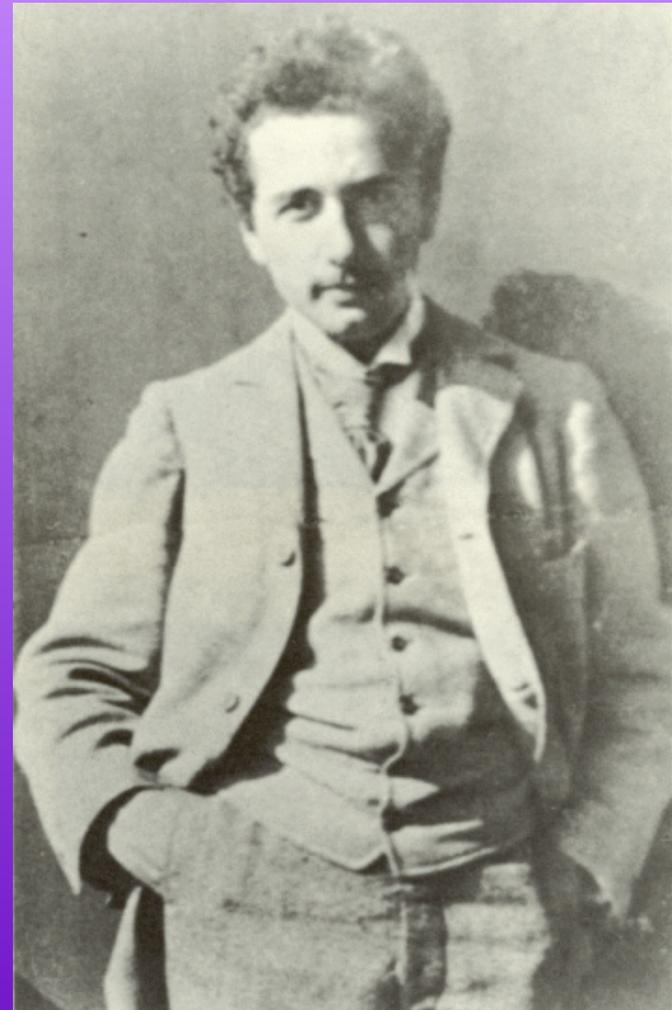


Einstein the Philosopher

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Lectures on Quantum Phenomena
PITP
University of British Columbia
March 5, 2014



Einstein as a college student, ca. 1900

In Einstein's Own Words

Albert Einstein. “Physik und Realität.” *Journal of The Franklin Institute* 221 (1936), 313-347.

It has often been said, and certainly not without justification, that the man of science is a poor philosopher. Why then should it not be the right thing for the physicist to let the philosopher do the philosophizing? Such might indeed be the right thing at a time when the physicist believes he has at his disposal a rigid system of fundamental concepts and fundamental laws which are so well established that waves of doubt cannot reach them; but it cannot be right at a time when the very foundations of physics itself have become problematic as they are now. At a time like the present, when experience forces us to seek a newer and more solid foundation, the physicist cannot simply surrender to the philosopher the critical contemplation of the theoretical foundations; for, he himself knows best, and feels more surely where the shoe pinches. In looking for a new foundation, he must try to make clear in his own mind just how far the concepts which he uses are justified, and are necessities.

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Einstein to Robert Thornton, 7 December 1944.

I fully agree with you about the significance and educational value of methodology as well as history and philosophy of science. So many people today—and even professional scientists—seem to me like somebody who has seen thousands of trees but has never seen a forest. A knowledge of the historic and philosophical background gives that kind of independence from prejudices of his generation from which most scientists are suffering. This independence created by philosophical insight is—in my opinion—the mark of distinction between a mere artisan or specialist and a real seeker after truth.

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How does it happen that a properly endowed natural scientist comes to concern himself with epistemology? Is there no more valuable work in his specialty? I hear many of my colleagues saying, and I sense it from many more, that they feel this way. I cannot share this sentiment. When I think about the ablest students whom I have encountered in my teaching, that is, those who distinguish themselves by their independence of judgment and not merely their quick-wittedness, I can affirm that they had a vigorous interest in epistemology. They happily began discussions about the goals and methods of science, and they showed unequivocally, through their tenacity in defending their views, that the subject seemed important to them. Indeed, one should not be surprised at this.

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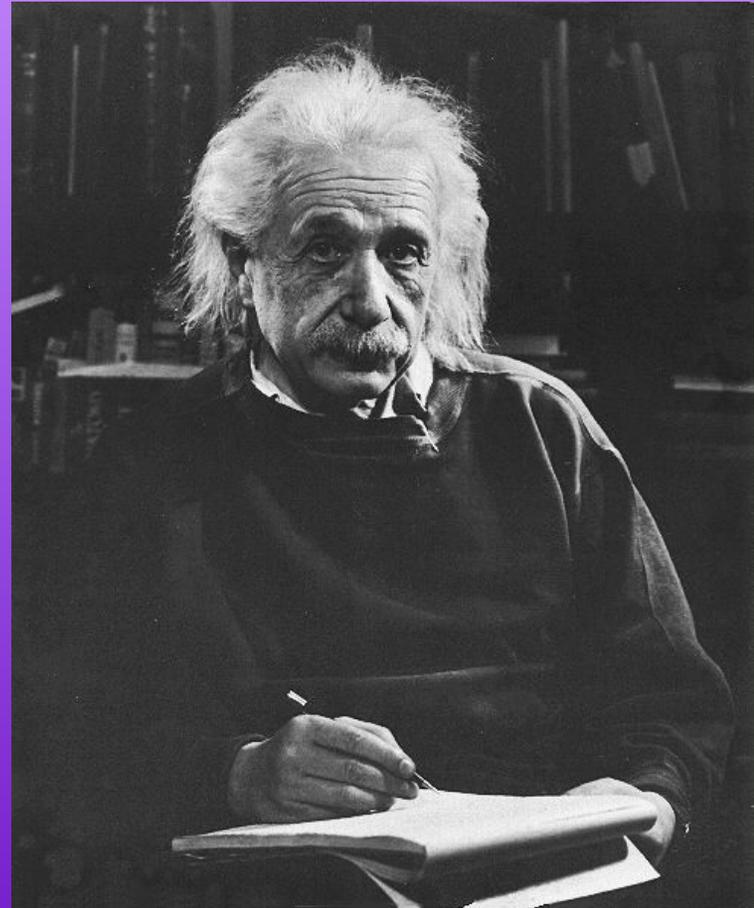
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History of Science and Philosophy of Science in Einstein's Physics

