

# “Theory of Everything”

**VS.**

## EMERGENCE

*Is the whole really greater  
than the sum of its parts?*

- Jess Brewer

# What is *Reductionism*?

*Wikipedia:*

“*Reductionism* ... does not preclude the existence of what might be termed *emergent phenomena*, but it does imply the ability to *understand* those phenomena *completely* in terms of the processes from which they are *composed*.”

“This *reductionist* understanding is very *different* from *emergentism*, which intends that what emerges in ‘emergence’ is *more* than the sum of the processes from which it emerges.”

# Mathematically,

$X > \sum_{\forall i} \Delta X_i$  makes no sense and is patently **wrong**.

Maybe what we mean is that  $\sum_{\forall i} \Delta X_i \not\Rightarrow X$

(the sum of the parts **do not imply** the whole).

Or maybe Mathematics (the preferred language of Physics) is *intrinsically Reductionist*, which inclines physicists toward that outlook. ??

Let's look at some **examples...**

*“just mathematics”:*

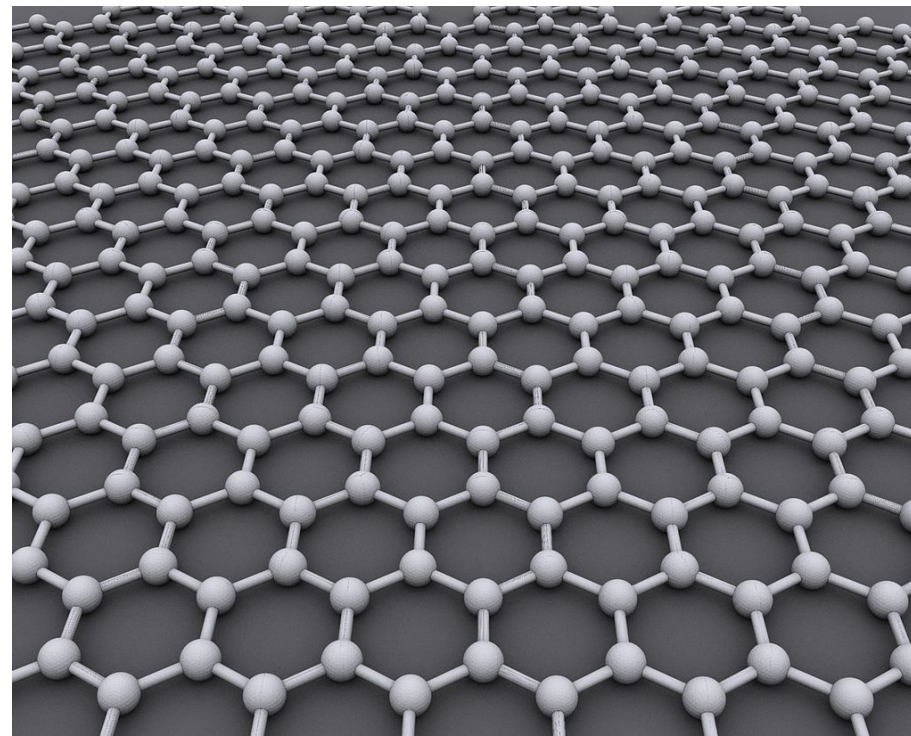
# Julia Sets



→ Plot a complex number  $z$ ,  
then *square* it and subtract a  
constant  $c$  to get a new  $z$  value.

