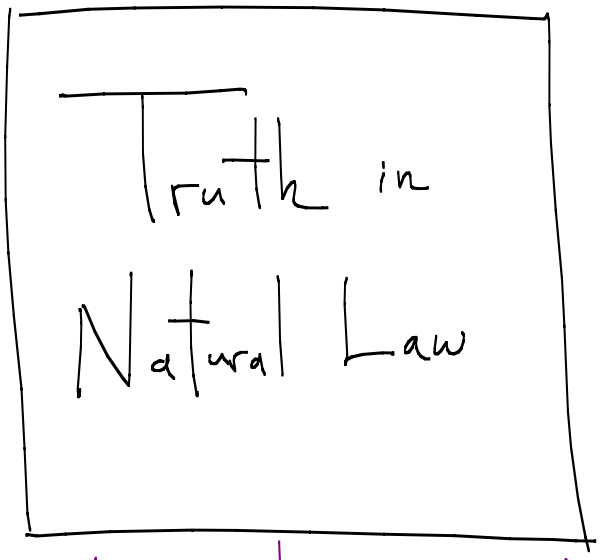
The Morality of Fundamental Physics

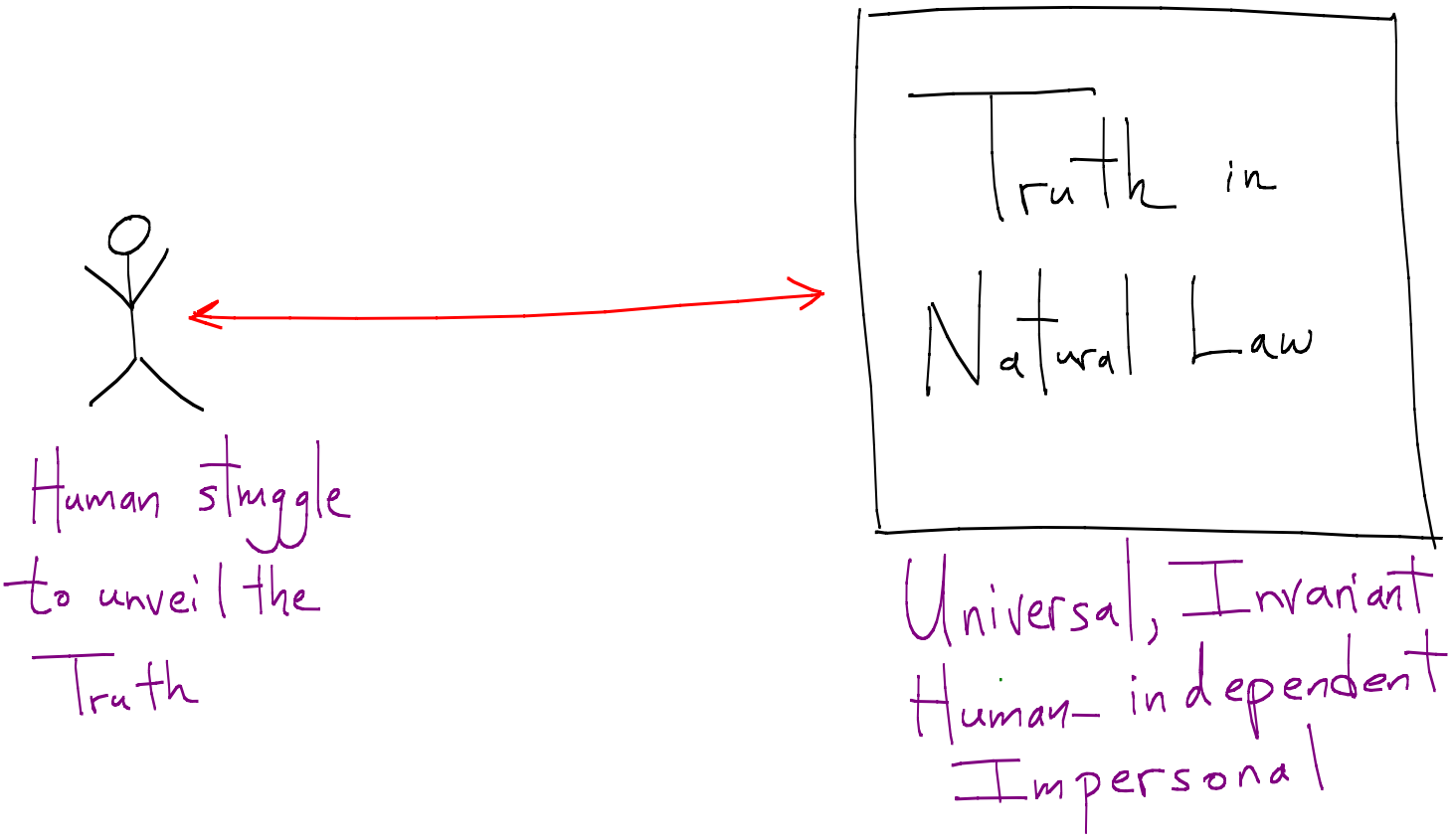
In science + mathematics, we have objective notions of right + wrong.

