Larry Sklar, "Naturalism and the Interpretation of Theories" (2001)

I.

Naturalism means many different things to many different people. The variety of it that I am concerned with here goes something like this: "It is an illegitimate pretension of philosophy that it can present "orders" to science. Metaphysicians think that they can tell science what the limits are of acceptable ontologies. Epistemologists believe that they can provide science with the appropriate rules for accepting and rejecting hypotheses. And philosophers of language claim to tell the scientists what the bounds of meaningful discourse are and how the scientist's concepts accrue their meanings. But insofar as these philosophers pretend to base their own assertions on reasoning that is itself outside the bounds of science and that is prior to science, they live a life of illusion. There simply is not and cannot be a "first philosophy" that can find its grounds outside the conclusions of the best available science and that can dictate to the sciences from a higher standpoint.

To believe in first philosophy, it is claimed, is not only to fall into illusion. It is to maintain a position that throws roadblocks into the path of progressive science. Time and time again, it is said, we see the pretensions of philosophy being used to impede the advance of science.

For an alleged example: Cartesian philosophy demanded that our physical concepts eschew those referring to "occult" causal powers, that all causation proceed continuously in space and that all spatio-temporal relationships be framed in terms of the spatial and temporal relations among things and events. But Newton invokes the latent potentiality of all matter to attract all matter. Worse yet, it appears, at least on the surface, as though this gravitational attraction amounts to causal interaction at a distance. Still worse, it is Newton's famous claim that the basic laws of dynamics require the positing of absolute reference frames for rest and motion and absolute scales of temporal congruence which, for Newton, imply the falsehood of a relationistic account of space and time. For how many decades did a prioristic Cartesian metaphysics impede the full acceptance of the Newtonian scheme despite the latter's astounding scientific success?

Here is another alleged example: With the acceptance of the Newtonian program, it soon became a philosophical theme that many aspects of the new world-view (now thought of as the "mechanical" view although that term was once reserved for Cartesianism) were establishable as a priori philosophical principles. For an example there is the fact that Kant comes awfully close to trying to establish Newtonian dynamics and gravitational theory as a priori in his Metaphysical Foundations. Some of the Energeticists, especially Duhem, would claim in the nineteenth century that it was just this metaphysical a priorism that was leading scientists down the garden path of trying to discover mechanical models of the aether, instead of simply formulating the general, abstract phenomenological laws of electricity and magnetism as an autonomous discipline of physics.

Others would probably claim that philosophical a priorism in the guise of claims to demonstrate the universality of causation (Leibniz on sufficient reason, Kant on universal causation) stood in the way of many who ought to have immediately and enthusiastically welcomed quantum mechanics, even if that theory seemed to reject such universal causation. Indeed, even the great Einstein, it is argued, may have suffered from the perils to taking first philosophy too seriously.

Within philosophy attacks on first philosophy are often taken up by philosophers who can broadly be labeled "empiricists." It was, after all, Hume who first starts telling us about the "sophistry and illusion" that traditional metaphysics amounts to, but who, at the same time, espouses so many of the typical empiricist themes: immediate contents of sensation, the accrual of meaning by ostensive definition, generalization from experience by induction alone, the rejection of intelligibility to that which refers to what allegedly outruns the possibility of epistemic access, and so on.

But the naturalists I am concerned with are adamant that empiricism itself is just one more example of first philosophy run riot. Like any other first philosophy it establishes its theses on grounds that do not really advert to any contents of the best available scientific description of the world. And like any other first philosophy it is just as subject to claims of total illegitimacy. (Do we commit the Enquiry to the flames? It certainly doesn't look like a logic text, or a treatise on inductive science. Can we really climb Wittgensteinian ladders that actually don't exist?)

Worse yet, empiricism commits the same heinous crime of which the other first philosophies are convicted. It stands in the way of scientific progress.

Consider the claims of some cognitive psychologists that it was radical empiricist presuppositions that led not only to philosophical logical behaviorism, but to the psychological methodology of behaviorism that for so long impeded the progress of a full-blooded cognitive psychology, a psychology that legitimately posited such things as internal mental representations in its explanations of externally observable behavior.

