

# Philosophy of Science

## **Lecture 6: Realism and Anti-realism** **Special Topic: Underdetermination**

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# The Scientific Realism Debate

# The *scientific realism* debate

- This debate typically concerns the third of these *three realist theses*. The first two are often taken for granted.

**Metaphysical:** There exists a mind-independent (MI) world.

Excludes: idealism, phenomenalism, solipsism, etc.

**Semantic:** All scientific claims have truth-values.

Excludes: verificationist instrumentalism.

**Epistemic:** We can, and do, have knowledge of the truth of some such claims (incl. those about unobservables).

Excludes: constructive empiricism, social constructivism,...

# Scientific realism: A rough guide

- **Scientific realists:**

Our best scientific theories are (approx.) true in regards to what they say about both observables and unobservables.

Prominent advocates: Smart (1963), Boyd (1973), Kitcher (1993), Putnam (1978), Psillos (1999), Worrall (1989).

- Some types of realism:

- \* traditional scientific realism
- \* entity realism
- \* structural realism (epistemic and ontic)
- \* semi-realism

# Scientific anti-realists: A rough guide

- **Scientific anti-realists:**

We are not (and some claim cannot be) justified in saying that our best scientific theories are (approx.) true.

**NB:** At least in relation to unobservables.

Prominent advocates: Feyerabend (1974), Kuhn (1962), Stanford (2006) and van Fraassen (1980).

Some types of anti-realism:

- \* constructive empiricism – we focus on this one!
- \* recent instrumentalists

# Constructive Empiricism

# Human observability

- The view called ‘constructive empiricism’ is developed in van Fraassen (1980; 2002).

“X is observable if there are circumstances which are such that, if X is present to us under those circumstances, then we observe it” (1980, p. 16).

“The human organism is, from the point of view of physics, a certain kind of measuring apparatus. As such it has certain inherent limitations – which will be described in detail in the final physics and biology. It is these limitations to which the ‘able’ in ‘observable’ refers – our limitations, qua human beings” (p. 17).

# Observability and instruments

- Observations made through instruments that cannot *also be made with unaided sensory organs* lack credibility.

**Examples of observables:** fish in the Mariana Trench and rocks on Mount Everest.

**Examples of unobservables:** quarks, atoms and molecules (e.g. nucleotides).

**Q:** How about a crater on Jupiter's moon Europa?

**A:** It would come out as an observable.



# Belief vs. acceptance

- Constructive empiricism urges us to accept, not believe, scientific theories.

To **believe** a theory is to commit to its truth, i.e. to what it says about both the observable and unobservable posits.

To **accept** a theory is to merely commit to its empirical adequacy, i.e. only to what it says about observables.

- Truth still plays a restricted role in constructive empiricism.

“a theory is empirically adequate exactly if what it says about the observable things and events in the world is true” (1980, p. 12).

# Constructive empiricism: A statement

- Thus, to accept a theory is to restrict commitment to its empirical consequences and to be agnostic otherwise.

## **Constructive Empiricism:**

“Science aims to give us theories which are empirically adequate; and acceptance of a theory involves as belief only that it is empirically adequate” (1980: p. 12).

## **Realism:**

“Science aims to give us, in its theories, a literally true story of what the world is like; and acceptance of a scientific theory involves the belief that it is true” (p. 8).

