

Information

people

Of blind ~~men~~ and elephants:  
information, WTF?!

Ian Durham



means-relative

semantic

relational

statistical

observer-dependent

task-oriented

quantum

indexical



means-relative

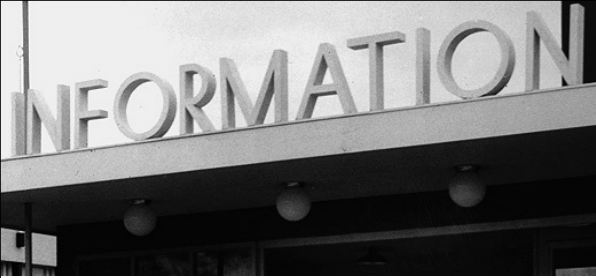
semantic

relational  
**rough consensus:**  
statistical  
**contextual**  
observer-dependent

task-oriented

quantum

indexical



## Further thoughts:

- Davies: determinism **must** be emergent since purpose-driven ideas arise from randomness
- Hamilton/Page: conservation of quantum information is bold claim
- Koch: we need a “calculus” of information
- Myrvold: should we instead be comparing theories as opposed to falsifying them?
- Adams: information content is **not equal to** complexity
- Gleiser: what is **knowledge**?
- Tononi: we need a maximally irreducible conceptual structure



## break-out session results

1. information is **not** more fundamental than matter/energy but **something** is (perhaps Max Tegmark)
2. quantum information **is** necessary for an understanding of quantum gravity. period.
3. complexity, vis-à-vis information about a structure, is **not** information itself
4. whether information is conserved in isolated systems depends on how the system is defined
5. physics can and will eventually account for consciousness.
6. there **are** limits on information storage and processing, e.g. spacetime itself

what is quantum information really good for?



**relationships**

**but not fixing  
the WiFi**



# what is quantum information good for?

- randomness is strongest evidence of outside world since it limits our ability to **control** the outside world. the limit is related to our choice of apparatus but there are two freedoms: our choice and Nature's.
- does information actually have causal power or is it merely explanatory?
- correlations are general — sub-categories include quantum and classical

# what is quantum information good for?

- randomness is strongest evidence of outside world since it limits our ability to **control** the outside world. the limit is related to our choice of apparatus but there are two freedoms: our choice and Nature's.
- does information actually have causal power or is it merely explanatory?
- correlations are general — sub-categories include quantum and classical
- Zeilinger: QM was invented to explain nature  
Adesso: there is actually a way to identify “quantumness”

# measuring and manipulating information

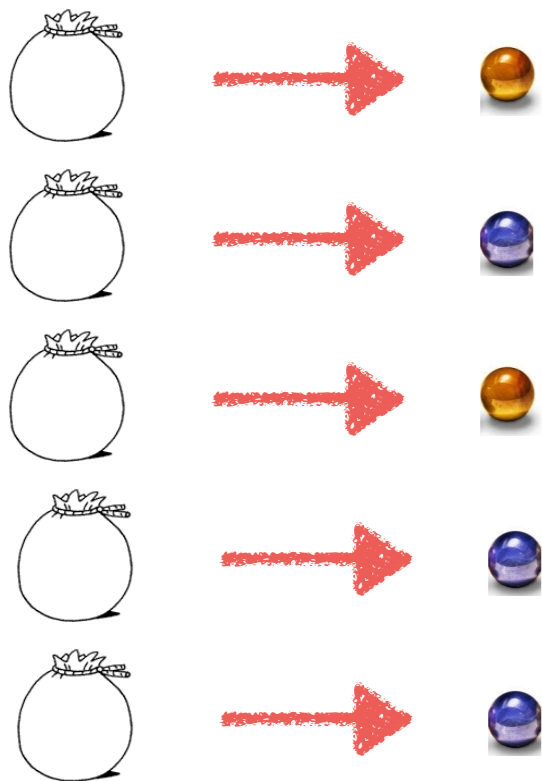
- our level of control over quantum systems has dramatically increased in recent years **and**
- the Church-Turing thesis is on solid ground **but**
- if universe is mathematical then Gödel's theorems apply to quantum and computational systems