Our Obsession is finding Truth with a capital T

Over a period of centuries, we have found that the most successful way for humans to discover these truths is associated with certain patterns of behavior - a "right" way of doing things, and an intellectual moral code.

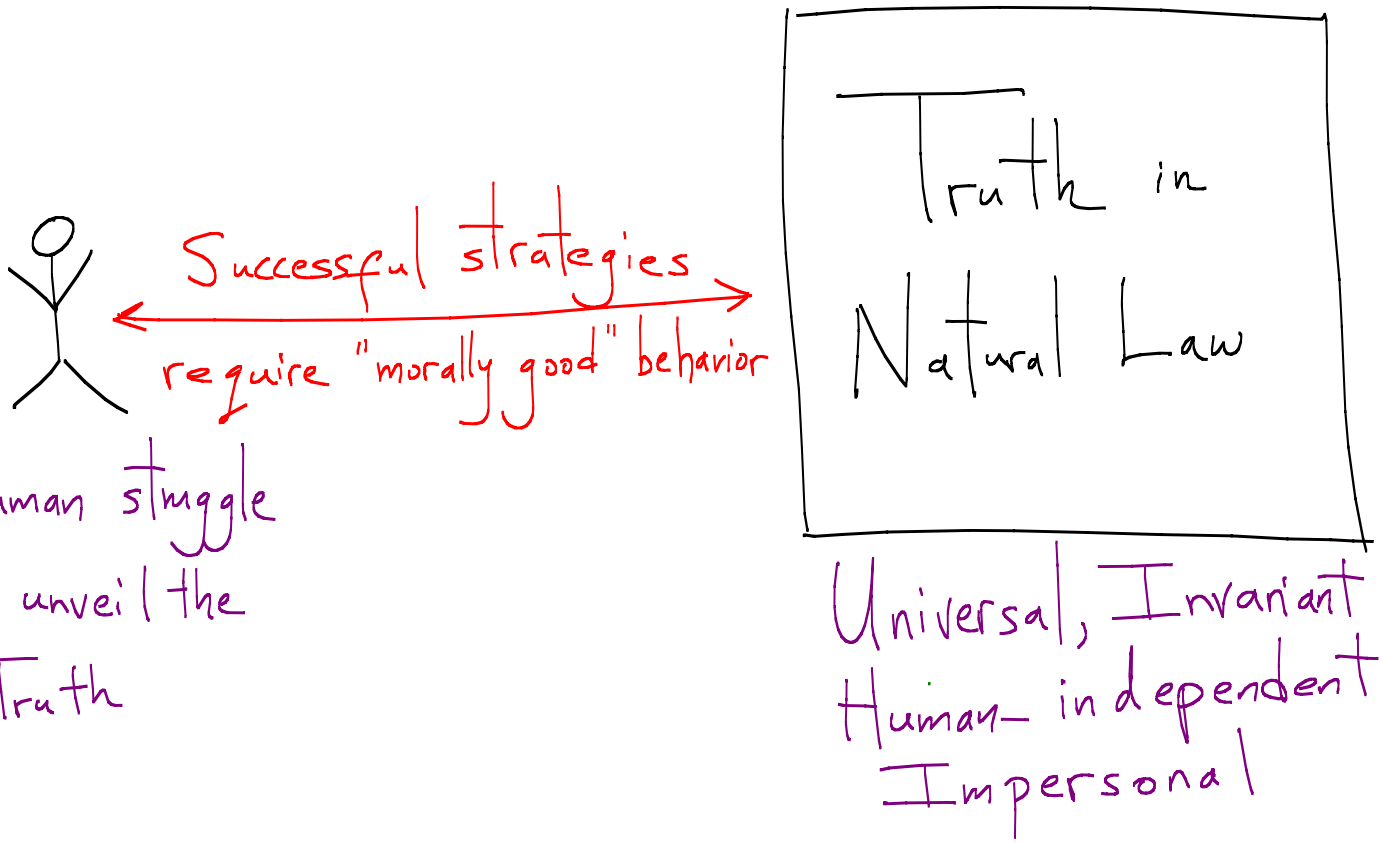


Universal, Invariant
Human-independent
Impersonal



Human struggle to unveil the Truth

Universal, Invariant
Human-independent
Impersonal



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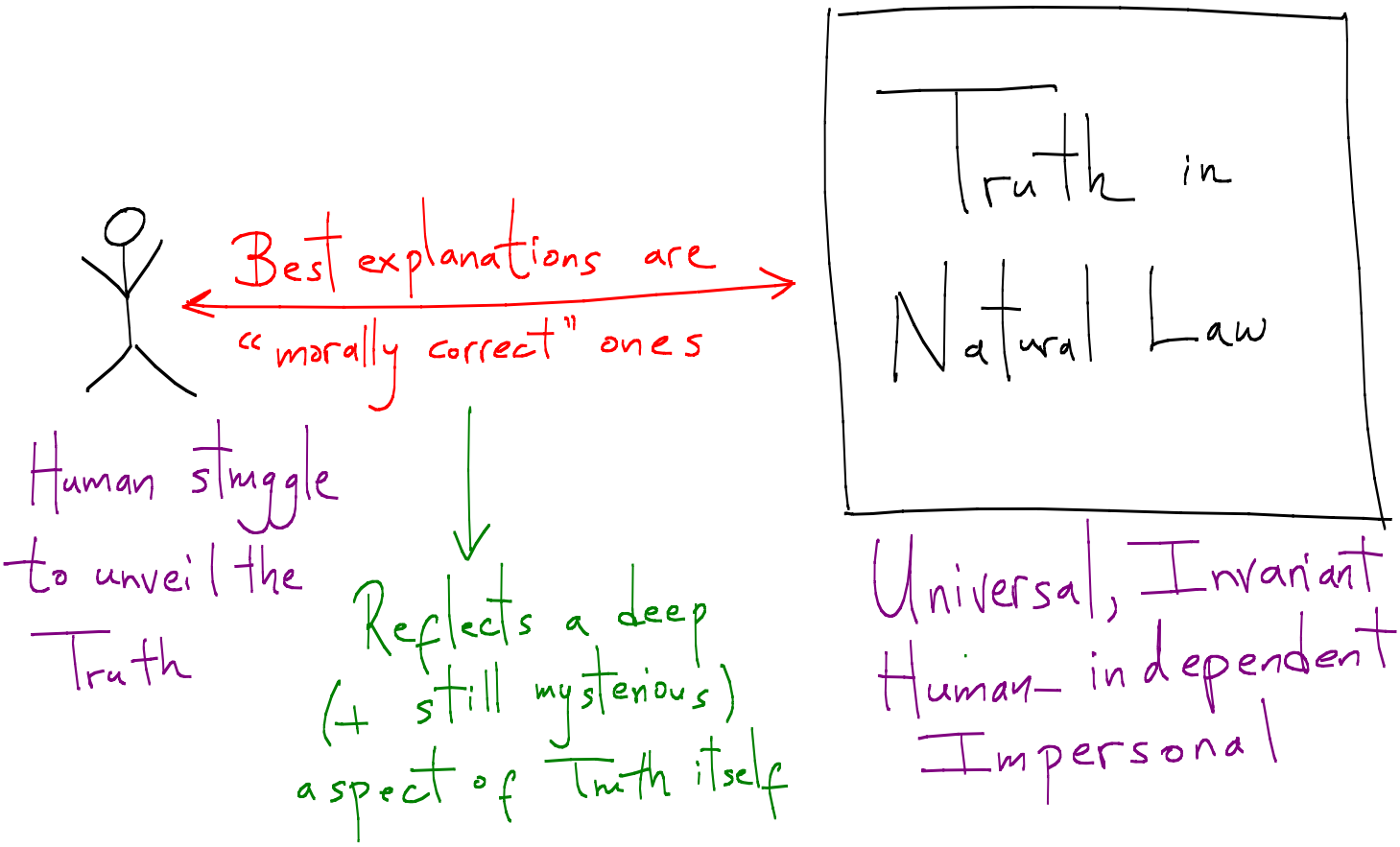

Truth in
Natural Law
Best explanations are
"morally correct" ones
Human struggle
to unveil the
Truth
Reflects a deep
(+ still mysterious)
aspect of Truth itself
Universal, Invariant
Human-independent
Impersonal

This "intellectual moral code"
derives its authority from Nature.
It has striking similarities to
what we think of good moral behavior
more generally.
It is invariant, not dependent on
gods or other human constructs

"Morally Good" Behavior

Be Honest

To yourself + Others

It doesn't matter who you are, only the content of your ideas are relevant.

