Against Brute Fundamentalism

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The Metaphysical Background

- 'A fact is **fundamental (or brute)** iff it does not obtain in virtue of other facts' (Rosen 2012)
- 'The **fundamental (or brute)** truths (if such there be) give us the ultimate foundation for the whole of reality' (Cameron 2015).

A fundamental existent [is] one whose existence is a brute fact, not one admissable of explanation' (Cameron 2015).

- '**Fundamental or "brute"** facts must be facts within physics' (Arno'dottir and Crane 2013).
- 'Micropsychism would need to posit **fundamental or brute** laws' (Kriegel 2013).

Call this view of the fundamental 'brute fundamentalism', or *brutalism*.

Arguing Against Brutalism

- For all its familiarity, it seems in increasing tension with *physicalism*.
- Cf Weinberg (1992): 'the aim of physics at its most fundamental level is not to describe the world but to explain why it is the way it is' .

Today:

- Begin to think about what it would mean to explain the fundamental and deny brutalism.
- Use QFT as a model of how brutalism can be denied, hoping that metaphysical and methodological morals generalise.
- Try to diagnose the disconsonance between physics and metaphysics w/r/t the fundamental.

The Core Commitments of Brutalism

"The fundamental $=_{def}$ that which is brute and inexplicable":

- *Every feature* of the fundamental level *is wholly lacking* in explanation.
- A core commitment of brutalism concerns the *fundamental natural kinds*:

  Brutalism about fundamental natural kinds*: Suppose that the fundamental kinds of this world are* $\{K_1, ..., K_j\}$*. Let this set be denoted* ***{FK}****. Then that the set of fundamental kinds is* ***{FK}*** *is a brute and inexplicable feature of the world.*

Suspicions about Brutalism

- Take it as a datum that we do not yet have a fundamental theory and thus do claim to know what the set **{FK}** is.
- But we might already be suspicious of brutalism on the basis of what we *do* know.
  - Some of the most fundamental particles we know of have been predicted in advance.
- But brutalists are free to deny this.
- In fact, seems that brutalists are always free to make this move so long as we await the fundamental theory.

Making Progress in the Present.

However, there may be a workaround here.

- Suppose we have some idea of the *kind of physical object* that the fundamental kinds are.
  - **Natural kinds:** electrons, positrons, photons....
  - **Objectual kinds:** classical particles, classical fields, wavefunctions, quantum fields, strings....
- Seems that we can have a view on the fundamental **objectual** kinds without knowing the **natural** kinds.
- This does *nothing to change* the fact that what the fundamental natural kinds are is a fundamental feature.
- Thus if *after postulating* some fundamental objectual kinds we find we have *some explaination* of **{FK}**, **brutalism will be false**.

Making Progress in the Present.

My claim: If we impose the **{FK}** is a set of *quantum fields*, then we can argue that *whatever* those kinds are they are not a 'brute and inexplicable' feature of the world.

- This is likely a fiction.
  - Note that there are attempts to incorporate gravity into QFT framework: Percacci 2008; Niedermaier *et al.* 2006.)

Baseline assumptions

Assumption: the fundamental kinds are *kinds of quantum fields*: *quantum systems* defined on *Minkowski spacetime*.

Wavefunctional interpretation:

At any time, state of quantum field given by $\Psi = \Psi[\phi_i(x)]$:

A map from classical field configurations $\phi_i(x)$ to $c_i \in \mathbb{C}$, interpreted such that $c_i^2 =$ prob. of finding Ψ in $\phi_i(x)$ at t.

Suppose quantum fields are *by their nature probabilistic*: in every world in which they exist, they imply probabilities for finding classical fields in accordance with the above recipe.

- This claim on 'natures' seems a necessary assumption, and one that Humeans (perhaps) won't like.
- But note that assuming this doesn't trivialize my claim.

Pinning Down the Fundamental Kinds

Question: what now do we know about the members of **{FK}**?

- We've *put in by hand* that they are quantum systems in Minkowski spacetime. (This sets the 'baseline'.)
- This tells us something about the *laws* that the fundamental kinds obey.
- It tells us that the laws must be *unitary*.
  - Unitarity is needed to ensure that the probabilities encoded in $\Psi(x, t)$ sum to one at every moment.
  - Required to *consistently talk* of $\Psi(x, t)$ as being probabilistic at all.

