Review

Reviewed Work(s): Bangs, Crunches, Whimpers, and Shrieks: Singularities and Acausalities in Relativistic Spacetimes by John Earman

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possible to the critic's experience of literature. For the deep appeal to critics of Barthes' "post-structuralism" or of a critical approach drawing on Lacanian psychoanalytic theory lies not in arguments for adopting those theoretical stances, but in the critical benefits such adoption brings. Lamarque may demolish those arguments, and some of them certainly invite attack; but if he wants to persuade critics to abandon their methodological stance, he needs to show them that its apparent benefits for reading particular texts are illusory. This demands argument at a level much closer to critical practice than we are offered here.

Lamarque's final chapter goes some way towards meeting this demand. He attempts to pull together the underpinnings of humanist criticism, around the notion of the "literary point of view." He implies that it is the point of view all critics adopt when doing literary criticism, whether or not they acknowledge it. In support, he briefly samples the work of avowedly hostile critics, looking for evidence that they do adopt the perspective he describes (212-14). Here he does precisely what is needed. My regret is only that there is so little argument of this nature.

However, perhaps Lamarque concentrates on his opponents' arguments, and on exploring the concepts he wishes to return to center stage, because that is what he considers himself, as a philosopher, best fitted to do. As an exploration of some key concepts in critical and philosophical reflection on literature, this is a useful book. It is recommended to all those interested in the nature of our engagement with literature.

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*BANGS, CRUNCHES, WHIMPERS, AND SHRIEKS: SINGULARITIES AND ACAUSALITIES IN RELATIVISTIC SPACETIMES.* By JOHN EARMAN. New York: Oxford University Press. 1995. Pp. xi, 257.

For much of this century, philosophers hoped that Einstein's general theory of relativity (GTR) would play the role of physician to philosophy. Its development would positively influence the philosophy of methodology and confirmation, and its ontology would answer many traditional philosophical debates—for example, the issue of spacetime substantivalism. In physics, by contrast, the attitude is increasingly that GTR itself needs a physician. The more we learn about GTR the more we discover how odd are the spacetimes that it allows. Not only does GTR permit singularities, naked and clothed, but it allows time travel, topology change, and event and particle horizons, to name but a few of these oddities. Rather than revel in the riches of the theory, however, many physicists seek to rule out one or more of the above "pathologies" on the grounds that they are "physically unreasonable." Thus contemporary researchers hawk various "cures" for the "illnesses" of GTR: among them, Chronology Protection to ensure against time travel, Cosmic Censorship for naked singularities, Inflation for horizons, and so on. The physics of these illnesses and cures, and the problems they engender, are the source of much controversy in the physics literature. Philosophers have largely neglected it. But clearly the subject needs philosophers of physics to determine whether the patient is genuinely ailing, and if so, to sift the real antidotes from the snake oil.

In *Bangs, Crunches, Whimpers and Shrieks,* the noted philosopher of physics John Earman demonstrates why he is a master in the field. His latest book is a *tour de force* concerning the physics and philosophy underlying the above "pathologies." In his characteristically exacting and witty manner, Earman digests and comments on a remarkable amount of the recent physics literature on singularities and acausalities in GTR. And as we have come to expect from Earman, he offers many sharp philosophical insights into the subject. The book contains six largely self-contained chapters, each on a different topic, plus an introduction and afterword. The topics covered are the nature of spacetime singularities, cosmic censorship, "supertasks," the horizon problem, time travel, and eternal recurrence. The level of presentation is high. To read most of the chapters with profit, one must have mastered GTR. Fortunately, the exposition is clear, and the book benefits from approximately forty illustrations. The latter are particularly helpful: whenever the ideas are especially unintuitive or important, the reader can usually count on an illustration to help guide the way.