**Repeat.**

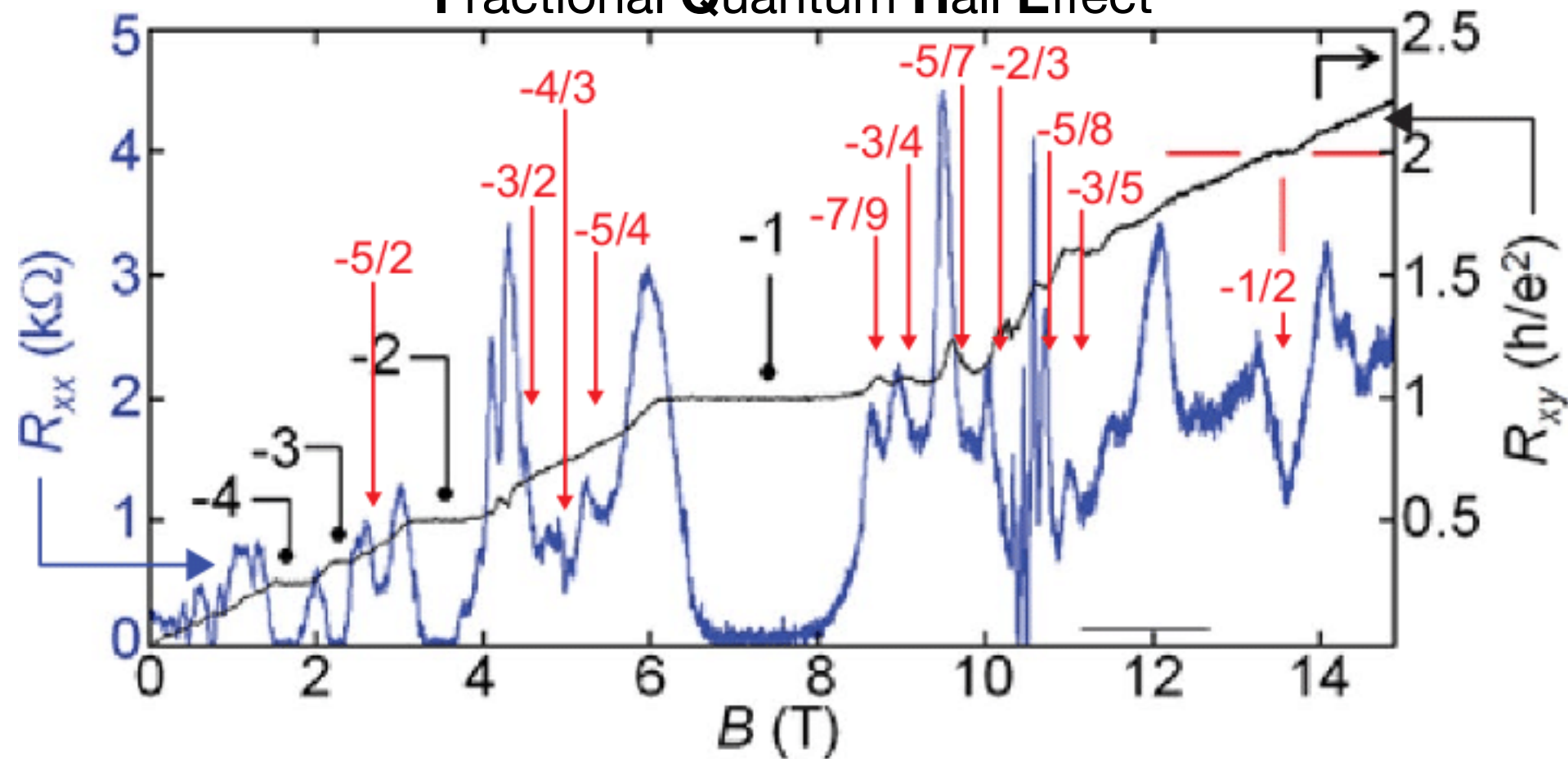
g  
r  
a  
p  
h  
e  
n  
e



...explained  
“after the fact”