Or again: Although the Energeticists claimed that it was mechanism promoted to the rank of first philosophy that impeded science by leading many distinguished researchers onto the time wasting path of a search for a mechanical model of the aether, one could also claim that it was the Energeticist's own empiricist first philosophy that came close to impeding the development of one of the late nineteenth century's greatest scientific accomplishments, the kinetic theory of gases. Empiricism led some to anti-atomism in a time when the positing of atoms was supported only in a very indirect manner by the laws of chemical combination and by the, then highly speculative, atomic and kinetic theory of heat. There are, indeed, those who claim that Boltzmann's unfortunate depression and eventual suicide were at least in part brought on by his fear that the scientific community would neglect his work because of the philosophically motivated objections to it launched by Duhem and others. Even if anti-atomism hardly held up the progress of science at all (or for very long), wouldn't that be crime enough if it were legitimate to attribute the anti-atomists stance to an a prioristic empiricism adopted as first philosophy?

If all first philosophy, empiricism included, is not only of dubious legitimacy but also bears the strong potential of standing in the way of scientific progress when taken seriously, why not do without it entirely? One way to de-fang its pretensions might be to reduce its claims to a "manner of speaking" or a "conventionally adopted framework." Then one could still talk in a philosophical vein, but would have to always keep in mind that any of the alternative ways of talking would function equally well. But even that approach has been subject to claims that it has its own a priorism, at least to the extent that it thinks it can distinguish the merely conventional ways of talking from the contentful assertions internal to science itself.

Why not, instead, just eschew anything like first philosophy altogether. “Let science be science.” And insofar as there are terms such as ‘metaphysics,’ ‘epistemology,’ or ‘philosophy of language,’ let them be nothing but, at best, honorifics applied to particularly large, deep or especially interesting bodies of the conclusions of science itself. Insofar as we can ask philosophical questions at all, their answers are to be sought in what our best available science tells us about the nature of the world. And if we feel that science could never answer some philosophical question or other, we ought to reflect on what is either on our part an antecedent limitation upon our conception about what science might be, or a failure on our part to really have in mind a question whose import we truly understand.

If it is issues of epistemology or of philosophy of language that we have in mind, then, presumably, many of the “mental,” or psychological, or social or linguistic sciences would be needed to properly deal with the questions asked. But what if our questions are questions of metaphysics? Well, insofar as things like the mind-body problem are metaphysical, presumably there too everything the neurologist and psychologist could tell us about “mind” would be relevant to answering the questions. But if the metaphysical questions are questions about the fundamental stuff of the world, including the world of the non-mental, then surely physics, indeed foundational physics, is the place to look for the scientific answers to the questions. Indeed, one prominent line has it that even if it is such questions as the existence of abstract objects – universals or sets or numbers – that is in metaphysical question, the answers are to be found in foundational physics. What exists is what foundational physics says exists or what foundational physics presupposes as existing (modulo such emergent things as minds).

II.

There could be a host of reasons for challenging this “naturalistic” proposal. But there is only one such objection that I will be concerned with here. We are to take as that which exists that which our fundamental physical theories tell us exists, or, perhaps, that whose existence these theories must presuppose in order to be true. But does a fundamental theory ever really tell us what exists – according to its own lights? The problem I am concerned with here is this: All of the fundamental physical theories I know about are subject to multiple interpretations. And what there is in the world according to one of these interpretations is very often not what there is in the world according to some other of these interpretations.

Why are there manifold interpretations of these fundamental theories? Here I am not concerned with the game that one can play by ignoring the science altogether and simply reformulating the theory in various ways according to some Carnapian framework manipulation. It is not, say, that we can substitute n-tuples of numbers for spacetime points, say, that is bothering me here. The interpretations I am concerned with, rather, are those that arise out of debates within the scientific community over how to understand exactly what some fundamental theory or other is telling us about the nature of the world.

These debates are always driven by specific problematic aspects of the fundamental theories themselves. It is out of the internal difficulties presented by the theories that the interpretive debates arise. Each and every fundamental physical theory that I know of has been born with such puzzling and problematic aspects. It is in trying to ease the puzzlement and resolve the problems within science that the multiplicity of interpretations are proposed.

Should classical dynamics be interpreted in the form that uses Newton's absolute space and time? Or, rather, should it be interpreted using what is called Galilean or neo-Newtonian spacetime? Or instead of these should it be reformulated to use only spatio-temporal relations as in its Machian versions? Should force be taken as a primitive in the theory, as Euler and Daniel Bernoulli believed? Or should it be eliminated from the theory entirely as many since D'Alembert have proposed? Should the accompanying gravitational theory be understood as positing action at a distance? Or should that theory be taken as merely a temporary expedient to be replaced by a field theory? Or, to mention another alternative once proposed by Hertz, should it be viewed as expressing a constraint imposed on visible matter by the configuration and motion of an invisible aether?