"In science we have heroes, not prophets" – S. Weinberg

* We are never in posession of the whole truth, and never pretend to have complete certainty.
* Not an excuse for laziness nor timidity — we do the best we can, and boldly extrapolate ideas we have most confidence in.

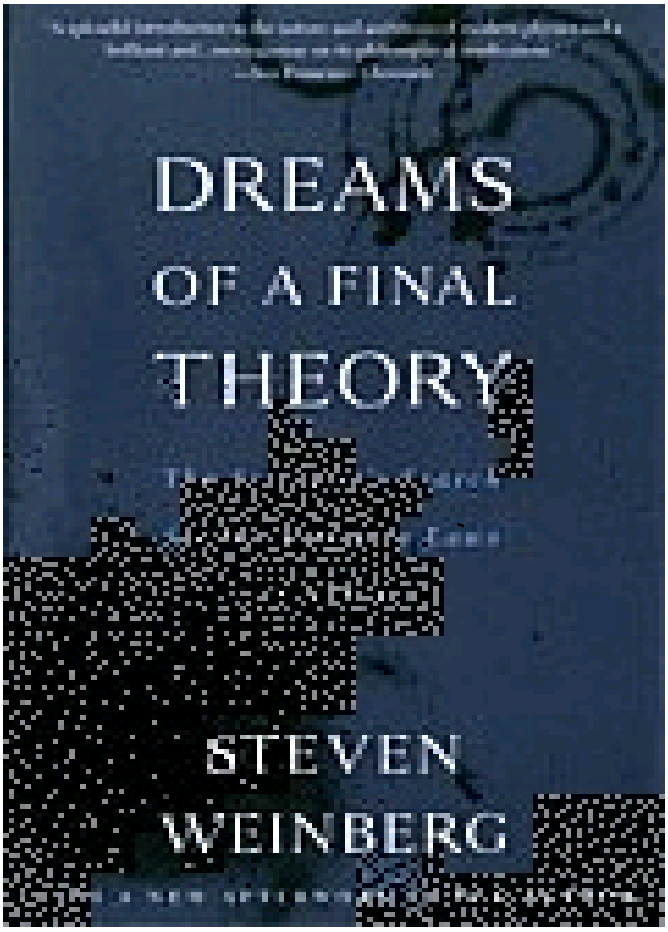
Be tolerant, keep an open mind

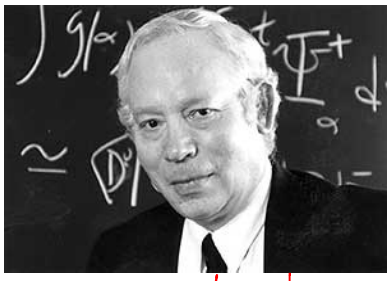
"It is important to keep an open mind, but not so open that our brains fall out" – R. Oppenheimer

It is necessary to be INTOLERANT + HARSHLY JUDGEMENTAL of ideas that are not perfectly honest, intellectually lazy. [Especially your own!]

"Morally Correct" Understanding

* Even the provisional understanding of the Truth we have at any given time has a large degree of "local perfection". The deepest principles of physics, once uncovered, have a feeling of inevitability.