History and Philosophy of Science in Einstein's Physics

1. Einstein's Early Acquaintance with History and Philosophy of Science
2. Specific Examples:
 - a. Mach and the Historical-Critical Analysis of Scientific Theories
 - b. Poincaré and Duhem: Conventionalism and the Empirical Interpretation of Scientific Theories
 - c. Schlick and the Univocal Determination of Spacetime Events
 - d. Cassirer and the Neo-Kantian Interpretation of Relativity
 - e. Einstein on the Principle Theories–Constructive Theories Distinction
 - f. Kant and Schopenhauer on Space, Time, and the Individuation of Physical Systems
3. The “Philosopher-Scientist” – Symbiosis between Philosophy of Science and Theoretical Physics



See: Don Howard. “Einstein as a Philosopher of Science.” *Physics Today* 58, no. 11 (2005), 34-40.

Einstein in Munich, 1880-1894



Luitpold Gymnasium, which Einstein attended
1888-1894

“At the age of twelve years I experienced a . . .
wonder. . . . Euclid.”

“If Euclid fails to kindle your youthful
enthusiasm, you were not born to be a
scientific thinker.”



Einstein and Luitpold classmates
(Find Einstein)

AE

Einstein in Munich, 1880-1894

“Between the ages of twelve and sixteen I made myself familiar with the elements of mathematics, including the principles of the differential and integral calculus. . . . I also had the good fortune to learn the essential results and methods of all of the natural sciences in a splendid popular presentation.”

Circa age 13 (thanks to Max Talmey):

Aaron Bernstein. *Aus dem Reiche der Naturwissenschaft. Für Jedermann aus dem Volke.* (12 vols., 1853-1857).

Aaron Bernstein. *Naturwissenschaftliche Volksbücher.* (1870).
[Popular Books on Natural Science]

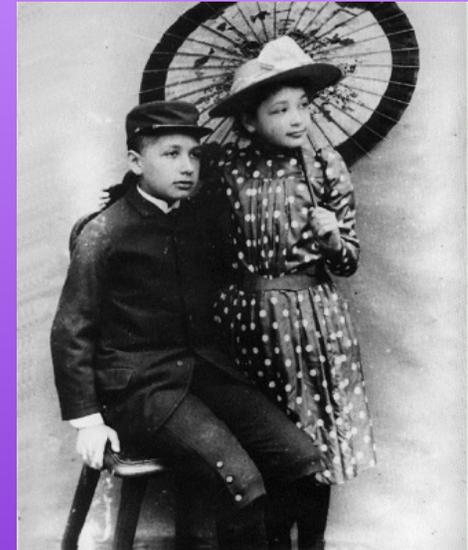
Immanuel Kant. *Kritik der reinen Vernunft.*
[Critique of Pure Reason]

Immanuel Kant. *Kritik der praktischen Vernunft.* **[Critique of Practical Reason]**

Immanuel Kant. *Kritik der Urteilskraft.*
[Critique of Judgment]



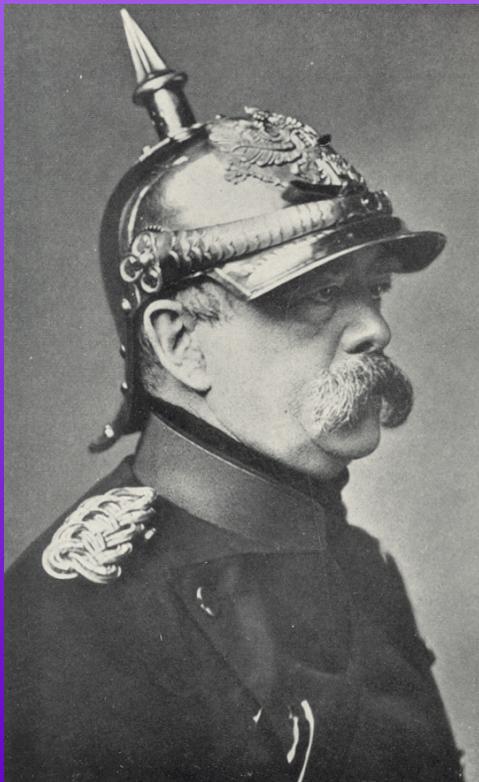
Max Talmey (1869-1941)



Einstein and sister, Maja

Einstein in Munich, 1880-1894

“When I was in the seventh grade at the Luitpold Gymnasium [ca. age 15] I was summoned by my home-room teacher who expressed the wish that I leave the school. To my remark that I had done nothing amiss he replied only, ‘your mere presence spoils the respect of the class for me.’ I myself, to be sure, wanted to leave school and follow my parents to Italy, but the main reason for me was the dull, mechanized method of teaching. Because of my poor memory for words, this presented me with great difficulties that it seemed senseless for me to overcome. I preferred, therefore, to endure all sorts of punishments rather than learn to gabble by rote.”



“The teachers in the elementary school appeared to me like sergeants, and the gymnasium teachers like lieutenants.”



Einstein in Aarau, 1895-1896



Einstein's graduating class, Aargauer Kantonsschule, 1896

“The school left in me an unforgettable impression, thanks to its liberal spirit and to the teachers' pure dedication, that wasn't based upon any external authority.”