# information and cosmology

- and so it begins...
- do quantum (thermal) fluctuations only happen when you look at them?

two analogies for two views:



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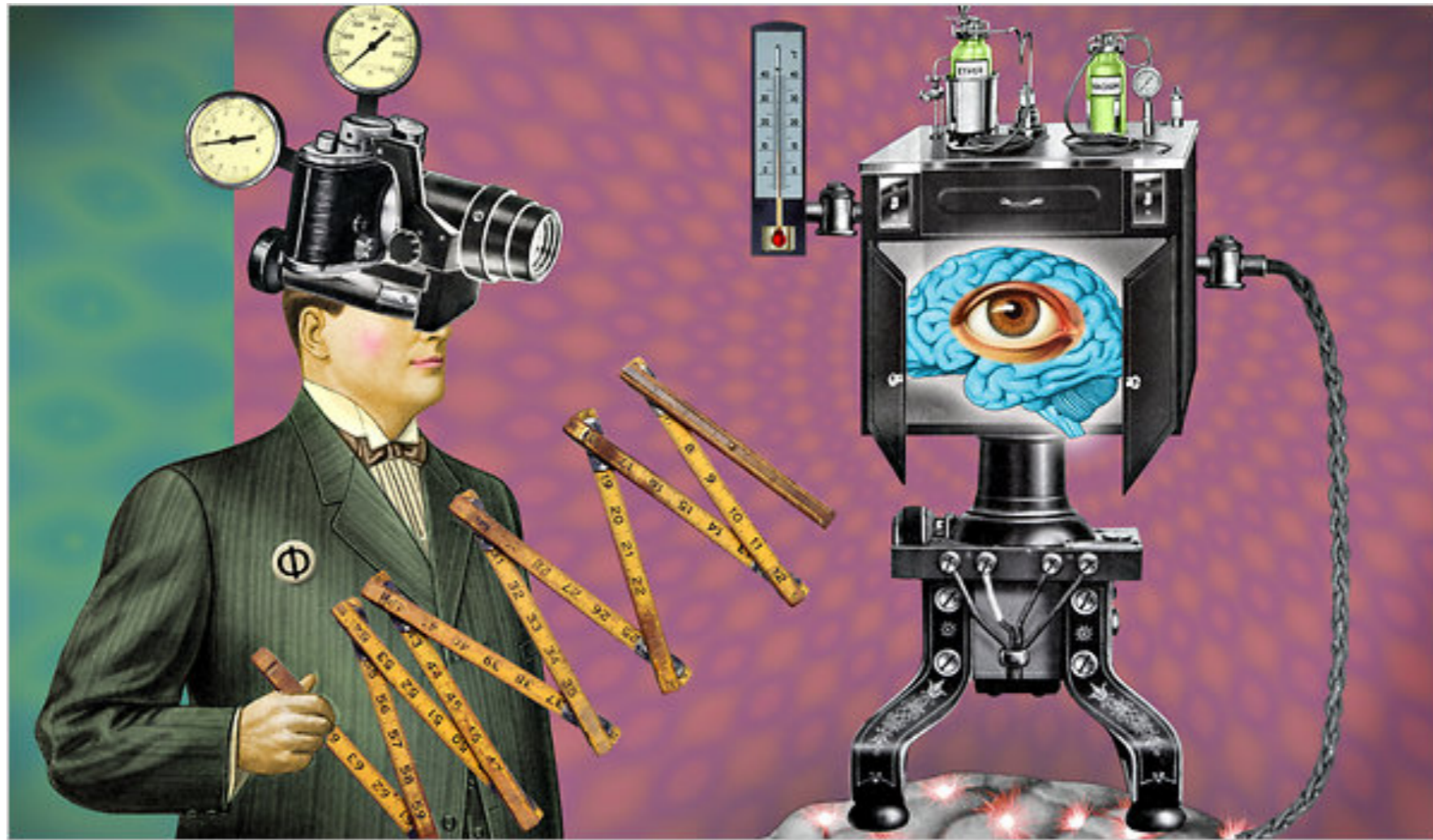
**it's a debate over the interpretation  
of the wavefunction**