This variety of interpretations does not disappear with the transition to the special and general theories of relativity, for these too can be viewed from the perspective of a multiplicity of viewpoints. Indeed, many of the old arguments about how to understand the Newtonian theory reappear, sometimes subtly transformed, in interpretive debates about the relativistic theories.

Quantum mechanics, of course, is notorious for generating interpretive controversy. Should it be understood in the quasi-instrumentalistic version of Bohr's Copenhagen interpretation? Or should it be understood from the violently opposed point of view of Bohm's theory of determinate particle positions and "pilot waves" with instantaneous action at a distance? Or must we revert to idealism to understand the theory as Wigner insisted? Or, instead, is the theory telling us about a universe that is constantly splitting into innumerable parallel coexisting but non-interacting multiple universes?

Even statistical mechanics is open to a wide range of interpretations. Are its probabilities measures of actual frequencies of outcomes in "real ensembles?" Or are they measures of rational expectation to be inferred from an inductive logic? Is it "mixing" that grounds the approach to equilibrium, or is it, instead, the many degrees of freedom of the systems and their (sometimes) low densities? Is the origin of temporal asymmetry to be found in an initial "improbable" smoothness of spacetime at the big bang? Or does it arise instead out of some underlying time asymmetry of the dynamical laws of quantum mechanics?

And so on.

How can we ask our fundamental physical theories to tell us about what there is in the world when each of those theories is subject to multiple interpretations, interpretations that often radically disagree with one another about what kind of a world the fundamental theory is really describing?

One natural suggestion is to try and eliminate this super-abundance of interpretations, not by adopting one or another of them, but, instead, by identifying the theory with "what all the interpretations have in common." Find the equivalence relation that makes them all interpretations of "one and the same theory," and identify the theory as the equivalence class of all these interpretations generated by that relation.

But that proposal always comes down to the same thing, as far as I can see. It amounts to claiming that the theory is nothing but the set of lawlike generalizations true of the theory's observational consequences. And even thinking that this notion is comprehensible, that is that one can make sense of the notion of "all possible observational consequences" of a theory as distinct from the set of all its consequences in general, is to assume an enormous chunk of that very empiricism that was being derided as just one more obsolete first philosophy. And to assume that it is legitimate to identify the theory with the set of such observational consequences, if such a set is a coherent notion, is again to make a philosophical commitment to one of the major themes of traditional empiricist and positivist thought.

So if the naturalist is going to hold to the demand that the only legitimate metaphysics is that generated by what the fundamental theories of our best available science tells us constitutes the world, is this naturalist then going to be happy with the possibility that these theories leave this metaphysics in a radically under-determined state? Not because of any of the sorts of trendy relativism about science that flow from some version of the sociology of knowledge or other, nor because of the possibility of trivial re-writings of the theories, but because of the persistence within fundamental physical science of a multiplicity of interpretations for our best available foundational physical theories.

III.

One challenge to naturalism, then, is that the necessity for interpreting fundamental physical theories makes it very dubious that any such theory "by itself" can tell us to what kind of world we are committed to as metaphysicians when we accept the theory as correct. But there is another way in which the issue of interpretation within fundamental physical science casts doubt on the claims of the naturalist.

When presented with the need to provide an interpretive understanding of a foundational theory, what are some of the strategies employed within foundational science itself? There are many such fundamental theories and they certainly differ from one another in a wide variety of ways. And the internal difficulties they confront are manifold as well. So we expect that each "unhappy" theory will be unhappy in its own way and that each such theory will require an individualized therapy to bring it to some state of conceptual equilibrium. In other words, interpretations will have to be custom designed for each problem case. We cannot expect one program of "universal interpretation" to do justice to all of the cases of interpretive need that arise in foundational physics.

Nevertheless, it is certainly possible that some common elements might be found that appear and reappear across a variety of interpretations for a variety of foundational theories. Can we discover any such threads that weave through the fabric of interpretation? I believe we can.

