REVIEW ESSAY

Arthur Fine. *The Shaky Game: Einstein, Realism, and the Quantum Theory*, University of Chicago Press, Chicago, 1986, paperback ed. 1988, xii + 186 pp., $10.95.

"Every absurdity has now a champion" – so Arthur Fine, quoting Borges, begins this delightful collection of papers. Those who think that Fine has, himself, championed a few absurdities in his day will be disappointed to learn that this is not self-deprecating humor, the principal intended target being instead the Copenhagen interpretation of quantum mechanics. But I suspect that Borges represents more to Fine than a source of quips with which to beat Bohr. For there is at least a certain affinity of style between Borges and Fine – combining creative imagination, playfulness, earnest depth, and a none-too-heavy-handed regard for history – which helps to explain why Fine's work is such a pleasure to read. One senses also that the Fine who promotes the Natural Ontological Attitude shares some of Borges's doubt that language, theory, and the world actually fit together in the way tradition would have it. And finally, like Borges, Fine is provocative, he moves one to think; which is perhaps more important than being right, as Fine also happens to be much of the time. Simply put, this is a good book, highly to be recommended.

Collected here are nine essays. In addition to the title essay, which serves as an introduction, two of the nine are new: 'Schrödinger's Cat and Einstein's: The Genesis of a Paradox' and 'Is Scientific Realism Compatible with Quantum Physics?' Four of Fine's earlier papers on Einstein are reprinted: 'The Young Einstein and the Old Einstein', 'Einstein's Critique of Quantum Theory: The Roots and Significance of EPR', 'What Is Einstein's Statistical Interpretation, or, Is It Einstein for Whom Bell's Theorem Tolls?', and 'Einstein's Realism'. And the volume is rounded out by the two "NOA" papers: 'The Natural Ontological Attitude' and 'And Not Antirealism Either'. Since the NOA program and Fine's views on the interpretation of quantum mechanics have been widely discussed elsewhere, this review will focus on what

Synthese **86**: 123–141, 1991.

Fine has to say about Einstein, with special attention being paid to Fine's interpretation of Einstein's realism as developed especially in the essay by that title and in Fine's essays on Einstein and quantum mechanics.

In what follows I will disagree in certain respects with Fine's analysis of Einstein's realism. In particular, I think that Fine at the very least gets the emphasis wrong in his discussion of the way in which a commitment to realism contributed to Einstein's critique of the quantum theory. And while I am delighted by the wealth of good history in Fine's essays, and by his way of using history to illuminate systematic problems, I will nevertheless point out a few places where Fine's analysis would have been improved and enriched by his having paid more attention to the philosophical and intellectual context within which Einstein worked. Among other things, greater attention to context would help to correct the imbalance implicit in so prominently featuring Einstein's realism. Caught up, as we are, in the realism/instrumentalism controversy, we, today, care a lot about whether or not Einstein was a realist, and about what kind of realism he may have espoused. When we read Einstein in the proper historical context, however, we see that the realism/instrumentalism or realism/positivism dispute was somewhat less important to him than it is to us; we see that, for him, Marburg neo-Kantianism, for example, was at least as much a threat as positivism.

But let there be no misunderstanding. I know of no one who has given us a more persuasive and enlightening account of Einstein's realism than has Fine, certainly not when it comes to the sensitive and sensible weighing of the import of Einstein's own words on the matter, and I strongly recommend Fine's essays to any student of the subject. Aside from specific points of interpretation, which I will detail below, I especially applaud Fine's careful use of correspondence and manuscripts from the Einstein archive. This is all the more important in the case of a thinker like Einstein, who deliberately aimed not to be a systematic philosopher of science, and whose views therefore cannot reliably be tracked in his published writings alone. Too much of what others have written about Einstein's philosophy of science is flawed by the selective use of published writings, as well as by reliance on secondary sources and on such primary source material as happens, by accident, to have found its way into print. The resulting interpretations are most often simplistic, superficial, and suspiciously flattering of their authors' own philosophical agendas. The Einstein who emerges from the archive is, by contrast, a complex figure, whose philosophy of science does not bend easily to fit the mold of popular, contemporary philosophical programs. But this Einstein is also, for that very reason, a more interesting figure from whom we have much to learn.

There is much that is new and provocative in Fine's characterization of Einstein's realism, such as his suggestion that realism for Einstein is not so much a philosophical doctrine about the needed fit between theory and reality as it is a program for the construction of certain kinds of theories, or his suggestion that the psychological aspect of realism – what Fine dubs "motivational realism" – is perhaps even more important for Einstein than its methodological aspect. I will discuss all of these issues in this review, but I want to begin with what is doubtless the most important point that Fine makes about Einstein's realism – important not only for our understanding of Einstein, but also for our understanding of how the philosophy of science ought to be done – namely that this realism is an integral part of Einstein's way of doing science. Gerald Holton (1968) was the first to explore with care Einstein's turn toward a more explicitly realistic philosophy of science, especially during the 1920s, thus correcting the still all-too-common view of Einstein as the patron saint of positivism and operationalism, and since then allusions to Einstein's realism have become something of a commonplace among commentators on Einstein. But Fine was among the first to insist that Einstein's realistic philosophy of science must be seen as continuous with his scientific practice, and in doing so he has helped to clarify the scientific roots of Einstein's philosophical commitments.