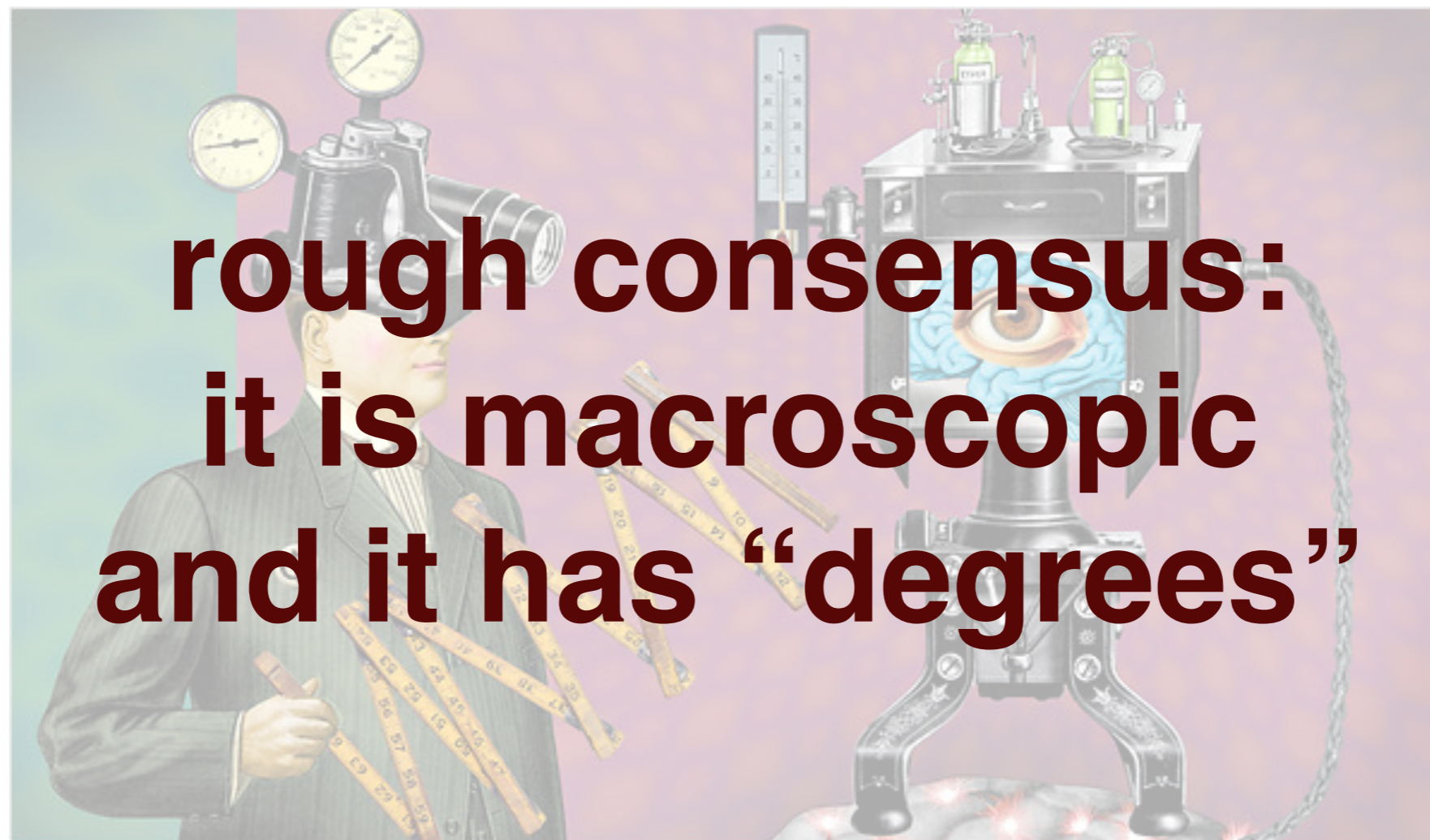
# information and cosmology

- if maximum entropy is infinite, then **any** realistic entropy is low
- how can we compute a probability in an infinite universe?
- Anthony, provocation #1: there is only indexical information
- Anthony, provocation #2: an infinite universe and a really, really big universe are ~~not~~ observationally distinguishable

