

ESSAY REVIEW: *The many Metaphysics within Physics*¹

9 February 2009

(Appeared in *Studies in History and Philosophy of Modern Physics*, 40, August 2009, pp. 273-76).

Tim Maudlin's new book *The Metaphysics within Physics* (Oxford University Press, 2007) collects six essays by one of the most thoughtful and original minds working in the philosophy of physics nowadays. Some had previously circulated informally for years. For example, chapter 1 ("A Modest Proposal Concerning Laws, Counterfactuals and Explanations") is as old as my own philosophical career – I recall reading a draft in the early nineties. The mere publication of such a long-awaited collection is therefore already good news. In addition the degree of coherence and the lack of redundancy are greater than one would expect from a collection of disparate essays written at diverse times and with a range of different targets. The whole book can be understood coherently as an extended argument in favour of a particular "physics-based" methodology for inquiry in metaphysics. This methodology recommends a detailed and thorough analysis of current physics as a benchmark for any thesis, dispute or argument in metaphysics. It follows that proper metaphysical inquiry must be suitably informed not just about the current state of play in analytical metaphysics but also about the current state of development of the relevant part of present day physics.

The thought that metaphysics must adjust to the results of our best empirical inquiry is of course not new. Empiricists have defended it in different forms over the centuries. Hume famously went as far as to condemn as meaningless any statement that can not be shown to express an idea - the copy of an impression - or a relation among such ideas. Scholastic metaphysics seemed to comply with neither requirement, so Hume condemned it to the 'flames' of 'sophistry and illusion'. Closer to our times the logical empiricists defended a verificationist criterion of meaning that turned metaphysical statements into cognitively groundless expressions of 'emotional or volitional dispositions' (Carnap, 1935, p. 29).

But Maudlin is resolutely no Humean. He does not think present day analytical metaphysics is a waste of time. On the contrary he is knowledgeable and sensitive to its nuances. Although he would reject a metaphysics that is not properly grounded on physics, he does not think that it would be meaningless or bankrupt. In this regard his methodology is not empiricist in any of the traditional senses; it is best to describe it as a 'physics based' approach to metaphysics. Part of the strength of this approach is that it does not deprive us of the use of metaphysics wherever it can be shown to be a powerful and interesting tool for a more accurate reflection upon the state of current physics or its ontology. Nor does Maudlin make the mistake to think that as a rule any consensus within the physics community on a metaphysical issue is bound to be more informed than a contrary pronouncement by a metaphysician. Rather each claim must be judged on its own merits, where the merits involve some comparison with current physics. There are plenty of good applications of this sensible maxim in the book. Particularly

¹ I am grateful to Janneke Van Lith for detailed suggestions and to Ned Hall for a helpful brief comment – needless to say they do not necessarily share my views. Financial support is acknowledged from the Spanish Ministry of Science and Education (research projects FFI2008-06418-C03-01 and PR2008-0079).

salient is the defence of a paradigmatic metaphysical view – the passage of time – against the prevalent consensus in physics and philosophy of physics.

In other words, this book is not an empiricist attempt at the annihilation of metaphysics. On the contrary, Maudlin's approach to ontology is methodologically conservative, or *minimalist*. He believes that everyday inquiry presupposes a traditional ontology of substance and properties, laws and temporal evolution;² and that there is no point altering this ontology *unless* an informed and careful study of current physics provides us with convincing reasons to revise it. I agree with this pragmatic attitude to metaphysics and ontology, but it seems to me that Maudlin does not always sufficiently emphasise an important consequence. The notorious underdetermination of metaphysics by physics, and of physics by empirical data, is bound to make such revisions unlikely and hard to come by. And indeed a considerate summary of Maudlin's book could well be that – with a few exceptions – current physics, far from displacing the everyday ontology, entrenches it. (Contrary to claims by fellow philosophers of physics who have occasionally – to my mind mistakenly – argued that current physics requires a radical revision of 'everyday' ontology).

