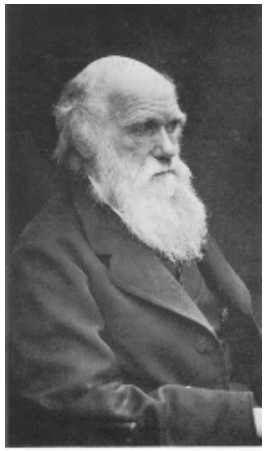
04. Popper: Conjecture and Refutation

Sir Karl Popper
(1902-1994)

Demarcation Problem

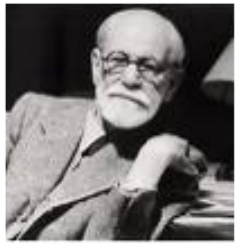
- How is science demarcated from pseudo-science?



vs

Falsificationism: A hypothesis is scientific *if and only if* it has the potential to be refuted by some possible observation.

- *Idea*: A scientific hypothesis is *risky*. Non-risky hypotheses are pseudo-scientific:
  - *Marxism*
  - *psychoanalysis*
  - *astrology*



- Compare HD reasoning with Falsificationist reasoning:

Hypothetico-Deductive Reasoning

If (H & A_1 & A_2 & ...) is true, then E is true.

E is true.

Therefore (H & A_1 & A_2 & ...) is confirmed.

} *inductive argument!*

Falsificationist Reasoning

If (H & A_1 & A_2 & ...) is true, then E is true.

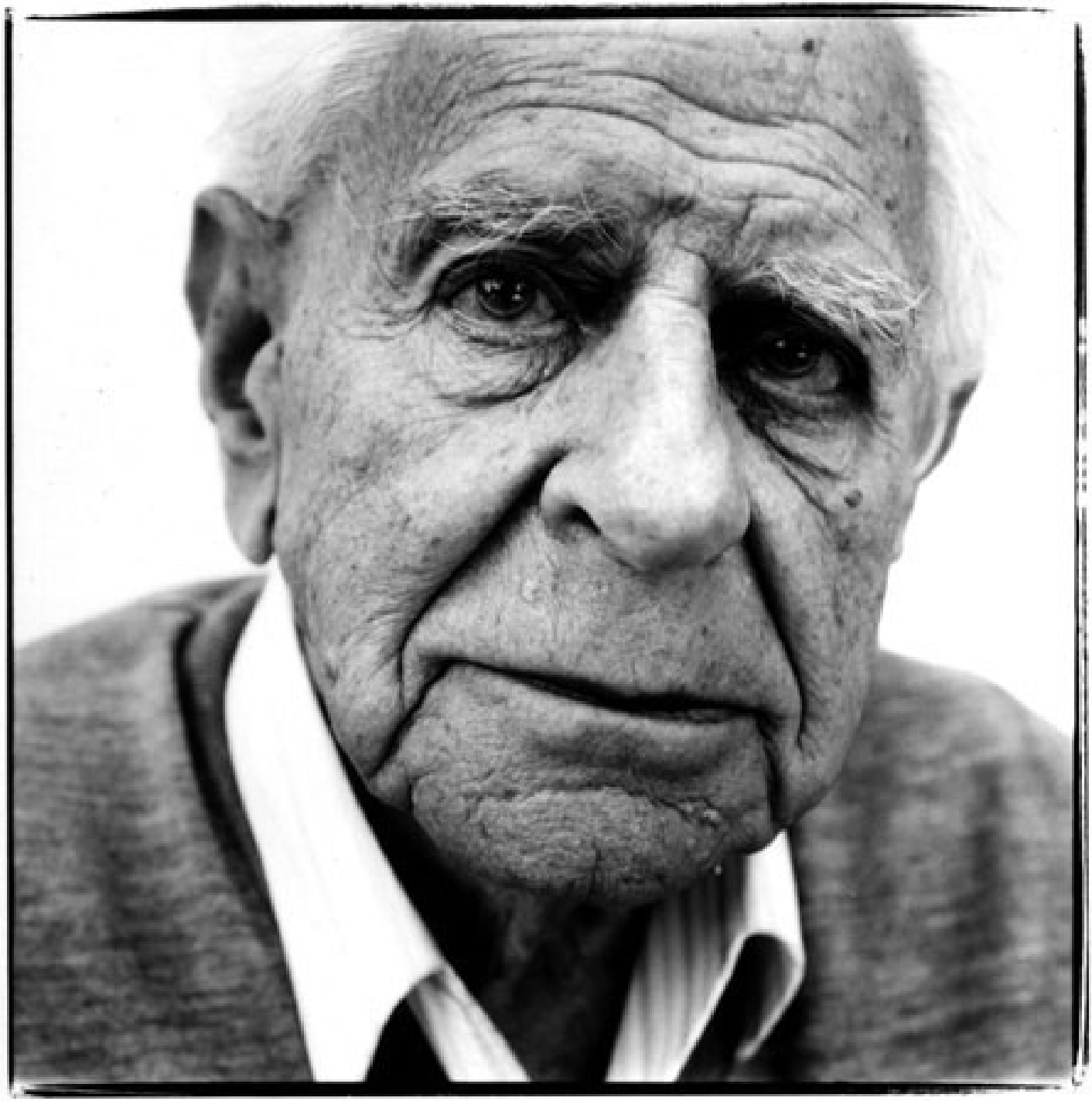
E is false.