## Fractional Quantum Hall Effect

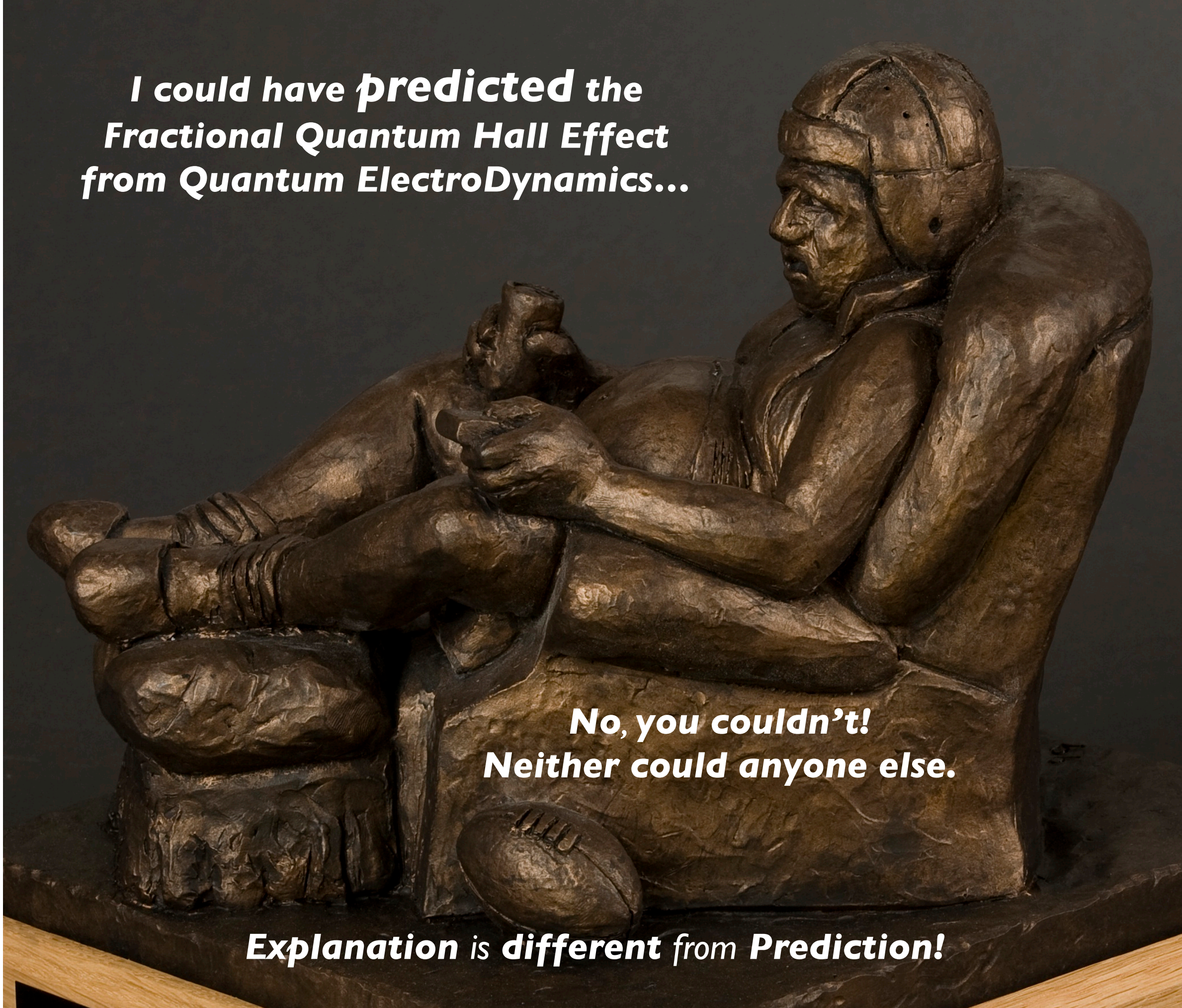




***I could have predicted the  
Fractional Quantum Hall Effect  