One such thread, by no means the only one, is a general principle of "retreating to the local." When confronted with empirical or conceptual difficulties in a fundamental theory a common proposal is to reconstruct the theory on a basis that relies only upon physical relations that can be construed as existing only “at a point” or “within a small region” and by avoiding as basic any physical relations that one must think of has having a “distant” or “global” nature. Let us look at some examples of this “going to the local” as it appears across a variety of theoretical interpretations.

When the null results of the round-trip experiments with light seemed to show that as far as experimental results “at a point” were concerned it looked as though the speed of light was the same in all directions in all inertial frames, Einstein responded with his famous critical examination of the notion of distant simultaneity. Any attempt at discovering the “real” one-way speed of light in a laboratory frame required synchronizing clocks at a distance from one another. But this could not be done “directly.” Only some process that restricted itself to determining physical relations locally could legitimately be used to determine when events at a distance from one another were to be taken as occurring “at the same time.” In constructing the spatio-temporal relations of one’s theory it is considered legitimate to take as fundamental and undefined the notion of two events being coincident, of occurring at the same place at the same time. It is also implicitly viewed as legitimate taking continuity along any path in the spacetime that can be traversed by a material signal as fundamental and undefined. But it is denied that it is legitimate to take as undefined either features of the spacetime structure itself (as opposed to features of the material occupants of the spacetime), or to take as undefined even relations among the material things, so long as those relations are “at a distance.” The simultaneity of two distant events or the equal length of two rigid rods that are separated from one another cannot be used as primitives.

It is within this framework that Einstein then goes on to propose a “definition” for distant simultaneity, a structure for the spacetime of the world, later formalized by Minkowski and called by his name, and a set of physical laws that would retain the traditional laws of electromagnetism, that would revise the older Newtonian dynamical principles, but that would retain the principle, true in the older dynamics and apparently false in the older understanding of electromagnetism, that all inertial reference frames are fully physically equivalent to one another.

The idea that physical theories ought to be founded upon undefined notions only if those notions are properly “local” is also implicitly at the heart of Einstein’s second great physical theory of spacetime, the theory of general relativity. That this is the case was not so apparent at the inception of the theory. The theory arose out of an attempt to find a relativistically acceptable theory of gravitation. Einstein’s initial motivations came primarily from noting the degree to which gravitational force was equivalent to viewing phenomena from the point of view of an accelerated reference frame, and from the desire to find a theory that would conform to Mach’s relationism. That ideas of “going to the local” were playing a crucial role was only realized later.

Faced with his discovery of the “hole” argument, the fact that the theory seemed to allow multiple possible curved spacetimes in a region devoid of non-gravitational mass-energy for a single fixed set of boundary conditions, Einstein worried that his theory failed, inappropriately, to be deterministic. His way out was to show that the multiple solutions all led to the same intersections of paths of test particles and light rays outside the “hole” and to the same proper time measurements on clocks transported through the hole. And, it could be argued, once again, that only these relationships among material test objects "at a point" counted as the physical facts the theory needed to save. The multiple solutions to the equations could then be viewed as simply alternative representations of the true factual contents of the theory.

Further reflection of the way in which the theory disposes of Newton's gravitational field, and, at the same time disposes of Newton's global inertial reference frames that had been preserved in the special theory of relativity, replacing these with locally determined "free fall" reference frames and accelerations determined relative to these, once again suggests that proper understanding of the theory requires an interpretive program that restricts attention to that which is locally determinable as that which constitutes the factual content of the theory.

But it is not only in spacetime theories that we find such "retreats to the local" when interpretive problems arise. The next examples I am going to give, however, are much more problematic than those which arise out of spacetime theories. For one thing, the notion of "the local" is vaguer than the notion of pointlike spatio-temporal coincidence that keeps coming up in interpretations of relativistic spacetime theories. For another, these interpretations are far from universally accepted as the right way to go about solving the interpretive problems with which they are designed to deal.

Quantum field theory is supposed to provide the solution to scattering problems. A group of particle thought of as "free," as non-interacting, approach one another. As their spatial separation diminishes they interact. After a long time a group of outgoing particles, once again not interacting with one another, is seen. Given the input particles, and their energy, spins and momenta, with what probabilities do which output particles emerge and with what energies, spins and momenta? That is a typical scattering problem.

Quantum field theory is usually based on a number of axioms. Some of these embed the principles of quantum mechanics into the theory, and some the relativistic spacetime posits. The problem is that in the standard older version of the theory, if one is not careful, it is possible to show that the only solutions consistent with the axioms are those in which the interaction is null. Only free particle solutions exist (Haag's Theorem).