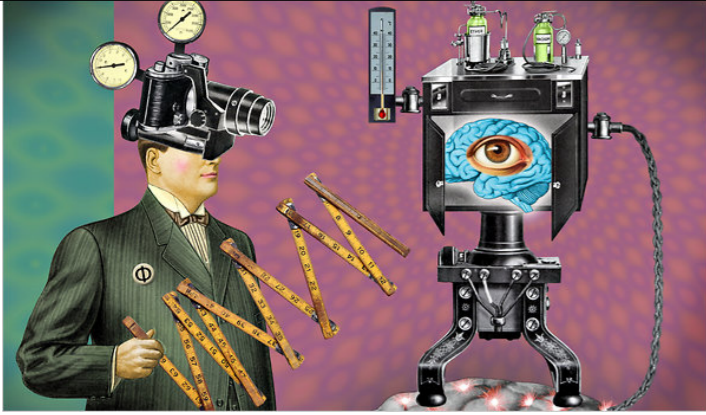
# Consciousness



# Consciousness

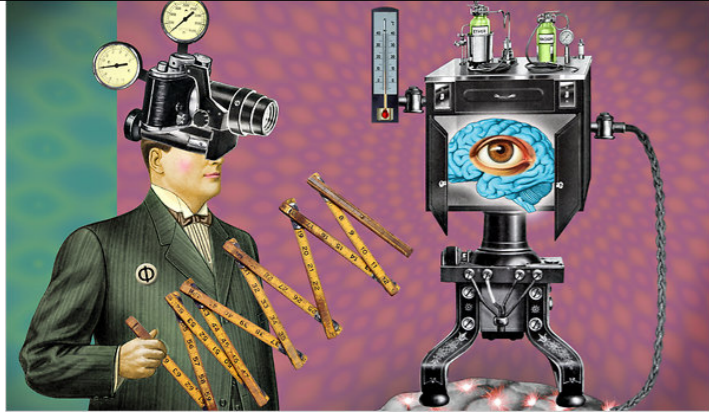


**rough consensus:  
it is macroscopic  
and it has “degrees”**



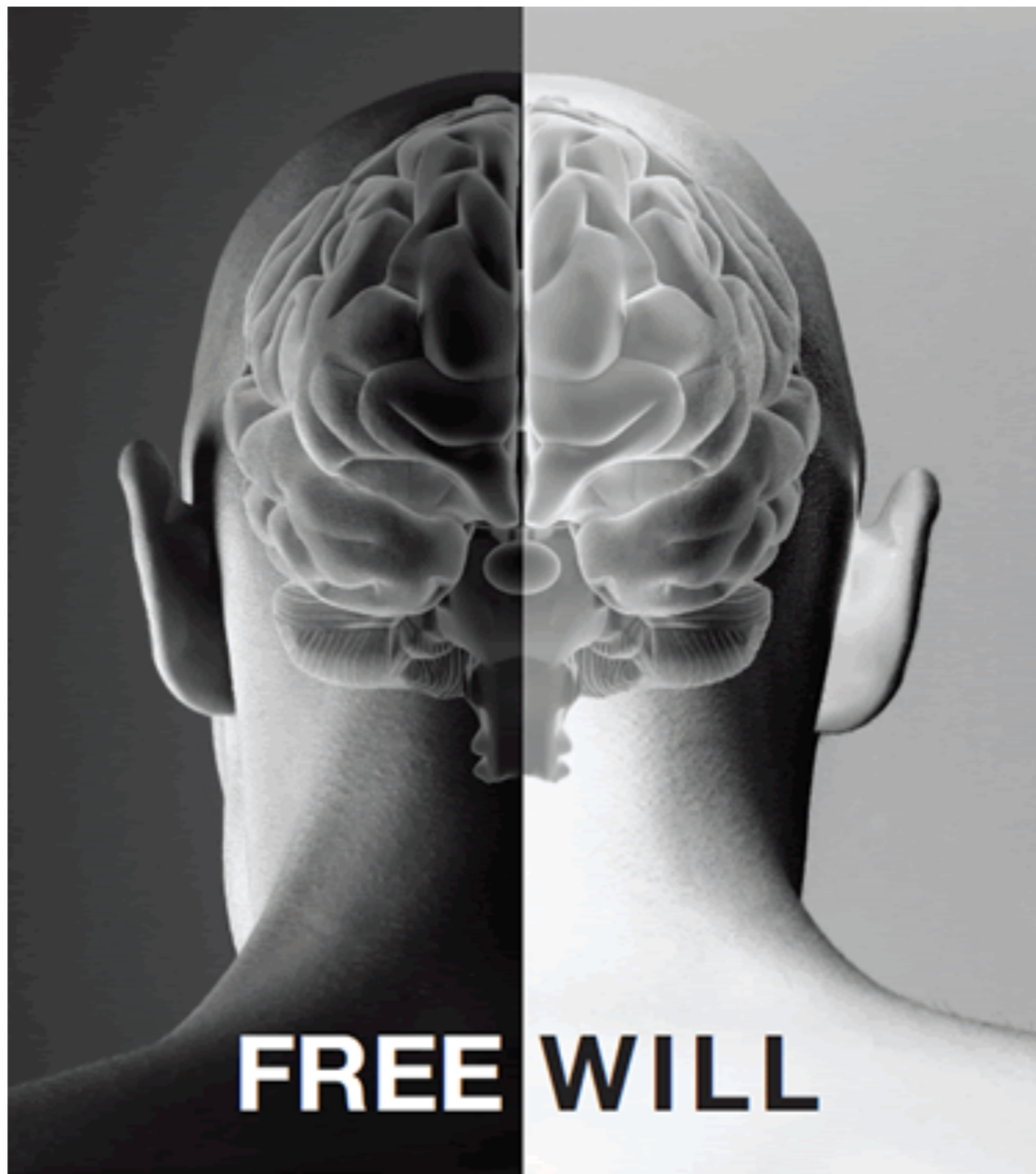
# Consciousness

- Undeniable fact: we know we are conscious.
- Chalmers' "hard" problem: how does matter and energy give rise to consciousness?
- There are empirical ways to determine consciousness.