from Quantum Electrodynamics...***

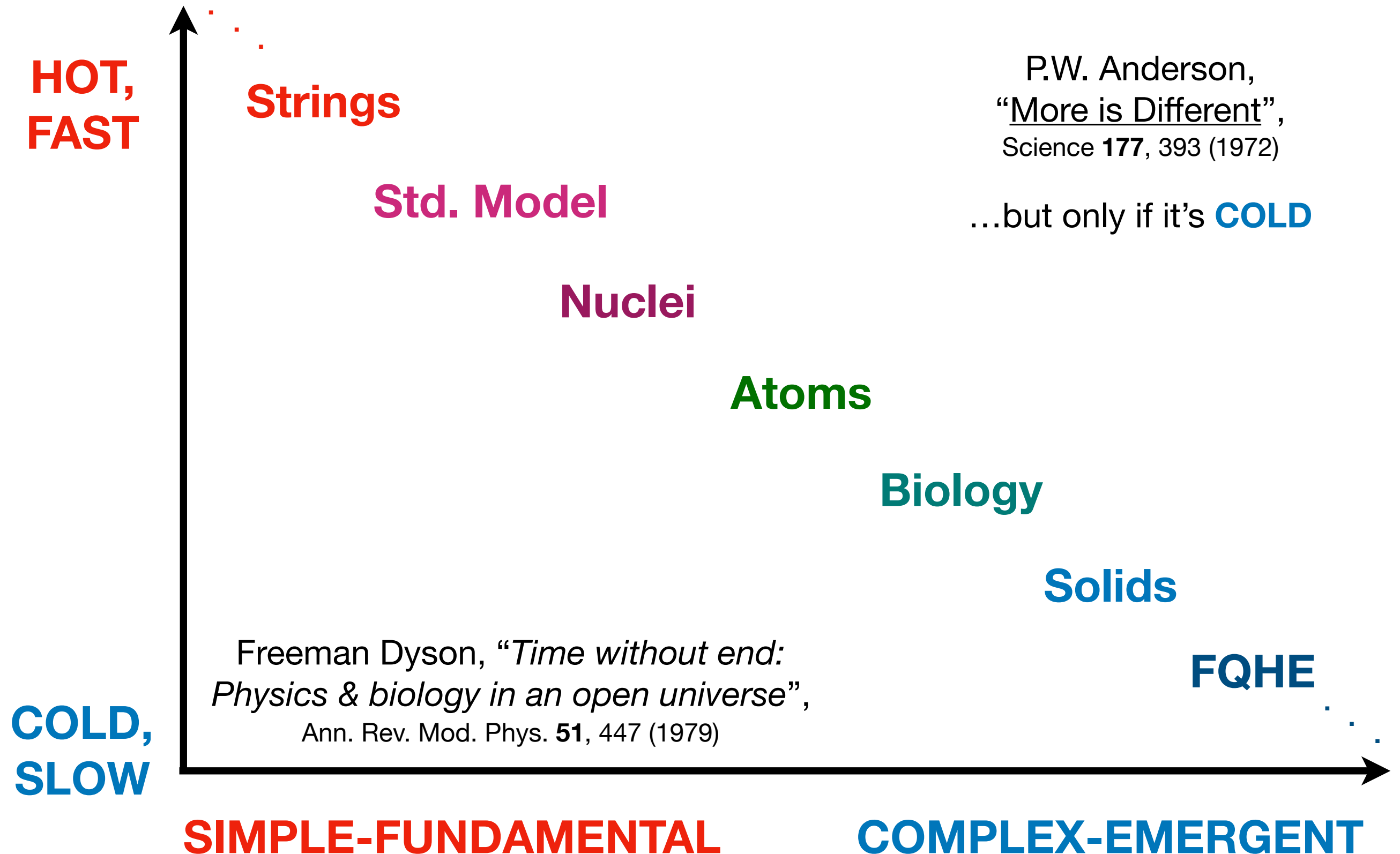
***No, you couldn't!  
Neither could anyone else.***