There is more than one way to try and deal with the problem. One way is to stop thinking of the particles long before and long after the interaction as really "free." Instead a subtler technique is invoked to try and say what is meant by the particles being asymptotically non-interacting (LSZ approach). With this move the source of the problem that resulted in Haag's Theorem is circumvented. (Essentially the standard approach requires two "lowest energy states," "vacuua," whereas the axioms entail that there can only be one.)

But a different, broader, approach finds the difficulties with the theory in its reliance upon physical quantities that can only be globally defined. Even a single "particle" in quantum field theory is a global entity, a field with values at every spacetime point. Perhaps, once again, the solution to the interpretive difficulty should be found in "going to the local." Out of this perspective comes the "local algebraic approach" to quantum field theory. Here the fundamental mathematical elements introduced are supposed to correspond representationally to things such as the responses of spatio-temporally limited "particle detectors." Elements representing the global, the old quantum fields, are eliminated.

Were the local algebraic approach only of use in solving this one technical problem of quantum field theory, it wouldn't get much attention. It has, however, other, more profound uses as well. Even working in the flat spacetime of special relativity, quantum field theory can be shown to have some very puzzling consequences. A quantity in the theory might be thought of a representing the total number of particles in the universe. But it is a peculiarity of the theory that it seems to say that if an inertially moving observer declares the universe to be empty of particles, any accelerated observer will be forced to declare the universe populated by a non-null collection of particles with a specific probabilistic distribution of their energies.

There are a number of ways of dealing with this puzzle. One way is to declare the inertially moving observers "privileged," and to account for the particle numbers imputed to the world by the accelerated observers as "mis-readings" of the world due to their motion. Or one could take particle number to be relative to state of motion. Indeed, one can show that the different particle numbers are "complementary observables" that bear a fascinating analogy to the "complementary" position and momentum of ordinary quantum mechanics. But another alternative is to once again remark on the "global" nature of particle number as a feature of the world, and to try and reconstruct the theory in terms of only more local quantities. From this perspective it is the responses of spatio-temporally local particle detectors carried by the observers that are the real elements of the theory's concern. It is the establishment of lawlike correlations among these detection probabilities that is, from this perspective, the goal of the theory. Not surprisingly, once again it is the local algebraic formulation of the theory that is best suited to interpreting the theory in this manner.

But it is when one moves to the problem of understanding quantum field theory and the underlying spacetime is taken to be the curved spacetime of general relativity, that the local algebraic approach truly come into its own. Quantum field theory in curved spacetime is a way of bringing gravity into the quantum field theoretic picture. It is only an intermediate step, since it still takes the spacetime itself as classical. But it is, for example, the hybrid theory that allow us to do such things as attribute temperatures to black holes and to predict their quantum "evaporation."

In curved spacetimes, the particle number attributed to the world will vary from reference frame to reference frame. Even distinct, freely falling observers will come up with different particle number attributions. As usual there is more than one attitude one can take. You can take particle number to be a relative property of the world. You can eschew the notion of particles and the numbers of them as fundamental at all, focusing instead on the quantum field as the fundamental bit of global ontology. Or you can, once again, go local. Here, as before, the talk becomes that of particle detectors moving along locally construed spacetime paths. It is the probabilities of responses of these detectors to particles of different kinds, energies, momenta and spins with which the theory is concerned, and the lawlike correlations among these quantities that are fundamental. Once again it is the local algebraic approach to the theory that is ideal for reconstructing the theory in this vein.

This interpretation by “going to the local” is far more problematic than those that are used to understand the spacetime theories. For one thing, this interpretive move is far more controversial. Many interpreters of quantum field theory reject this whole way of going about understanding the theory. For another, the notion of what is “local” is harder to get a grip on than it is in the spacetime theory cases. In the latter, it is coincidences of events “at a point” and continuity along paths in spacetime that can be traveled by material signals that are taken to be the “local” facts. In the quantum field theoretic case it is detections by spatio-temporally limited detectors that are taken to be the local facts.

Indeed, there are additional problems with quantum field theory that lead interpreters to deny that “local facts” in the strict sense can be legitimately dealt with by the theory. That is to say, to avoid a number of other problems that the theory can run into, it is often suggested that values “at a spacetime point” be excluded from the domain of facts whose probabilities are to be predicted. Instead quantities that result from “smearing” some pointlike value over a region are to be preferred as the “real physical facts” with which the theory is to deal.