More precisely, there are two unifying threads throughout the book, in the form of a negative and a positive thesis. The negative thesis is a powerful critique of David Lewis' *Humeanism* as inappropriate for science; and in particular the thesis of *Humean supervenience* comes under heavy fire. Maudlin repeatedly quotes Lewis' definition of Humean supervenience as "the doctrine that all there is to the world is a vast mosaic of local matters of fact, just one little thing and then another. [...] All else supervenes on that". The vast mosaic of facts on which everything else supervenes is the *Humean mosaic*: the complete set of spacetime points (or maybe just discrete matter points) with their intrinsic or monadic properties (qualities) and the spatio-temporal relations between them. The thesis of *Humean supervenience* is then the thesis that there can be no differences between two possible worlds that share their Humean mosaics: If two worlds have identical Humean mosaics then they also share all other actual or modal properties, laws, causal connections, propensities or chances, etc. By contrast Maudlin believes that the modal properties encoded in natural laws of evolution – such as propensities, causes and even mere physical possibility – do not supervene on the Humean mosaic. So, contrary to Humeanism, two worlds can agree on their Humean mosaic but differ in some of their fundamental modal properties. This conclusion strikes me as correct, even though I am unconvinced that Maudlin has provided the best available arguments for it.

As regards the positive thesis, following the author (p. 182), we may refer to it as Maudlin's *non-Humean package*. This package is essentially the combination of three independent claims: (i) the laws of nature are basic postulates that can not be reduced to relations between universals, nor do they supervene on the Humean mosaic; (ii) the direction or arrow of time also fails to supervene on the Humean mosaic; instead time's passage is to be regarded as a primitive and non-reducible physical fact; (iii) the direction of causation is however a by-product of a particularly felicitous feature of temporal laws of evolution, and should therefore not be considered a primitive. (Causal speech is just a particular kind of nomological speech, involving a well defined state of

² Although in the book minimalism is only applied thoroughly to the four notions mentioned above, it seems to have in principle wider application including to those other notions that Maudlin treats only sparingly such as identity, kinds, or universals.

inertia, and the postulation of causes in order to explain departures from it). In other words Maudlin's non-*Humean package* is a combination of primitivism about laws and time with a weak sort of reductionism regarding causation.

Chapters 1, 4 and 5 contain most of Maudlin's positive arguments in favour of his Non-Humean package, while chapters 2, 3, and 6 contain the negative arguments against Humeanism. There is also a brief introduction, and an epilogue containing some reflections on the relationship between physics and metaphysics. Let me start with the negative arguments against Humeanism in chapters 2, 3, and 6.

In chapter 2 Maudlin provides some exacting arguments against *Humean supervenience*. This thesis is analysed as the conjunction of two conditions, *separability* and *physical statism*. *Separability* asserts that the complete physical state of the world supervenes on the intrinsic physical state of each spacetime point and the spatio-temporal relations between such points. In other words the physical state of the world supervenes on the Humean mosaic. *Physical Statism* further stipulates that the physical state completely determines all the facts about the world, including modal and nomological facts. In other words all facts supervene on the physical state. The conjunction of both yields Humean supervenience: if all facts supervene on the physical state, and if the physical state supervenes on the Humean mosaic, then all facts (including modal and nomological facts) supervene on the Humean mosaic. The fate of Humean supervenience is thus shown to crucially depend on the status of these two conditions, and Maudlin finds both seriously defective. First, he thinks that quantum mechanics shows *separability* to be false. Second he argues that the practice of science does not warrant the claim that nomological facts supervene on the physical state of the world, since the states do not determine the laws. I tend to agree that *Humean supervenience* fails, but on the whole I find the failure of *physical statism* to be more clearly convincing – in particular with respect to modal, not merely nomological, facts generally. Let me take them in turn.

Maudlin's main argument against *physical statism* is that in the practice of science two different incompatible laws may have models with the same physical state. According to Maudlin, a model of a law, or set of laws, is a possible way the world could be if governed by the laws. At any given time, the state of the world at that time is a time slice of the complete arrangement of such world. The state of the whole model is then the full time evolution of such slices. It seems obvious then that two different and incompatible sets of laws may share the same state – since they may well share the same model. Maudlin cites the example of flat Minkowski spacetime which is both a model of general and special relativity. There are other examples one could think of. For instance orthodox quantum mechanics and quantum diffusion theory (a stochastic version of the theory endowed with a non-linear version of the Schrödinger equation) share many models - in fact they share all models for a completely isolated system.