***Explanation is different from Prediction!***



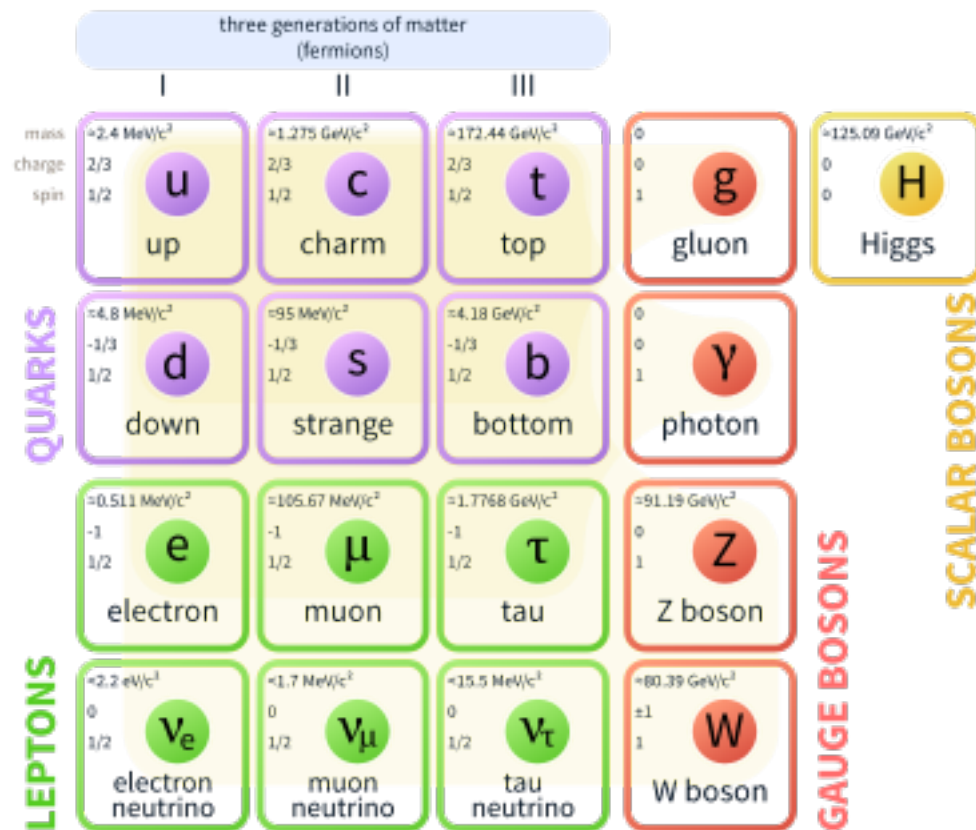


# *Emergence* vs. *Temperature*

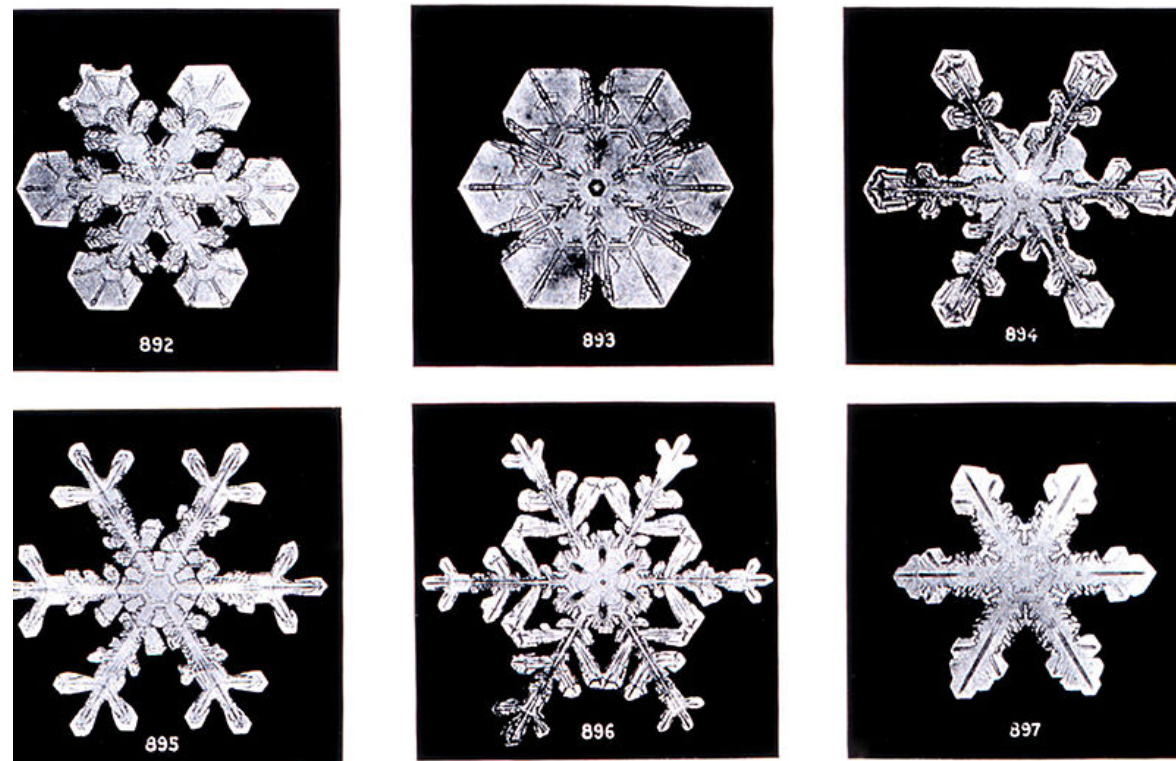




# Standard Model of Elementary Particles



whereas