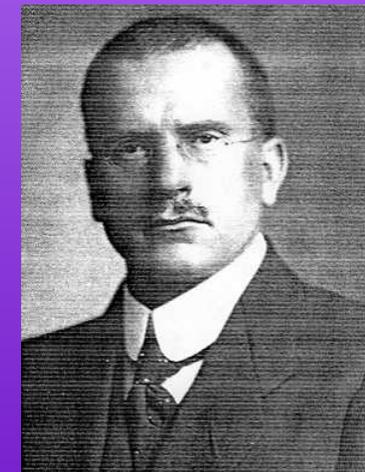
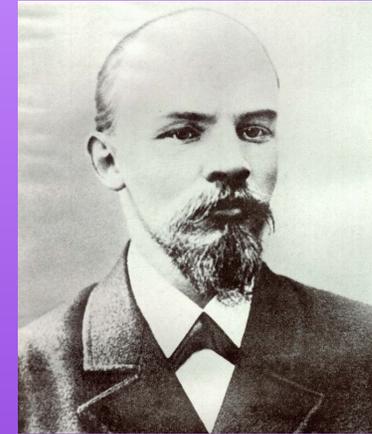
Einstein in Zurich, 1896-1901

“A foolish faith in authority is the worst enemy of truth.”

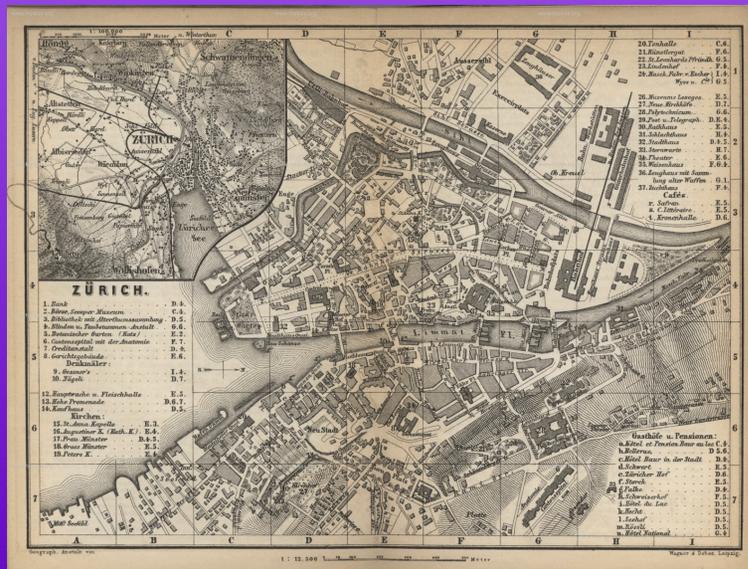
Einstein to Jost Winteler,
July 1901



Lenin (1870-1924)



Carl Jung (1875-1961)



James Joyce (1882-1941)

Einstein in Zurich, 1896-1901



Friedrich Adler (1879-1960)

Son of Victor Adler, co-founder of the Austrian Social Democratic Party, Einstein's good student friend (Adler trained in physics as well), famous proponent of "Machist" Austro-Marxism, principal target of Lenin's attack in *Materialism and Empiriocriticism* (1909), Einstein's Zurich next-door neighbor 1909-1911, and assassin of Austrian Minister-President Stürgkh in 1916.



ETH – Swiss Federal Polytechnic Institute,
Physics Institute

Einstein in Zurich, 1896-1901

In the mid-1890s, Marić arrived from her home in Novi Sad, a predominantly Serbian city in what was then the Hungarian part of the Austro-Hungarian empire, to begin medical studies at the University of Zurich. It was then one of only two universities in Europe admitting women to the study of medicine.

“It is really a very funny life that I am living here, entirely in Schopenhauer’s sense.”

Einstein to Marić, December 1901



Mileva Marić (1875-1948)
Einstein’s fellow ETH physics student and
first wife.

Einstein in Zurich, 1896-1901

Lectures by August Stadler (student of Friedrich Albert Lange in Zurich; Ph.D. under the Marburg neo-Kantian, Hermann Cohen):

Sommersemester 1897 — Die Philosophie Kants

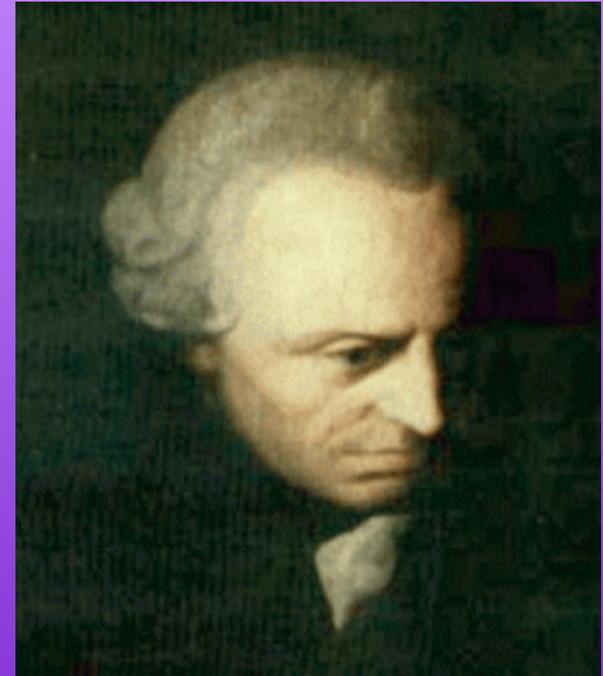
[The Philosophy of Kant]

Wintersemester 1897 — Theorie des wissenschaftlichen Denkens

[Theory of Scientific Thought]