However, the validity of this argument depends upon taking a robust ontological view of laws, possibly as primitives in the sense of Maudlin. For if laws were just Humean best-system regularities then the argument would not fly. For given only one physical state of the world, the Humean must accept only one set of laws. So the Humean can not accept that the laws of special and general relativity both simultaneously 'govern' the same world. Presumably, for the Humean, the laws of special relativity (say the principle of relativity between non-accelerated frames, or the Lorentz transformations,

or the light cone structure of Minkowski spacetime) are just approximately true regularities, but they would not appear in the best-system *laws*, which would only contain the laws of general relativity. So there seems to be some circularity in this argument since in order to show the failure of Humean supervenience via a failure of physical statism, we seem to need to first assume a non-Humean account of laws, i.e. a failure of Humean supervenience!

An alternative interpretation of Maudlin's argument is roughly as follows. Suppose that following Maudlin (pp. 12-15) we distinguish between fundamental laws of temporal evolution (FLOTES) and all other non fundamental laws, which might or not supervene on FLOTES. We could then argue that for the non-Humean it becomes trivial that two different sets of laws can share a model. In the example above general relativity would provide the FLOTES, while special relativity can give at best effective or approximate laws. It follows that there might be violations of *physical statism* wherever FLOTES and non-FLOTES apply to the same domain, since these laws may well share a model, as in the relativity case. But would this distinction pose a problem for the Humean? I fear the Humean has a similarly easy way out: on his / her account the true set of laws can only be the one that results out of best system analysis. So whenever two sets of 'laws' appear to apply to a domain – or to be precise a particular region of the Humean 'mosaic' – the Humean will have the obligation to discount whichever does not result out of the best system analysis. Hence the Humean will typically not admit that effective 'laws' are genuine laws; and *physical statism* is safe again.³

A better argument against *physical statism* is in my view provided by objective chance. It is easier to show that two different chance-ascriptions are compatible with the same state of the world. The coin I hold in my hand has chance $\frac{1}{2}$ of landing heads. This chance is compatible with any sequence of results in an experiment of tossing the coin, say, 10 times. If the coin was loaded and its chance of heads was, say $\frac{1}{3}$, it would still be compatible with any sequence of results. So it is clear that two different chance ascriptions are compatible with the same world state. This is, after all, at the heart of all the problems the Humean has in accounting for chance (see Lewis, 1986, pp. 83ff.). The practice of science shows that there is chance, or chance ascriptions at least – for the concept of a stochastic process or law would be impossible without chance. A stochastic process is roughly a temporal succession of states related with a particular transition probability between the states. Transition probabilities then represent the chance of a dynamical change of state. If there was no objective chance there would be no well defined transition probabilities, and hence there would be no change or evolution of states in indeterministic theories. This is in blatant contradiction with current physics practice; hence there must be objective chances, and *physical statism* is false.

Maudlin does not employ this argument, although he does agree that stochastic or probabilistic laws provide the strongest grounds against *physical statism*. He would not say though that the concept of stochastic law requires the concept of chance, but the other way round: chances supervene on stochastic laws, and it is the laws that are basic. He then tries to argue that stochastic laws on their own ground the claim above according to which different incompatible laws can share the same models. His

³ Admittedly this response to Maudlin depends on it not being possible for the Humean to accept genuine but non-fundamental laws that do not reduce or supervene upon the fundamental laws over the same domain. It is hard to see how the Humean could argue for this, given his or her commitment to supervenience (and Maudlin does not appeal explicitly to this possibility anyway).