I am certainly not claiming that “going to the local” is the only move to make in interpreting a fundamental theory, nor that what “going to the local” means is a simple matter. Even when it is invoked, its nature is highly dependent on the physical theory in question and on the interpretive puzzle to which the interpretive move of “going to the local” is responding.

IV.

Despite the varying meanings “going to the local” can have in interpretive programs, and despite the varying purposes to which it is directed, can we find any general features that all of these interpretive problems have in common, and any general features of what it is about “going to the local” that is supposed to be helpful that cuts across the variations from case to case?

In all of the cases of theory interpretation that rely upon “going to the local” a similar pattern emerges. A theory is found to be unsatisfactory. The failure of the theory is not one of simply predicting the wrong observational results. Rather there is something “conceptually” defective in the theory. The theory may have some wildly wrong prediction (that there is no interaction possible at all, say). Or it may imply that one of its fundamental quantities is observationally indeterminate (the absolute velocity of the laboratory frame with respect to the aether, say, or the absolute value of a uniform gravitational field that is everywhere present). Or the theory may deal in some quantity that is thought to be peculiar as a relativized quantity, but whose value is forced to be relational in the usual theoretical formulation (such as particle number in quantum field theory). Or the theory may have a broad consequence that doesn’t seem appropriate to its description of the world (implying that the world is indeterministic when nothing in the theory seems to be real grounds for indeterminism, say).

One desires to find a new “reformulation” of the theory, or a “reconstrual” of it, or just a new “interpretation” of it, that will retain the theory’s empirical and theoretical successes but that will avoid whatever in it gave rise to the conceptual difficulty the theory faced. The suggestion often is to observe that the theory has many elements in its representational structure that go far beyond that directly necessitated by data or the data’s regularities. Could it be that some (or much) of this representational structure is excessive? Could it be that the source of the conceptual problems lies in a part of the representational structure that is otiose? If that is so, perhaps the way to preserve the virtues of the theory and to rid it of its defects would be to "thin down" the representational structure of the theory, retaining what is needed but eliminating that which was excessive and which generated the conceptual anomalies.

In the spacetime theories it is some part of the spacetime structure that must go. In the quantum field theory case it may be particles (as they are construed in the theory) or, perhaps, the quantum field itself. The parts of the representational structure that are suggested as eliminable are always those that dwell in the realm beyond that which deals with the predicted results of observations and experiments. We don't, after all, "see" the spacetime structure or "observe" the quantum field. It is "epistemic remoteness" that is a necessary condition for being eligible for consideration as a part of the theory that could be possibly be dispensed with altogether, with the needed part of the theory being preserved.

And it is here, of course, that "going to the local" plays its role. In the spacetime theories it is taken for granted that the spacetime structure itself is not conceivably part of the "observable" realm dealt with by the theory. Only the behavior of material things (moving particles, light rays, clocks, measuring rods) could possibly be taken as part of the observable structure of things. And not even all relations among the material are observable. Only those relations among the material things that are local can be taken as being among the observables. So we can not only think of thinning down our theory by dispensing from it some of its posited spacetime structure, we can also contemplate with ease removing from it some posited relational structures among the material objects, so long as these relations are non-local. Distant simultaneity is dispensable in framing the spacetime of special relativity, and, along with the gravitational field and the neo-Newtonian spacetime structure, global inertial motions are dispensable in framing general relativity.

This suggestion, that the non-local relations among material things must be considered as being trapped in the realm of the in principle non-observable, pre-dated any of its really fruitful applications in the forming of the relativistic theories. It was the centerpiece of Poincaré's famous argument, dating back to the turn of the last century, to the effect that a choice among the Euclidean or axiomatic non-Euclidean geometries for describing the space of the physical world was purely a matter of "convention." But one need not accept the full brunt of Poincaré's conventionalism to agree with him, at least implicitly, about the once-and-for-all non-observability of non-local relations even among observable material things.

Are the constructions of the modern spacetime theories, or at least their interpretations, founded, then, upon an implicit distinction between the observable and the non-observable entities and relations posited by theories? Are they governed by an epistemically motivated preference for the observables as the items to be retained when, in dealing with conceptual anomalies, a theory is to be subjected to ontological "thinning out?"

