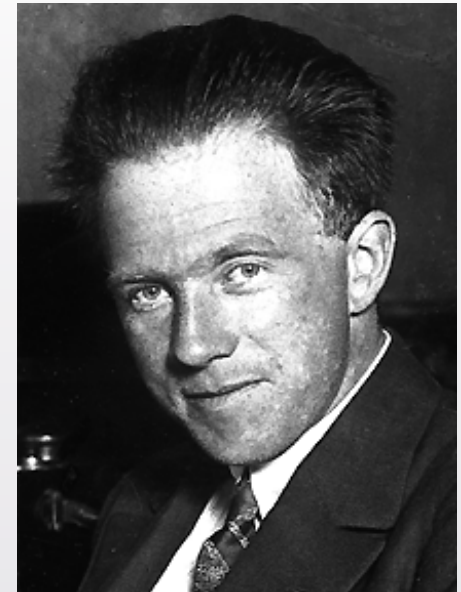


Aside: doesn't quantum mechanics undermine determinism? We can't predict the future uniquely.

That depends on your definition of "determinism," not to mention your interpretation of quantum mechanics.

But in every picture, quantum mechanics does not providing a hiding place for free will.

If you think that our choices affect quantum probabilities, you are violating quantum mechanics, not using it.

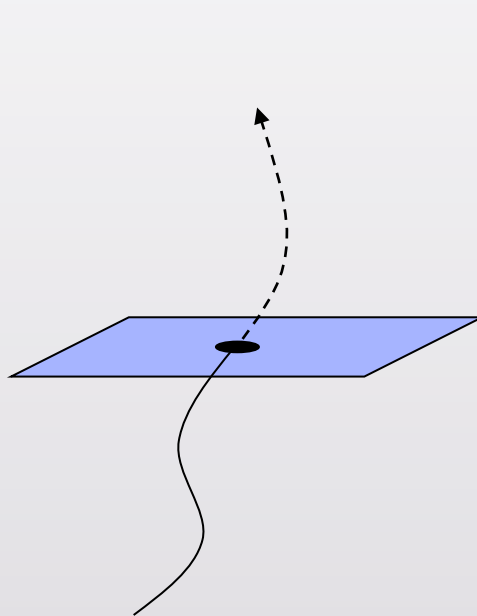
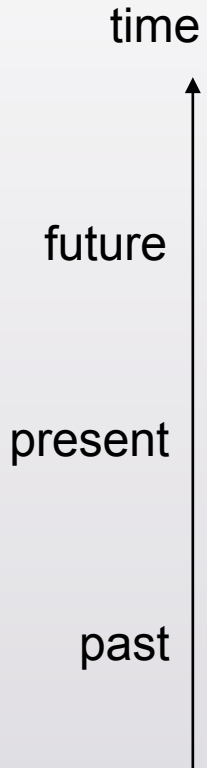