reasoning is that two different incompatible laws that ascribe different chances can share not just one model but will share them all; this is in agreement with the fact that a coin with chance $1/3$ is compatible with the same number of sequences of results as a coin with chance $1/2$. I see two problems with this argument. First, it assumes a particular notion of chance as a probability ascription to some event, according to which chances are just the probabilities ascribed to events by the stochastic laws. This is controversial. Many philosophers believe that objective chances are rather dispositional properties of events or objects themselves, and stochastic laws govern the evolution of the probabilities for their manifestation (e.g. Mellor, 1971). On this view chances are more primitive than laws. So on this view Maudlin's argument can not get off the ground because the models *include* information about the different objective dispositional properties and thus we can not say that the two different laws *share* the same model. The other problem with Maudlin's argument is again related to circularity: to argue against *physical statism* from objective chances via stochastic laws requires us to believe first of all that Humean supervenience fails, at least for stochastic laws. The conclusion of Maudlin's argument is thus presupposed in the premises, and a Humean would not find it compelling. So although I agree with the conclusion that *physical statism* is in contradiction with our practice and is thus likely false (and therefore so is Humean supervenience), I do not think Maudlin has provided the best argument for it.

Maudlin also claims that *separability* is demonstrably refuted by quantum mechanics. He invokes here a whole tradition in the philosophy of quantum mechanics that claims that EPR-type correlations imply a failure of supervenience. The axiom of reduction in quantum mechanics allows us to work out the mixed states corresponding to each of the sub-systems in an entangled-state composite. It is then possible to show that the mixed states do not determine the state of the composite, so the global state of the composite fails to supervene upon the states of the components. Does this entail the failure of *separability*? This is arguably a much larger thesis. For any model of the EPR correlations that includes backwards in time connections, or non-local connections outside the light cone could perfectly well replicate the predictions of quantum mechanics. Such models exist outside quantum mechanics and they are separable. So it is by no means obvious that the phenomena violate separability. Maudlin seems to defend that if we take quantum mechanics to be the final word, thus rejecting such separable but non-local models, then *separability* definitely fails. But notice that there is a big difference between this claim and the superficially similar claim against *physical statism*. In the latter case we argued unconditionally from the practice of physics to the failure of a particular thesis regarding the relation between some concepts involved in that practice (*state*, and *laws*, *properties* or *facts*). In the former case we argue conditionally from a physical theory to a metaphysical thesis involving the physical state of the whole world. Underdetermination is notoriously rampant in the latter but not the former case. And indeed there are already other options, such as Bohmian mechanics. (Maudlin claims separability fails in Bohmian mechanics too, but this depends on ignoring the fact that in Bohmian mechanics the wavefunction lives in configuration space, not 3-d space – what *separability* means in configuration space is still an open question). There is the further problem that *separability* is entrenched in the ordinary practice of physics, as Einstein was so fond of reminding us – so its failure seems correspondingly bizarre. To sum up, the grounds for *separability* are stronger than Maudlin admits.

The aim of chapter 3 is to show that the standard metaphysics of substance and property that the Humean mosaic presupposes is inconsistent with present-day gauge theory. The exposition of the technical details of gauge theory is lucid and clear. Together with the discussion of *separability* this is the only point in the book where physics is said to contradict the entrenched ontology of everyday or common sense inquiry, and I find it similarly contentious. According to Maudlin gauge theory contradicts the traditional metaphysical dichotomies between monadic and relational properties, intrinsic and extrinsic relations, and the substance / property dualism. In particular it shows that there are no metaphysically pure external relations. This entails a revision of the ordinary ontology because we tend to unreflectively suppose that most relations in the natural world are metaphysically pure – even though not necessarily external. (Metaphysically pure relations may be instantiated in a world in which only the relata of the relation exist; external relations do not only depend on the intrinsic properties of the relata – but also depend either on their extrinsic properties or on properties of objects other than the relata). My inclination by contrast is to think that underdetermination must weigh in here too, and that different ontologies will be compatible with gauge theory. And gauge theory itself is underdetermined anyway. Maudlin himself admits as much when he writes “The fan of philosophical ontology can no doubt find a way to jerry-rig an object that can do the same mathematical work as a fiber bundle” (p. 101). So it does not help us decide questions of metaphysics in the real world to conclude “that the structure of the world *might* be that of a fiber bundle” (p. 101). Then again, for all we know, it might not be.