An interesting discussion of this issue is in Reichenbach's Axiomatization of the Theory of Relativity dating back to the early 1920's. In the introduction to the book Reichenbach takes up the issue of using spacetime coincidence as a primitive in any formal reconstruction of the theory. He argues there that this is not because coincidence is somehow a fact that is completely theory independent and knowable directly and perhaps with certainty?. Those features could only hold of "subjective coincidence" and not of the physical, "objective coincidence" on which his formalization of relativity is based.

Why, then, is coincidence the right primitive concept to employ? It is because it "is justified by the consideration that objective coincidences are elementary facts…that remain invariant with respect to a great variety of interpretations." But this seems to put the cart quite decisively in front of the horse. Isn't it, rather, the case that we will count alternative accounts as interpretations of one and the same physical world only when they preserve all the predictive content of the theory in question with respect to spacetime coincidences? And isn't that demand based upon some epistemically motivated "theory independence," or at least relative theory independence, of coincidence facts?

To be fair to Reichenbach, it may be that he is only trying to avoid the suggestion that in basing the spacetime theory on local coincidences he is trying to found physics on "irrefutable facts" or on "totally theory independent concepts." Claims of objective coincidence may be fallible, like any other physical claims, and, he explicitly says, we may eventually reformulate physics without using the conceptual basis of objective coincidence at all. But those claims would still be compatible with the view that it is the epistemic priority of coincidence claims over claims about spacetime structure itself or claims about non-local relations among material things, that gives even objective coincidence its special role in interpreting the theory. It still is true though that the invariance of coincidence through many interpretations is a consequence of this assumed priority, and not the grounds for it.

Without pursuing the details of the interpretations of quantum field theory, used as my other example of an interpretations that is based in part on ontological thinning out grounded on saving the local and dispensing with the global, I think it can safely be asserted that here too it is the assumption, often implicit and taken for granted but sometimes explicitly asserted, that the basis for the distinction between the two classes of concepts and the motivation for reconstructing the theory using only the local notions, is the epistemic priority of these features. It is because we can dismiss the global aspects of the world as not open to experimental determination in the way in which the local aspects are, that when we come to reconstruct the theory, or to interpret it even if we leave its formal construction alone, we must use as our primitive concepts only those in the theory that characterize these local features of the world.

V.

The interpretive practice of thinning the ontology of a theory by "going local" in moving to a more restrictive conceptual basis for the theory certainly bears elements in common with familiar empiricist philosophy. Looking upon non-local concepts of the theory as dispensable, or as at best merely representational, will seem reminiscent of empiricist attempts to understand the role of material object concepts in a world whose fundamental entities are taken to be some kind of immediate content of experience. One can dispose of them with Berkeley or treat them as some kind of instrumental "logical constructs" with the phenomenalists. Distant simultaneity in special relativity, global inertial frames and gravitational fields in general relativity (and, perhaps, even the curved spacetime structure itself), global particles (and perhaps the quantum field itself) in quantum field theory, are all treated in various interpretations in the manner in which the not-immediately-perceivable gets treated in traditional empiricism.

But, of course, as Reichenbach emphasized, there are grave differences as well between such interpretive schemes in foundational physics and traditional empiricism. The "local" features held onto are still "physical" and "objective." There is no claim that they are truly knowable without any theoretical inference at all, or that knowledge of the facts involving them is in any way immune to empirical refutation or disconfirmation. The local facts are only relatively "observational," as opposed to the "merely inferred" global facts, in a particular context where a particular theory is being interpreted in order to deal with its specific conceptual anomalies.

Nevertheless, the scent of "first philosophy" is in the air when these interpretive programs are being bruited in the scientific context.

It may be suggested that the presence of such empiricist ways of thinking within science is just an indication of how scientists themselves may be influenced by philosophical trends from outside their true profession. But this won't do. The interpretive moves that we have been talking about are made in response to genuine conceptual problems internal to foundational physical theories. It is not idle philosophizing that motivates these interpretive constructions and reconstructions of theories, but existing internal problems of the theories themselves, problems that cry out for serious scientific solutions. And it is not empiricist or positivist prejudice that leads some (or sometimes all) of the scientific community to accept one of these interpretations as the "correct" way of dealing with the conceptual anomaly in question. It is, rather, the success of the interpretation in resolving the existing scientific dilemma that motivates its being absorbed into accepted science.