Therefore (H & A_1 & A_2 & ...) is false.

} *deductive argument!*

Popper Claim #1: *Deductive* method of falsification underlies scientific reasoning. No need for induction or inductive logic.

Popper Claim #1 (Radical Version):
Induction is a *myth*! Confirmation is a myth! It is *never* possible to confirm a theory. It is *only* possible to disconfirm a theory.



Fallibilism: We can never be completely certain that a theory is true.

- Popper agrees, but claims in addition there can be *no* degrees of support involved: confirmation is not possible.
- Most philosophers and scientists are fallibilists, but *also* think there *can* be degrees of support between theory and evidence.

Popper Claim #2: Only *universal generalizations* occur in science.

Universal generalization = "All *F*s are *G*s."

- Only need *one* instance of an *F* that is a non-*G* to falsify this.
- Can *never verify* it (given there are an infinite # of Fs in the universe).

Existential generalization = "Some *F*s are *G*s."

- Only need one instance of an *F* that is a *G* to *verify* it.
- Can *never falsify* it (given there are an infinite # of *F*s in the universe).

- *But*: Isn't science (or at least a part of science) the search for true descriptions of nature?
  - *How can such a search proceed if confirmation is impossible?*

Holy Grail Analogy

Goal: Find the One True Holy Grail.

Set-Up:

- There are many false grails.
- All grails initially glow, but only the One True Grail glows forever.

Method:

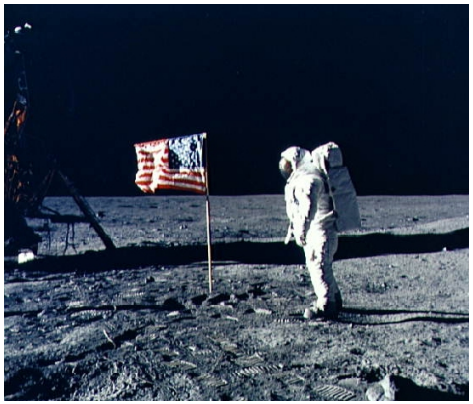
- Hold onto a grail as long as it's glowing.
- Throw it away once it stops glowing.

Consequence: We may never know if we've got the One True Grail, but at least we're tossing out fakes.

Popper on Scientific Change

Stage I: Conjecture.

- Scientists offer bold, risky hypotheses.
  - Hypotheses can't *just* accomodate data or correct previous mistakes.