# What does it mean to accept a theory according to van Fraassen? Commitment...

only to truths of observable claims

to no truths of claims

to all truths of claims

only to truths of unobservable claims

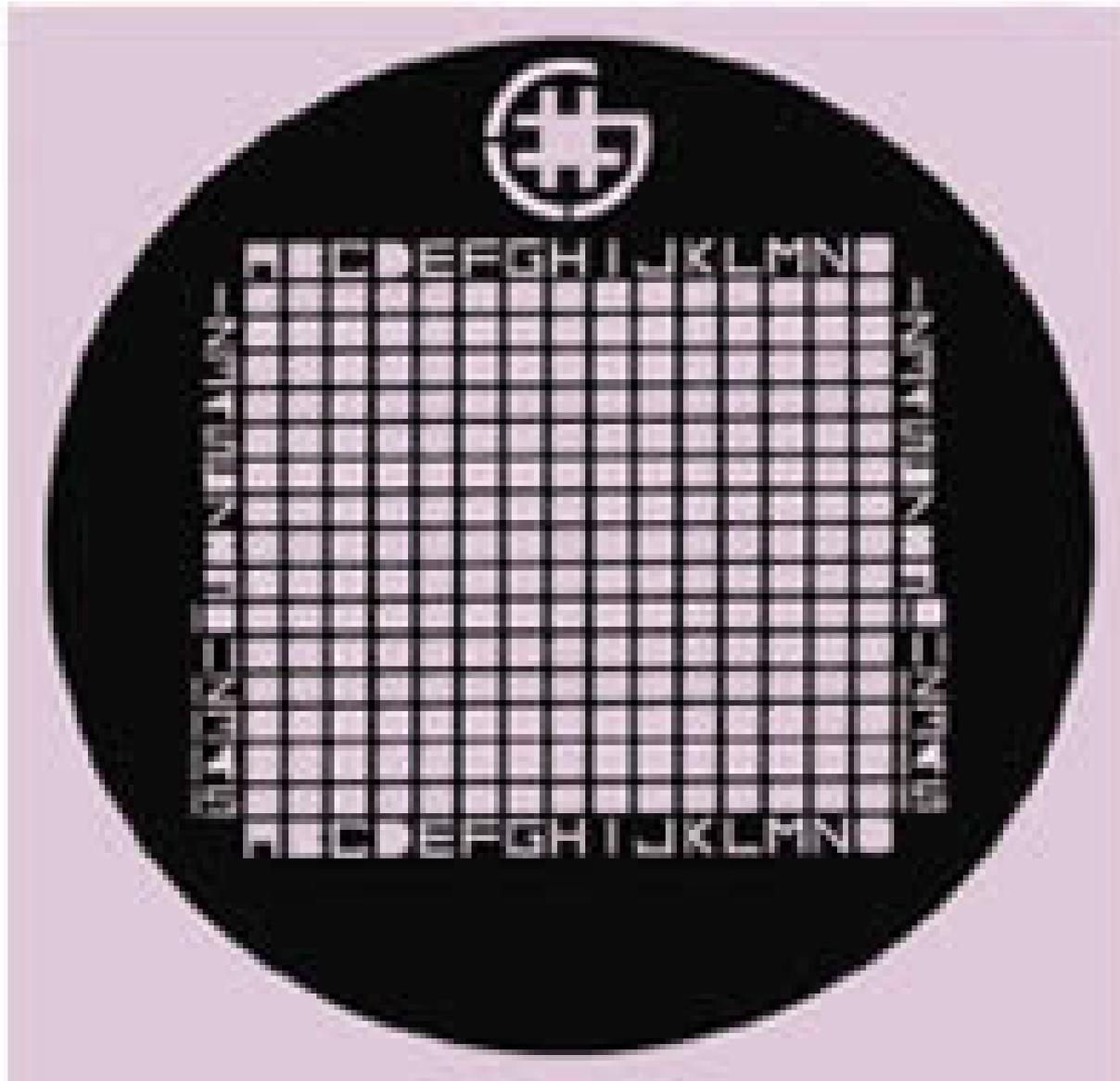
# Hacking's Objection

# The grid argument

- The so-called ‘grid argument’ points out that features in the microscopic images mirror features of the macroscopic ones.
- Hacking (1985): “The tiny grids are made of metal; they are barely visible to the naked eye. They are made by drawing a very large grid with pen and ink. Letters are neatly inscribed by a draftsman... Then the grid is reduced photographically. Using what are now standard techniques, metal is deposited on the resulting micrograph” (p. 146).