- Conscious and unconscious systems can be functionally equivalent, i.e. an inactive system can be conscious. Information need not be exchanged.
- Lived experience plays a major role in defining consciousness.
- It may be a state of matter.

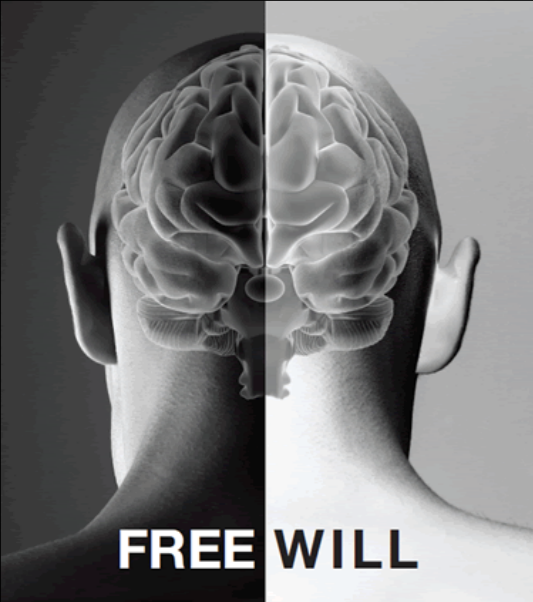


# Further thoughts

- Levels of causal analysis based on their informativeness.
- Consciousness is equivalent to the **information** at the macro level.