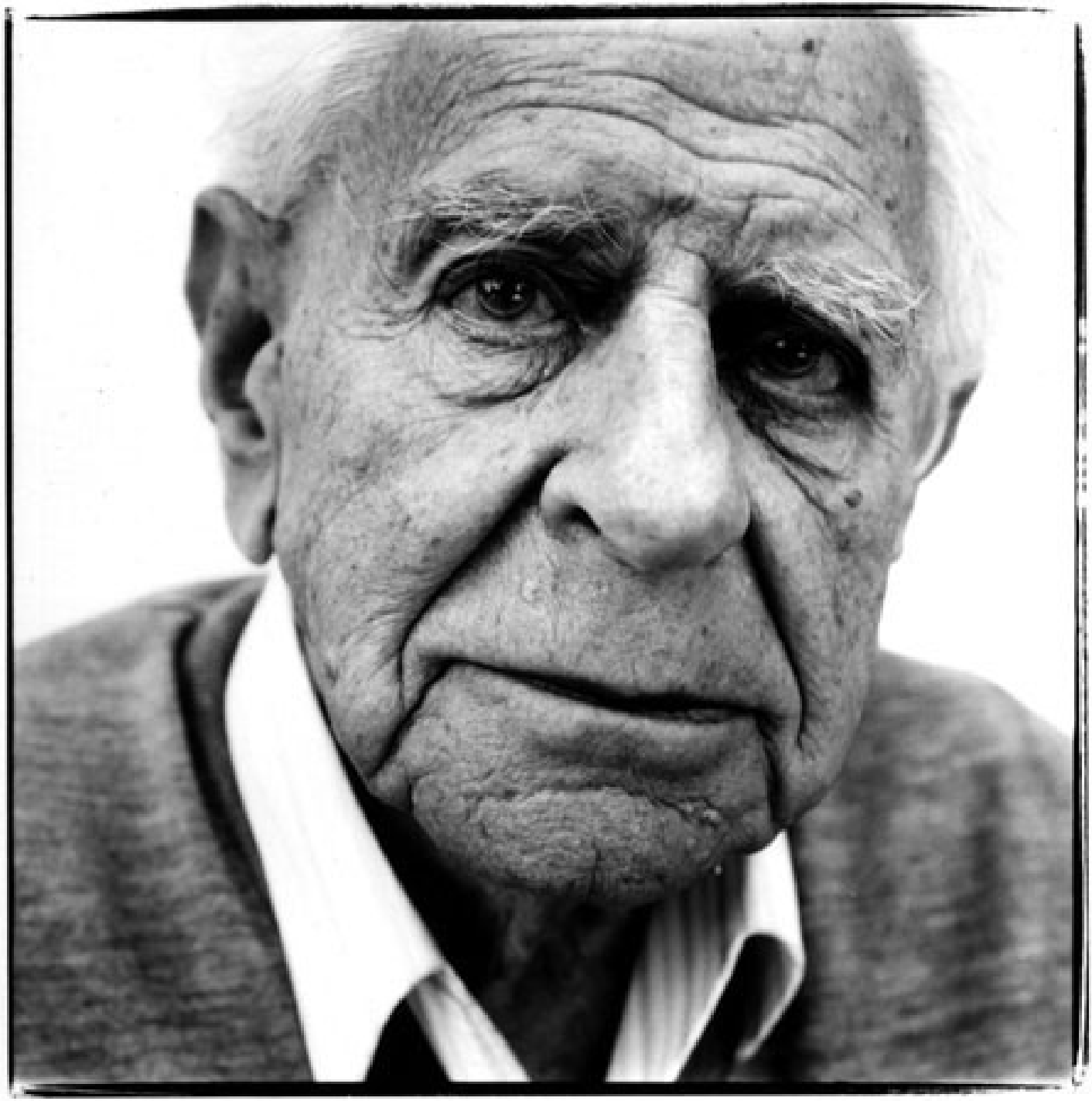


Stage II: Attempted Refutation

- Hypotheses are subjected to crucial tests.

- If refutation occurs, scientists return to Stage I.

4 Problems for Popper



4 Problems for Popper

(1) *Holism About Testing*

Falsificationist Reasoning

If $(H \,\&\, A_1 \,\&\, A_2 \,\&\, \ldots\,)$ is true, then E is true.

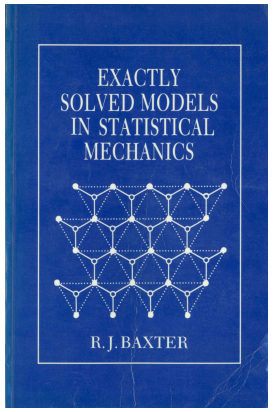
E is false.

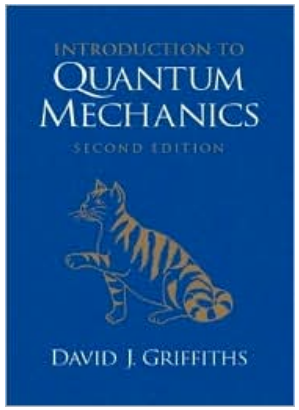
Therefore $(H \,\&\, A_1 \,\&\, A_2 \,\&\, \ldots\,)$ is false.