Varieties of predictive theories

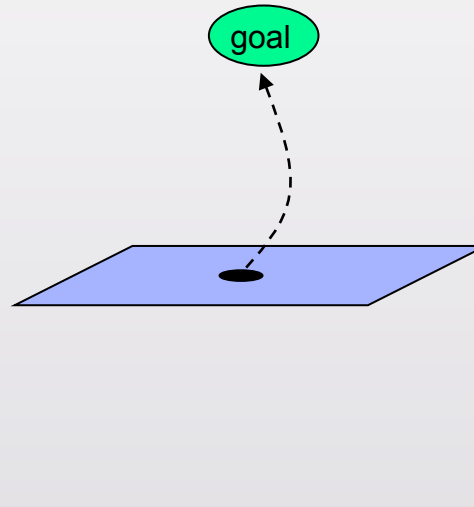
Historical

Teleological

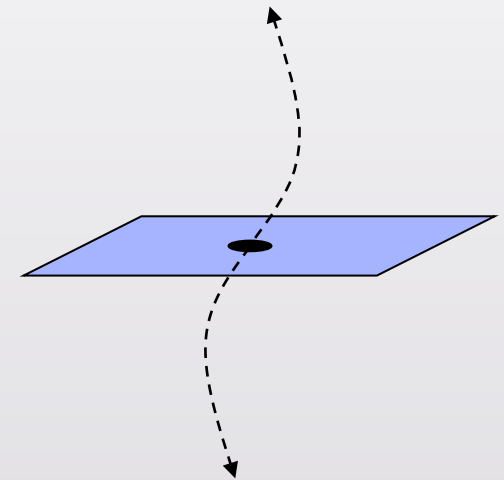
Laplacian



the past and present
together determine
the future



from the present
we move toward
some future goal



“in the moment”:
the present determines
the past and future

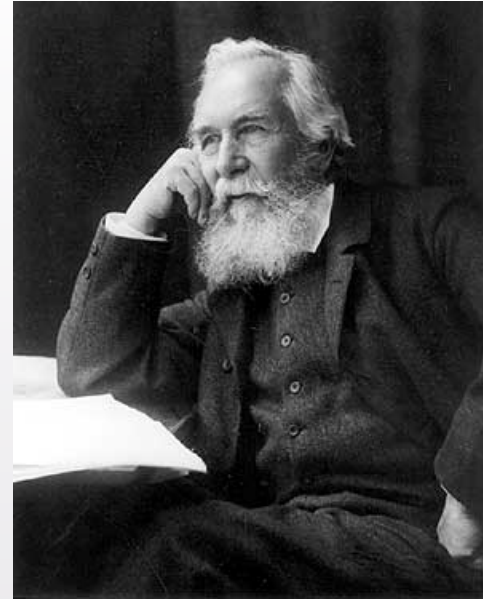
There is a strong human urge to find reasons for events.

Pat Robertson after Haiti earthquake:

“Many years ago, the island’s people ‘swore a pact to the devil.’ True story. And so the devil said, ‘OK, it’s a deal.’ They kicked the French out. The Haitians revolted and got themselves free. Ever since, they have been cursed by one thing after the other.”



The laws of nature
are dysteleological.



Ernst
Haeckel

They describe what will happen next on the basis of what the world is right now. One thing after another, following the basic patterns of nature.

That's it. No ultimate goals, no final purpose, no need for a sustaining external influence.

“The universe is made of stories,
not of atoms.”

--- Muriel Rukeyser

Particles and forces provide a
correct way of talking about the
universe -- but not the only correct way.

Crucial access to the world is provided by higher-level
models/theories/ontologies/vocabularies -- stories.

These stories must be compatible with the particles-
and-forces story, but they can sound very different.



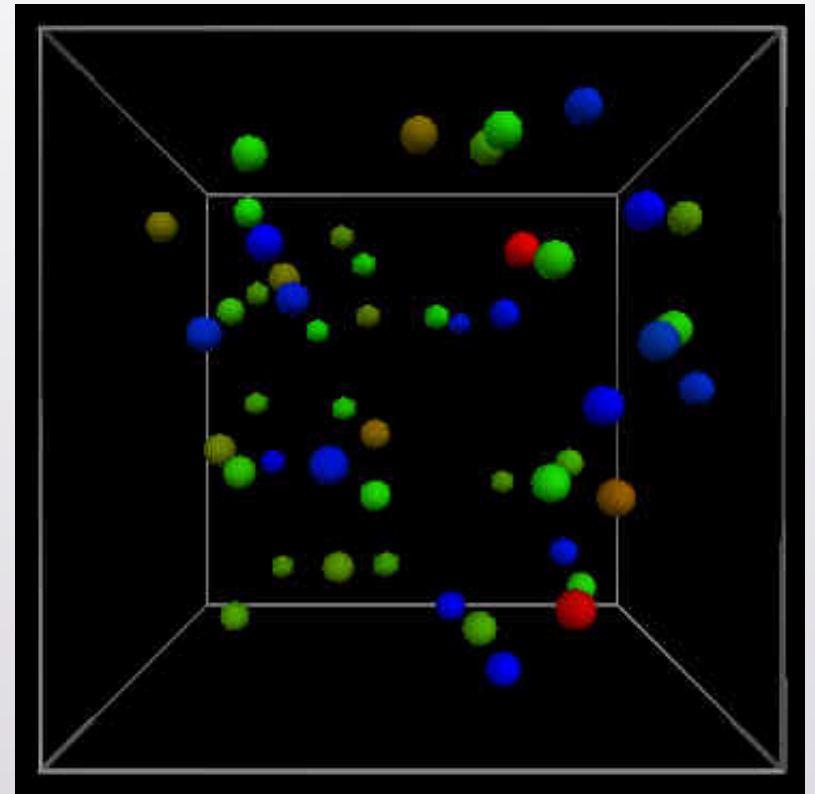
Simple example: thermodynamics.

A gas is a collection of atoms and molecules with certain positions and velocities.

But we'd be crazy to describe it that way.

Instead, we tell a story about temperature, pressure, wind velocity, etc.