The Physical World



The Aesthetic World



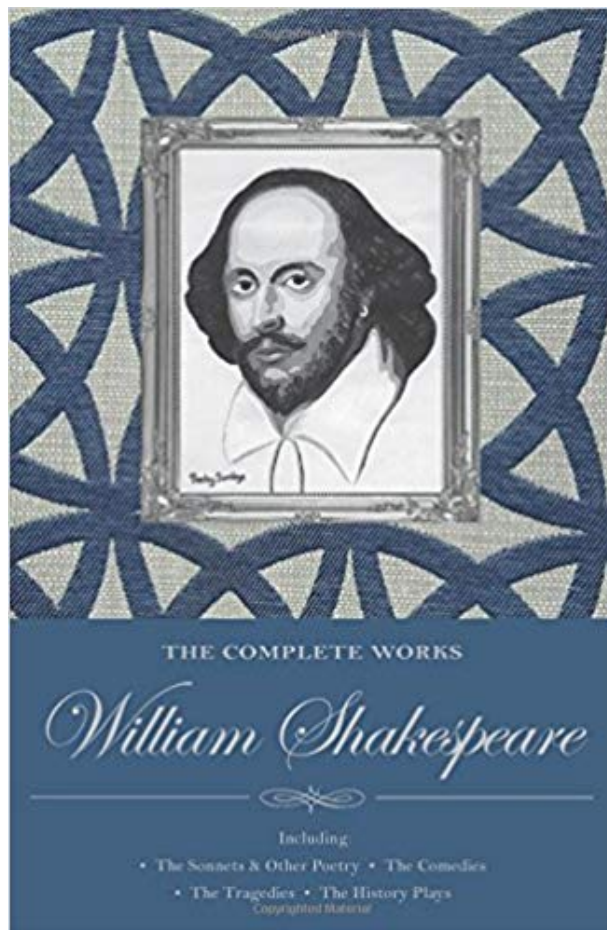
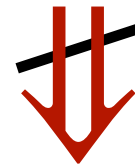
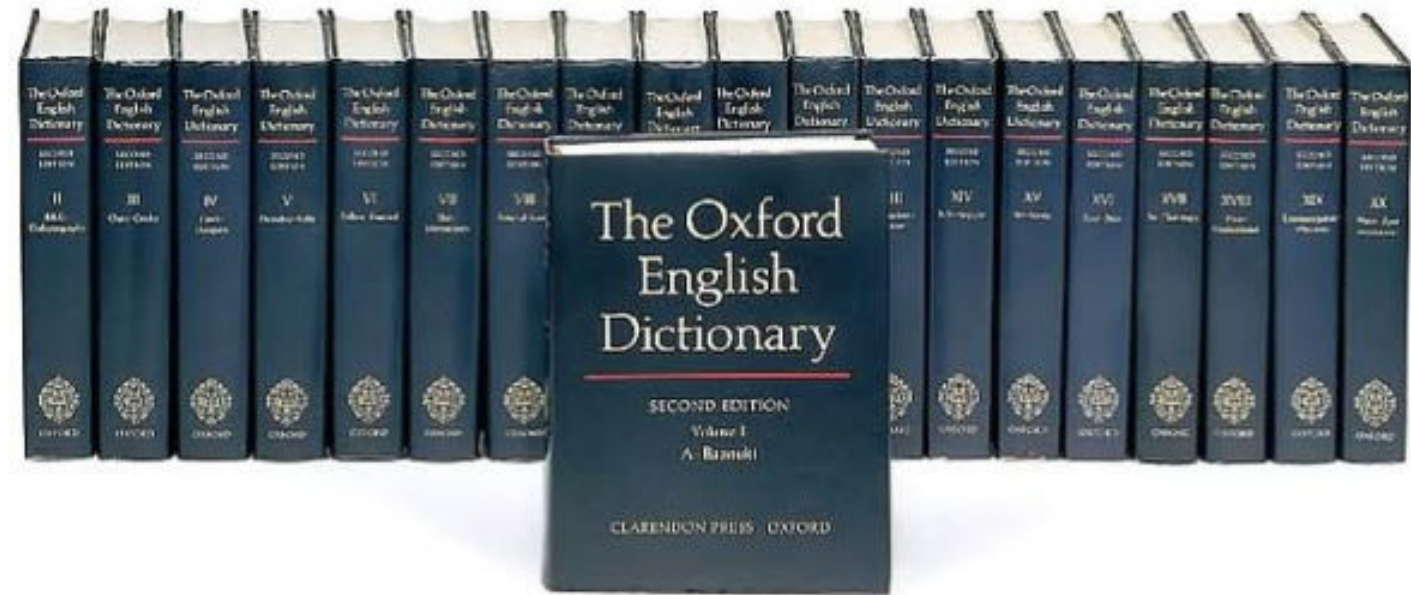
just as