# A microscopic grid



## The grid argument (continued)

- “Then we look at the tiny disc through almost any kind of microscope and see exactly the same shapes and letters as were drawn in the large by the first draftsman. It is impossible seriously to entertain the thought that the minute disc, which I am holding by a pair of tweezers, does not in fact have the structure of a labelled grid. I know that what I see through the microscope is veridical because we *made* the grid to be just that way” (p. 146) [original emphasis].

# The 'Ultimate Argument' for Realism

# The no miracles argument

- The no miracles argument, henceforth NMA, is considered by many to be the main argument for realism.

“The positive argument for realism is that it is the only philosophy that doesn’t make the success of **science** a miracle” (Putnam 1979: 73) [emphasis added].

**NB:** See also J.J.C. Smart (1963).

- This argument can be directed at both *science* or *theory*.

The truth (or approx. truth) of **theory**  $T$  is the only view that that doesn’t make the success of  $T$  a miracle.

# NMA as an explanation

- The NMA can also be formulated as an explanation.

## **Explanationism:**

*The only (or best) explanation of a theory's success that does not render it miraculous is that the theory is true or at least approximately true.*

NB1: The 'best' is a weaker condition than the 'only'.

NB2: There are, of course, explanationist defences of (successful) science, not just (successful) theories.

# What is success?

- What does it mean for a theory to be successful?
- There is discord over this notion's construal. Even so, the majority of realists take it that the notion should involve:

## **Predictive or empirical success:**

Often this means that the theory's consequences (perhaps even probabilistic ones), come out true.

## **Explanatory success:**

Often this means that the theory provides understanding vis-à-vis some domain of inquiry.

# Novel success

- Some versions of the NMA incorporate a more stringent notion of success, namely novel success.
- Recall that novel success is the ability to predict (temporal- or use-) novel phenomena.
- Novel-success reformulation of the NMA:

*The only explanation of a theory's **novel** success that does not render it miraculous is that the theory is true or at least approximately true.*

# Different versions of the NMA are formulable along the following dimensions:

science/non-science,  
best/only

science/theory, mira  
culous/non-miraculous

science/theory, best/only

science/non-science,  
miraculous/non-mirac  
ulous

# The Pessimistic Meta-Induction

# Success to truth and to reference denied

- Recall that Kuhn's work raises historically-motivated doubts about the cumulativeness of scientific knowledge.
- Laudan (1977; 1981) builds on these doubts.
- To be precise, he argues that history shows *success-to-truth* and *success-to-reference* inferences to be unreliable.

~~Explanatory and predictive success~~

~~∴ (Approximate) truth and referential success~~

**NB:** The inference is obviously invalid. The real issue is whether it is reliable or inductively strong.

# Laudan's list of discarded theories

- “- the crystalline spheres of ancient and medieval astronomy;
- the humoral theory of medicine;
- the effluvial theory of static electricity;
- ‘catastrophist’ geology, with its commitment to a universal (Noachian) deluge;
- the phlogiston theory of chemistry;
- the caloric theory of heat;
- the vibratory theory of heat;
- the vital force theories of physiology;
- the electromagnetic aether;
- the optical aether;
- the theory of circular inertia;
- theories of spontaneous generation.” (Laudan 1981: 33).

# Projecting the trend

- History is presented as inductively supporting the view that our current (and future) best theories will likewise succumb.
- We should thus not believe in their approximate truth or in the successful reference of their terms.

# The expression dissected

- Given the above explication, we can now understand the rationale behind the expression ‘pessimistic meta-induction’
  - \* **pessimistic** because we *cannot claim* that our best scientific theories are approximately true.
  - \* **inductive** because it’s taken to identify an *ampliatively supported historical trend*.
  - \* **meta** because it’s not an induction *in* science but *about* it.

# A Reply to the PMI

## *Divide-et-impera: The basics*

- This approach relies on some way of drawing the distinction between good and bad parts of a theory.

NB: Literally ‘divide-and-conquer’.

- One influential way to draw the distinction is as follows:

**Non-idle**: Those parts that contribute to a theory’s success.

**Idle**: Those parts that fail to contribute to that success.

NB: Cf. Kitcher (1993) working vs. presuppositional posits.