Fine coins the term "entheorizing" ('Einstein's Realism', p. 87) to describe Einstein's way of approaching what others might regard as traditional philosophical questions. Just as causality, for Einstein, is not so much a question of philosophical principle, but a question of whether or not causal theories work, so too realism is a question of whether or not realistic theories work. But what counts as a realistic theory and what does it mean to say that a theory works?

The latter question has been discussed by a number of commentators on Einstein, and something of a consensus has emerged that Einstein, always the good empiricist, regarded experience as the final arbiter of a theory's acceptability, but that, recognizing that empirical confirmation is often an elusive if necessary goal, he also placed great emphasis upon nonempirical criteria, foremost among them simplicity, as provisional guides to theory choice. What Fine adds to this standard picture (and it is a crucial addition) is a stress upon the holistic character of theory choice for Einstein and some reflections on what follows for certain traditional questions of semantics, namely, in what sense a scientific theory can be said to be "true" ('Einstein's Realism', pp. 87–91).

To say that theory choice is holistic is to say that it is only whole theories, and not individual propositions, that stand the test of experience. Recognizing that Einstein saw the matter thus is important for two reasons. First, it makes it clear just how far Einstein's view of theory choice stands from the orthodox positivist view, embodied in the verificationist theory of meaning, whereupon not only each empirical proposition in a theory but also each empirical term had to be tied down in a definite way to some empirical basis, say via correspondence rules. Second, it makes it clear how "entheorizing" can work, for surely one cannot pretend to put even a physicalized thesis of realism to an empirical test all by itself. Whatever makes a theory "realistic", that realism will no doubt be woven deeply into the fabric of the theory. What one does then is to ask whether whole theories, constructed according to realist standards, fare well in competition with non-realist theories.

There is yet another interesting aspect of Einstein's holism that does not, however, receive its due in Fine's hands, and that is conventionalism. Holists typically turn out to be conventionalists of the underdeterminationist, Duhemian kind, and Einstein is no exception. The reason is simple. If it is only whole theories that stand the test of experience, then in the typical case of a lack of fit between theory and experience, the fit can be restored by any of a number of different adjustments to the theory, each adjustment leading, in effect, to a different theory, all of the resulting theories squaring equally well with the available evidence. And the choice among these variant theories is thus, from an empirical point of view, a matter of convention, with, at best, non-empirical considerations like simplicity serving as a guide. This theme is clearly expressed in many of Einstein's writings, especially from the 1920s, but it is lacking in Fine's account. And yet it is important to an understanding of Einstein's realism, for a realism compatible with underdeterminationist, Duhemian conventionalism is not at all like the kinds of scientific realism so much in vogue today. Most contemporary scientific realists assume that the world our theories aim to describe is one, and that the method of science must therefore be such as always to sort out from among competing theories a single best theory; or at least that should happen in the infinite long run of inquiry. But Einstein's realism can live comfortably with the possibility that even in the long run there may be a multiplicity of theories all equally correct from an empirical point of view.

This is one of those places where more attention to historical context would be helpful, because an interesting story can be told about the varieties of conventionalism current in the early twentieth century, espoused by thinkers as diverse as Poincaré, Duhem, Schlick, Reichenbach, and Carnap, as well as about Einstein's acquaintance with and attitude toward them.[1] What one finds is a sympathetic endorsement by Einstein of the earlier robust conventionalism of Poincaré, Duhem, and the early Schlick, wherein any proposition in a scientific theory can take on the status of a convention, together with a thoughtful critique of the rather different conventionalism of Reichenbach and the later Schlick, wherein on the basis of a clean analytic/synthetic distinction only correspondence rules or bridge principles are accorded conventional status.

At this point Fine's remarks on the semantics implicit in Einstein's view of theories are relevant. For Fine contends that what the "truth" of a theory means for Einstein is simply empirical confirmation. And if that is the case, and if Einstein is a Duhemian underdeterminationist conventionalist, then it follows that there may be for Einstein a multiplicity of equally "true" theories of the world, surely not a view that would warm the heart of the contemporary scientific realist. Here again, some history would have been helpful, for it turns out that a rather similar view was defended in the middle to late 1910s by Moritz Schlick, at a time when his writings, such as the *Allgemeine Erkenntnislehre* (1918), were exerting a major influence on the development of Einstein's philosophy of science. And there is reason to think that Einstein was attracted to Schlick's point of view in part because of the way it helped him solve some riddles connected with the general theory of relativity, in particular concerning the sense in which the general theory can be said to admit of a realistic interpretation.[2] Exhibiting yet another such link between Einstein's physics and his philosophy of science only reinforces Fine's point about Einstein's tendency to "entheorize" issues like realism, to turn them into questions about the success of realistic theories.