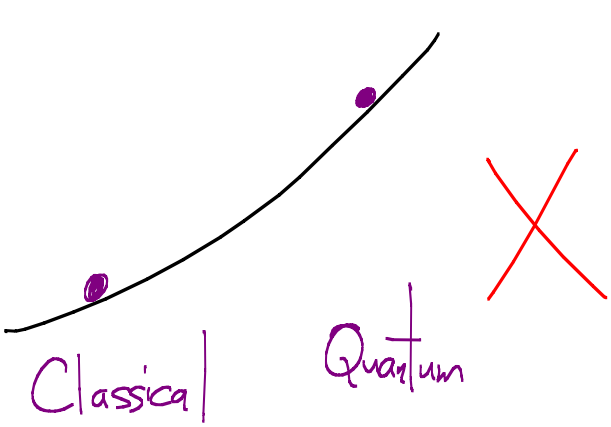


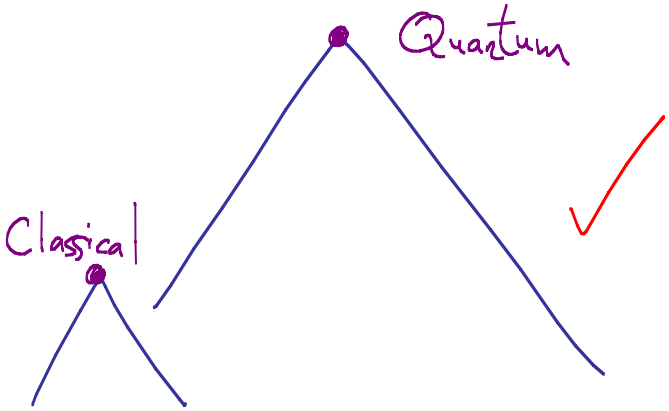


Steven Weinberg

* We eventually learn deeper truths, often with radical changes from the past [e.g. Classical → Quantum 100 yrs ago; today, Spacetime → ?!]

* These are NEW "perfect things", deepening the understanding of the old "perfect things" without altering their local perfection!


Classical
Quantum


Quantum
Classical

* Stunningly, the same Truth can be described in many seemingly radically different ways.

* Different paths to the top give different views of the next horizon — some better suited to next jump than others.

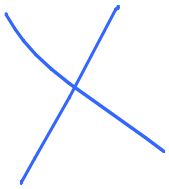
* So we need to learn all of them!

* "Morally Correct" explanations are ones that seem as close as possible to fundamental principles + have a similar sense of inevitability about them, reflecting perfection of laws. They are eternal.

Expedient

"Ingenious"

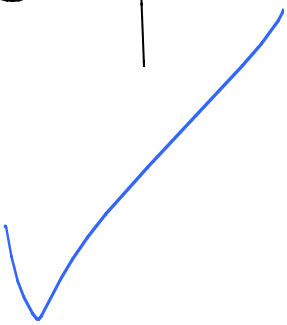
"Clever"

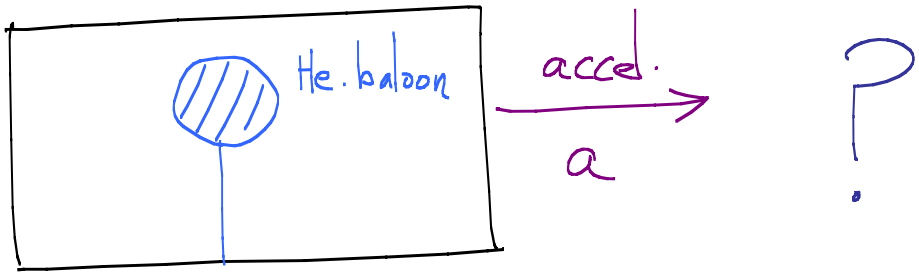


vs.

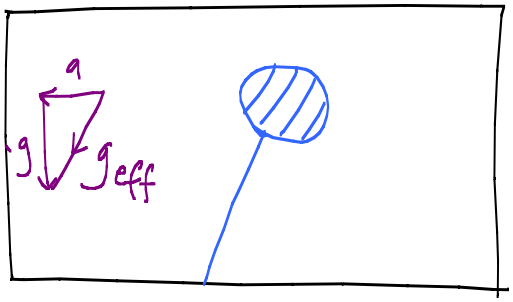
Simple

Deep

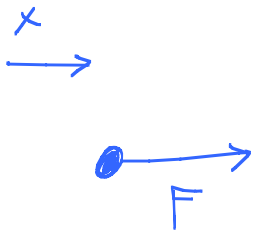



He. balloon
accel.
a
?

Einstein's Principle of Equivalence



Conservation of Energy

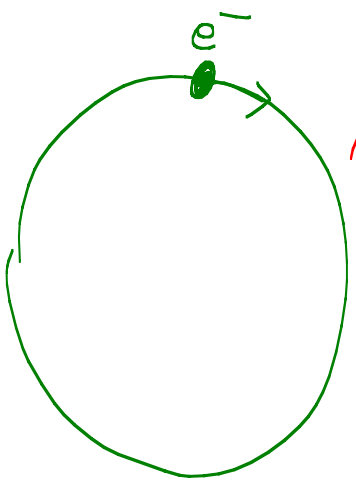


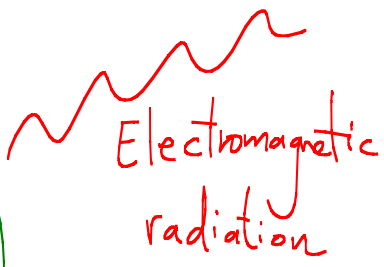
$F = ma$

$F = -\frac{d}{dx}V$ potential

$E = \frac{1}{2}m\dot{x}^2 + V(x)$ conserved

"Clever" observation — why is it true?



