TITLE

CAN PHYSICS EVER BE COMPLETE IF THERE IS NO FUNDAMENTAL LEVEL IN NATURE?

DISCUSSION NOTE ON LADYMAN & ROSS'S BOOK *EVERY THING MUST GO*.

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ABSTRACT

In their recent book *Every Thing Must Go* Ladyman and Ross (Ladyman et al. 2007) claim:

(1) Physics is analytically complete since it is the only science that cannot be left incomplete (cf. Ladyman et al. 2007, 283).
(2) There might not be an ontologically fundamental level (cf. Ladyman et al. 2007, 178).
(3) We should not admit anything into our ontology unless it has explanatory and predictive utility (cf. Ladyman et al. 2007, 179).

In this discussion note I aim to show that the ontological commitment in (3) implies that the completeness of no science can be achieved where no fundamental level exists. Therefore, if claim (1) requires a science *to actually be complete* in order to be considered as physics, (1), and if Ladyman and Ross's "tentative metaphysical hypothesis […] that there is no fundamental level" (178) is true, (2), then there simply is no physics. Ladyman and Ross can, however, avoid this unwanted result if they merely require physics *to ever strive for completeness* rather than to *already be complete*.

In what follows, I will first go through statements (1)-(3) in detail and then, second, show that there's some friction between them. Third, I suggest how this friction can be avoided.

Statement (1) that "physics is analytically complete since it is the only science that cannot be left incomplete" summarises the views expressed on page 283 of Ladyman and Ross's book[1] where *analytic completeness* can be further characterised as follows:

Completeness. For physics to be complete means that the (law) statements of physics hold omni-temporally and omni-spatially, everywhere at any time: "the generalizations of […] physics are exceptionless", "any measurement taken anywhere in the universe is a potential counterexample to them." (Ladyman et al. 2007, 283)

Analyticity of completeness. Moreover, this (alleged) completeness of physics is no mere fancy which can easily be given up in case it seems difficult or impossible to achieve. On the contrary, there is a demand that further research must be done should exceptions to a physical generalisation occur and, whatever the causes for the exceptions, they have to be incorporated and captured by a further advanced physical theory. Should (alleged) $\text{physics}_{\text{today}}$ not be complete then $\text{physics}_{\text{tomorrow}}$ must be in order to be *physics proper*. Ladyman and Ross call this "an institutional norm justified by appeal to the history of science." (Ladyman et al. 2007, 283). They back up their claim by quoting Earman and Roberts: "It is the goal of physicists to find such strict, proviso free laws […]. When exceptions are found to the candidates for fundamental physical laws […] the search is on for new candidates." (Earman et al. 1999: 446)

While it is fairly clear what "completeness" means, it remains slightly ambiguous how we shall interpret its analyticity. Taken in its orthodox reading, *analyticity* of completeness should mean that a science has *to be complete* in order to be considered to be physics proper: no completeness, no physics. Yet, Ladyman and Ross's writings suggest also a softer reading where "analytic completeness" indicates more a methodological aim rather than an essential conceptual requirement: physics is the (one and only)[2] science that *shall always strive for completeness*.

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[1] The formulation "analyticity of completeness" cannot be found explicitly in Ladyman and Ross's book. I borrow it from Ladyman's recent conference presentations where he uses it as an adequate summary of page 238.

[2] Note aside that the analyticity of completeness is not only seen as a virtue of physics in isolation but it is also meant to tell physics from other sciences which do not share this feature: the generalizations of chemistry, biology, empirical psychology, etc. need not be exceptionless. Potential counterexamples to generalizations of those sciences might well be explained by reference to underlying levels not belonging to the scope of these sciences: physical damage to the brain might, for example, explain the loss of some mental capacity.

In what follows, I will show that the latter but not the former interpretation is coherent with the other two claims, (2) & (3), from above. For that purpose I adopt, for now, the stronger reading. The upshot is then, in short, that physics can't be complete if there is no fundamental level in nature (an outcome that is, I hope, valuable also independent of Ladyman and Ross's book).

Before I turn to a closer examination of the second claim, (2), note that in their book Ladyman and Ross actually speak of "fundamental" where I have, in (1), used the term "complete". For example, they write: "By 'fundamental' physics [= 'complete physics' in my terminology, MS] we will refer to that part of physics about which measurements taken anywhere in the universe carry information." (Ladyman et al. 2007, 55).