This brings us back to the question of what counts as a realistic theory, a question best addressed in the context of this review in connection with Fine's discussion of Einstein's critique of the quantum theory, for one of Einstein's main reservations about the quantum theory was that it is not a realistic theory. Fine's account of this issue goes well beyond the facile remarks about the role of the observer in quantum mechanics customary in much of the secondary literature, and it has inaugurated a new round of critical investigations that have shed important new light on Einstein's real reasons for being dissatisfied with the quantum theory.

According to Fine, there are three chief characteristics of a realistic theory as Einstein conceived it. Such a theory must (i) provide a space-time representation of the systems and events it aims to describe, (ii) be causal or deterministic, and (iii) incorporate in a fundamental way the observer independence of the real ('Einstein's Realism', p. 98). But how did Einstein understand these three requirements? In particular, why did he think that quantum mechanics failed, thus, to qualify as a realistic theory?

When most of us think about Einstein's critique of quantum mechanics, we think about the Einstein–Podolsky–Rosen (EPR) paper (Einstein, Podolsky, and Rosen, 1935). But one of Fine's most important contributions to Einstein scholarship is his having been the first to point out that, from the very beginning, Einstein had misgivings about the EPR argument for the incompleteness of quantum mechanics (this in his 'Einstein's Critique of Quantum Theory'). As emerges from Einstein's correspondence with Schrödinger in the summer of 1935, right after the publication of the EPR paper, it was actually Podolsky who wrote the EPR paper, and Einstein's own argument for incompleteness was rather different from the published version, making no explicit use of the famous EPR reality criterion and no explicit assumptions about incompatible observables. What stands, instead, at the heart of Einstein's argument is what he calls the "*Trennungsprinzip*" (separation principle), according to which manipulations (measurements) performed upon one of two spatio-temporally separated systems, A, can have no effect upon the real physical state of the other, B. But in EPR-type experimental situations, where the systems A and B have interacted before separating, quantum mechanics assigns different theoretical states to B, depending upon the parameter we choose to measure on A. It follows that quantum mechanics is incomplete, since it associates two different theoretical states with what ought to be one and the same real state. Fine has uncovered evidence, in the form of an unpublished manuscript of Einstein's, suggesting that the roots of this way of conceiving the incompleteness problem may go back to as early as 1927.[3]

Subsequent research has traced the development and refinement of this argument in Einstein's later correspondence and writings, establishing most importantly its deep connections with (a) Einstein's commitment to field theories, and (b) his realism.[4] In the mature version of the argument, the *Trennungsprinzip* is further analyzed into two logically independent principles: (1) the "principle of the mutually independent existence of spatially separated systems" (which I prefer to call the "separability" principle), according to which any two spatio-temporally separated systems possess separate physical states that together exhaustively determine the properties of the joint system, and (2) the principle of local action (the "locality" principle), according to which one such separate state cannot be influenced by events in regions of space separated from it by a spacelike interval. Einstein argues that the first of these two principles, separability, is built into the ontological foundations of any field theory, inasmuch as the fundamental field quantities, such as the metric tensor, which are assumed to be well-defined at every point of the space-time manifold, implicitly determine a separate real physical state for each point of the manifold, these points playing the role of separate "systems" in the reductive, field-theoretic sense. In a more general sense, spatio-temporal separability is an essential feature of any theory providing a space-time representation of the kind that Einstein regarded as essential to a realistic theory, this in the sense that in such theories spatio-temporal separation is taken as a sufficient condition for individuating physical systems and states. The second principle is necessary to secure the testability of theories, Einstein argues, since without it we could not unambiguously characterize the notion of a closed physical system.

Einstein himself points out the connection between separability and realism in some remarkable comments that he included with an 18 March 1948 letter to Max Born. After saying, "I just want to explain what I mean when I say that we should try to hold on to physical reality", Einstein goes on to explain his commitment especially to the first of the two principles mentioned above, separability: "That which we conceive as existing ('actual') should somehow be localized in time and space. That is, the real in one part of space, A, should (in theory) somehow 'exist' independently of that which is thought of as real in another part of space, B" (Born 1971, p. 164). One wishes that Einstein had said more, but we can tease out at least two reasons why one might thus link realism and separability. The first is historical, for as Einstein himself explains, this is the form in which physical theory has always represented reality. But why history should so constrain us is not clear. The second is more subtle. It is that observer and observed must be viewed as, at least in part, interacting physical systems, and that a blanket assumption of the separability of interacting systems is therefore necessary to secure the kind of observer-observed independence traditionally assumed by the realist and highlighted by Fine as one of the essential features of Einstein's conception of a realistic theory.