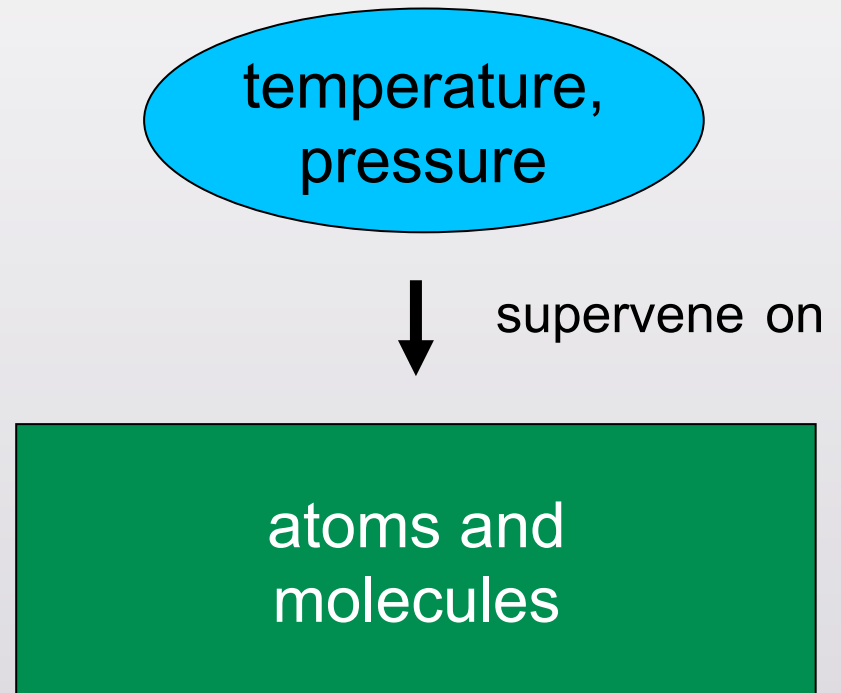
These are very real concepts.



Useful jargon term: supervenience.

High-level properties like temperature and pressure supervene on microscopic properties of atoms and molecules.

I.e., they are not independent. You can't imagine changing the temperature and pressure without changing properties of the atoms and molecules.





Here is a JPEG image.

Deep down, a string of 1's and 0's.

It's also a picture of a puppy.

The fact that it's a picture of a puppy is not independent of the 1's and 0's.

That doesn't mean it's not real, interesting, or important.

“picture of a puppy”



supervenies on

string of 1's and 0's
in image file

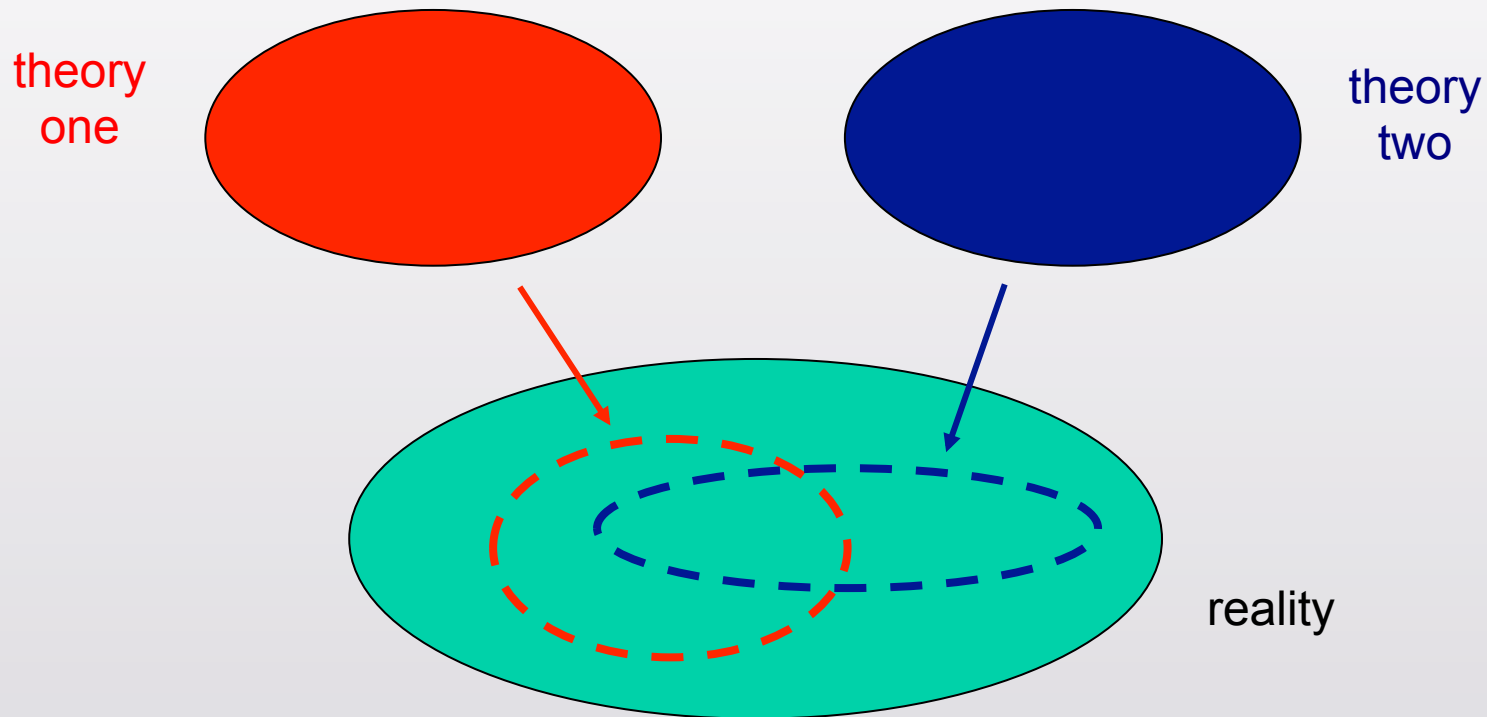
Pressure and temperature are real because they play a crucial role in a useful and accurate higher-level story about reality.

