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ARTICLE

The Reception of Relativity in American Philosophy

Sander Verhaegh

Tilburg Center for Moral Philosophy, Epistemology, and Philosophy of Science (TiLPS), Tilburg University, Tilburg, the Netherlands
Email: A.A.Verhaegh@tilburguniversity.edu

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Abstract

Historians have shown that philosophical discussions about the implications of relativity significantly shaped the development of European philosophy of science in the 1920s. Yet little is known about American debates from this period. This article maps the first responses to Einstein's theory in three U.S. philosophy journals and situates these papers within the local intellectual landscape. I argue that these discussions (1) stimulated the development of a distinctly American branch of philosophy of science and (2) paved the way for the logical empiricists who emigrated to the United States in the years before World War II.

1. Introduction

The early development of philosophy of science is deeply intertwined with the reception of special and general relativity. Einstein's work challenged prevalent perspectives about space and time and stimulated philosophers to rethink the relation between science and philosophy. Logical empiricism partly emerged out of neo-Kantian debates about relativity, British philosophers frequently discussed relativity after the 1919 Royal Society announcement about the results of Eddington's eclipse expedition, and the Bergson-Einstein debate sparked an intense discussion among French intellectuals (e.g., Reichenbach 1920; Schlick 1922; Carr 1920; Haldane 1921; Bergson 1922; Meyerson 1925). Much as the crises in the foundations of mathematics had stimulated the development of scientific philosophy at the turn of the century, the theory of relativity pushed philosophers in new directions in the wake of World War I.

In recent years, scholars have enriched our understanding of the history of philosophy of science by studying it through the lens of this reception history. They have reconstructed the complex interplay between neo-Kantian, conventionalist, and positivist responses to relativity in the works of, among others, Carnap, Cassirer, Reichenbach, Schlick, and Weyl (Friedman 1999; Ryckman 2005). They have documented its reception within the British philosophical community (Desmet 2007; Sanchez-Ron 2012). And they have analyzed the debate on Einstein's work in France (Biezunski 1987; Demoures 2007). Finally, there has been a lot of interest in the evolution of Einstein's own philosophical perspective (Howard 1984; Ryckman 2017).

Curiously, however, little is known about the philosophical reception of relativity in the United States. Historians have analyzed the first responses from American physicists, mathematicians, and astronomers (Goldberg 1984; Crelinsten 2006), but it is unclear how Einstein's theory influenced local philosophers. This is surprising because (1) a quick search reveals that U.S. philosophy journals published dozens of papers and reviews on relativity, and (2) some of the most prominent European voices in the debate—Carnap, Carr, Cassirer, Einstein, Reichenbach, Weyl, and Whitehead—eventually emigrated to the United States. If there was a community of scientific philosophers, however small, in North America in the 1920s, then studying its response to relativity might shed new light on the integration of logical empiricism and the subsequent institutionalization of philosophy of science.[1]

This article reconstructs the reception of relativity in American philosophy. I chart the more than 70 philosophical articles and reviews on the subject in three U.S. philosophy journals and situate these responses within the U.S. intellectual landscape, showing that its implications were studied by scholars representing a variety of philosophical traditions, including pragmatism, idealism, and (neo-)realism. I argue that the debate stimulated the development of American scientific philosophy and, thereby, the integration of logical empiricism in the 1930s. Before I turn to the philosophical responses, however, I outline the reception of relativity within U.S. physics because it will prove instructive to compare the two reception histories.

2. The scientific reception of relativity

Early-20th-century American physics has long had a reputation for its empiricist orientation. Unlike many of their European colleagues, U.S. physicists typically presupposed a strictly empiricist philosophy of science, demanding a tighter connection between theory and observation than was usual at the time. Daniel Kevles writes about the community's "arid form of empiricism" (1979, 37), and Stanley Goldberg argues that physicists almost exclusively relied on empirical arguments in deciding between theories. The idea that theory choice depends on experimental evidence *and* theoretical virtues (e.g., simplicity or generality), widely accepted in Europe, was considered heresy in the United States (Goldberg 1988, 79). U.S. physicists, Goldberg concludes, were often skeptical about abstract theorizing and exhibited a "general eschewal of metaphysics, which was identified with European culture" (1984, 267).

This empiricist approach is particularly evident in the community's first responses to special and general relativity. In recent decades, historians have reconstructed the theory's reception in a large number of countries, including Germany, England,

[1] Existing work on the development of U.S. philosophy of science tends to focus on the "golden age" of American pragmatism (approx. 1898–1914) or on the period after the logical empiricists moved to the United States (1931 and later). An exception is Katzav and Vaesen (2022), although they are primarily interested in the development of *speculative* philosophy of science.

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France, China, Russia, Japan, Italy, Spain, and Belgium.[2] This growing body of work reveals "the salience of national inflections" and shows that the reception of relativity was often colored by local scientific cultures (Glick 1987, vii). In the decade after Einstein published his 1905 papers on the subject, special relativity was heavily debated in Germany but ignored in France, and the British were aware of it but largely stuck to the ether theory. In the United States, the responses were mixed, but both proponents *and* critics generally appealed to empiricist arguments in their writings. Whereas aesthetic-mathematical considerations played a major role in the responses of European scientists—even in England—American physicists generally ignored the question of whether the theory is mathematically elegant or contributes to a more unified physical theory.[3]