Fine did not, himself, follow the story of Einstein's musings about separability, field theories, and realism to this conclusion. If he had, then his case for "entheorizing" as the key to understanding Einstein's realism would have been strengthened even more, because we now have Einstein's own testimony that what he meant by "realism" was not merely a philosophical doctrine about the interpretation of scientific theories, but was itself something with quite definite physical content: in effect, it is an assumption about the manner in which a physical theory individuates the systems and states constituting its fundamental ontology. We can also now appreciate even better the reason why Einstein's critique of quantum mechanics was invested with such emotion: it is because he saw in the quantum theory a fundamental challenge to the kind of physical theory that represented the essence of his life's work, the only kind of physical theory he thought worthy of serious investigation as a basis for the whole of a unified physics.

Understanding the role of the interaction problem in Einstein's critique of quantum mechanics can also help us to understand better the role in that critique of Einstein's famous commitment to determinism. Permit me a somewhat lengthy digression on this topic. Just how much Einstein was wedded to determinism, and whether it was more or less important than realism and field theories, is a matter of some dispute. Fine rightly inclines toward giving it a major role, seeing in it an enduring commitment of Einstein's and an essential aspect of what he dubs Einstein's "causal realism". But I think that he overstates the case when he claims that causality or determinism is more important to Einstein's conception of realism than are his demand for space-time representation and the associated demand for separability (or the separation principle, to use Einstein's own formulation, which Fine follows).

There is, for example, some evidence that, at least near the end of his life, Einstein was willing to compromise on the requirement of determinism. Fine quotes two of the most important pieces of documentation. The first is the letter from Wolfgang Pauli to Max Born of 31 March 1954, in which Pauli, who was trying to mediate a dispute over the completeness of quantum mechanics that threatened the thirty-eight-year-old friendship between Born and Einstein, wrote the following after a conversation with Einstein:

Einstein does not consider the concept of "determinism" to be as fundamental as it is frequently held to be (as he has told me emphatically many times). . . . Einstein's point of view is "realistic" rather than "deterministic," which means that his philosophical prejudice is a different one. (Fine, p. 101, quoting Born 1971, p. 221)

The second is a letter from Einstein to his life-long friend, Michele Besso, of 15 April 1950, where Einstein writes:

The question of "causality" is not actually central, rather the question of real existents, and the question of whether there are some sort of strictly valid laws (not statistical) for a theoretically represented reality. (Fine, p. 101, quoting Speziali 1972, p. 439)

But Fine's interpretation of these and similar remarks is curious, for he takes them to show not a retreat from determinism, but a reaffirmation of it. Thus, he introduces the previous quotation with the following comment:

Once again it is the conjunction of realism *and* causality ("laws" = nonprobabilistic laws) that is characteristic of Einstein's thought. And, even in the same breath in which Einstein tells us that realism is more central than causality, he actually conjoins the two of them – almost as though he didn't notice that they are linked together. (Fine, p. 101)

Surely this is unfair to Einstein. If Einstein said repeatedly, and to numerous different correspondents and discussants that realism, rather than causality or determinism is the central issue, and if he nevertheless also said that, as a realist, he wanted a nonstatistical theory, then it is not unreasonable to suppose that he had in mind some definite idea of how a realistic theory could be nondeterministic and yet also nonstatistical. At the very least, it is incumbent upon us, if our aim is truly to understand Einstein, to assume that he had in mind some coherent model for such a theory. We must begin our efforts at interpretation by taking his words at face value and asking how we can make sense of them. Only if sustained and sincere efforts to make consistent sense of his words fail should we conclude, reluctantly, that Einstein was guilty of the kind of contradiction insinuated by Fine.

Can we make consistent sense of Einstein's words? Let me make a suggestion. When Einstein spoke of a statistical interpretation, the sort of thing he wanted to avoid, what he meant was some kind of ensemble interpretation, an interpretation that construes the state function as pertaining not to individual systems but to ensembles. What Einstein wanted in an adequate (complete), fundamental physical theory was a theory whose states are regarded as states of individual systems.[5] But there is no inherent reason why the state of an individual system need be of such kind as to yield determinate values for all of the parameters characterizing that system; that is, the state of an individual system could itself be indeterministic, the "reality" pertaining to the individual system taking the form of objective, irreducible dispositions or propensities to manifest certain characteristics under certain circumstances, with strictly valid laws governing those dispositional states.