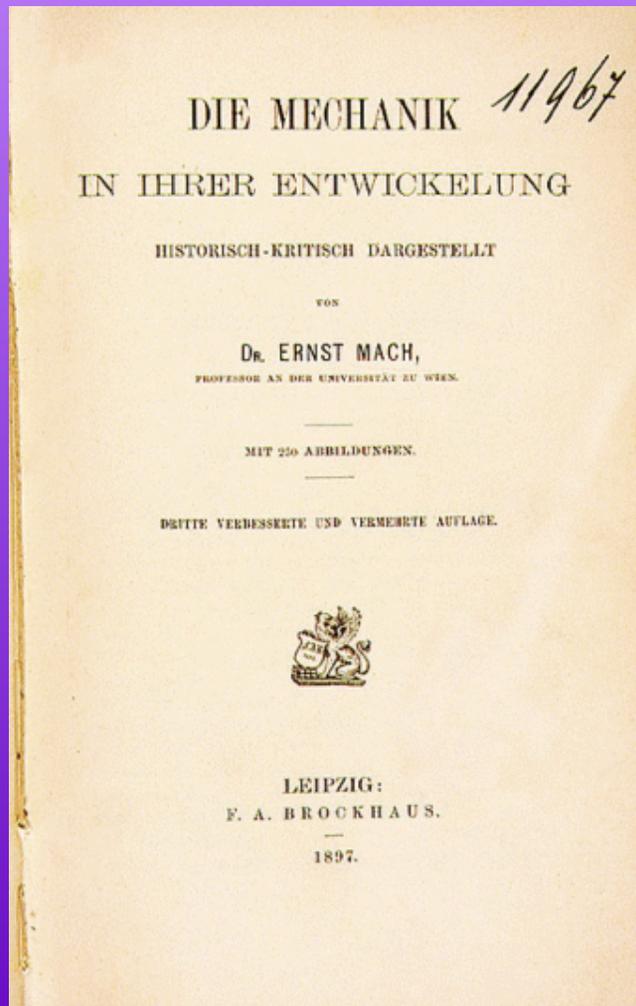
(“obligatorisches Fach”)

[“required subject”]



Immanuel Kant (1724-1804)

Einstein in Zurich, 1896-1901



Ernst Mach. *Die Mechanik in ihrer Entwicklung historisch-kritisch dargestellt.* (1883; 3rd ed., 1897). [***The Development of Mechanics: An Historical-critical Presentation.***]

Ernst Mach. *Die Principien der Wärmelehre. Historisch-kritisch entwickelt.* (1896). [***The Principles of the Theory of Heat: Developed in an Historical-critical Manner.***]

Arthur Schopenhauer. *Parerga und Paralipomena. Kleine Philosophische Schriften.* (1851). [***Parerga and Paralipomena. Little Philosophical Writings.***]

Friedrich Albert Lange. *Geschichte des Materialismus.* (1873-1875). [***History of Materialism.***]

Eugen Dühring. *Kritische Geschichte der Principien der Mechanik.* (1887). [***Critical History of the Principles of Mechanics.***]

Ferdinand Rosenberger. *Isaac Newton und seine physikalischen Prinzipien.* (1895). [***Isaac Newton and His Physical Principles.***]

Einstein in Bern, 1902-1909

Richard Avenarius. *Kritik der reinen Erfahrung*. (1888, 1890). [***Critique of Pure Experience.***]

Richard Dedekind. *Was sind und was sollen die Zahlen?* (2nd ed. 1893). [***What Are and What Should Be the Numbers?***]

David Hume. *A Treatise of Human Nature*. (1739; German trans. 1895; 2nd ed. 1904)

Ernst Mach. *Die Analyse der Empfindungen und das Verhältnis des Physischen zum Psychischen*. (2nd ed. 1900; 3rd enl. ed. 1902; 4th enl. ed. 1903). [***The Analysis of Sensations and the Relation of the Physical to the Psychological.***]

John Stuart Mill. *A System of Logic*. (1872; German trans. 1877 and 1884-1887).

Karl Pearson. *The Grammar of Science*. (1900).

Henri Poincaré. *La science et l'hypothèse*. (1902; German trans. 1904). [***Science and Hypothesis.***]



The Olympia Academy, Bern, ca. 1904. From left: Conrad Habicht, Maurice Solovine, Albert Einstein.

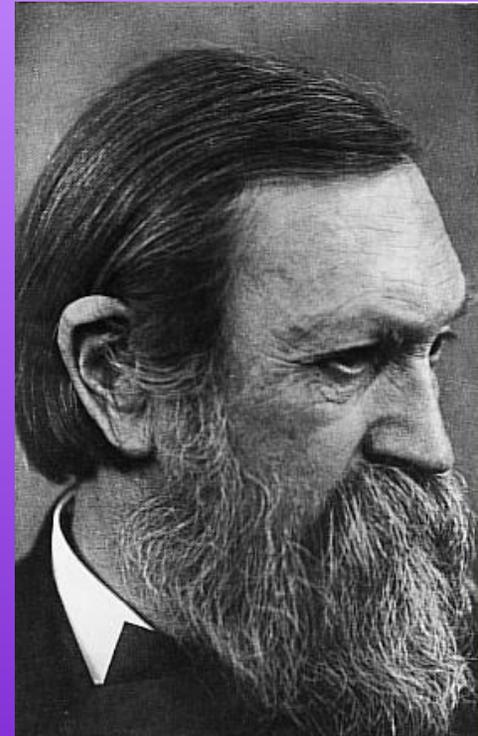
Mach and the Historical-Critical Analysis of Scientific Theories

Ernst Mach. *Die Mechanik in ihrer Entwicklung historisch-kritisch dargestellt.* (1883; 3rd ed., 1897). [*The Development of Mechanics: An Historical-critical Presentation.*]

Ernst Mach. *Die Principien der Wärmelehre. Historisch-kritisch entwickelt.* (1896). [*The Principles of the Theory of Heat: Developed in an Historical-critical Manner.*]

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- Historical analysis of the genesis of concepts.
- Biologico-economical view of knowledge.
- Neutral monist; not the reductionist phenomenalist many think he was.