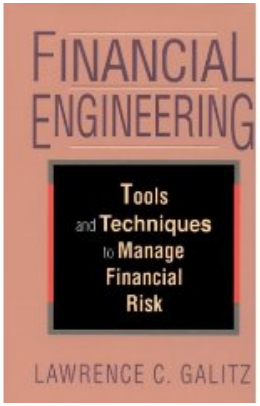
- Which of $(H \,\&\, A_1 \,\&\, A_2 \,\&\, \ldots\,)$ is to blame for the refutation?
- *Recall Quine*: We can always retain H and reject one or more of the auxiliaries A_i.

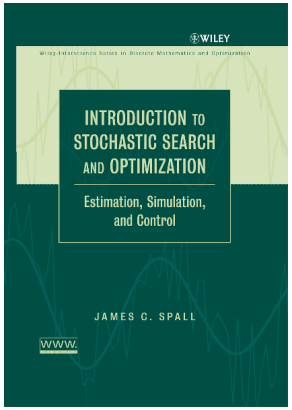
(2) *Probabilistic Theories*

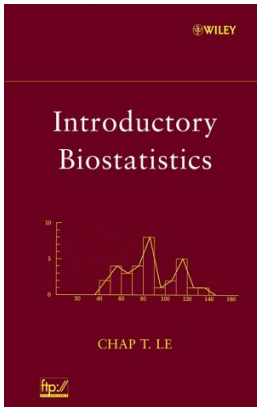
- A probabilistic theory of coin tossing entails that it is *possible*, but *highly improbable*, to get a series of 100 heads in 100 tosses of a fair coin.
- Such a theory is not risky! It can account for *any* observed number of heads outcomes of coin tossing experiments.
- *So*: Popper must claim it isn't scientific.
- *But*: There are many theories in science that employ probabilistic reasoning of this sort.











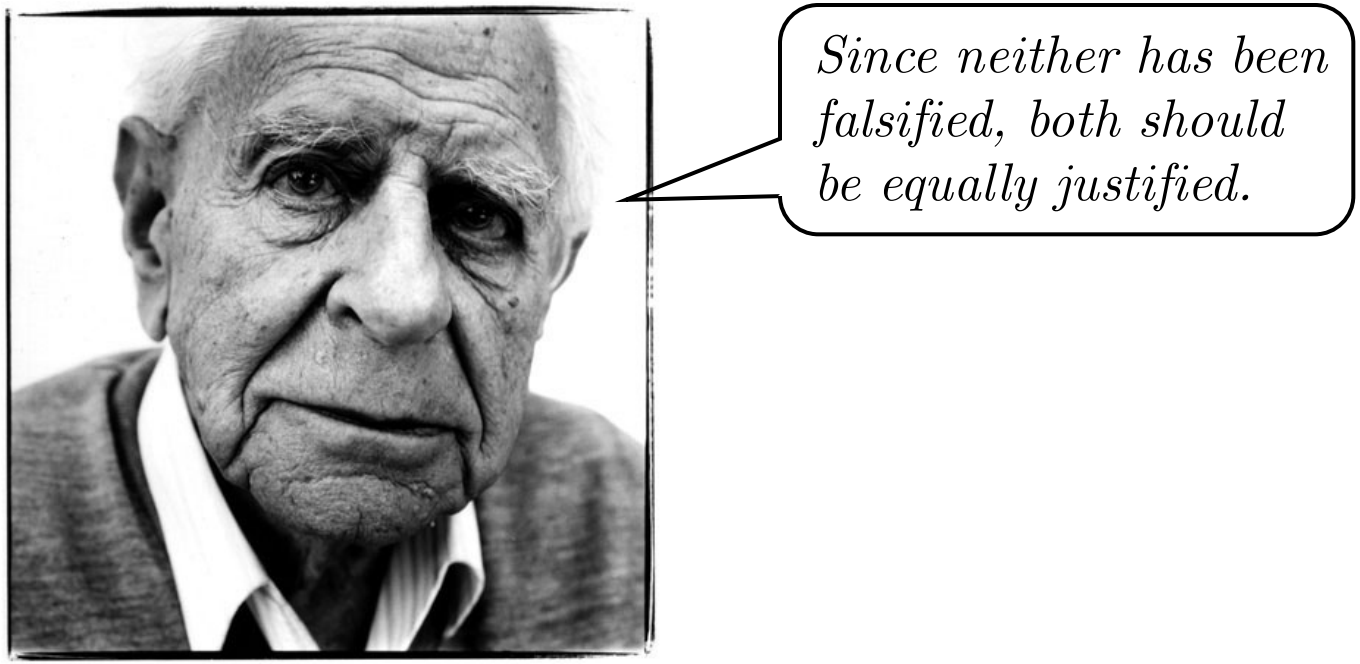
Moral: Deductive inferences, as well as *simple* versions of inductive inferences, are not the only types of inferences used in science.