Now I do not mean to assert that this was, in fact, Einstein's view. But if one looks one can find additional evidence that makes such an interpretation not wholly implausible. Thus, the foregoing quotation from Einstein's 15 April 1950 letter to Besso continues (this portion is not quoted by Fine):

> That such laws do not exist for observable facts is completely clear. But the question is: Is there any substitute for "reality" as a theoretical program? In your idiom I would say: If the "cloud" is not an expression of a one-time-only state-of-affairs [*einmaligen Thatbestandes*], but instead only a "probability cloud", then there must exist behind the cloud an entity [*ein Ding*] with more characteristics. (Speziali 1972, p. 439)

Besso had introduced the "cloud" vocabulary in his letter to Einstein of 11 April, the letter to which Einstein is replying. Besso wrote that the question separating Einstein from most contemporary physicists was this: "Is the probability cloud not a reasonable generalization compared to strict givenness [*der strikten Gegebenheit*]?" Since the point of the "cloud" metaphor is to suggest something indefinite (not like a point in phase space), Einstein's rather tolerant allusion to the "cloud" (read "objectively indefinite physical state") as a "one-time-only state-of-affairs", this as opposed to a "probability cloud" (read "ensemble"), invites the speculation that he had in mind something like propensities or objective dispositions of individual systems as part of the ontology for one possible model of a nonstatistical but also nondeterministic and realistic fundamental physical theory.

A different perspective on Einstein's commitment to determinism is achieved if we ask how this may be linked with Einstein's commitment to field theories in his critique of quantum mechanics. Fine has little to say on this score. But an interesting story can be told. In outline, it is this.

Einstein's conception of a field theory – the background against which all of his work in physics must be weighed – included a very definite version of causality: an adequate field theory would be causal or deterministic in the sense that its equations plus boundary conditions determine a unique or unambiguous solution for the value of its fundamental field parameter – the metric tensor in the case of general relativity – at every point of the space-time manifold (modulo mere coordinate relabelings of those points). And the fact that these uniquely determined solutions are invariant under arbitrary coordinate transformations is connected, via the Noether theorems, with another aspect of causality or determinism, namely, strict energy-momentum conservation. Recall, as well, that such a field theory also has built into it the assumptions about the mutual independence of interacting physical systems – the assumptions of separability and locality – that are essential to Einstein's conception of a realistic physical theory. The point is that a kind of causality or determinism was for Einstein just as much an integral part of his conception of a field theory as were separability and locality, and hence, realism.

During the 1920s, however, Einstein gradually came to realize that, in attempting to explain quantum phenomena, one might be forced to choose between these two commitments, or more specifically, between the independence of interacting systems and the kind of causality embodied in the conservation laws. Certainly by the winter of 1924/1925, when he was reflecting on the Bohr–Kramers–Slater theory and publishing his three papers on the quantum mechanics of an ideal gas of material particles, Einstein had recognized that one gets the correct quantum statistics for interacting systems, while preserving the energy-momentum conservation that had been demonstrated in the Bothe–

Geiger and Compton–Simon experiments, only if one denies the statistical independence of those systems. This is exactly what is involved in the shift from classical Boltzmann statistics to Bose–Einstein statistics. As early as 1909, Einstein had recognized that interacting photons or "light quanta" lack such independence: what was new in the mid-1920s was the realization that the same is true for interacting material particles.[6]

Thus, when we find Einstein objecting both to the failure of separability in quantum mechanics and to the failure of determinism, we must realize that he is lamenting the fact that quantum mechanics forces us to choose to give up one or the other of these desiderata, both of which are built into the foundations of field theories as Einstein conceived them.

This very dilemma – either separability or causality (in the form of strict energy-momentum conservation) – is embodied in the modern quantum mechanical interaction formalism. In describing interacting systems, one can preserve the strong correlations needed to secure conservation only by using a nondecomposable joint state function. If you try to describe the interacting systems by means of separate state functions, you can guarantee conservation for at most one set of co-measurable observables (though conservation of other observables may come by accident, as it were, in special cases). One way of reading Bohr's doctrine of complementarity is as yet another expression of this dilemma, especially when complementarity is formulated as a relationship between "spatio-temporal coordination" and the "claims of causality", the former being Bohr's way of describing a physics – whether field theory or classical mechanics – incorporating the separability principle.

What may have happened in Einstein's thinking about these matters in later years is that he may finally have asked himself: If I am going to have to give up either separability or determinism, which should it be? And his answer, reflected in his remarks to Pauli, Besso, and others, was: Better to give up determinism, because, of the two, separability is more essential to my conception of a realistic physical theory.

Even while doubting that quantum mechanics would be the starting point of a future physics, Einstein had his own ideas about how one could make sense of it as at least a provisional theory, and thus understand the significance of its obvious empirical successes. What Einstein said is that quantum mechanics cannot be interpreted as completely describing the behavior of individual physical systems, but should be viewed instead as describing the average behavior of large ensembles of systems, much like classical statistical mechanics describes only the average behavior of collections of atoms or molecules. But Einstein never spelled out in detail the nature of his ensemble interpretation, and that leaves open the door for Fine to suggest that what Einstein may have had in mind by an ensemble interpretation is in fact the curious models for quantum statistics that Fine himself invented – under the name of "prism models" – for the purpose of showing how one could get the strong quantum correlations evinced in the Bell experiments while, in effect, preserving both locality and separability. This is the subject of Fine's 'What Is Einstein's Statistical Interpretation, or, Is It Einstein for Whom Bell's Theorem Tolls?'. Without going into detail, let me just comment that Fine's reading of Einstein's ensemble interpretation via prism models is no more persuasive than is the case for the prism models themselves as a solution to puzzles made vivid by Bell's theorem. Readers wishing a more detailed critique should consult Guy and Deltete (1990); see also Fine's reply (1990).