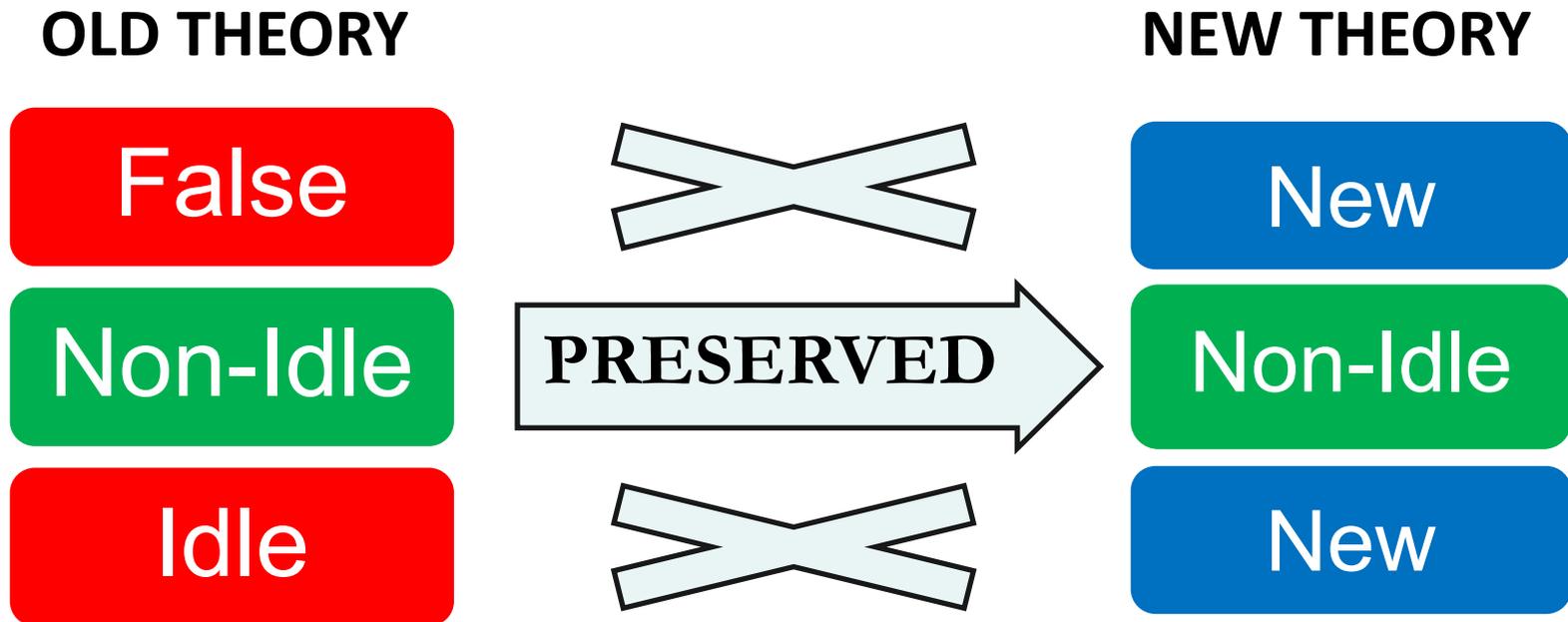
## *Divide-et-impera: The main claim*

- When a successful theory is discarded, only its idle parts are to blame. So long as the non-idle parts survive into the successor theory, nothing of consequence is lost.
- It is the non-idle parts that granted their parent theory the designation ‘approximately true’ or at least ‘partially true’.
- With their help we can now claim that the new theory is (strictly speaking) closer to the truth.
- That’s because the non-idle parts are preserved and the new theory typically contains further non-idle parts.

**NB:** Views that endorse this claim are branded ‘selective’.

# An optimistic argument

1. Past successful theories are approximately or partly true.
  2. Only parts of them were responsible for that success.
  3. Those parts survive scientific revolutions.
- 
- ∴ The link between success and truth is upheld.