Aa Bb Cc Dd Ee Ff Gg Hh Ii Jj Kk  
Ll Mm Nn Oo Pp Qq Rr Ss Tt Uu  
VvWw Xx Yy Zz

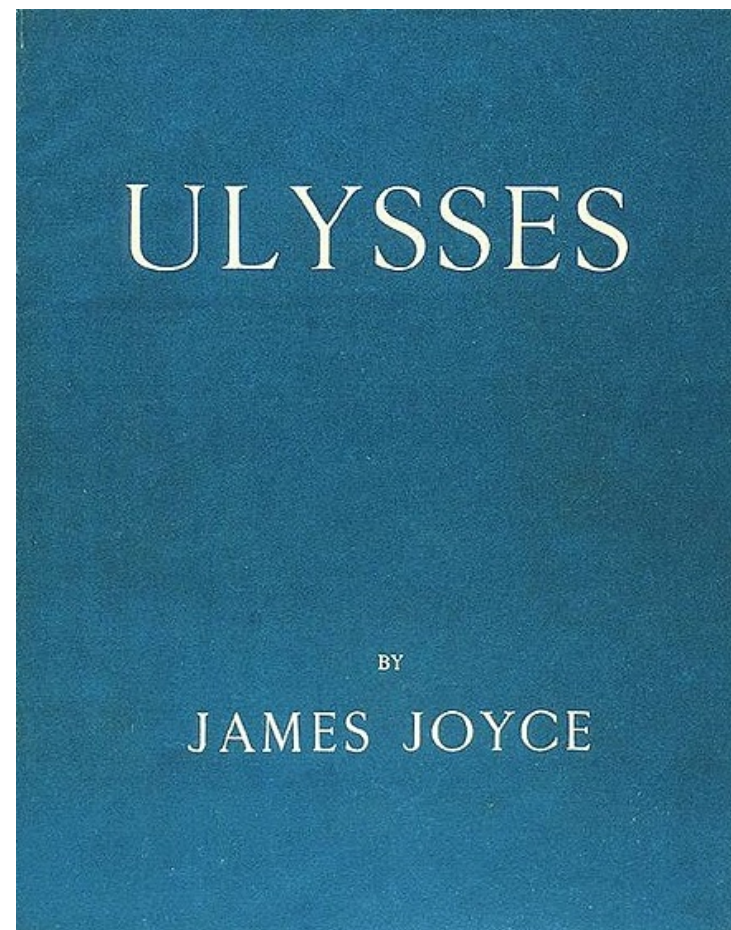
+

Aα Bβ Γγ Δδ Εε Ζζ Ηη Θθ Ιι Κκ  
Λλ Μμ Νν Ξξ Οο Ππ Ρρ Σσ Ττ υ  
Φφ Χχ Ψψ Ωω

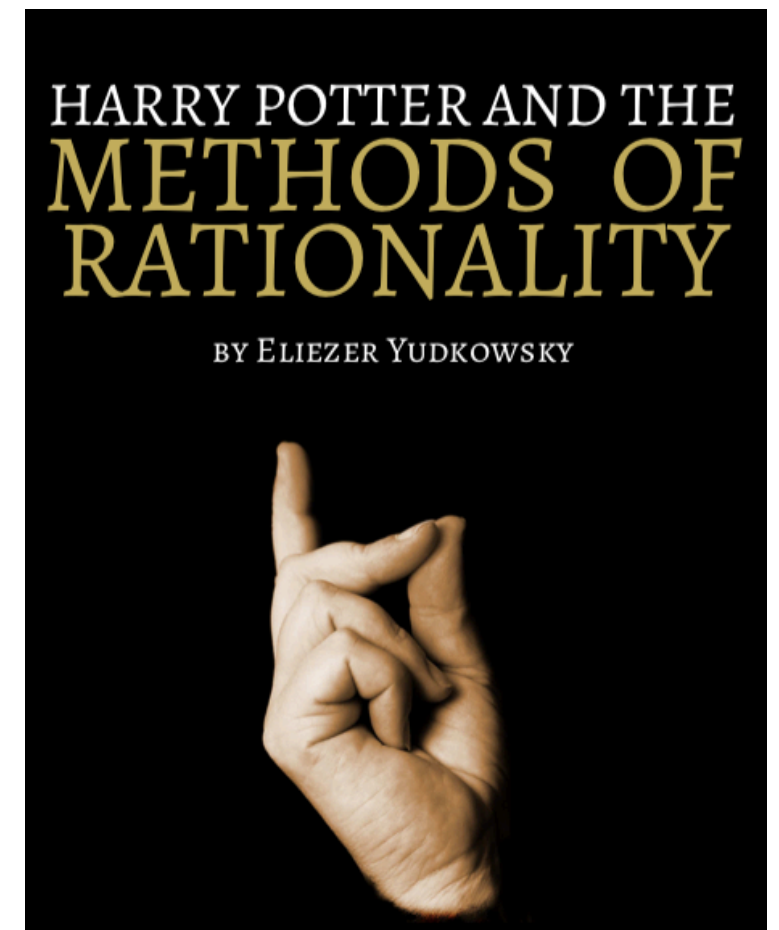
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# “Magical Thinking”

- Clarke’s Third Law: “*Any sufficiently advanced technology is indistinguishable from magic.*”
- Critics complain that this encourages an attitude of, “*If it’s too complicated to understand, we might as well treat it as magic — i.e. intrinsically incomprehensible.*”
- Obviously many phenomena that once *appeared “magical”* are now at least partially *explained*.
- But what’s wrong with “*magical thinking*” as a *provisional* outlook? (What is the **alternative**?)



# Brewer's Conclusion:

Even when the emergent entity is *composed* of known subunits *and their known interactions*, and **could** be *predicted* to appear spontaneously *if only we understood* those subunits and their interactions well enough to see *all* their potentialities — and even if we **are** able to “*explain*” the emergent entity “after the fact” in terms of said subunits and interactions — ***until then*** it is sensible to *treat* the whole as greater than the sum of its parts.