The first American response to special relativity—Lewis and Tolman's "The Principle of Relativity, and Non-Newtonian Mechanics"—was published in 1909. The two Massachusetts Institute of Technology (MIT) scientists discussed a number of recent experiments and analyzed to what degree the results supported special relativity. Likely inspired by A. A. Michelson's 1908 Nobel Prize—the first to be awarded to a U.S. scientist—Lewis and Tolman focused mostly on the implications of the former's ether experiments. Although the, at the time, diverse responses to these experiments show that their results can be variously interpreted, Lewis and Tolman claimed that the body of evidence left only one satisfactory explanation, namely, Lorentz's conclusion that all moving bodies contract in the line of their motion (1909, 711–12). Einstein, the two acknowledged, was going a bit "beyond existing facts" in rejecting absolute motion altogether. But they were reasonably confident about the possibility of "further verification" because Einstein had deduced additional empirical consequences from his hypothesis (Lewis and Tolman 1909, 712, 718). As such, Lewis and Tolman concluded, the principle of relativity appeared to be "established on a pretty firm basis of experimental fact" (712–13). The first English-language *book* on relativity, by the U.S. mathematician R. D. Carmichael, also relied on empiricist arguments. Although many mathematicians evaluated the theory's formal properties, Carmichael exclusively focused on its empirical support. Like Lewis and Tolman, his conclusions were cautiously optimistic. Carmichael concluded that "there is no experimental evidence which is undoubtedly opposed" to the theory, although there may be *indirect* evidence in its favor (1912, 18–19, 63–65).[4]

Opponents of relativity theory appealed to empiricist considerations, too. W. F. Magie, one of the founding members of the American Physical Society, objected to what he deemed to be a metaphysical theory, arguing that "Michelson-Morley" only supported the conclusion that there is no way to determine the relative motion of Earth and the ether when the observer and the source of light are moving along with our planet (1912, 288). To abandon absolute motion altogether would be to draw an empirically unwarranted conclusion. His colleague L. T. More, a professor of physics at the University of Cincinnati, was equally worried that Einstein's principle

[2] See, for example, Hu (2007), ten Hagen (2020), and the papers collected in Glick (1987).

[3] Some U.S. physicists even explicitly argued against aesthetic arguments. See Magie (1912).

[4] Carmichael mainly focused on Bucherer's 1908 beta-ray experiments in his overview. He took these findings to offer *indirect* evidence because Bucherer presupposed the law of conservation of electric charge. Compare Lewis and Tolman (1909, 712).

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obliterated "the boundary between science and metaphysics" and argued that it transcended the discussion of postulates "determined by experience" (1911, 196). Interestingly, the two critics disagreed about where to draw the distinction between physics and metaphysics. Magie was a staunch defender of the ether theory and believed it to be the only empirically plausible explanation of the transmission of light. More objected to *any* speculation about the nature of the cosmos and submitted that both "atoms and ethers … are metaphysical creations" (1910, 815). A true scientist, More argued, is exclusively concerned with the formulation of laws "deduced mathematically from experimental data" (1909, 876).

Empiricism is not just a view about epistemic justification. Typically, empiricists also believe that theoretical terms should have the appropriate *semantic* connection to observational concepts. Indeed, some of the most sophisticated treatises of the period also emphasized this conceptual side of empiricism. In doing so, they often followed Peirce, who had argued that the meaning of a hypothesis is determined by its experimental effects, or J. B. Stallo, a German-born philosopher of science who had published *The Concepts and Theories of Modern Physics* in 1882. Stallo defended a quasi-positivist perspective and warned against the reification of basic physical concepts. He primarily used his approach to criticize what he deemed to be the metaphysical assumptions of Newtonian physics, rejecting absolute space, absolute time, and absolute motion. In eliminating from science "its latent metaphysical elements," he hoped to contribute to the scientific endeavor to gain "a sure foothold on solid empirical ground, where the real data of experience may be reduced without ontological prepossessions" (1882, 8).[5]

Both the theory of special relativity and that of general relativity stimulated American physicists to further reflect on the conceptual foundations of their discipline, not in the least because Einstein himself appeared to give a positivist spin to his discovery. In writing about the "profound influence" of Mach and in arguing that a "concept does not exist for the physicist until he has the possibility of discovering whether or not it is fulfilled in an actual case" (1917, 22), Einstein seemed to presuppose a positivist perspective, inspiring U.S. scientists to adopt a similar approach.[6] In 1927, the Harvard physicist P. W. Bridgman published *The Logic of Modern Physics*, a book that applied the lessons of, among others, Stallo and Mach to the recent revolutions in physics (1927, v–vi). His solution was to adopt a strictly empiricist, or operationist, attitude toward the concepts of physics, exemplified in his mantra that we "mean by any concept nothing more than a set of operations" (1927, ix–x). Although Bridgman was critical of general relativity, he believed he was criticizing Einstein on Einsteinian grounds, using the latter's perspective on "what the concepts useful in physics are and should be" (1927, 4). In equating the meaning of statements about simultaneity with the concrete operations we use to determine whether two events occur simultaneously, Einstein had developed an operational analysis of time in his 1905 papers. Moreover, he had repeated the point in his more popular *Relativity: The Special and General Theory* (Einstein 1917).

[5] Scholars disagree about whether Stallo, like, for example, Mach, anticipated some of Einstein's arguments. See Bridgman (1960, xxvi), Kevles (1979, 30), and Herbert (2001, ch. 2).

[6] I write that he "seemed" to defend a positivist perspective because present-day scholars dismiss this interpretation (e.g., Howard 1984; Ryckman 2017).

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The crucial difference between Bridgman's perspective and traditional approaches is the way concepts are conceived. Classical physicists often defined concepts in terms of properties. Newton, for example, defined absolute time as that what "of itself, and from its own nature flows equably without regard to anything external" (Bridgman 1927, 4). The danger of this approach is that we might discover that there is nothing in nature that has these properties, so we are constantly confronted with scientific revolutions like the one sparked by Einstein. Bridgman instead proposed to define concepts in terms of *operations*. Applied to Newton's concept of absolute time, this means that we do not understand its meaning "unless we can tell how to determine the absolute time of any concrete event"; once we see that the operations by which we measure time are relative, as Einstein demonstrated, we have to conclude that the concept is operationally "meaningless" (Bridgman 1927, 5). In order to prevent similar revolutions in the future, we have to subject all concepts of physics to an operational analysis.