Pinning Down the Fundamental Laws

- While we do not know precisely what the fundamental law is, given the objectual kinds involved we know it respects unitarity.
- What else do we know about this law?
  - It is a law of interaction. (Empirical fact / conceptual truth.)
  - It is a law that is not superceded by another as we probe smaller scales. (Conceptual truth.)
  - Given Minkowski spacetime, it is a law that is valid to *arbitrarily high* energies.
- The fundamental law, then, is valid in the $E \to \infty$ limit.

However, *respecting unitarity* in this limit is an extremely demanding requirement: *a priori* we would not expect any theory to satisfy it.

Satisfying Unitarity

- Technically this is because in QFT the interaction couplings are functions of energy.
  - $H = H(g)$, $g = g(E)$.
- Generically, then, expect predictions of the theory to violate unitarity bounds.
  - Prob $h = |\langle h|H|pp\rangle|^2$

Bottom line: Only very special Hamiltonians can be expected to respect unitarity in the $E \to \infty$ limit.

Constraints on Fundamental Theories

- What Hamiltonians have the property of respecting unitarity in the infinite energy limit?
  - At a minimum, those whose couplings stay finite in the limit.
- Which Hamiltonians have *this* property?
  - No results both general and specific.
  - We *do* know that it is in general a function of the field content of the theory:

$$\beta(g_i) = f(\textit{spin} / \textit{mass} \text{ each field})$$

  - Know precisely the constraints on field content for a special case: theories whose couplings *disappear* in the limit ('asymptotically free' theories).

For now, take *asymptotically free* theories and *fundamental* theories to be the same thing.

Constraints on Fundamental Theories

Results.

- To be asymptotically free, *non-abelian gauge bosons* must feature. Shown by Coleman and Gross 1973, in a proof by cases.
- To be asymptotically free, there are limitations on the number of allowed fermions. (Gross and Wilczek 1973).

  "Theories of non-Abelian gauge fields and Fermi multiplets are sometimes asymptotically free and sometimes not... if the theory has too many fermions, the sign of beta is reversed and asymptotic freedom is lost." (Coleman 1975)

Constraints on Fundamental Theories

Significance.

- There are *non-fundamental* theories containing only fermions, eg Fermi theory of weak interaction; Nambu–Jona-Lasiño model: perfectly good as *effective theories*.
- But Coleman and Gross show that these are not candidates for *fundamental* theories. *There must also exist gauge bosons*.
- Similarly, we could spoil the fundamentality of a theory by adding too much matter content (cf. QCD and > 16 flavours of quark).

Fundamental Kinds and the Goldilock's principle

***Goldilock's principle for fundamental kinds**: Whatever the set of fundamental kinds **{FK}** is, it will take the form $\{B_1, ...B_m; F_1...F_n\}$ for some $m > 0$ and with an upper bound on n, and with m and n related.*

Fundamental Theories and the Goldilock's principle

Note that:

- Many (most) sets of kinds will not conform to the **GP**.
- Imposing compatability with the **GP** does not pin down **{FK}** *uniquely*.
- My claim that **{FK}** subject to the **GP** assumed that the fundamental theory is an asymptotically free theory.
- However, can expect *something like* the **GP** to be true in the more general case of *asymptotic safety*.
  - While we do not know in the general case precisely *how* the matter content has to be tuned, we know it must be tuned *somehow*.

Explaining the Fundamental

My claim: the *GP* suggests that brutalism about fundamental kinds is wrong.

> ***Brutalism about kinds****: Suppose that the fundamental kinds of this world are* $\{K_1, ..., K_j\}$*. Let this set be denoted* ***{FK}****. Then that the set of fundamental kinds is* ***{FK}*** *is a brute and inexplicable feature of the world.*

Explaining the Fundamental: Challenges

- What *sort* of explanation is afoot here is not obvious, and as such nor how to secure that there *is* explanation:
  - not *causal* explanation;
  - not *grounding* explanation.
- What *does* seem plausible is that some kind of *mathematical* explanation is afoot, since *consistency* considerations doing so much work.

Take as our starting point early work in causal explanation: Mellor's *modal account*.

A first stab: Mellor's Modal Account

Mellor's *Probabilistic Explanation* (1976):

Thesis: 'a (good) explanation raises or makes high its explanandum's probability [...], and the more it does so (*ceteris paribus*) the better it is' (p. 232).