However, "complete" (as used here) is the more adequate term because we need to distinguish "fundamental = complete" from Ladyman and Ross's second and different use of "fundamental" as *ontologically basic*. In that latter sense, "fundamental" refers to an ontological rock bottom level, to, so to speak, the atoms of atomism (in the original meaning of *atomos)*. In other words, where *completeness* is a feature of scientific theories, i.e., of abstract entities used by epistemic subjects as predictive and explanatory devices, *fundamentality* is a feature of worlds: a world has, ontologically speaking, a fundamental level if this level has no underlying substructure.

This brings us straight to claim (2): the thesis put forward by Ladyman and Ross is that our world has no such fundamental level. The authors believe, on inductive grounds, that the world is ontologically endlessly complex: "We have inductive grounds for denying that there is a *fundamental* level since every time one has been posited, it has turned out not to be fundamental after all." (178; my italics). The history of science teaches us that once postulated "atomic" entities turned out to have sub-structures. Atoms divided into electrons, protons and neutrons, the latter further into quarks, and, maybe, string theory has yet another story to tell about a deeper, more fundamental structure. This might go on forever: "there might not be a fundamental level", rather, there might be an endless "Russian Doll" cascade of infinitely many levels (where any whole has parts that all have further proper parts).

I turn to claim (3). The almost neo-positivist or verificationist demand, (3), of *Every thing must go* that "we should not admit anything into our ontology unless it has explanatory and predictive utility" must hold for ontological levels as well. That is, for any given ontological level we shall postulate a deeper (more fundamental) level *only if* its postulation contributes to a theory's predictive or explanatory power. Stipulating a causally, predictively, explanatory idle underlying level would be what Ladyman and Ross call "pointless": this level would not make

a "contribution to objective inquiry" (cf. Ladyman et al. 2007, 30; also cf. their *Principle of Naturalistic Closure* (PNC) on 37-8).

We can now put together (1)-(3). Ladyman and Ross came to believe, (2), that there are infinitely many levels on inductive grounds and not, in the first place, because the stipulation of these levels has explanatory or predictive power. However, if this belief is to be coherent with their neo-positivist demand (3) that "we should not admit anything into our ontology unless it has explanatory and predictive utility", they have to assume, also, that without the postulation of the existence of those many ontological levels, plus the respective lawlike generalisations, physics (at any level) would leave some phenomena unexplained and unforeseen. Yet, unforeseen and, especially, unexplained phenomena are, perceived from the viewpoint of an experimental, empirical science, nothing but "measurements taken somewhere in the universe that constitute counterexamples" to that science, i.e., the generalizations of that science would not be exceptionless and so it would, contra (1), not be complete.

Put in the form of a dilemma, *either* science/physics stops at some level then some phenomena are left unexplained, *or* physics doesn't stop in which case it becomes an infinite endeavour. In any case, any concrete allegedly fundamental physical theory at any point in time is not actually complete. So, if we read the methodological requirement of completeness in its strongest sense and "physics", properly so called, must actually *be complete* then no human science ever qualifies as physics.[3]

Here's a suggestion: if we adopt the softer reading, introduced above, where completeness is a methodological aim rather than an essential conceptual requirement (i.e., completeness in its aspiration rather than in actuality) then physics can be rescued like Goethe's hero Faust: redeemed from his endless quest to find "what it is that girds the world together in its inmost being" the angels welcome Faust in heaven with the words: "Him can we save that tirelessly strove ever to higher level". Where no inmost being girds the world together, also physics can be saved if it *tirelessly strives ever to higher level* instead of *having to be complete* already.

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[3] I leave it an open question whether there is the following metaphysical possibility for completeness despite endless complexity: it might be that from a certain level onwards the underlying levels are structurally perfectly alike the ones above, endlessly. In that case, physics could be completed by, so to speak, adding a clause "and so on, over and over again". It is, however, doubtful whether we would ever be able to know whether this possibility is actualised.

REFERENCES

Ladyman, J. and Ross, D. 2007 Every Thing Must Go. Metaphysics Naturalized, Oxford: Oxford University Press

Earman, J. and Roberts, J. T. 1999 "*Ceteris paribus*, there is no Problem of Provisos", Synthese 118, pp. 439-478