Ernst Mach (1838-1916)

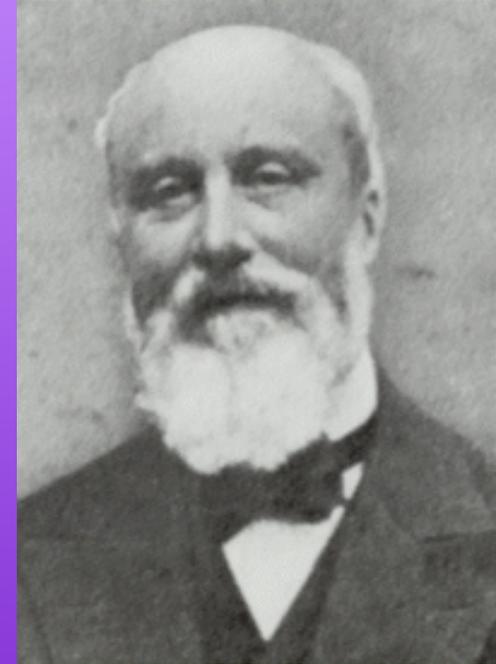
See: John Norton. "How Hume and Mach Helped Einstein Find Special Relativity." Paper presented at the conference, "Synthesis and the Growth of Knowledge," October 1-3, 2004, University of South Carolina.

Poincaré and Duhem: Conventionalism and the Empirical Interpretation of Scientific Theories

Pierre Duhem. *La Théorie physique: son objet et sa structure*. (1906). [*The Aim and Structure of Physical Theory*.]

German translation: *Ziel und Struktur der physikalischen Theorien*. Leipzig: Johann Ambrosius Barth, 1908. Preface by Ernst Mach. Translator was none other than Einstein's old friend Friedrich Adler.

- Theory holism and the empirical underdetermination of theory choice.
- Healthy French “Bon sens” as the theorist’s guide.
- Circumscribing the limits of science to make room for faith.



Pierre Duhem (1861-1916)

See: Don Howard. “Einstein and Duhem.” In *Pierre Duhem: Historian and Philosopher of Science*. Roger Ariew and Peter Barker, eds. *Synthese* 83 (1990), 363-384.

Poincaré and Duhem: Conventionalism and the Empirical Interpretation of Scientific Theories

Henri Poincaré. *La science et l'hypothèse*. (1902).
[Science and Hypothesis.]

Henri Poincaré. *La valeur de la science*. (1905).
[The Value of Science.]

Henri Poincaré. *Science et méthode*. (1908).
[Science and Method.]

- The conventional character of metrical geometry, such as Euclidean geometry.
- Simplicity as a criterion of theory choice.
- The “universal invariant.”



Henri Poincaré (1854-1912)

See: Michael Friedman. “Poincaré’s Conventionalism and the Logical Positivists.” *Foundations of Science* 1 (1995), 299-314.

Schlick and the Univocal Determination of Spacetime Events

Moritz Schlick. “Die philosophische Bedeutung des Relativitätsprinzips.” *Zeitschrift für Philosophie und philosophische Kritik* 159 (1915), 129-175. [***The Philosophical Significance of the Relativity Principle.***”]

Moritz Schlick. *Raum und Zeit in den gegenwärtigen Physik. Zur Einführung in das Verständnis der allgemeinen Relativitätstheorie.* Berlin: Julius Springer, 1917. [***Space and Time in Contemporary Physics: An Introduction to the Understanding of the General Theory of Relativity.***]

Moritz Schlick. *Allgemeine Erkenntnislehre.* Berlin: Julius Springer, 1918. [***General Theory of Knowledge.***]

- “Events” as invariant space-time coincidences.
- Epistemological or ontological foundation?
- Conventionalism about metrical structure is a consequence.

See: Don Howard. “Point Coincidences and Pointer Coincidences: Einstein on Invariant Structure in Spacetime Theories.” In *History of General Relativity IV: The Expanding Worlds of General Relativity.* Hubert Goenner, Jürgen Renn, Jim Ritter, and Tilman Sauer, eds., Boston: Birkhäuser, 1999, 463-500.



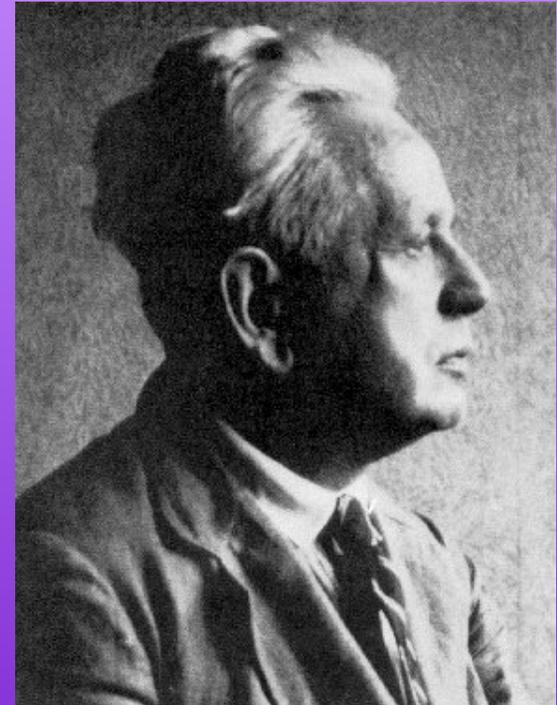
Moritz Schlick (1882-1936)

Cassirer and the Neo-Kantian Interpretation of Relativity

Ernst Cassirer. *Substanzbegriff und Funktionsbegriff. Untersuchungen über die Grundfragen der Erkenntniskritik.* Berlin: Bruno Cassirer, 1910. [***Concepts of Substanz and Concepts of Function. Investigations on the Basic Questions in the Critical Analysis of Knowledge.***]

Ernst Cassirer. *Zur Einsteinschen Relativitätstheorie. Erkenntnistheoretische Betrachtungen.* Berlin: Bruno Cassirer, 1921. [***On Einstein's Theory of Relativity. Epistemological Considerations.***]

- Only the topological structure of space-time is a priori, not the metrical structure.
- Einstein invokes theory holism to question the a priori-a posteriori distinction.