3. American philosophy at the turn of the century

Early discussions of relativity were mostly confined to a small circle of physicists, astronomers, and mathematicians. This changed in November 1919, when the Royal Society announced that Einstein's predictions about the bending of starlight had been confirmed by Eddington's solar eclipse expedition. In the years after the announcement, American media published hundreds of articles trying to explain the theory. Einstein was described as the "destroyer of space and time" and became a national celebrity when he visited the country in 1921 (Missner 1985, 271–73). Given this widespread attention for topics that had traditionally been the domain of philosophy—space and time—it should not be a surprise that philosophers quickly started to write about relativity, too.

Historians often divide early-20th-century American philosophy into three distinct but partially overlapping schools: idealism, realism, and pragmatism (Kuklick 2001; Campbell 2006, ch. 3). The most sizable of the three, the idealist movement, was skeptical about the empiricist approach that dominated the sciences. Most idealists believed that experimental findings can, at best, deliver a partial understanding of reality. Two hundred years of modern epistemology had shown that empiricism leads to skepticism because there is no way to determine whether our ideas correspond to an independently existing material world. Instead of blindly relying on science, we should accept that reality is mind dependent and that there are moral and spiritual dimensions to experience, too. The idealists held that it is the philosophers' job to ground physical, moral, and religious truths and unify these domains into a coherent system. Only philosophy, idealists believed, can "investigate the grounds … of the whole body of truth with a view to its unity and meaning as a whole" (Ormond 1906, 3).

It is no coincidence that idealism dominated philosophy at the turn of the century because the development of philosophy as a distinct academic discipline was partly a response to the increasing influence of science in American academia. The establishment of dozens of new laboratories and polytechnics, the rise of experimental psychology, and the popularity of philosophically minded naturalists such as Ernst Haeckel and Herbert Spencer contributed to the feeling that philosophy

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was in danger of being swallowed by the sciences (Campbell 2006; Wilson 1990). In response to this threat, idealists helped found the first professional journals (e.g., *Philosophical Review* in 1892) and organizations (e.g., American Philosophical Association [APA] in 1902) to establish philosophy as an independent discipline. The first president of the APA, the idealist J. E. Creighton, argued that philosophy had to protect itself against scientists who "wholly unschooled in the subject … feel themselves competent … to write philosophical books" (1902, 232).

The idealist movement began to be challenged in the first decade of the 20th century. In England, the revolt was led by G. E. Moore and Bertrand Russell, two Cambridge graduates who objected to the views of their idealist colleagues and sought to replace them with a variant of realism. Something similar happened in the United States. Two recent graduates from "the other Cambridge"—W. P. Montague and R. B. Perry—objected to the views of Josiah Royce, America's best-known idealist (Montague 1902; Perry 1902). Inspired by Russell's work, they argued for a more scientific approach to philosophy. Whereas their idealist predecessors distinguished between scientific findings and philosophical synthesis, these "new realists" viewed themselves as part of an "era of united and complimentary endeavor" (Holt et al. 1912, 21). They promoted the use of mathematical logic, analytic methods, and a piecemeal approach, dealing with "one problem at a time" instead of attempting to "answer all questions together" (Holt et al., 21–26). The "most notable feature of a realistic philosophy," the realists believed, "is the emancipation of metaphysics from epistemology" (Holt et al., 32). Whereas the idealists had put epistemology center stage, using the theory of knowledge to draw conclusions about the nature of reality, the realists turned this relation on its head, arguing that the knowledge relation is just one of many relations between independently existing objects.

The second, and nowadays best-known, alternative to idealism was developed by the pragmatists. Building on the work of, among others, Peirce, James, and Dewey, pragmatism became an influential yet diverse philosophical movement that was more closely tied to the empiricist tradition in the sciences. William James had been a crucial figure in the development of experimental psychology, and Peirce's aforementioned criterion of meaning implied that two hypotheses have the same content if they have the same observational consequences. James first invoked C. S. Peirce's pragmatic test in an 1898 paper and used it to argue that many speculative debates about the nature of reality are pointless. Dewey had started out as a Hegelian but came to replace his idealist approach with a naturalized perspective on man, mind, and morality.

4. The philosophical reception of relativity

The 1919 Royal Society announcement gave new impetus to the debate between idealists, realists, and pragmatists. In the decade after the news about Eddington's expedition, American philosophy journals published dozens of papers and reviews on relativity, discussing its foundations and philosophical implications.[7] Table 1 lists most of the papers published in three prominent American philosophy journals—the

[7] Only few philosophical articles on relativity appeared before the 1919 announcement. See, for example, Carus (1913). Henderson (1993, 146–48) discusses Carus's response.

Table 1. Selection of Papers on Relativity Theory Published in Three Prominent American Philosophy Journals between 1921 and 1930