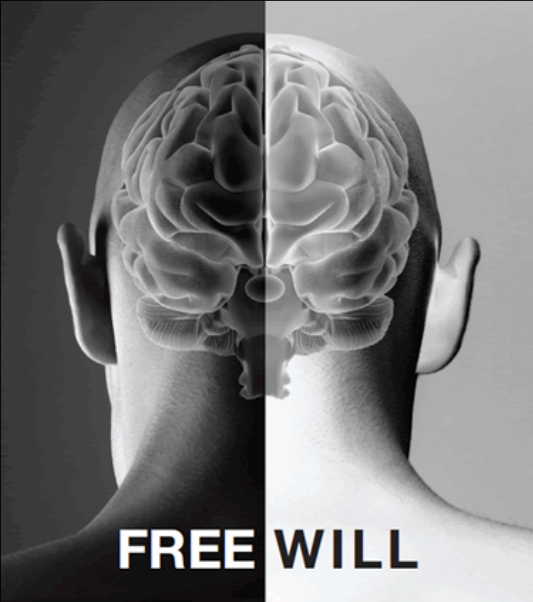


**FREE WILL**



# free will — biological basics and definition

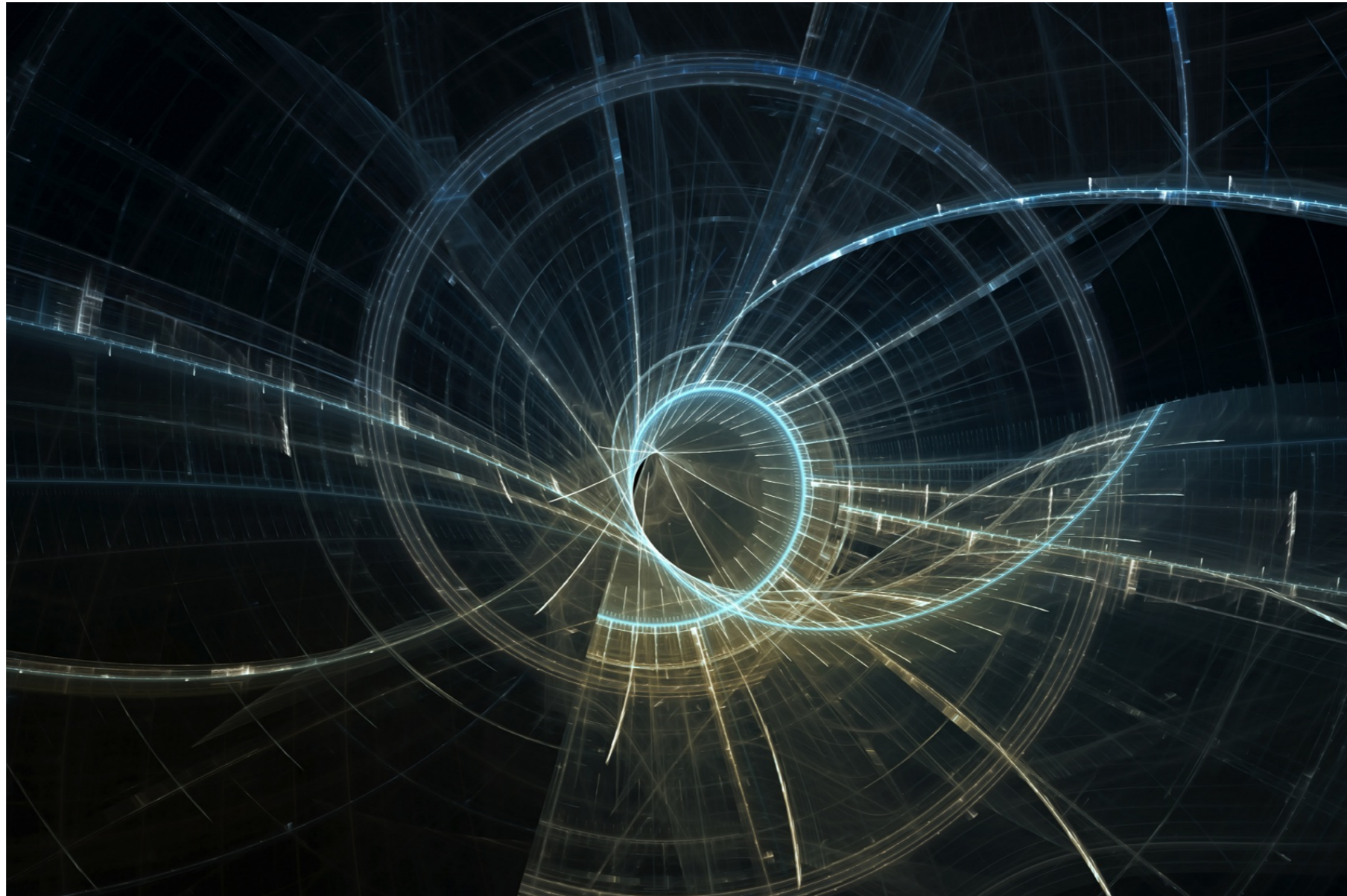
- Life is about a pattern — how the information is organized, **not** the actually “stuff”
- Lots of things in our bodies are **not** in thermodynamic equilibrium
- Consequence of lived and remembered existence.
- Necessary illusion for life.
- Evidence it exists: inability to predict behavior.