Chapters 1 and 2 constitute, to my knowledge, the first major treatment by a philosopher of the concept of a spacetime singularity. Here Earman imposes order upon the chaos found in the physics literature on singularities. The puzzle about singularities is easy to see. A singularity in the electromagnetic field can be said meaningfully to exist at a point *in* spacetime, but a singularity in GTR is a singularity in spacetime *itself*. There is no background to which we can point to say where or when the singularity exists. Earman divides attempts at characterizing singular spacetimes into four different strategies, but the real difficulty lies in a basic tension between two ideas. One idea is a development of the feeling that a spacetime is singular if the metric breaks down at a finite distance. Following this line of thought leads one to the notion of geodesic incompleteness and its generalizations (so-called "k-incompleteness"). The other idea is that a singularity occurs if spacetime itself is defective or missing some points. Geodesic incompleteness and its generalizations are viewed, on this conception, as evidence for missing points. For Riemannian spaces, the Hopf-Rinow theorem links these two notions: it shows that geodesic incompleteness is essentially the same as the "existence" of missing points. Unfortunately, nothing like this holds generally for the pseudo-Riemannian spaces of relativity. The two notions diverge in many relativistic spacetimes. Earman conjectures, plausibly, that the two notions are extensionally equivalent for physically reasonable spacetimes (in this case, spacetimes with closed or almost closed timelike curves). After discussing a few more issues, and describing the Hawking-Penrose singularity theorems, Earman closes chapter 2 with a plea for tolerance for spacetime singularities. To my mind, he successfully argues that singularities are not the seeds that sow the destruction of GTR.

Because the Hawking-Penrose theorems seem to demonstrate that singularities are a generic feature of spacetimes like ours, physicists have had to learn to live with singularities. But there is one kind of singularity many physicists will not tolerate: naked ones (observable singularities). The fear is that naked singularities signal a wholesale breakdown of predictability and determinism. The hope is that a cosmic censor operates in the universe, ensuring that Nature exercises modesty. The cosmic censorship hypothesis (CCH), the subject of chapter 3, claims that naked singularities occur only in physically unreasonable models of GTR.

Earman does philosophy a genuine service by nicely mapping out the logical geography surrounding CCH. He shows how hard it is to formulate an interesting version of CCH, and argues that we are a long way from knowing whether it is true. I wish there were more philosophical discussion here, however. For instance, what is meant by 'physically unreasonable' in CCH—that is, what is the status of the claim? Is it merely that naked singularities do not occur in realistic models, or is it the stronger claim that models including naked singularities are physically impossible in some sense? Also, GTR is time reversal invariant. In a world governed by time reversal invariant laws of nature, one person's white hole is another's black hole. Consequently, if CCH prohibits the former, won't it also (presumably, incorrectly) prohibit the latter? Earman touches on both questions but leaves them rather quickly. Yet plainly they are connected in an important way: the stronger reading of CCH sits uncomfortably with GTR's time symmetry. If the mechanism ensuring CCH operates with nomic force, then it will have to appeal to a new temporally asymmetric law; otherwise, consistency forces it to rule out black holes as well as white holes. This suggests that CCH is really a claim about the contingently (temporally asymmetric) initial conditions of our universe. But if that is all there is to CCH, then much of the talk connected with the issue is very misleading.

Chapter 6 investigates the physics and philosophy of Gödelian (no backward causation) time travel. After updating the reader on models of GTR with closed timelike curves, Earman turns to the notorious grandfather paradox. He maintains that this kind of paradox is "a rather ham-handed way of making the point that local data in spacetimes with CTC's [closed timelike curves] are constrained in unfamiliar ways" (161). Earman then explores the nature of these constraints with a rigor not found among philosophical treatments and a clarity of purpose not found in their counterparts in physics. He convincingly argues that the ambiguous status of these constraints reveals a tension between two concepts of physical possibility. Here we also find a real philosophical gem: the idea that the requisite consistency constraints may emerge as laws of nature on the Ramsey-Lewis conception of laws. Using detailed models of GTR, Earman argues that Ramsey-Lewis will sometimes, but not always, judge these constraints to be lawlike. Since this philosophical move may apply more generally to situations where one requires constraints on boundary conditions, I think the point deserves serious consideration.