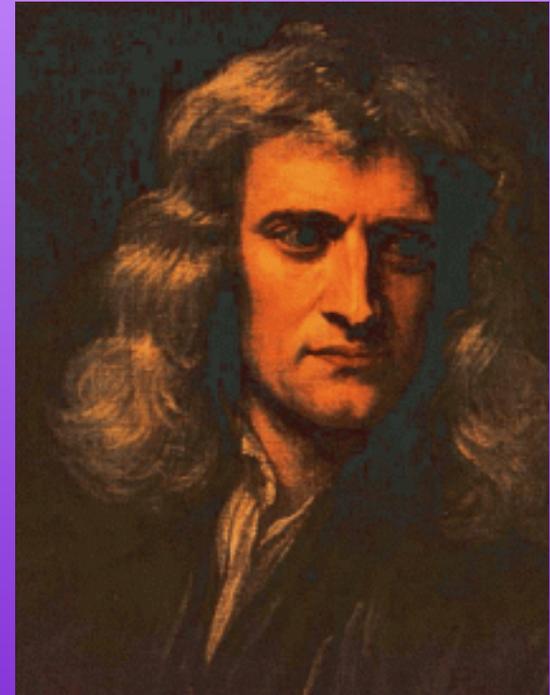
Ernst Cassirer (1874-1945)

See: Don Howard. "Einstein, Kant, and the Origins of Logical Empiricism." In *Language, Logic, and the Structure of Scientific Theories*. Wesley Salmon and Gereon Wolters, eds. Pittsburgh: University of Pittsburgh Press; Konstanz: Universitäts-verlag, 1994, 45-105.

Einstein on the Principle Theories–Constructive Theories Distinction

Albert Einstein. “Time, Space, and Gravitation.” *Times* (London).
28 November 1919.

- Principles: empirically well-grounded, mid- or high-level empirical generalizations that constrain the search for models.
- Constructive theories: ontological model of phenomena.
- Progress often best achieved by looking first for principles.



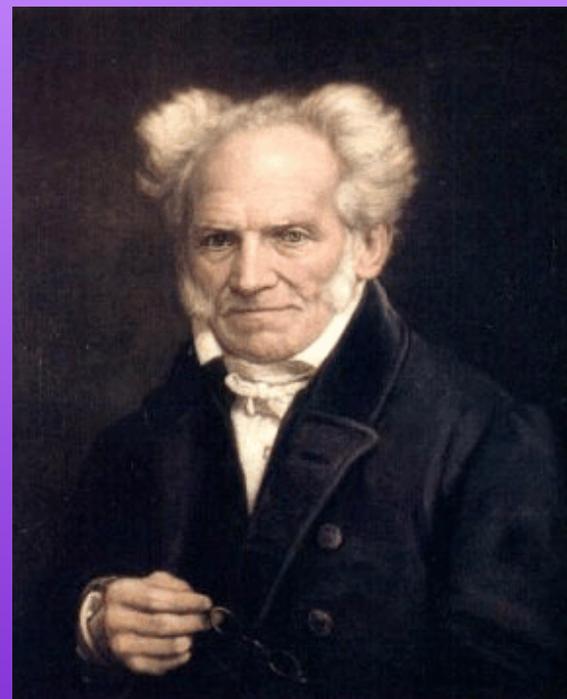
Isaac Newton (1643-1727)

See: Don Howard. “‘And I shall not mingle conjectures with certainties.’ Einstein on the Principle Theories–Constructive Theories Distinction.” British Academy, London. March 4, 2005.

Kant and Schopenhauer on Space, Time, and the Individuation of Physical Systems

Arthur Schopenhauer. *Die Welt als Wille und Vorstellung*. Leipzig: F. A. Brockhaus, 1819. [*The World as Will and Representation.*]

- Space and time as the *principium individuationis* on this side of the “veil of Maya.”
- Radical ontological holism on the other side of the “veil.”
- Other realm accessible mainly only through aesthetic experience, especially music.
- Implications for morality.

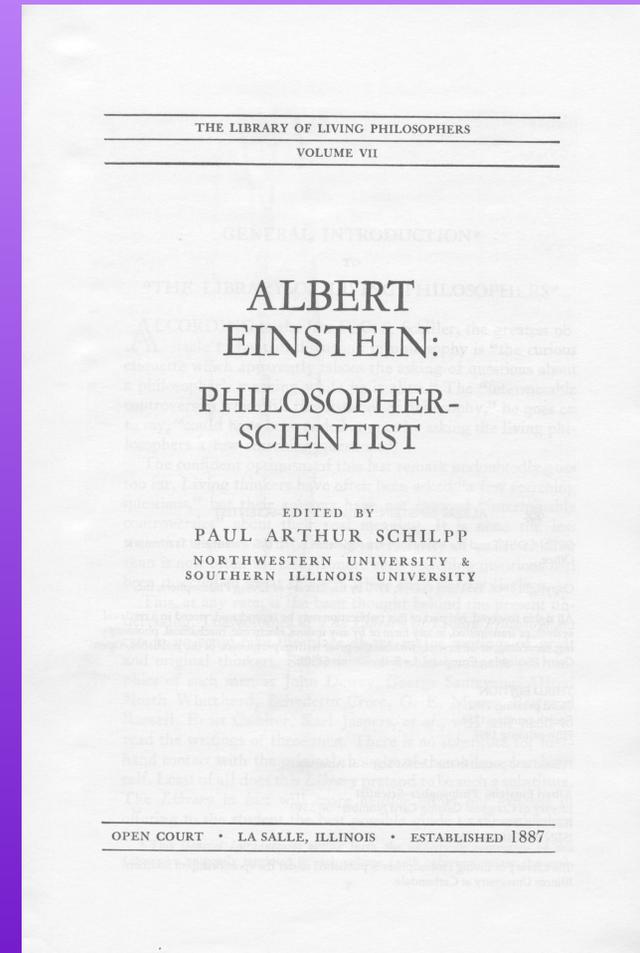


Arthur Schopenhauer (1788-1860)

See: Don Howard. “A Peek behind the Veil of Maya: Einstein, Schopenhauer, and the Historical Background of the Conception of Space as a Ground for the Individuation of Physical Systems.” In *The Cosmos of Science: Essays of Exploration*. John Earman and John D. Norton, eds. Pittsburgh: University of Pittsburgh Press; Konstanz: Universitätsverlag, 1997, 87-150.