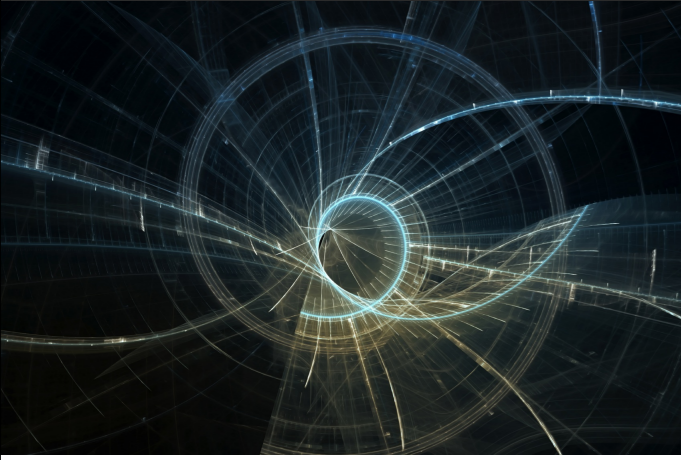


# free will — general thoughts

- A lot of progress on free will, just not related to the typical questions
- Problem: what do we tackle first?
  - origin of life
  - origin of consciousness
  - free will

# quantum gravity





# quantum gravity

- temperature at equilibrium is **not** constant in a gravitational field but information **is**
- if you fall into a black hole **don't struggle**

# firewalls: Raphael Bousso versus the world



- except maybe for Seth Lloyd and Don Page.
- ~~slight (?) majority~~: firewalls do not exist, but no agreement why
- Anthony wanted to know source of Hawking radiation:
  - after much coaxing, the answer was that, whatever it is, its **physical**