After reading what Fine has to say about Einstein's "entheorizing" of the realism issue, one is surprised to find Fine arguing in the last paper in the volume, 'Is Scientific Realism Compatible with Quantum Physics?', that the quantum theory cannot be regarded as either favoring or refuting realism. One is surprised because Fine seems here to have forgotten all about entheorizing. The "entheorizing" Einstein (and the Fine who wrote 'The Natural Ontological Attitude') would appear to be committed to the claim that the only way profitably to pose the realism question is as a question about the empirical success of realistic theories. And when the realism question is so posed, as Einstein's own critique of quantum mechanics makes clear, then the quantum theory can have quite important implications for its resolution. Einstein regarded it as a non-realistic theory. Thus, its successes, together with the failure of more "realistic" programs such as Einstein's unified field theory program, must be interpreted as arguments against a realism so conceived.

Indeed, history has awarded the palm to quantum mechanics rather than to field theories as Einstein understood them, confirming the judgment that had already been made by most of Einstein's colleagues in physics by the mid-1930s. Those who want to understand how it could be that Einstein doggedly pursued his own program to the dismay of the broader physics community would do well to study what Fine has to say about "motivational realism" as the key to Einstein's commitment to his own vision of a future physics ('Einstein's Realism', pp. 109–111). One need not accept Fine's Freudian gloss on this (realism as "imago", p. 11) in order to appreciate his point about the psychological significance of realism for Einstein. Flight from the merely personal, the merely subjective is a constant refrain in Einstein's published writings and correspondence from his adolescent years until his death; it is a theme that finds perhaps its most vivid expression in Einstein's fondness for Spinoza.

But here again more attention to historical context would help put even this psychological side of Einstein's realism in proper perspective. For Einstein was by no means alone in so regarding and in being so moved by a commitment to realism. The same attitude is clearly expressed as early as 1908 by one of Einstein's own heroes, Max Planck, in his famous Leiden lecture, where he concludes his criticism of Mach's philosophy of science with these words:

> In conclusion, yet another argument that will perhaps make more of an impact than all of the previous factual considerations on those who are inclined, in spite of it all, to represent the human-economical point of view as the really decisive one. As the great masters of exact natural scientific research brought forth their ideas in science: as Nicolaus Copernicus removed the earth from the center of the world, as Johannes Kepler formulated the laws named after him, as Isaac Newton discovered universal gravitation, as your great countryman Christian Huygens established his undulatory theory of light, as Michael Faraday created the foundations of electrodynamics – the list could be extended still further – there economical viewpoints were certainly the very last that steeled these men in their battle against received views and against outstanding authorities. No – it was their rock solid belief, whether resting on an aesthetic or religious basis, in the reality of their world picture. In view of this certainly incontestable fact, one cannot reject out of hand the guess that if the Machian principle of economy were ever actually to become the centerpiece of epistemology the ways of thinking of such leading minds would be disturbed, the flight of their fantasy would be crippled, and thus the progress of science might be arrested in an ominous way. (Planck 1909, p. 74)

What conclusion can we draw from the fact that both Einstein and Planck emphasize the motivational aspect of realism? Two instances is a small basis from which to project a hypothesis, but let me do so anyway: I think of Einstein as belonging, if not chronologically then at least temperamentally, to that same first generation of theoretical physicists that was led by physicists like Lorentz and Planck. The recent work of Jungnickel and McCormmach (1986) charts the difficult road that theoretical physics had to follow to win a place for itself in the larger community of physicists in the late nineteenth century. And there is reason to think that one of the many factors delaying the start of Einstein's real scientific career upon his graduation from the ETH in Zurich was his having to contend with those who would insist that physics is, first and foremost, an experimental science. It may well be that the psychological significance of realism loomed larger for this first generation of theoretical physicists, who for institutional reasons needed sanction from philosophy and other sources for their way of doing physics, than it did for the next generation, among whom positivistic rhetoric was more common (think, for example, of the propagandists for the Copenhagen interpretation, Bohr himself excepted). Here is a subject for further research.