Likewise: meaning, purpose, free will, morality.
These play a crucial role in talking about humanity.

These human concepts are perfectly real, even if they are nowhere to be found at the level of particles and forces.



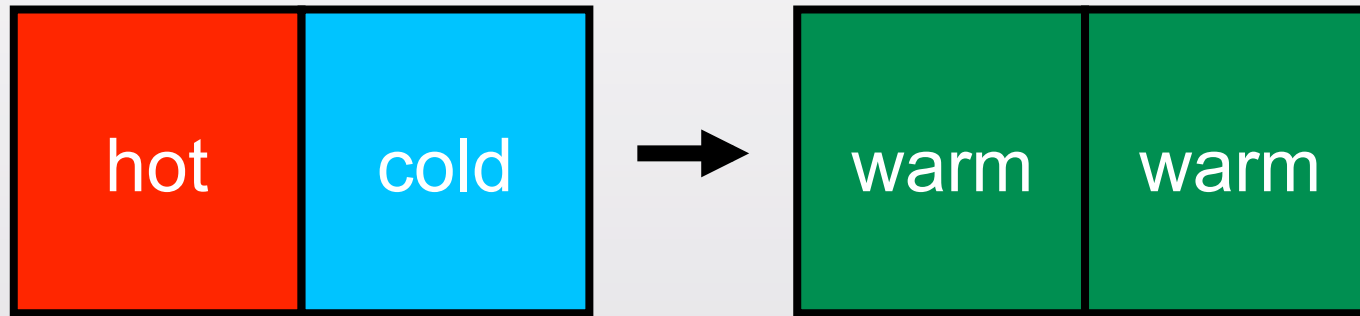
The stories we tell must be compatible with the real world (“true”), and with each other.



Grammar: claims make sense within a particular vocabulary, but not when we mix vocabularies.

Fundamental dystelology/indifference doesn't preclude higher-level purpose and meaning.

Novel concepts arise at higher levels. E.g. irreversibility.



Different levels must be ultimately compatible, but can appear very different.

I can talk about my “free choices” because I am not Laplace’s Demon -- I don’t have that information.

How determinism works.

Myth



Wise old oracles
telling you how
you will die.

Reality



An annoying kid saying
“I knew you were
going to do that.”

Some stories are not fixed by the facts.

Two fundamentally different views on gay marriage.



1) There is a “natural” and correct way for humans to live. There is a natural and correct form of marriage. One man, one woman.

2) How to live is a decision we human beings have to make. No configuration is naturally correct. We decide how to best guarantee happiness and protect individual dignity.

Bottom line:

Meaning, purpose, beauty, morality --
these concepts are invented by human beings.
Stories we tell about the world.

Not out there in the universe
to be discovered, but
nonetheless real.

It's our responsibility --
and opportunity.



