

Abstract: Spacetime and the Patchwork Theory of Laws of Nature¹
Emily Fox-Penner

This paper outlines the challenge that fundamentalism about spacetime – the position that spacetime is characterizable by universal, exceptionless laws – poses to Nancy Cartwright’s patchwork theory of the laws of nature (PT). I briefly examine Newtonian absolute space before turning chiefly to general relativistic (GR) spacetime. I suggest that absorbing fundamentalism about spacetime will require discarding features of Cartwright’s particular metaphysics but allow us to preserve the epistemic motivation of the view.

PT holds that the laws of nature state genuine truths but not universal ones; they are only true in certain ‘domains.’ Cartwright argues that natural laws are a) derivative of the way the natures of things manifest in typical or experimentally controlled situations and b) tools we construct at a higher level of abstraction out of concrete phenomena, where phenomena are understood as interactions between the inherent natures of entities. Contexts and conditions in which our observations and experiments took place speak crucially to the domains in which our derived or constructed laws will be relevant. I propose two maxims to motivate at least considering PT. The first is that postulating the universality of a law is inherently more extravagant than the alternative and therefore requires a corresponding increase in the burden of evidence. The second maxim is that context limits how broadly we are warranted to generalize and induct.

Granting that GR spacetime is governed by universal laws, I find that spacetime’s role in gravitation and in delimiting trajectory-space pushes us to abandon a patchwork founded in Cartwright’s causal capacities in favor of a metaphysics of natures that is ill-defined, but no more so than the fundamentalist alternative. Considering the geodesic hypothesis alone suggests that the plausibility of PT may be bound up in what one has to say about the relationship between matter and spacetime curvature and the law in which GR captures this relationship.

GR characterizes spacetime as a four-dimensional smooth manifold (M) of variable curvature with an associated metric (g). Einstein’s field equations are a set of differential equations lawfully relating the curvature of spacetime encoded in g to certain features of matter – mass energy distribution – encoded in the stress-energy tensor T . If features of matter as basic as mass are tied to spacetime, shouldn’t this give rise to worry about PT? In the fundamentalist’s view it looks more extravagant to conceive of diverse laws governing matter managing to pan out by pairing lawfully to a universally governed spacetime than to be a full-blooded fundamentalist.

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Why grant some aspects of the world precise, universal mathematical description but insist that others have only patchwork and messy descriptions? In this picture the nature of laws themselves would not be uniform and universal, but also patchwork. Call this the mixed-bag objection.

From the perspective PT, when assessing whether all aspects of the order of nature should be capturable in the same kinds of laws the proper question is whether all of the features of the world we are trying to capture in our laws exhibit the same degree of stability in occurrence and generality in the concepts most amenable for their representation. The mixed-bag objection will hold much less force for PT if we can motivate within the PT framework the claim that the GR manifold, as a single connected entity, has exceptionally stable and universally applicable conceptual handles, while matter remains a messy hodgepodge. But in order to assert this, we need reason to believe that it would be wrong to take the field equations to indicate the existence of neat, universal laws about matter.

The defense of PT here might go as follows. Maybe we have good *a priori* or mathematical reasons to believe that M submits to the same universal, fundamental laws describing its nature in a tube in Jefferson Lab containing some protons and in distant galaxies. But to claim that this entails that matter therefore must fall under the fundamentalist program is just to beg the question about whether there exist universal fundamental laws governing matter. Cosmological observations involve streams of photons in a vacuum save for a comparatively huge massive object. The experiments in the labs are designed to replicate these basic features by shielding out everything except the effect of a gigantic mass on elementary particles. This looks like the same domain of complexity under PT.

If the choice is between fundamentalism about laws governing matter or the non-universality of the field equations, we could simply insist that we have better reason to believe that the field equations fail to be relevant to domains of complexity so far unrepresented in experimental confirmations of GR than to believe in universal governing laws for matter. In doing so we place PT at the mercy of the course of epistemic progress, but is this really such a problem for the patchwork theorist? Recall our motivation for PT: our metaphysics should be only so bold as our epistemology is rigorous. If epistemic progress achieves unifications of domains while abiding by these recommendations, then the patchwork theorist is hardly the worse for it. If candidate fundamentalist theories instead run roughshod over these maxims, then they don't really represent epistemic progress after all.

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