On the metaphysical content of scientific theories

Alex LeBrun, UC Santa Barbara lebrun@ucsb.edu

How can we determine the metaphysically significant content of our best scientific theories?

1 INTRODUCTION

Dispensable Definition. An entity (or structure) X is *dispensable* to a theory T if and only if there exists a theory T^- in which:

(i) T^- doesn't appeal to Xs,

(ii) T^- is empirically equivalent to T, and

(iii) T^- is suitably attractive.

Indispensability. If some entity or structure is indispensable to any of our best scientific theories, then we ought to metaphysically commit to that entity or structure.

Dispensability. If some entity or structure is dispensable to all of our best scientific theories, then we ought not metaphysically commit to that entity or structure.

Some claim that mathematical objects (e.g., numbers) are indispensable to our best physical theories.
Uncontroversial examples:

(a) Absolute space is *dispensable* to Newton's theory of space(time):

"[Absolute space] is theoretically dispensable: there is an alternative theory...that drops absolute space but does everything we wanted Newton's original theory to do." (Friedman 1983: 112)

(b) Electrons are *indispensable* to our best theories

"The attempt to eliminate theoretical entities of physics (e.g. electrons) from explanations of observable phenomena is not likely to be possible." (Field 2016: 43)

Four broad upshots of dissertation:

- Some naturally occurring composite objects are indispensable to our best scientific theories.
- Existing composite object indispensability arguments are not good.
- Theories have more metaphysically significant content than many philosophers of science think, but less than many metaphysicians think.
- Philosophy of language can help us understand this content.

2 ON DISPENSABILITY AND INDISPENSABILITY

Thesis: I argue against the above definition of 'dispensability'. Condition (ii) is not the right relation that a dispensing theory ought to bear to the original.

Upshot: Giving a dispensability or indispensability argument requires first articulating exactly what is the essential scientific content of a theory.

One example to show that empirical equivalence is not necessary for dispensing and one to show that empirical equivalence is not (jointly) sufficient for dispensing:

(c) Numbers (a metric) seem dispensable to theories of affine plane geometry.

But geometric theories do not have empirical consequences.

(d) Causation is not trivially dispensable to theories.

But we can craft attractive, causation-free, empirically equivalent theories.

Revised Condition (ii) on the definition of dispensability: T^- preserves all of the essential scientific content of T

Result 1. Dispensability and indispensability arguments require two distinct steps. Step 1: Identify the essential scientific content. Step 2: Ask whether some entity or structure is required to capture that content.

3 WHAT ARE EMPIRICAL CONSEQUENCES? ON DISPENSABILITY AND COMPOSITE OBJECTS

The question: Are there any naturally occurring composite objects like bars of iron, or are there only microphysical particles arranged iron bar-wise?

Hofweber: There are iron bars, and their existence is given by our theories' empirical consequences.

> "There is lots of evidence that supports the [composite] object theory over the things arranged object-wise theory. The object theory predicts that there is a bar of metal in the lab, the object-wise theory doesn't predict it. That there is such a bar can be confirmed with the observation that there is such a bar of metal in the lab."

For two theories T_A and T_B and their respective empirical consequences,

Fine Grained. If the underlying mereological picture associated with (a_1), (a_2), ... is different from the underlying mereological picture associated with (b_1), (b_2), ..., then T_A and T_B are not empirically equivalent.

I argue there is no good theory of empirical consequences that can vindicate Fine Grained. All such theories will entail that too many things are indispensable.

Result 2. For any distinctively metaphysical debate (like the debate over composition), a scientific theory's empirical consequences are silent on the debate.

4 NO SCIENCE WITHOUT COMPOSITES

Where things-arranged theories are empirically equivalent, I argue that some composites are still indispensable to some of our best scientific theories.

NSwC. Any theory that attempts to dispense with composite objects will fail to preserve all of the important scientific content of our best scientific theories.

Some science essentials:

- Ferrimagnetic minerals have non-net-zero spontaneous magnetization.
- Many different minerals are ferrimagnetic.
- Ferrimagnetism is only had by composite objects.

Three theories that attempt to dispense with composites and their problems:

1. **Ferrimagnetic^{-}.** Replace all instances of ferrimagnetic with ferrimagnetic^{-}, a property of simples in arrangements.
    - Different bacteria use different ferrimagnetic minerals for magnetotaxis.
2. **Ferrimagnetic^{or}.** Replace all instances of ferrimagnetic with ferrimagnetic^{or}, a disjunctive property where all disjuncts are had by simples in arrangements
    - No good way to characterize the disjuncts.
3. **Ferrimagnetic.** Replace all instances of ferrimagnetic with ferrimagnetic$^{\wedge}$, an irreducible property of simples in arrangements.
    - No good way to characterize the irreducibility of ferrimagnetic$^{\wedge}$.

Result 3. Some naturally occurring composite objects, like magnetite minerals, exist.

5 PUTNAM ON MATHEMATICS AND ONTOLOGICAL COMMITMENT

Quine-*Putnam* indispensability argument:

P1. If some entity is indispensable to some of our best scientific theories, then we ought to ontologically commit to that entity.

P2. Mathematical objects are indispensable to some of our best scientific theories.

P3. So, we ought to ontologically commit to mathematical objects.

Putnam's *actual* conclusions:

C1. Some mathematical statements are objectively true.

C2. We need not be ontologically committed to mathematical objects.

My reconstruction of Putnam's argument:

1. Our best physical theories are truth apt.
2. Our best physical theories presuppose some mathematical statements.
3. If 1 and 2, then some mathematical statements are true.

C1. So, some mathematical statements are true.

4. There are non-platonistic metaphysical pictures of the truth of mathematical claims.
5. If so, then we need not be ontologically committed to mathematical objects.

C2. So, we need not be ontologically committed to mathematical objects.

Presupposition. A statement S presupposes a statement p IFF for S to be truth apt, p must be true.

Metaphysical Picture Theory. The ontological commitments of S's acceptance of a theory T are the entities appealed to in the metaphysical picture that S accepts of the truth of T.

6 THE PRAGMATICS OF SUBTRACTION AND WEASELING

Melia's weaseling strategy:

> The force between two massive objects is *proportional* to the *product* of the masses *divided* by the square of the distance, except that numbers might not exist.

My thesis: To provide a purely pragmatic theory of the permissibility of linguistic subtraction in an effort to vindicate weaseling.

Relevance. An instance of subtraction is permissible when and only when what you subtract is not the essential relevant content of your conversational contribution.

(d) The length (in years) of the life cycle of periodical cicadas is 13.

Result 4. One can subtract metaphysical content out of empirical consequences. Cf. Chapter 3.