Author	Year	Title	Journal
E. E. Slosson	1921	Eddington on Einstein	*Jphil*
V. A. Endersby	1921	Einsteinian Space and the Probable Nature of Being	*Monist*
J. E. Turner	1921	Some Philosophic Aspects of Scientific Relativity	*Jphil*
J. E. Fries	1921	"Relativity": A Searchlight on Human Perception	*Monist*
A. L. Hammond	1921	Appearance and Reality in the Theory of Relativity	*PhilReview*
W. B. Smith	1921	Relativity and Its Philosophic Implications	*Monist*
H. A. Wadman	1922	Relativity, Old and New	*Jphil*
T. de Laguna	1922	The Nature of Space—I	*Jphil*
T. de Laguna	1922	The Nature of Space—II	*Jphil*
T. de Laguna	1922	Point, Line, and Surface, as Sets of Solids	*Jphil*
A. A. Merrill	1923	Duration and Relativity	*Jphil*
W. P. Montague	1924	The Einstein Theory and a Possible Alternative	*PhilReview*
Filmer Northrop	1925	Relativity and the Relation of Science to Philosophy	*Monist*
L. E. Akeley	1925	The Problem of the Specious Present and Physical Time	*Jphil*
J. R. Haldane	1925	Gravitation: A Simplified Theory of Relativity	*Monist*
W. Gordin	1926	The Philosophy of Relativity	*Jphil*
O. L. Reiser	1926	The Problem of Time in Science and Philosophy	*PhilReview*
E. Wind	1927	Alfred C. Elsbach's *Kant und Einstein*	*Jphil*
E. T. Mitchell	1927	Kantian Relativity	*Monist*
A. E. Murphy	1927	Alexander's Metaphysic of Space-Time (I)	*Monist*
B. I. Gilman	1927	Relativity and the Lay Mind. I	*Jphil*
B. I. Gilman	1927	Relativity and the Lay Mind. II	*Jphil*
W. A. Shimer	1927	Evolution of Relativity	*Monist*
Filmer Northrop	1928	The Theory of Relativity and the First Principles of Science	*Jphil*
Filmer Northrop	1928	A Physical Interpretation of the Theory of Relativity	*Jphil*
J. E. Turner	1929	The Essential Distinction between Science and Philosophy	*PhilReview*
R. P. Richardson	1929	Relativity and Its Precursors	*Monist*
A. E. Murphy	1929	The Anti-Copernican Revolution	*Jphil*
F. P. Hoskyn	1929	The Problem of Motion	*Jphil*
H. Margenau	1929	The Problem of Physical Explanation	*Monist*
J. A. Lynch	1929	Time-Systems as Perspectives	*Jphil*
J. E. Turner	1930	Relativity Without Paradox	*Monist*
J. MacKaye	1930	The Theory of Relativity: For What Is It a Disguise?	*Jphil*

(*Continued*)

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Table 1. (*Continued*)

Author	Year	Title	Journal
Filmer Northrop	1930	Concerning the Phil. Consequences of the Theory of Relativity	*Jphil*
A. A. Merrill	1930	Limitations	*Jphil*
Filmer Northrop	1930	The Unitary Field Theory of Einstein and Its Bearing on …	*Monist*
F. P. Hoskyn	1930	The Relativity of Inertial Mass	*Jphil*
A. O. Lovejoy	1930	The Dialectical Argument Against Absolute Simultaneity. I	*Jphil*
A. O. Lovejoy	1930	The Dialectical Argument against Absolute Simultaneity. II	*Jphil*

Jphil, Journal of Philosophy; PhilReview, Philosophical Review.

Journal of Philosophy, *Philosophical Review*, and *The Monist*—between 1921 and 1930 and shows that these periodicals published a host of articles on relativity theory.[8] Table 2 lists most of the reviews of books on relativity theory in two of these journals[9] and reveals that the philosophical community also kept a close eye on foreign publications on the subject, even if they were written by physicists.

A closer study of the papers listed in Table 1 shows that the theory was discussed by philosophers from a variety of schools. Idealists, realists, and pragmatists, but also philosophers representing smaller movements such as Bergsonism and phenomenology, responded to relativity, and many of them were convinced that Einstein's principle supported the perspective they had been developing themselves. H. R. Smart, who regularly reviewed books on relativity (Table 2), said that many philosophers viewed relativity as a "welcome vindication of their particular philosophical doctrines" (1925, 511), and Russell wrote that "there has been a tendency, not uncommon in the case of a new scientific theory, for every philosopher to interpret the work of Einstein in accordance with his own metaphysical system" (1926, 331).

Many idealists felt vindicated by relativity because they took Einstein to have shown that there is no mind-independent order of temporal relations. Realists had argued that space and time have an objective existence, but Einstein's theory, these idealists held, revealed this to be a mistake. Whereas the aforementioned Montague had characterized reality as a distribution of qualities over an independently existing four-dimensional manifold of spatial and temporal positions (1912, sec. 1–2), these idealists believed Einstein to have shown that even a basic property like length belongs not to an independently existing object but exists "as a relation of observer-and-observed" (Smith 1921, 505). In drawing these conclusions, they followed the British philosopher R. B. Haldane, who argued that "if the principle of relativity is well-founded the very basis of the New Realism seems to disappear into vapour" (Haldane 1921, 273). And they were likely inspired by the London-based philosopher H. W. Carr, who held that Einstein's theory shows that there is no

[8] This list is more or less complete depending on one's selection criteria. I only included articles that discuss relativity, ignoring work on space and time in philosophy proper. Note that most but not all authors of the articles listed are American or based at a U.S. university.

[9] That is, the *Journal of Philosophy* and *Philosophical Review*. *The Monist* rarely published reviews.

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Table 2. Selection of Reviews of Books on Relativity Theory in the *Journal of Philosophy* and *Philosophical Review* between 1921 and 1930