Chapter 6 contains Maudlin’s attempt to show that his non-Humean package is explanatorily superior because it explains the Humean mosaic itself. This is because primitivism about laws and time passage yields a *productive* explanation of the total state of the universe. On the basis of the initial state we can explain the final state as a consequence of the productive causation of the final state by the initial state and the laws. (Maudlin follows Hall (2004) in distinguishing causation as genuine production from causation as mere counterfactual dependence). Humeanism by contrast is not able to explain either the initial or the final state of the universe by means of any laws, since the laws are precisely a feature of the mosaic, i.e. of the whole succession of states throughout time. And as Maudlin rightly points out in a productive explanation the explanans must be ontologically distinct from the explanandum. This is a nice argument that carries some weight for someone who has already rejected Humeanism; but I doubt that it would convince the Humean. He or she would reject the request for an explanation of the Humean mosaic, and would instead retort that every account has its own unexplained explainer – including, certainly, Maudlin’s own (primitive laws).

The positive arguments in favour of Maudlin’s positive theses (i), (ii) and (iii) are contained in chapters 1, 4 and 5 respectively. But they all turn out to be essentially criticisms of Humeanism! This is most evident in chapters 4 and 5, which are involved and sophisticated arguments against the reduction of the directions of time and of causation to local facts about particulars, and counterfactuals over possible Humean alternatives. There is an obvious problem with this argumentative strategy: it assumes that the only alternative to Humeanism is Maudlin’s non-Humean package. But if there are other non-Humean alternatives, then a rejection of Humeanism is not *ipso facto* an argument in favour of Maudlin’s package.

What are the alternatives? Two at least come straight to mind. They are neither varieties of Humeanism, nor “primitivist” about laws or time. First, there is a large family of causal and dispositional realisms, which take dispositions, propensities, causation, causings, causal relations, or causal laws, to be primary and non-supervenient upon the Humean mosaic (i.e. they take these notions to be irreducible to either particular matters of fact and their relations, or the kind of Humean laws of association that supervene upon them). Some of these views admit further entities – such as the passage or arrow of time – in the primitive ontology; others aim to reduce everything to the primitive causal or dispositional ontology. All of them stand very much to Maudlin’s critique of Humeanism.

A second alternative to Humeanism is a thoroughgoing representationalism that takes all fundamental physical notions – laws, time, causation, etc – to be features of the modelling practice of scientists, not of the world so modelled. Ronald Giere (1999), for instance, has defended the view that laws are just guiding principles in the construction of scientific models. Van Fraassen (1989) has argued that laws are not even needed for this job – since symmetries do all the work required. On such accounts reductionism is unnecessary, for there is no real parsimony attached to it – except possibly in the sense of intellectual economy. (Some of the most convincing and original passages in Maudlin’s book concern the critical rejection of ontological parsimony, or Ockham’s razor, as a methodological rule in either physics or philosophy of physics – see particularly pp. 3-4, 129-130, 179-181). Maudlin takes issue with one version of this approach in his critical dismissal of Van Fraassen’s rejection of laws of nature, on pp. 38-40. In my view he provides a controversial account of Van Fraassen’s views – which seems to trivialise the empirical adequacy of theories. And Van Fraassen’s is not the only, or even the most powerful, brand of representationalism around anyway.

To conclude, Maudlin has provided us with intriguing and interesting arguments against Humeanism. I have focused here on a few features of some of the arguments with which I disagree, even when I tend to agree with the conclusions. But one wonders how convincing the committed Humean would find them. And for non-Humeans, Maudlin’s primitivism about laws and the passage of time is only one among several options. Realism about causation or dispositional properties – with or without further ambitions to provide a reductive basis for other concepts – is another. A thorough representationalism that locates matters of ontology in the modelling practice of scientists is yet another. The arguments in this book are directed against Humeanism and do not compromise these other views. Realism about non-reducible or primitive laws and the passage of time does emerge as an attractive combination, and the book constitutes the most formidable defence of this position to date. But Maudlin does not show that we are forced to accept it. It is in any case a virtue in a philosophical book to provoke critical reactions and reasoned disagreement. *The Metaphysics within Physics* is a wonderful tour de force that should interest all philosophers of physics, and will keep them thinking hard for a long time to come.

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