The chapter ends with an appendix on Gödel's infamous argument for the ideality of time. Earman argues that Gödel's argument is hopelessly unpersuasive. What is certainly true, I think, is that the argument is hopelessly metaphysical. The crucial point in the argument is Gödel's claim that the matter distribution cannot determine the lapse of time. Earman finds no support for this premise. Whether space is open or closed depends on the matter distribution, he writes, so why shouldn't the lapsing of time? But surely the disanalogy is due to the fact that Gödel held the tensed theory of time in mind. Temporal lapsing on this view is the coming into being of "fresh" slices of existence. I doubt that there is a plausible reading of ontological becoming that makes it dependent upon the distribution of matter. Earman may find this woolly metaphysics, and perhaps it is, but given the metaphysics, I find Gödel's inference acceptable.

These brief comments do not do justice to the riches found in this book. Rather than say more about these chapters, however, let me quickly sketch the contents of the remaining three chapters. Chapter 4 analyzes spacetimes allowing tasks whereby one could know (in a finite proper time) the result of an infinite computation. If a spacetime permits an extreme form of the twin paradox, one can perform "supertasks" such as having Fermat's last theorem proved for you by direct calculation, instead of with two-hundred-page proofs. Earman investigates the question of whether these physically possible spacetimes are physically realistic. Chapter 5 is once again the first major philosophical discussion of a very interesting topic, the so-called "horizon problem" in cosmology. The cosmic background radiation's temperature is (mostly) isotropic. However, due to the particle horizons in the standard big bang models, the different regions of the universe never had time to causally interact with each other, and therefore, couldn't have relaxed to equilibrium together. The temperature correlations between the different regions do not have a common cause. After clarifying what is right and wrong about this story, Earman spends most of the chapter trying to determine exactly what is problematic about the horizon problem. He then critically examines the extent to which physicists solve the problem by positing a period of rapid cosmic inflation in the early universe. He ends with the appealing idea that the horizon problem needs deflation rather than inflation. Chapter 7 asks whether GTR is hospitable to eternal recurrence and cyclic time. Here we see how sensitive the answers to these questions are to issues covered previously about singularities and cosmic censorship. Earman also introduces the reader to the intriguing possibility of spacetimes that are both open and closed and of spacetimes neither open nor closed.

In sum, I enthusiastically recommend this important work to anyone, philosopher or scientist, interested in the foundations of spacetime. Not only does the book include discussions of fascinating topics previously neglected by philosophers, but it is also chock full of original arguments in both physics and philosophy.

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*PHILOSOPHY OF MATHEMATICS AND MATHEMATICAL PRACTICE IN THE SEVENTEENTH CENTURY.* By PAOLO MANCOSU. New York: Oxford University Press, 1996. Pp. viii, 275.

This volume brings together a number of previously published works and some new material to mount a sustained argument for the interaction between seventeenth-century philosophy and mathematics. More particularly, Mancosu wants to show that there was a reciprocal influence between the philosophy of mathematics and the mathematical practice of this era. The idea that philosophical theories about mathematics might affect and be affected by technical developments in mathematics is a commonplace in the twentieth century. Anyone acquainted with the history of set theory or the intuitionist program in mathematics should find it obvious that mathematical practices are often guided by philosophical theories, while philosophies of mathematics can be significantly influenced by technical developments in mathematics. The interactions between philosophy and mathematics in the seventeenth century were at least as powerful as those of the twentieth, yet historians of philosophy and mathematics tend to ignore such interaction. Historians of philosophy usually focus on the epistemological and metaphysical doctrines of seventeenth-century thinkers but pay scant attention to the dramatic mathematical advances of the period, even when (as in the case of Descartes and Leibniz) the philosophers