Reviewer	Year	Reviewed Book	Journal
J. E. Trevor	1921	*Relativity. The Special and General Theory* by A. Einstein	*PhilReview*
H. R. Smart	1921	*General Principle of Relativity* by H. W. Carr	*PhilReview*
E. B. McGilvary	1921	*The Concept of Nature* by A. N. Whitehead	*PhilReview*
J. E. Turner	1922	*The Reign of Relativity* by R. B. Haldane	*JPhil*
E. Kasner	1922	*General Principle of Relativity* by H. W. Carr	*JPhil*
E. Kasner	1922	*Space and Time in Contemporary Physics* by M. Schlick	*JPhil*
E. Kasner	1922	*On Gravitation and Relativity* by R. A. Sampson	*JPhil*
H. R. Smart	1922	*The Rudiments of Relativity* by J. P. Dalton	*PhilReview*
J. E. Creighton	1922	*The Reign of Relativity* by R. B. Haldane	*PhilReview*
T. de Laguna	1922	*The Absolute Relations of Time and Space* by A. A. Robb	*JPhil*
T. de Laguna	1922	*Philosophy and the New Physics* by L. Rougier	*JPhil*
H. R. Smart	1922	*Space, Time and Gravitation* by A. S. Eddington	*PhilReview*
C. I. Lewis	1923	*La Notion d'Espace* by D. Nys	*JPhil*
J. A. Leighton	1923	*A Theory of Monads* by H. W. Carr	*PhilReview*
H. T. Costello	1924	*Relativity, Logic, and Mysticism.* Arist. Soc. Suppl. Vol. III.	*JPhil*
H. R. Smart	1924	*Einstein's Theory of Relativity* by E. Cassirer	*PhilReview*
G. Cunningham	1925	*Relativity, Logic, and Mysticism.* Arist. Soc. Suppl. Vol. III.	*PhilReview*
E. H. Kennard	1925	*Sidelights on Relativity* by A. Einstein	*PhilReview*
C. I. Lewis	1925	*Scientific Thought* by C. D. Broad	*PhilReview*
H. R. Smart	1925	*La Déduction Relativiste* by E. Meyerson	*PhilReview*
W. P. Montague	1925	*A Theory of Monads* by H. W. Carr	*JPhil*
H. T. Costello	1925	*La Déduction Relativiste* by E. Meyerson	*JPhil*
C. W. Cobb	1926	*The Origin, Nature, and Infl. of Relativity* by G. D. Birkhoff	*JPhil*
H. R. Smart	1927	*Relativity and the Critical Philosophy* by F. Kassel	*PhilReview*
A. C. Benjamin	1927	*The Logic of Modern Physics* by P. W. Bridgman	*JPhil*
E. Nagel	1927	*An Experiment with Time* by J. W. Dunne	*JPhil*
W. van de Walle	1928	*The Logic of Modern Physics* by P. W. Bridgman	*PhilReview*
E. H. Kennard	1928	*The Analysis of Matter* by B. Russell	*PhilReview*
R. M. Blake	1928	*Temps, Espace, Relativité* by A. Metz	*JPhil*
R. M. Blake	1928	*The Theory of Relativity* by L. Siff	*JPhil*
A. C. Benjamin	1928	*The Evolution of Scientific Thought* by A. D'Abro	*JPhil*
V. F. Lenzen	1929	*The Analysis of Matter* by B. Russell	*JPhil*
E. B. McGilvary	1930	*The Nature of the Physical World* by A. S. Eddington	*JPhil*

(*Continued*)

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Table 2. (*Continued*)

Reviewer	Year	Reviewed Book	Journal
E. B. McGilvary	1930	*Science and the Unseen World* by A. S. Eddington	*JPhil*
A. E. Murphy	1930	*The Nature of the Physical World* by A. S. Eddington	*PhilReview*
P. P. Wiener	1930	*Essai Philos. sur la Théorie de la Relativité* by M. C. Dupont	*JPhil*
S. K. Langer	1930	*Philosophie der Raum-Zeit-Lehre* by H. Reichenbach	*JPhil*

Jphil, Journal of Philosophy; PhilReview, Philosophical Review.

"concrete four-dimensional space-time" that serves as the substratum of our activities but that there are only the "perception-actions of infinite individual creative centres in mutual relation" (Carr 1920, 162). In 1922, Carr even organized a debate at the Aristotelian Society on the thesis that the "principle of relativity … is in complete accord with the neo-idealist doctrine in philosophy, and in complete disaccord with the fundamental standpoint of every form of neo-realism" (Carr et al. 1922, 123).[10]

In the United States, this reading was defended by a number of philosophers, including mathematician-philosopher William B. Smith. In a paper titled "Relativity and Its Philosophic Implications," Smith developed the thesis that relativity was a further step into the direction of a view in which "objects … are not *discoveries* but the *creations* of psychic activity" (1921, 505). The Tulane professor was working on a book titled *Mind: The Maker* and was convinced that Einstein's theory fitted "completely and perfectly … with the general world-view that I have long cherished and am gradually shaping into expression" (1921, 509). Another example is the Russian-American philosopher Wolf Gordin, who argued that Einstein had "disproved" those who would "banish philosophy from the realm of reality"; Gordin believed that Einstein had set in motion an "an unsurmized renaissance of philosophy, mathematics, logic, epistemology, and metaphysics" that combined non-Euclidean geometry with Cantor's work on infinity and "Hegel's dialectics" (1926, 518).

Many realists, on the other hand, were critical of relativity, and some of them even tried to *dismiss* the theory.[11] Montague, for example, published an analysis of special relativity and concluded that Einstein's ideas are internally inconsistent. One of his central arguments was a version of the twin paradox, in which one of two twin brothers travels back and forth into space and discovers, upon return, that he has aged less than his stay-at-home brother. Applying the relativity of motion, such that the stay-at-home brother could also be viewed as the one who has been traveling back and forth in the opposite direction, Montague derived the paradoxical conclusion that each twin is younger than his brother (1924, 156). In order to resolve the paradox, Montague proposed an alternative to special relativity built on the assumption that

[10] See Sanchez-Ron (2012) for a reconstruction of the British reception of relativity.

[11] Already in 1913, Morris Cohen had warned realists "who assume an absolute time or space" that their theory might be "inconsistent" with the newest physical insights and "should at least reckon with the recent relativity theory of Einstein and Minkowsky" (1913, 210–11).

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the speed of light *is*, pace Einstein, affected by the velocity of its source. In fact, Montague even sketched an experiment designed to test his alternative and called upon the readers of *Philosophical Review* to help and fund it: "The cost of the experiment might run to $20,000. . . . Perhaps some of you will be willing to pray that there be sent to me a kind-hearted rich man who will take a sporting chance and put up the necessary funds" (1924, 162).