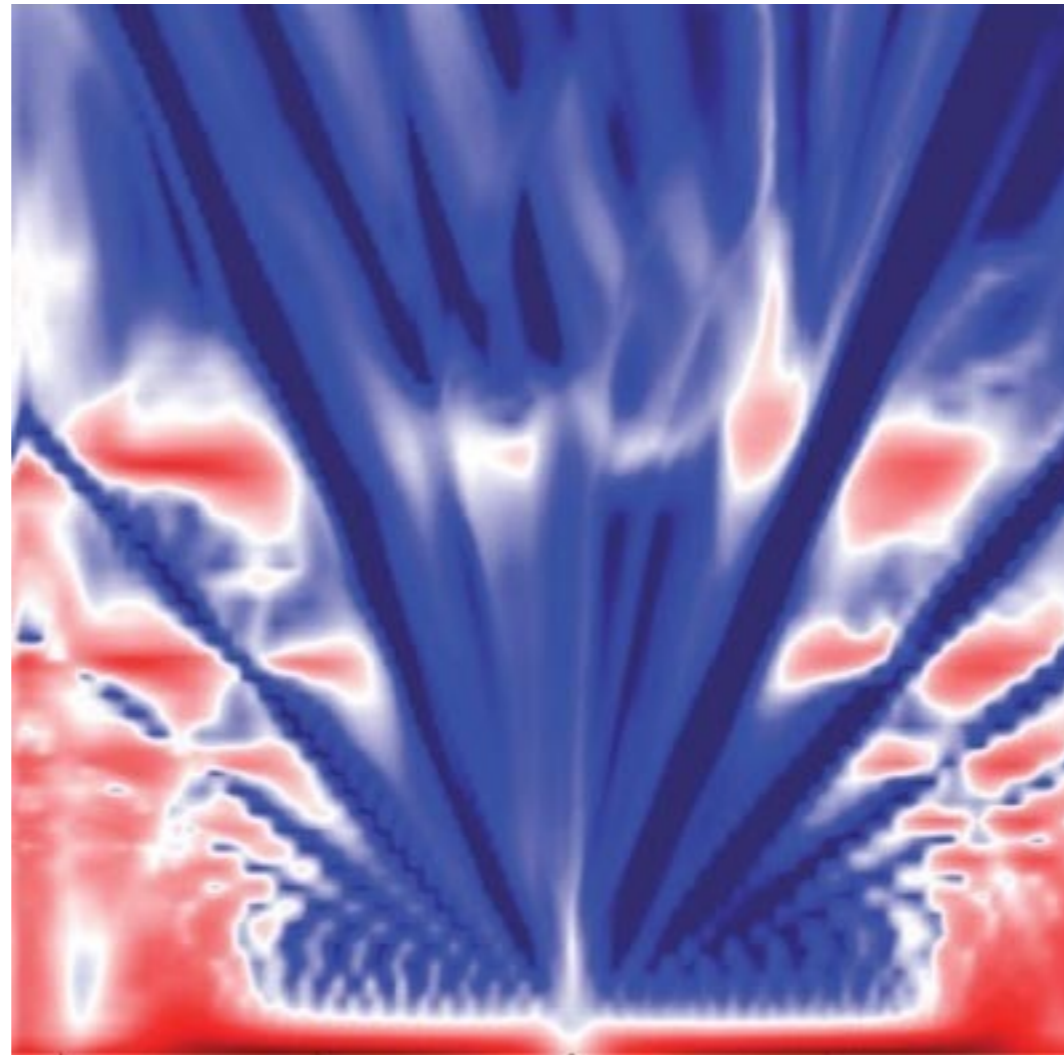
# existential risk

- global warming
- biotechnology
- AI gone bad
- decline of biodiversity
- ourselves

# what can we do about it?

- FQXi can help formulate the questions surrounding it
- effective altruism
- education is at the root of the problem
- learn a lesson from religion: genuine empathy
- science communication is a two-way street
- change ourselves

**hope is a phoenix spreading wings to fly**  
**-bajka**



**(Hofstadter's butterfly)**