The “Philosopher-Scientist” – Symbiosis between Philosophy of Science and Theoretical Physics

- Ernst Mach and Ludwig Boltzmann are the first two occupants of the chair for “History and Theory of the Inductive Sciences” at the University of Vienna (1896-1906); Schlick takes up this chair in 1922.
- Moritz Schlick does a physics Ph.D. under Planck in Berlin (1904), before retooling himself in Zurich as a philosopher (1908-1910).
- Arnold Berliner founds *Die Naturwissenschaften* (1913) and edits it for twenty-three years.



See: Don Howard. “Fisica e filosofia della scienza all’alba del XX secolo.” [“Physics and Philosophy of Science at the Turn of the Twentieth Century.”] In *Storia della scienza*. Vol. 8, *La Seconda rivoluzione scientifica*. Umberto Bottazzini, John L. Heilbron, Gilberto Corbellini, and Daniel J. Kevles, eds. Rome: Istituto della Enciclopedia Italiana, 2004, 3-16.

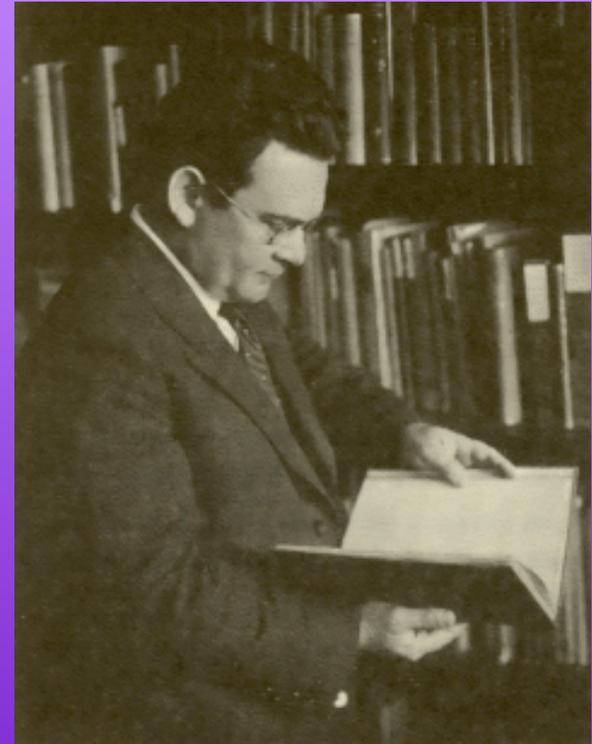
The “Philosopher-Scientist” – Symbiosis between Philosophy of Science and Theoretical Physics

Hans Reichenbach. *Relativitätstheorie und Erkenntnis Apriori*. Berlin: Julius Springer, 1920. [*Relativity Theory and A Priori Knowledge.*]

Hans Reichenbach. *Axiomatik der relativistischen Raum-Zeit-Lehre*. Die Wissenschaft, vol. 72. Braunschweig: Friedrich Vieweg und Sohn, 1924. [*Axiomatization of the Relativistic Theory of Space-time.*]

Hans Reichenbach. *Philosophie der Raum-Zeit-Lehre*. Berlin and Leipzig: Walter de Gruyter, 1928. [*Philosophy of the Relativistic Theory of Space-Time.*]

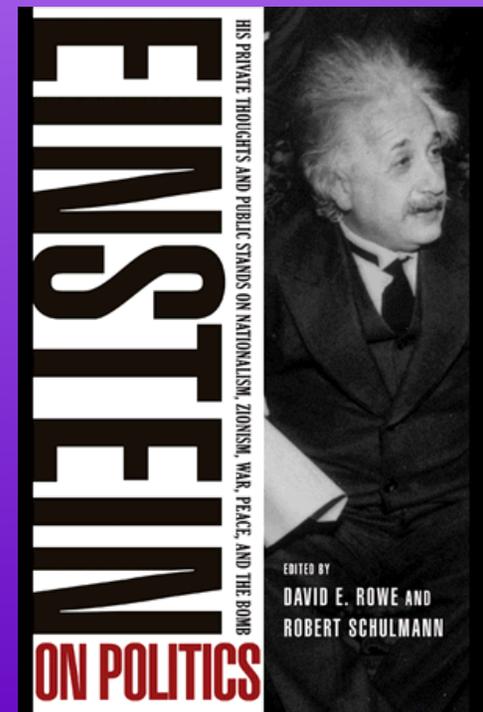
- Philosophy Ph.D. Erlangen, 1915; audits Einstein’s Berlin lectures, 1917-1920.
- Neo-Kantian, later logical empiricist interpretation of relativity theory.
- 1926 position in physics department at Berlin with help of Einstein, Planck, and von Laue.



Hans Reichenbach (1891-1953)

Einstein the Social Philosopher

See: David Rowe and Robert Schulmann, eds. *Einstein on Politics: His Private Thoughts and Public Stands on Nationalism, Zionism, War, Peace, and the Bomb*. Princeton University Press, 2007.



Zionism

- Cultural Zionism, not National Zionism
- Support for Hebrew University



Jewish Students' Conference, Berlin, 1924



Einstein, Chaim Weizmann (on Einstein's left), et al., 1921, on a US fundraising trip for Hebrew University. Einstein's first trip to the United States.