Montague was not the only philosopher to make use of the twin paradox to dismiss special relativity. A few years later, Arthur Lovejoy published an article sketching a similar paradox (1931). Lovejoy, who had a stake in the debate because he had long defended a position that has been dubbed "temporal realism" (Kurz 1966, 354), believed it was simply inconsistent to dismiss the assumption "that there is a single universal order of temporal relations . . . in which every event can be unequivocally assigned" (Lovejoy 1930, 617). Lovejoy's most important objection to relativity, however, concerned Einstein's theory of *meaning*. Turning Bridgman's modus ponens into a modus tollens, Lovejoy accepted the latter's diagnosis that Einstein presupposed a "radically experimental theory of meaning" but used it to *reject* special relativity. It is simply "preposterous," Lovejoy argued, to suppose that "no term can ever signify anything *more* than what is actually given in the verifying experience":

> astronomers were long able to judge of the probable distances of remote stars . . . only by observing and measuring the "apparent brightness" of the stars. The degree of brightness, that is, was the sole experimental criterion (admittedly a poor one) of distance which they could apply; they did not even then, however, suppose themselves to *mean* by the star's distance its "apparent brightness." (1930, 620)

Mocking Einstein's criterion, Lovejoy argued that it implied that if a bedridden patient observes two men, one outside in the rain and another entering her room with wet clothing, her inference that rain had fallen upon both could not have the same meaning in the two cases because it had been verified in a different way (1930, 628). Instead, Lovejoy proposed an alternative theory of meaning in which an experimental finding is "the sign or circumstantial evidence of something else," not the "meaning" of the term (1930, 620).

Not everyone accepted Lovejoy's argument. A substantial group of philosophers embraced Bridgman's conclusions and interpreted them as confirming a broadly *pragmatist* orientation. They felt emboldened by the *Logic of Modern Physics* because they read it as offering an essentially Peircean perspective on scientific concepts. J. S. Bixler argued that Bridgman's "new physics" confirmed the "pragmatic theory that knowledge is directed toward the consequences of experimental operations" (1930, 214). And Ernest Nagel saw Bridgman's perspective as a new version of the approach Peirce had developed 50 years before:

> Many years ago Peirce made clear that our ideas are to mean all the experimentally verifiable consequences which follow our acting upon them. Since Peirce was bred in the laboratory . . . it is not surprising that critically conscious scientists should have, independently, voiced a full-throated

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> endorsement of many of his positions. . . . With Bridgman we may say that "the concept is synonymous with the corresponding set of operations."[12] (1929, 172)

W. E. Van de Walle even suggested that Bridgman's book could have been titled "The Evidence from Physics for Pragmatism" (1928, 286). Einstein had ignited an intellectual firestorm, and one of the country's most prominent physicists advanced a perspective that sounded very much like the view pragmatists had been defending for decades.

5. Scientific philosophy

Many of the aforementioned papers are relatively shallow when compared to some of the work that was published in, for instance, Germany and England. It is unlikely that philosophers such as Smith, Gordin, Montague, Lovejoy, Bixler, and van de Walle fully understood Einstein's theory. Montague's version of the twin paradox had already been resolved when he published his paper.[13] And Lovejoy's reading of Einstein's theory of meaning was quickly rejected by Evander McGilvary, who showed that the Swiss-German professor had never claimed that concepts ought to be defined in terms of the operations we use to test them. Einstein, McGilvary argued, defended a subtler criterion in which concepts are only *indirectly* tied to operations. A circle, for example, is not defined in terms of the method we use to determine whether a particular shape qualifies as a circle. Conversely, we use the definition of a circle—a figure consisting of points equidistant from a given point in a two-dimensional plane—to find a method for "how to go about finding out whether a figure is a circle" (McGilvary 1931, 427).

Still, several American philosophers made lasting contributions in the wake of Einstein's discoveries. One important example is Theodore de Laguna, whose work on geometry helped found the field of mereotopology (1922a, 1922b, 1922c). De Laguna, a Bryn Mawr professor, proposed to define standard spatial concepts such as "point" and "coordinate position" in terms of region-based concepts such as "solid" and "connection," instead of the other way around, and is today still considered "a forerunner" in the area of qualitative topological reasoning (Varzi 2007, 979). Not only did it influence Whitehead's work on the relation of extensive connection (Whitehead 1929, 287), but present-day mathematicians still view him as one of the first scholars to develop a region-based geometry (Pratt-Hartmann 2007, 91). Another set of valuable contributions came from Yale, where an interdisciplinary group of philosophers and physicists—Filmer Northrop, Henry Margenau, and Fred Hoskyn—regularly contributed to debates about the methodological implications of relativity (see Table 1). All three were critics of Bridgman's view and aimed to develop a theory of meaning that allows theoretical constructs.[14] Whereas Bridgman held that we

[12] See Verhaegh (2020). Verhaegh argues that Dewey and Lewis embraced operationism, too.

[13] Einstein (1918) solved the paradox within the framework of general relativity. It is unclear whether Montague was aware of Einstein's response.

[14] In addition to his work on scientific concepts, Northrop was known for positing the existence of a macroscopic atom, which he thought was needed to explain atomic motion within the framework of general relativity (Northrop 1928). This theory generated quite some attention as an alternative to Whitehead's cosmology, which itself was viewed as an alternative to general relativity (see Whitehead

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employ different concepts of length if we use different operations to measure length in different domains, Margenau believed that such a criterion dissolves reality into an "unmanageable variety of discrete concepts without logical coherence":

> If carried to its consequence . . . [t]here would be no way of telling . . . why a time interval read from a clock is more closely related conceptually to a time interval measured by astronomical observations than to weight determined by means of a balance. (Margenau 1931, 16–17)

Instead, Margenau and Northrop introduced a separate category of concepts—"concepts by postulation"—and argued that modern physical theories, including Einstein's mechanics, require such notions. Although concepts by postulation cannot be operationally defined, theories involving such concepts are testable because one can derive consequences from them that can be directly verified (Northrop 1939, 434–35).[15]