One might object that it was the older Einstein who was the realist, the younger Einstein being himself an ardent positivist. But I mean quite deliberately to deny this common view – faint echoes of which persist in Fine's 'The Young Einstein and the Old Einstein' (p. 16) and his 'Einstein's Realism' (pp. 86–87). The younger Einstein especially owed a considerable debt to Mach, Hume, and the empiricist tradition, a debt that he freely acknowledged on many occasions. The mistake is thinking that a sympathy with Mach is incompatible with a belief that physics aims to describe an independent reality. Einstein was himself careful to explain that what he valued in Mach was not the phenomenalistic epistemology that would reduce all admissible scientific concepts to the "elements of sensation", but rather the style of conceptual criticism practiced by Mach. When one reads Einstein's early papers with an unprejudiced eye, one sees that the idiom employed is thoroughly realistic. How else can one understand Einstein's talk of the molecules composing a gas or his talk of light quanta? Indeed, late in life he said himself that one of the most satisfying consequences of his early work on statistical physics and Brownian motion was that it convinced skeptics like Ostwald and Mach of the reality of atoms.

There is still more to Fine's discussion of Einstein's realism, much of it to be recommended to the interested reader. For example, better than any other student of the subject, Fine tries carefully to locate Einstein's realism among the other currently popular forms of realism. He concludes that it is definitely not a "metaphysical realism", which Fine takes to be the view that Holton (1968) ascribed to Einstein, this because a "metaphysical" interpretation of Einstein misses the force of the "entheorizing" strategy as "deflect[ing] questions of meaning (and 'correspondence') onto questions of empirical support for the theory as a whole" ('Einstein's Realism', p. 106). It is also not the same as "scientific realism", argues Fine, for though Einstein talks about the truth of theories in much the same way as the scientific realist, what he means by "truth" is more akin to what van Fraassen would call the "empirical adequacy" of the theory considered as a whole (p. 108). Indeed, for this reason, Einstein's realism may have more in common, according to Fine, with van Fraassen's "constructive empiricism", which van Fraassen regards as an anti-realist theory, than with scientific realism. One wishes; however, that Fine had considered additional possibilities, such as Putnam's (1976) "internal realism", which may have suggested to Fine yet other ways of construing Einstein's realism, constructions that would allow us to take more literally Einstein's talk of the "truth" even of those deep parts of theory far removed from the realm of the directly observable, this without shorting Einstein's insistence that something like empirical adequacy is the "cash value", as it were, of all truth claims. For it is possible to have a semantics for a theory, even for its nonobservable parts, without thereby committing metaphysics. Still, Fine's location of Einstein's position in a thinly populated region of the map of possible realisms goes far to block all-too-common, hasty attempts to enlist Einstein as a supporter of some current philosophical fad.

A word or two is also in order about the most straightforwardly historical essay in the volume, 'Schrödinger's Cat and Einstein's', where Fine tracks in meticulous detail the correspondence between Einstein and Schrödinger from the summer and fall of 1935, relating this correspondence to the composition of Schrödinger's classic paper. 'Die gegenwärtige Situation in der Quantenmechanik', the paper in which the famous "cat paradox" was first introduced. What will be new to most readers is the role Einstein played in developing the cat paradox, in part through his independent invention of a similar thought experiment involving a pile of exploding gunpowder. More important for an understanding of Einstein's critique of quantum mechanics is Fine's analysis of the way in which this correspondence helped Einstein (and Schrödinger) to get clear about the kind of incompleteness allegedly manifested by the quantum theory and to develop his ensemble interpretation of the quantum theory. If space permitted, I would quibble about some of the details of Fine's account, but this is still a solid piece of scholarship.

Let me conclude this review by turning to one of Fine's most insightful observations about Einstein's realism, namely, that realism for Einstein is not so much an epistemological thesis about the existence of a mind-independent reality or about the semantics of scientific theories, but rather more an assertion of a program for science. It is not so much a doctrine as it is sage advice to the community of physicists, advice to the effect that a program of advancing realistic theories is the way to make progress in science ('Einstein's Realism', p. 95). No one, to my knowlege, had previously noted this important theme in Einstein's comments on realism, but now that Fine has drawn attention to it, one finds it in many places. My favorite example comes from a surprising source: the diaries of Rudolf Carnap. An entry for 16 November 1952 reports that Einstein's old friend Paul Oppenheim had brought Einstein to visit Carnap, who was then staying in Princeton. They talked of many things, including the problem of reality. Toward the end of Carnap's account of this discussion, one finds the following passage:

> Oppenheim often speaks at length in between; I am impatient at the fact that he wastes so much of the precious time with Einstein. He thinks that he must formulate Einstein's view for me, which I would nevertheless rather hear from Einstein himself, and then he always wants to bring forth his own solutions, such as, e.g., the view that the assumption of reality is a contrary-to-fact working hypothesis (for which I had once before criticized him). Instead of "working hypothesis", Einstein wants rather to say "program of science", because a "hypothesis" is of course something this is either true or false (yes).[7]

I would like to think that *The Shaky Game* represents the beginning of a new trend in which philosophers of science well-trained in wrangling with important systematic and technical questions like the realism/instrumentalism debate or the interpretation of quantum mechanics take the historical turn. Those who do take this turn tend, like Fine, to find not only that history is interesting in its own right but also that its study makes them better systematic philosophers of science. The reason is that all problems have histories and that those ignorant of the history are less likely to understand what the problem is, and hence less likely to contribute to its solution, or, where appropriate, its dissolution. Serious attention to the history of the philosophy of science is all the more to be recommended at a time like the present, when the received view (whatever that is) is under broad attack – witness Fine's NOA papers. As we search for a new way or for new ways to conceive the role and task of the philosopher of science, we would do well to look to our history, the better to understand how we arrived at our present situation, the better to realize what other ways there were and are for philosophers of science to be.