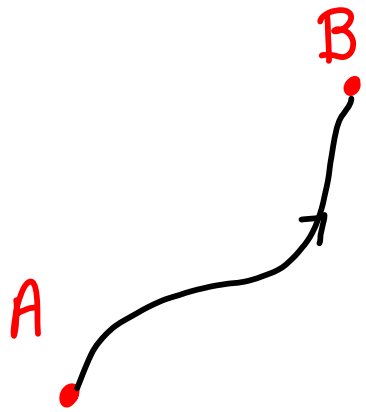


$$E = \text{Kinetic} + \text{Potential} + E_{\text{electromagnetic}}$$

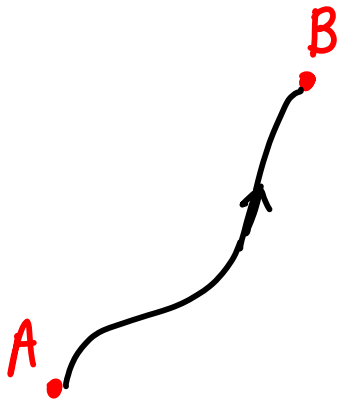
$$= \int d^3x \, \frac{1}{8\pi}\left(\vec{E}^2 + \vec{B}^2\right)$$

Mysteriously its always possible to define "additional energies" so total is conserved.

WHY?



$$m\ddot{x} = -\frac{\partial V}{\partial x}$$



$x(t)$ minimizes "action"

$$S = \int dt \left[\frac{1}{2} m\dot{x}^2 - V(x)\right]$$

Emmy Noether
(100 yrs ago!)

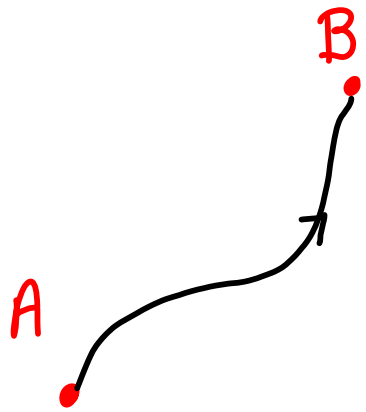
Symmetries of Action → Conservation Laws!

Time translations → Energy Conservation

Space translations → Momentum Conservation

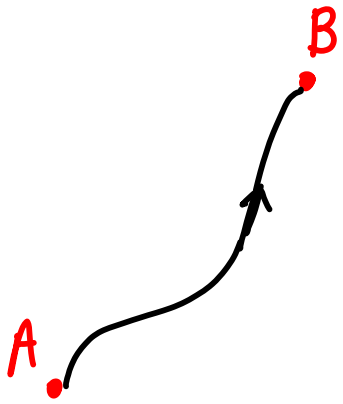
Rotations → Angular momentum Conserv.

Simple + Deep. Eternally Correct



$$m\ddot{x} = -\frac{\partial V}{\partial x}$$

Manifestly Deterministic



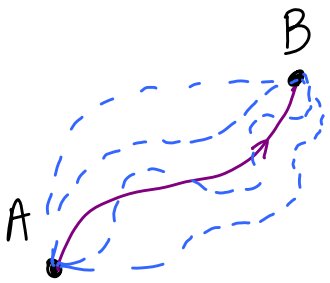
$x(t)$ minimizes "action"

$$S = \int dt \left[\frac{1}{2}m\dot{x}^2 - V(x)\right]$$

Not manifestly deterministic

Quantum Mechanics

Richard Feynman



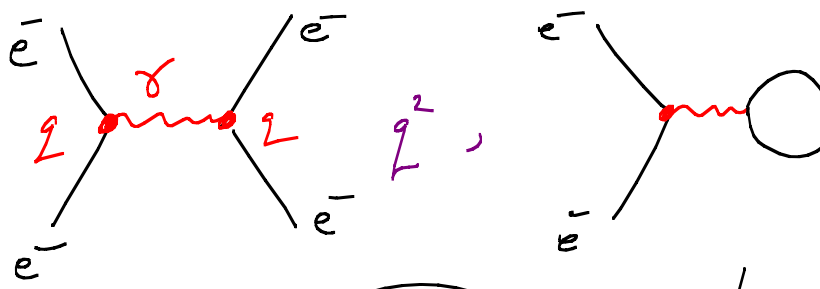
All paths are taken.