Although only a few of the articles listed in Table 1 have withstood the test of time, it would be a mistake to conclude that this literature has been rightly ignored by historians. On the contrary, these philosophical discussions about relativity are significant because they contributed to the development of a uniquely American branch of philosophy of science. Whereas the first decades of the century were marked by philosophical disputes between idealists, realists, and pragmatists, participants in the debate about relativity contributed to the development of a more scientifically oriented philosophy. Even some idealists, who had traditionally been suspicious of overly scientistic approaches (see sec. 3), now explicitly recognized the "the dependence of philosophy upon the findings" of the special sciences (Northrop 1925, 6). Unlike the situation in Italy, where "neo-idealists just dismissed the question of the philosophical consequences of relativity" because the "idea of an idealist science" would be "a contradiction in terms" (Reeves 1987, 206–8; Sanchez-Ron 2012), several American idealists helped promote the idea that philosophy should become more scientific. And although some opponents of idealism were skeptical about the value of metaphysical speculation, most of them could live with a speculative movement that had "its feet on the ground, however much its head may swim" (Costello 1931, 245). Einstein's theory, in other words, stimulated philosophers to develop more scientifically informed perspectives. Perry, the aforementioned realist, even wrote a paper in which he signaled that the scholastic disputes that had characterized U.S. philosophy before World War I (see sec. 3) had made a place for an "era of philosophical peace" because science had given everyone "something new to think about" (Perry 1928, 311–12).[16]

1929, 333). Northrop's student Hoskyn compared Einstein's and Whitehead's cosmologies in "The Problem of Motion" (1929).

[15] Northrop's position here is similar to Einstein's response to Bridgman. See Einstein (1949, 679): "In order to be able to consider a logical system as physical theory it is not necessary to demand that all of its assertions can be . . . 'tested' 'operationally'; *de facto* this has never yet been achieved . . . In order to be able to consider a theory as a *physical* theory it is only necessary that it implies empirically testable assertions."

[16] Naturally, this development did not start in the 1920s. American philosophers had also responded to scientific advances before the rise of relativity. Still, the Royal Society announcement appears to have

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Conversely, physicists and mathematicians also became increasingly interested in the *philosophical* foundations of their disciplines. Bridgman and Margenau were certainly not the only scientists to do work in the philosophy of physics. The aforementioned Carmichael wrote a paper on the "philosophical implications" of relativity (Carmichael 1927) and published a textbook titled *The Logic of Discovery* (Carmichael 1930). The mathematician G. D. Birkhoff developed an axiomatization of general relativity (much like Reichenbach had done in Berlin), adding a chapter on the theory's "philosophical influence" (Birkhoff 1925). And the Columbia mathematician C. J. Keyser, one of the American postulate theorists, published a book titled *Mathematical Philosophy* in which he aimed to bring philosophers and mathematicians closer to one another (Keyser 1922).

Together, this growing community of scientists and philosophers started to develop a new field that was variously called "scientific philosophy" or "philosophy of science."[17] In 1925, C. I. Lewis signaled the rise of a "new movement in philosophy" inspired by the "revolutionary advances in logic, in mathematical, and in physical theory" and noted that "the partitions between these subjects have become thin or disappeared" as they all developed "in the direction of greater comprehensiveness and increased rigor" (1925, 410). Similar observations were made by Paul Schilpp, who recognized "a tendency in recent American philosophy which . . . may perhaps most adequately called and described as the philosophy of science" (1930, 276); by Frank Thilly, who noted the rise of "new movements" that "derive their inspiration from the methods and results of natural science . . . and seek . . . to avoid the metaphysical presuppositions of the older schools" (1926, 522); and by Charles Morris, who recognized "many streams of activity" that contribute to "a wide convergence toward a unified philosophical science and scientific philosophy" (1935, 147–48; Verhaegh Forthcoming).

6. Logical empiricism

Although it is difficult to estimate the relative size of the community of philosophers and scientists involved in debates about the foundations of science, there is quite a lot of evidence that the American reception of logical empiricism was directly connected to the previously discussed debates. German and U.S. philosophers had worked in relative isolation since the First World War, but the philosophy of relativity functioned as a shared reference point when the Allied boycott on German scholarship was lifted in 1926. Whereas Reichenbach's first two books on relativity, published during the years of the boycott, had been generally ignored, for example, his 1928 *Philosophie der Raum-Zeit-Lehre* was positively reviewed and regularly cited in

given new impetus to American philosophy of science. Moreover, it changed the nature of the debate about science because philosophical discussions about Einstein's theory were often focused on questions about meaning and verification.

[17] Both labels have their origin in the 19th century. *The Monist* had used the subtitle "Devoted to the Philosophy of Science" since 1898; the *Journal of Philosophy, Psychology and Scientific Methods* promoted itself as a periodical "in the field of scientific philosophy" in the 1900s. Labels such as "philosophy of science," "scientific philosophy," "analysis of science," "mathematical philosophy," and "logic of science" were often used alongside each other, and different philosophers seem to have used these terms in slightly different ways.

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the American literature (Langer 1930; Northrop 1931). Susanne Langer, for example, praised Reichenbach's approach to philosophy of science because it concerned "the philosophical reflection of a scientist, not the scientific speculation of a philosopher" like "Einstein, Whitehead, or Weyl" before him (1930, 611). Moritz Schlick, who had written one of the best-known philosophical works on relativity in the German-speaking world, was quickly invited to come and lecture in the United States. H. W. Stuart, chairman of Stanford's philosophy department, had been reading Schlick's exposition of Einstein's theory and wrote that it would be his great pleasure to welcome him to California.[18] And Philipp Frank, Einstein's successor in Prague, was invited to do a lecture tour in the United States, where he was greatly admired for his understanding of "modern physics and philosophy" and his competence "to treat these two fields jointly."[19] Although the American reception of logical empiricism is commonly tied to its "philosophical" program, many of the first encounters between U.S. philosophers and logical empiricists were concerned with the philosophical implications of relativity.