# Example: Structural realism

- **Structural realism (SR):** Successful scientific theories are at least partially true in regards to what they say about observables and about only the structure of unobservables.
- More precisely, such theories can describe the observable world fully but the unobservable world up to isomorphism.

NB1: Commitment only to *non-idle* structures.

NB2: Purely epistemic (see above) vs. ontic form.

*Prominent proponents:* French (2014), Ladyman (1998), Poincaré (1905), Russell (1927) and Worrall (1989).

# 'The best of both worlds'

- **Structural continuity** (Worrall 1989):

(1) Theory change leads to the discarding of ontic posits.

PMI: pessimism regarding the true nature of such posits.

(2) The structural parts of the old theory responsible for its success survive into the new theory.

NMA: optimism regarding the structure of the world.

- **Some examples** (X – structurally continuous with – Y):

\*Fresnel's light theory – Maxwell's EM theory (Worrall 1989)

\*Phlogiston theory – Oxygen theory (Ladyman 2011; Schurz and Votsis 2014)

\*Caloric theory – kinetic theory (Votsis and Schurz 2012)

# Objections

- Several objections have been raised over the years.
  - (1) Cannot draw structure vs. non-structure distinction well.
  - (2) Collapse to something like constructive empiricism.
  - (3) Incoherence (ontic version).
- For an extensive critical overview of SR in its various guises, arguments in favour and against, see Frigg and Votsis (2011).

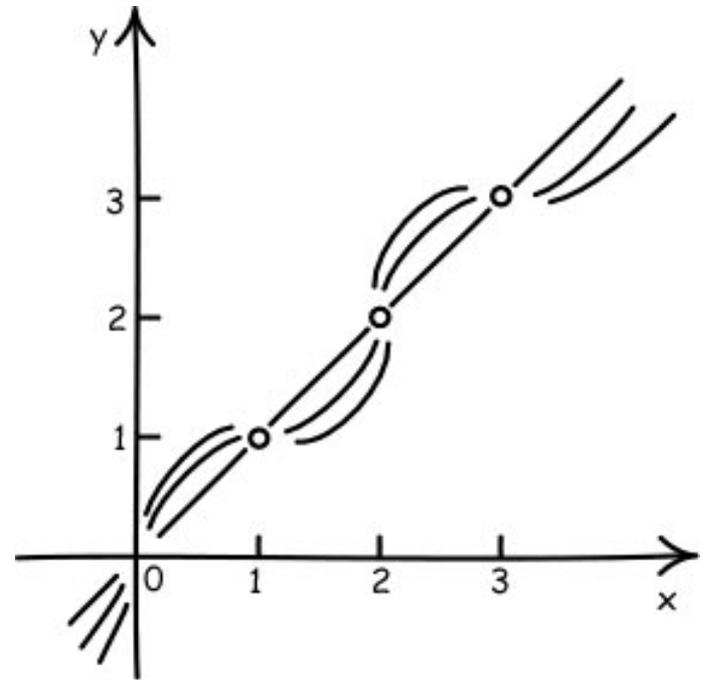
# Special Topic: Underdetermination

# Underdetermination and empirical equivalence

- **Underdetermination (UTE)**: Any body of observational evidence is insufficient to determine the truth of those parts of a theory that posit unobservables.
- According to CE, there are always empirically equivalent yet theoretically incompatible theories.
- Two or more theories are **empirically equivalent** if and only if they entail the same observational sentences.
- **Empirical Equivalence Thesis (EET)**: There are empirically equivalent rival theories to any given theory.

# Underdetermination: An example

- A good place to see UTE in action is in **curve fitting**.
- For any number of finitely many data points plotted along real-valued axes there are infinitely many curves going through them.



# Permanent underdetermination and genuine rivals

- It is useful to distinguish between **permanent** and **transient** forms of underdetermination.
- Roughly, transient underdetermination means that the *current* evidence is insufficient to fix the truth of a theory.
- For van Fraassen's arguments to hold, he needs to establish the existence of a permanent form of underdetermination.
- Moreover, he needs to establish that the rivals involved are not mere terminological variants.

The End