Prompt: 'a general thesis about explanation' according to which 'we call for explanation only of what, although we know it is so, *might have been otherwise for all else of some suitable sort we know*'; when there is a 'gap, between knowledge of what is and what must be'.

- Begins with intuitions that seem nicely general.
- Seems nicely neutral on whatever factors involved.
- Enjoys some contemporary support (cf Strevens (2000).
- Sanctions indeterministic explanation.

Mellor's 'General Thesis'

Ideally, an explanation 'closes the gap' altogether. Sometimes, however, such an explanation

> *is not to be had. An event may lack sufficient causes, as radioactive decay does. In all these cases what happened might not have happened for all we can learn of the prescribed prospective causes; we cannot, in the prescribed terms, close the gap that calls for causal explanation. But perhaps we can narrow it. The epistemic possibility of an explanandum's falsehood comes by degrees, and relative probability I take to be (inter alia) the measure of it. So gaps that causal explanation would close completely may be partly closed by probabilistic explanation; that indeed I take to be its object" (p .235).*

We can marshall 'partial closure' against brutalism about **{FK}**.

Marshalling Mellor Against Brutalism

- Mellor's 'general thesis' tells us, if we want to explain *p*, then we need to show *why p and not q*, where *q* expresses 'what might have been otherwise for all else of some suitable sort we know'.
  - 'The respondent presumes a background *K* of relevant common knowledge.
- Call *q* a 'foil'.
- To explain fully, need to rule out *all* such foils. Rule out *some* and we have a *partial* explanation, and the more ruled out, the better.
- Even if we have a *partial* explanation of **{FK}**, it cannot be said to be brute.

The Space of Foils

$\therefore$ We can deny brutalism if we can say why **{FK}** and not some *other* set **{NK}**, so long as it *could* have been **{NK}** 'for all else of some suitable sort we know'.

- We know what we put in by hand: that the kinds involved are quantum fields.
- At that point, candidate foils = arbitrary sets of qm fields.
- Considerations of *consistency constaints* on a probabilistic theory in the $E\infty$ limit show that most of these sets not consistent with the **GP**, and hence not consistent with being *fundamental*.
- **{FK}** is nevertheless *not unique* in being so consistent.

Mellor's strategy implies we have a *partial explanation* of {FK}.

Criticism of Mellor's Approach

- However, Mellor's strategy not immune from criticism.
- We can claim that 'modal explanation' is too weak: explanation is *hyperintensional*.
- Eg. explanation in mathematics.

> *"The thesis is itself supported by explaining why explanation figures less in logic and mathematics than it does in history and science. To know something in logic and mathematics is mostly to have proved it, and so to know also that it could not be otherwise. There is not the gap, between knowledge of what is and what must be, that calls forth explanation to close it. (Where there is, as perhaps with Fermat's Last Theorem, a proof would indeed explain.)"*

$\Rightarrow$ Try to emphasize that we can also say *why* ruled out.

The shape of the explanation

1. The fundamental entities are quantum fields. (Stip.)
2. Quantum fields are by their nature probabilistic. (Meta. claim.)
3. The fundamental level is one in fundamental kinds interact in accordance with laws. (Empirical / conceptual claim.)
4. Fundamental laws are laws valid in infinite energy limit. (From 1 and meaning of 'fundamental law'.)
5. Laws of probabilistic systems must be unitary. (Meaning of 'probabilistic system'.)
6. Laws featuring arbitrary set **{NK}** *not* unitary in high-energy limit. (C&G 1973).
7. ∴ **{NK}** do not feature in fundamental laws (From 2, 4, 5, and 6).
8. ∴ **{NK}** are not the fundamental kinds (From 3, 7).

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Criticisms

1. QFT maybe not a fundamental framework.
2. Putting the conclusion in by hand? – No, twice over.
3. Not an explanation of a type relevant to metaphysics:
   - Whether something is brute depends on our interests. (Cf. van Fraassen; Fahrbach 2005).

   But components of our explanation *look* metaphysical, and is *about* something of central interest to metaphysicians.

A final reflection.

Whence the difference between physics and metaphysics w/r/t explaining the fundamental?

> *Philosophers have long pondered explanation in the natural sciences. If they have ignored it in the mathematical sciences, blame lies perhaps with a lingering distinction between 'matters of fact' and 'relations among ideas', the corollary being that mathematics (belonging to the latter class) has nothing to explain. (Steiner 1977)*

Thank you!