The logical empiricists, in turn, were also interested in the perspectives on relativity that had been developed in the United States. Schlick read up on Bridgman's work before he traveled to the United States and published a review of *The Logic of Modern Physics* in *Die Naturwissenschaften*. And Schlick's student Herbert Feigl even acquired a Rockefeller fellowship to study with Bridgman at Harvard in the 1930–31 academic year. Carnap had already discovered the diverse Anglophone literature on relativity in 1923, when he had attended a congress of the American Mathematical Society in New York. In a letter to Reichenbach, Carnap described the growing "interest in … mathematical logic" and surveyed the Anglophone literature on relativity. His letter includes a list of English-language publications on Einstein's theory (including, among others, Carmichael's and Keyser's books) and expresses his surprise about the amount of "valuable work that has been done and is important for us."[20]

The philosophy of relativity, in sum, stimulated European and American philosophers to get acquainted with each other's work, thereby paving the way for the relatively warm reception of logical empiricism in the United States.[21] Some American philosophers even traveled to Europe to visit the Berlin Group and/or the Vienna Circle. The Yale philosopher Northrop acquired a fellowship to visit Reichenbach and Einstein in Berlin, describing Reichenbach's work as exactly "the

[18] October 2, 1928, *Wiener Kreis Archiv* (hereafter, WKA), 118/Stua-1, Haarlem.

[19] Robert A. Millikan to Edgar J. Fisher, December 7, 1938, cited in Reisch and Tuboly (2023).

[20] Carnap to Reichenbach, May 7, 1923, Hans Reichenbach Papers (hereafter, HRP), 016-28-12, Archives of Scientific Philosophy, University of Pittsburgh.

[21] Interestingly, the philosophy of relativity played a far less important role in bridging the gap between European and *British* philosophy. British discussions about the philosophical implications of relativity had emerged a bit earlier and had already lost momentum in the late 1920s. Sanchez-Ron (2012, 78) speculates that the "momentum was not sustained" because British philosophy was more "academic" and because there were fewer "scientists with deeply rooted philosophical interests." One could add that philosophical publications by British physicists (e.g., Jeans and Eddington) were often criticized by philosophers in the United Kingdom (e.g., Stebbing 1937). I thank an anonymous reviewer for this suggestion.

kind of thing we need in philosophy."[22] The New York philosopher Sidney Hook visited Reichenbach in Germany and described *Philosophy der Raum-Zeit-Lehre* as "the most lucid and comprehensive exposition of the philosophical implications of the theory of relativity" (Hook 1930, 159). And the critical realist C. A. Strong invited Feigl to come to his Italian residence in Fiesole in order to help the American philosopher acquire "a better understanding of Einstein's theory of relativity." Strong "was working on a metaphysical theory of space and time and wanted to find out to what extent his views were compatible with those of Einstein" (Feigl 1969, 68). Feigl, in turn, traveled to the United States to work with Bridgman and learn more about his operationist approach to the philosophy of physics and, in doing so, helped spread the views of the Vienna Circle to some of the philosophers (most notably, C. I. Lewis and W. V. Quine) who would come to play an important role in the further promotion of logical empiricism in the United States.[23]

A few years later, several members of this diverse community of European and American philosophers (idealists, pragmatists, operationists, realists, and logical empiricists) would become involved in the two boards of *Philosophy of Science*, which published its first issue in 1934, thereby contributing to the institutionalization of philosophy of science in North America. Indeed, the editorial and advisory boards of this new journal perfectly reflect the intellectually diverse community of philosophers of science working on relativity in this period. The team included—in addition to editor William Malisoff—Bridgman, Carnap, Feigl, Lovejoy, Margenau, Montague, Northrop, Reichenbach, Schlick, and Whitehead.

7. Conclusion

Historians have shown that philosophical debates about special and general relativity have shaped the development of philosophy of science. This article argued that the United States was no exception. The American intellectual climate had been characterized by (1) a deeply empiricist approach to science among physicists and (2) abstract discussions between idealists, realists, and pragmatists in philosophy. Throughout the 1920s, however, some members of all these groups came to focus on the philosophical implications of relativity, thereby giving rise to a substantial literature on Einstein's theory in American philosophy journals. And although not all participants agreed on whether to accept general (or even special) relativity, the discussion helped stimulate an interdisciplinary movement that was variously called "scientific philosophy" or "philosophy of science." Philosophers reflected on the consequences of modern physics, and physicists became interested in the philosophical foundations of their discipline. This article has provided an overview

[22] Northrop to Reichenbach, Jan. 5, 1932, HRP, 014-57-12.

[23] See Verhaegh (2020, 2023). Lewis is an interesting figure because he proposed a relativized (or pragmatic) conception of the a priori that was quite similar to the perspective Carnap and Reichenbach had been developing in Europe. In a letter to Schlick, Feigl even called Lewis's position "barely distinguishable from our positivism" (Dec. 6, 1930, Moritz Schlick Papers, Noord-Hollands Archief, 99/Fei-17). Interestingly, Lewis had used Einstein's definition of simultaneity as an illustration for his claim that "the fundamental laws of any science . . . are a priori because they formulate just such definitive concepts . . . by which alone investigation becomes possible" (1923, 173). See Lewis (1923) and Franco (2020) for a discussion.

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of these responses and argued that the discussions paved the way for the successful integration of logical empiricism in the 1930s. Americans were not just eager to learn about the views of their colleagues because Viennese philosophers had developed an analytic approach to philosophy or radically empiricist views about meaning and metaphysics. They were first and foremost interested in their views about Einstein's theory because they themselves had debated the implications of relativity for more than a decade.

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