NOTES

[1] For more on this history, see Howard 1990a.
[2] For more on the relationship between Einstein and Schlick, see Howard 1984.
[3] For more on this manuscript and the historical background to the EPR paper, see Howard 1990b.
[4] See, for example, Howard 1985, 1989.
[5] For a development of this idea, see, for example, Einstein 1953, the essay that lay behind the dispute between Einstein and Born that Pauli sought to mediate.
[6] For more on the history of Einstein's worries about the quantum theory, see Stachel 1986 and Howard 1990b.
[7] Quoted by permission of the University of Pittsburgh. All rights reserved. I thank Richard Nollan, who transcribed this passage from the Stolze–Schrey shorthand in which Carnap's diary is written.

REFERENCES

Born, M. (ed.): 1971, *The Born–Einstein Letters: The Correspondence between Albert Einstein and Max and Hedwig Born from 1916 to 1955*, I. Born (trans.), Walker, New York.

Einstein, A.: 1953, 'Elementare Überlegungen zur Interpretation der Grundlagen der Quanten-Mechanik', in *Scientific Papers Presented to Max Born*, Hafner, New York, pp. 33–40.

Einstein, A., Podolsky, B., and Rosen, N.: 1935, 'Can Quantum-Mechanical Description of Physical Reality Be Considered Complete?', *Physical Review* **47**, 777–80.

Fine, A.: 1990, 'Einstein and Ensembles: Response', *Foundations of Physics* **20**, 967–89.

Guy. R. and Deltete, R.: 1990, 'Fine, Einstein, and Ensembles', *Foundations of Physics* **20**, 943–65.

Holton. G.: 1968, 'Mach, Einstein, and the Search for Reality', *Daedalus* **97**, 636–73.

Howard, D.: 1984, 'Realism and Conventionalism in Einstein's Philosophy of Science: The Einstein–Schlick Correspondence', *Philosophia Naturalis* **21**, 618–29.

Howard, D.: 1985, 'Einstein on Locality and Separability', *Studies in History and Philosophy of Science* **16**, 171–201.

Howard, D.: 1989, 'Holism, Separability, and the Metaphysical Implications of the Bell Experiments', in J. T. Cushing and E. McMullin (eds.), *Philosophical Consequences of Quantum Theory: Reflections on Bell's Theorem*, University of Notre Dame Press, Notre Dame, Indiana, pp. 224–53.

Howard, D.: 1990a, 'Einstein and Duhem', in R. Ariew and P. Barker (eds.), *Pierre Duhem: Historian and Philosopher of Science*, Proceedings of the Conference at Virginia Polytechnic and State University, 16–18 March, 1989, *Synthese* **83**, 363–84.

Howard, D.: 1990b, '"Nicht sein kann was nicht sein darf", or The Prehistory of EPR, 1909–1935: Einstein's Early Worries about the Quantum Mechanics of Composite Systems', in A. I. Miller (ed.), *Sixty-two Years of Uncertainty: Historical, Philosophical, and Physical Inquiries into the Foundations of Quantum Mechanics*, Plenum, New York, pp. 61–111.

Jungnickel, C. and R. McCormmach: 1986, *Intellectual Mastery of Nature: Theoretical Physics from Ohm to Einstein*, 2 vols, University of Chicago Press, Chicago.

Planck. M.: 1909, 'Die Einheit des physikalischen Weltbildes', *Physikalische Zeitschrift* **10**, 62–75. (Lecture, 9 December 1908, University of Leiden.)

Putnam, H.: 1976, 'Realism and Reason', Presidential Address to the Eastern Division of the American Philosophical Association, Boston, 29 December 1976, reprinted in *Meaning and the Moral Sciences*, Routledge & Kegan Paul, Boston, London, and Henley, 1978, pp. 123–38.

Speziali, P. (ed.): 1972, *Albert Einstein/Michele Besso: Correspondence, 1903–1955*, Hermann, Paris.

Stachel, J.: 1986, 'Einstein and the Quantum: Fifty Years of Struggle', in R. G. Colodny (ed.), *From Quarks to Quasars: Philosophical Problems of Modern Physics*, University of Pittsburgh Series in the Philosophy of Science, vol. 7, University of Pittsburgh Press, Pittsburgh, pp. 349–85.

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