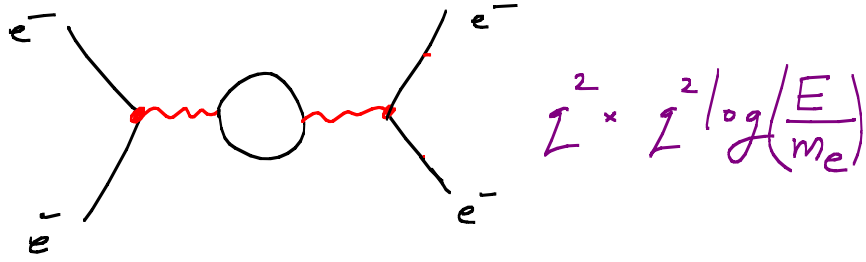
$$Amp = \sum_{paths} e^{i S/\hbar}$$

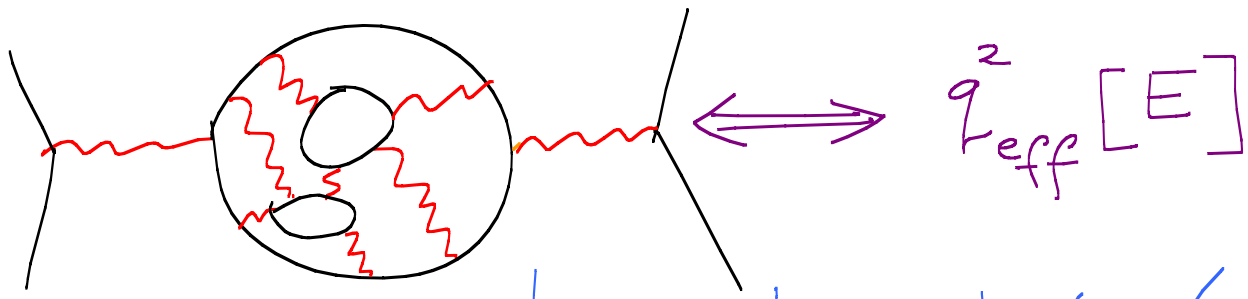
$\hbar \to 0$ limit of QM = Least action principle,

Simple + Deep + Eternal

not $F = ma$!







Profound, simple fact; in 1960's,
HORRIBLE, complicated proofs

Ken Wilson

Physics is local.

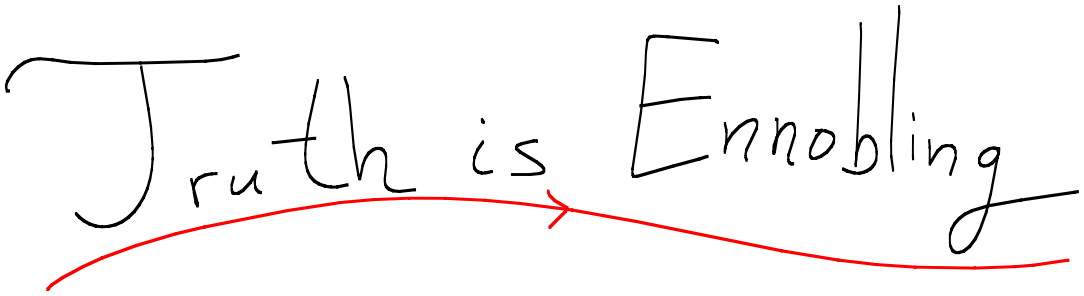
Don't organize by diagrams

Organize by scale

Gradually zoom out

Simple + deep. Revolutionized fundam. physics.

Eternal.

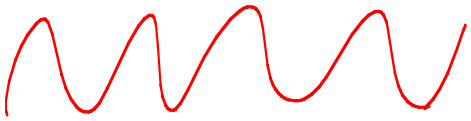

Truth is Ennobling

* The laws are perfect, but humans are imperfect. We are filled with unconcious assumptions + prejudices that obstruct our path to the Truth.

* But "acting morally" allows us to better interact with the Truth. It enhances our abilities, makes us better. And finally "reels us in" to find it.

At most exciting moments there seems to be mutually contradictory Truths

Light is a Wave!



Light is a particle!

Here it is especially important to bend over backwards in an effort to understand the opposing points of view — they will all be necessary to find the deeper Truth superseding them.