(3) *Theory Choice*

Task: Build an extension of the Brooklyn Bridge.

- Theory A has been used repeatedly in the past to construct bridges.
- Theory B is a new, untested theory of bridge construction.

- Which theory should we use?
- Most engineers and scientists would say: "Theory A!"
- Without further qualification, Popper must say:



Popper's Attempt at Further Qualification

Def. A theory is *corroborated* just when it has survived many attempts to falsify it.

Popper Claim #3: All things being equal, we should prefer theories that have been corroborated over theories that have not.

- *Important*: "Corroboration" is not the same as "confirmation"!

Confirmation
- *Analogous to a letter of recommendation.*
- *Indicates how a theory will perform in the future.*

Corroboration
- *Analogous to a grade transcript.*
- *Indicates how a theory has performed in the past.*

- *BUT!* If we aren't allowed to use induction anymore, what rationale do we have to prefer corroborated theories over new as-yet-untested theories?
  - *How can we justify the inference from a good grade transcipt to good future performance without induction?*

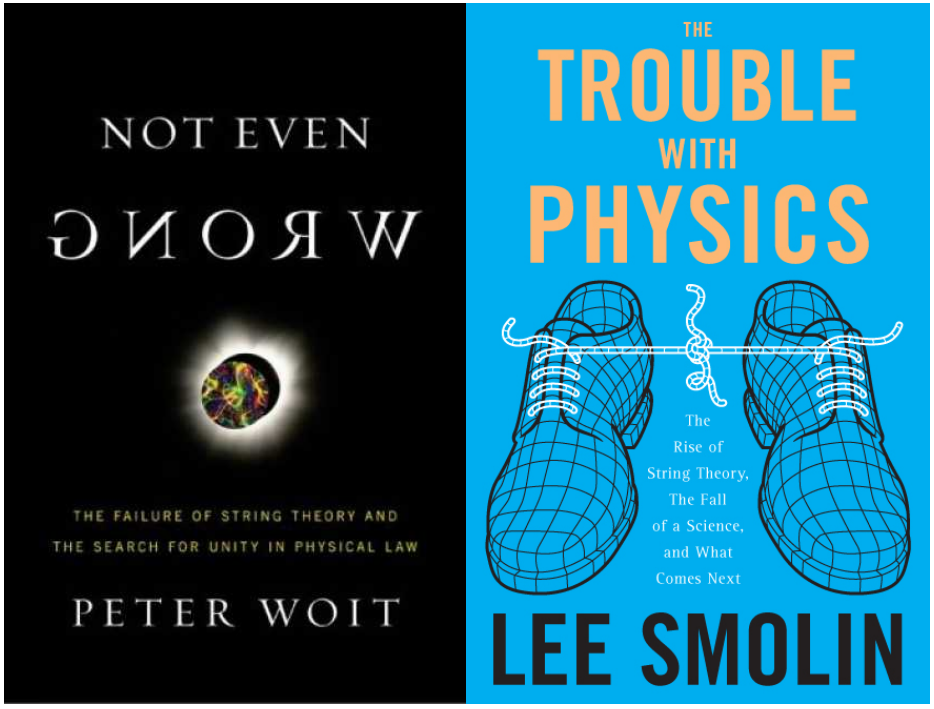
(4) *Problems with Demarcation*

- Popper's distinction is between scientific *vs* pseudoscientific theories as a *whole* (global demarcation).
- A heavy-handed way to weed out the chaff!

  Ex. String theory:
  - *Accomodates* all known observations in physics.
  - Attempts to *explain* how quantum physics and general relativity can be reconciled.
  - Makes *no* risky testable predictions.

  Ex. Loop quantum gravity.

- Many physicists are currently working on these research programmes.
- Are they engaged in pseudoscience?



- *Godfrey-Smith*: Better distinction is between scientific and unscientific ways of handling ideas within a given theory (local demarcation).

How to "scientifically" handle ideas:

- Expose them to observations.
- Employ elements of *both* falsification and confirmation.
- If ideas are handled in ways that insulate them from all risks associated with observation, then they are not being handled scientifically.