The motivation of one of these interpretations is, then, scientific and the appraisal of the success of the interpretation is also a matter of scientific appraisal. But what of the method of interpretation itself? Is it "scientific" or is it "first philosophy?" Or can any such distinction be drawn? Certainly the basic structure - retreating from a richer to a leaner conceptual framework and choosing that framework by considerations grounded in epistemic accessibility – is one that is familiar from the critical arguments of empiricist and positivist programs. But now it is such a program within science itself, and not the mere application of such a critique from an external, philosophically motivated perspective.

Consider the following question: Is it science itself that tells us that if we are to engage in such a program it should be structured by choosing as the legitimate conceptual elements to be retained those that are "local" in their nature? Is it science that informs the scientists that the epistemically accessible is the local? Or is that an a priori posit on their part? I don't know how to really answer such a question.

Certainly it is true that within science we often use science to tell us about how the elements of the scientific theory are to be experimentally determined. Einstein argued that no theory was "complete" unless it described its own observational procedures. It is that sort of thinking that has led to frameworks for relativistic theories that rely on the motions of particles and light rays to fix the geometry rather than on clocks and measuring rods. And it is the seeming inability of quantum theory to characterize classical measuring devices as required by Bohr, for example, that leads to some of the significant objections to his interpretive program.

Could it not be science that tells us that when we look for that which is empirically determinable we ought to look for the local facts dealt with by the theory? Could we not imagine a world in which global facts were "directly" available to observation? (Think of Newton is his unguarded Cambridge Platonist moment talking about infinite space as the "sensorium" of the Deity! Could we not be as such a God?) Here I tend to vacillate, sometimes thinking that the pragmatist could at least argue that fixing on the local as the observable was one more piece of bootstrapping within science that had no need of reliance on first philosophy, but at other times wondering if I can even imagine what a science could be like that wasn't grounded observationally in the local.

VI.

It has been a theme of analytical pragmatists, then, that we can escape first philosophy, as least as far as metaphysics goes, by relying upon our best available foundational physical theories to tell us what there is in the world. But, I have argued, these foundational theories remain silent about the basic contents of the world until they are understood or interpreted.

To claim that interpretation is unnecessary since all the interpretations are merely versions of one and the same theory is, I have claimed, to resort implicitly to empiricist first philosophy, and a pretty rigid version of that indeed. For only by such resort can we legitimately claim that there is some shared element that reveals what all the interpretations have in common. That could only be their sum-total of observational consequences construed in some old-fashioned empiricist manner.

But if we rely upon interpreted theories to give us our ontology, we must then ask how interpretation (in this sense) works. I have argued that at least one common thread in many interpretations is the process of responding to conceptual difficulties with a theory by thinning its ontology. This process is highly reminiscent of empiricist proposals to ground all assertion upon assertion about the observable alone. In the case of the interpretations within science, the need for such ontological retrenchment is based not on general philosophical views about semantics and its relation to epistemology, but upon the desire to confront internal scientific puzzles with the theories. And the acceptance of such reconstructions of theories is based on their scientific value in resolving the dilemmas with which the theory was originally confronted.

Nevertheless, the general process itself is one that is familiar from empiricist or positivist philosophy.

Within science the notion of "the observable" that is to be retained after the ontology of the theory has been pruned of otiose elements is often construed as the notion of "the local." Empiricism within theorizing often amounts to eschewing global elements of the theory's conceptual structure in favor of those elements referring to spacetime points or "small regions" alone.

It is arguable, perhaps, that some aspects of this whole way of dealing with theories has some of its own justification arising out of science itself. But that remains to be shown. On the surface, at least, what goes on in such interpretive projects within foundational physics looks to be based as much on "first philosophical" presuppositions as was the empiricism the pragmatist wanted us to replace with "science itself."

Indeed, from this perspective we might think of grand philosophical empiricism in a new vein. Perhaps the notion of a once-and-for-all totally theory independent characterization of the "observation basis" and a once-and-for-all logical construction or instrumentalistic characterization of everything outside of that basis is a philosophers illusion. But the process of "retreating to the observables" is one that is ongoing in a relative manner within the process inside of science of interpreting our foundational theories. From this perspective grand philosophical empiricism may be viewed (in a Kantian manner?) as the ideal limit point of a legitimate scientific pursuit.

Is that pursuit best characterized as internal science or "external" first philosophy? I am not at all sure I know what the difference between these is supposed to be.