"Shenkers Theorem"

Steve Shenker

"That subject you most hate will be the one you next need to master for your research"

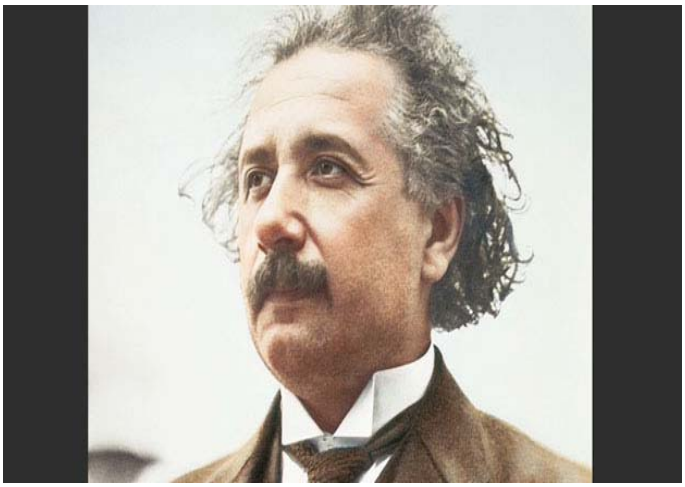
Why is it hard to be "morally good" always?

FEAR!

→ "Wasting Time" (Practically)

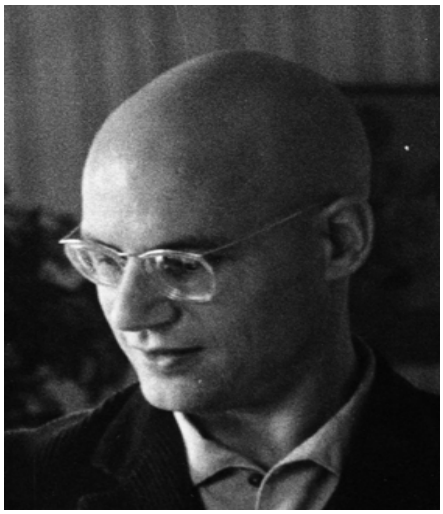
→ DEATH (Fundamentally)

Einstein

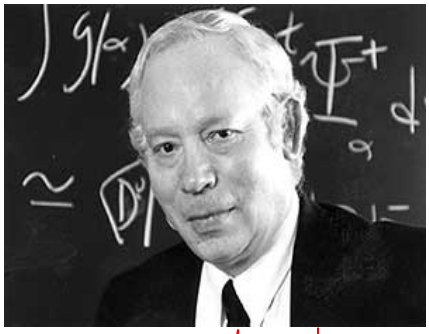


"The years of anxious searching in the dark, with their intense longing, their intense alternations of confidence and exhaustion and the final emergence into the light—only those who have experienced it can understand it."

Grothendiek



The unknown thing to be known appeared to me as some stretch of earth or hard marl, resisting penetration... the sea advances insensibly in silence, nothing seems to happen, nothing moves, the water is so far off you hardly hear it... yet it finally surrounds the resistant substance."



Steven Weinberg

The effort to understand the universe is one of the very few things which lifts human life a little above the level of farce and gives it some of the grace of tragedy.

Errol Morris

There is such a thing as truth, but we often have a vested interest in ignoring it or outright denying it. Also, it's not just thinking something that makes it true. Truth is not relative. It's not subjective. It may be elusive or hidden. People may wish to disregard it. But there is such a thing as truth and the pursuit of truth: trying to figure out what has really happened, trying to figure out how things really are.

Leonard Bernstein

And so Beethoven came to the end of this long symphonic journey, at least, for one movement. Imagine a lifetime of this struggle, movement after movement, symphony after symphony, quartet after concerto after sonata. Always probing and rejecting and this constant dedication to perfection, to the principle of inevitability. Somehow this is the key, the only key we can have, to the mystery of a great artist. That for reasons unknown to him, or to anybody else for that matter, he will give away his life and his energies just to make sure that one note follows another with complete inevitability. Seems rather an odd way to spend one's life, but it isn't so odd when we think that the composer, by doing this, leaves us at the finish with a feeling that something is right in the world, that checks throughout. Something that follows its own law consistently. Something we can trust that will never let us

Instead of Worshipping a vast + unknowable god, we can devote ourselves to the slow unveiling of the vastness of Truth in all its glory

It provides an invariant moral code

Its perfection makes us better

It allows us to transcend our mortality + touch something eternal