This implies that

- ★ Emergence is often ***temporary***.
- ★ Emergence is usually ***personal***.

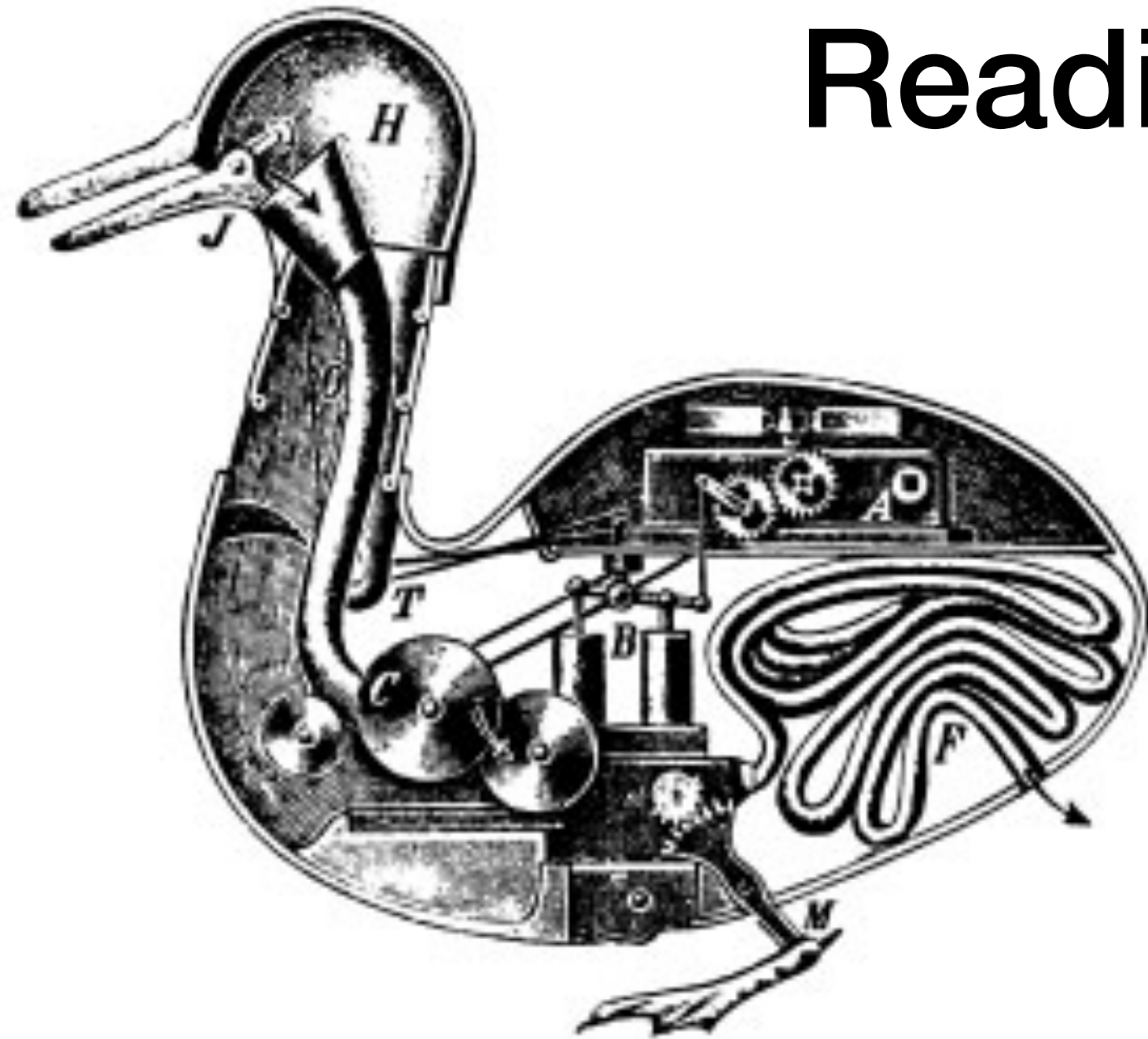
# Further Reading

- <https://en.wikipedia.org/wiki/Emergence>
- <https://en.wikipedia.org/wiki/Mereology>
- [Robert W. Batterman, "The Devil in the Details: Asymptotic Reasoning in Explanation, Reduction, and Emergence"](#)
- ... and references therein.



# Further

# Reading



*Duck of Vaucansen* & **Descartes'** automata

from Wikipedia page on ***Reductionism***

# Further

# Reading