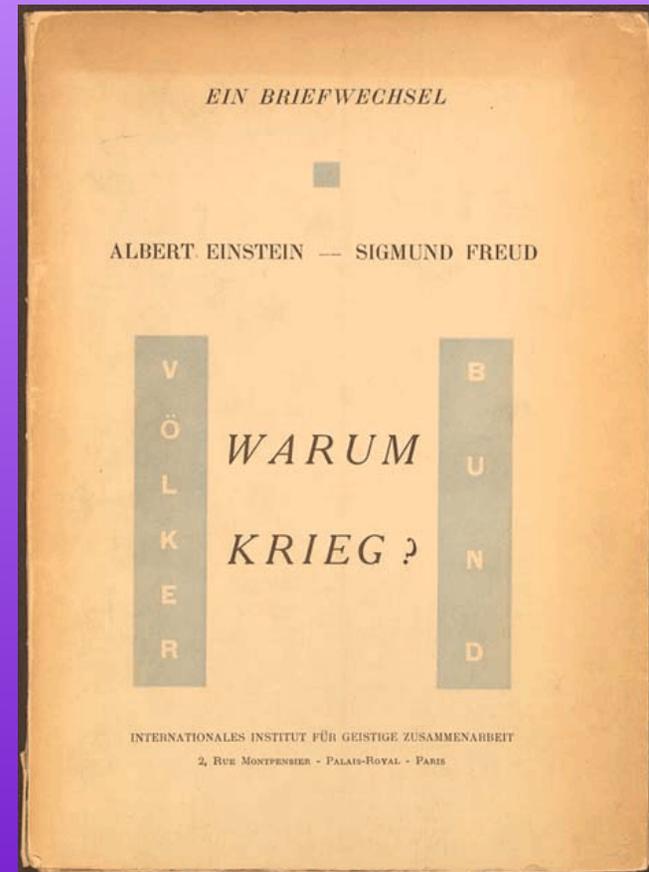
Pacifism

Albert Einstein and Sigmund Freud. *Warum Krieg?*
[*Why War?*] (1933)

“War cannot be humanized. It can only be abolished.”
(Einstein, 1932)



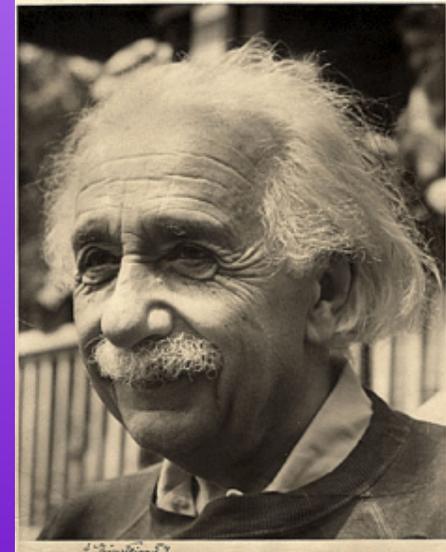
Einstein at a Berlin peace rally, 29 July 1923



Pacifism



The Russell-Einstein Manifesto
9 July 1955



“Here, then, is the problem which we present to you, stark and dreadful and inescapable: Shall we put an end to the human race; or shall mankind renounce war?”

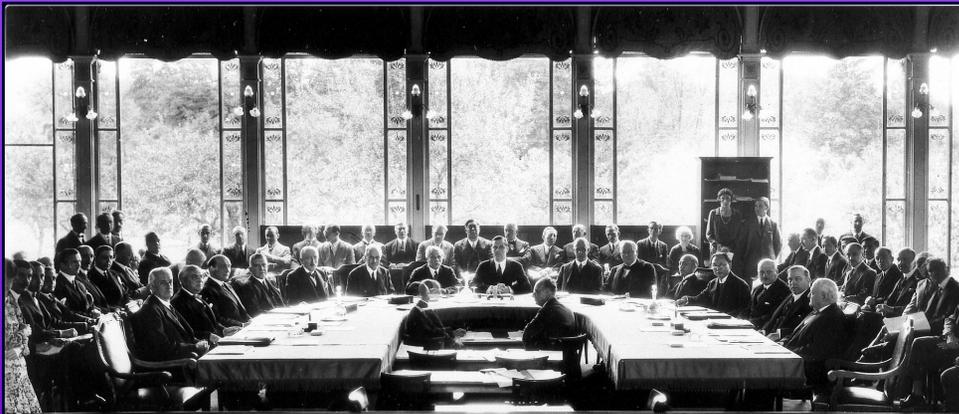
Internationalism

The League of Nations

- Judged by Einstein as too weak because it did not command police and military force sufficient to impose its decisions on member nations.



Palais des Nations, Geneva



League of Nations Assembly, 1 September 1928

Internationalism

International Committee on Intellectual Cooperation

later known as the

International Institute for Intellectual Cooperation

- One of the precursor institutions of UNESCO
- Einstein has an on-again/off-again relationship with the Committee, worried about perceptions of French domination after France occupied the Ruhr district in 1923, and worried, later, about the ineffectiveness of the League of Nations

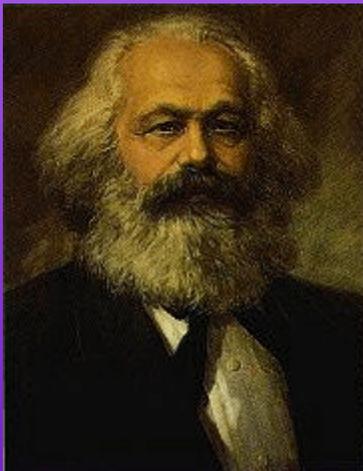


Einstein Meeting with the Committee in Paris, 1924

Socialism

Albert Einstein. “Why Socialism?” *Monthly Review* (1949).

- Democratic Socialism, not orthodox Marxism



Karl Marx (1818-1883)



Eduard Bernstein (1850-1932)

WHY SOCIALISM?

BY ALBERT EINSTEIN

Is it advisable for one who is not an expert on economic and social issues to express views on the subject of socialism? I believe for a number of reasons that it is.

Let us first consider the question from the point of view of scientific knowledge. It might appear that there are no essential methodological differences between astronomy and economics: scientists in both fields attempt to discover laws of general acceptability for a circumscribed group of phenomena in order to make the interconnection of these phenomena as clearly understandable as possible. But in reality such methodological differences do exist. The discovery of general laws in the field of economics is made difficult by the circumstance that observed economic phenomena are often affected by many factors which are very hard to evaluate separately. In addition, the experience which has accumulated since the beginning of the so-called civilized period of human history has—as is well known—been largely influenced and limited by causes which are by no means exclusively economic in nature. For example, most of the major states of history owed their existence to conquest. The conquering peoples established themselves, legally and economically, as the privileged class of the conquered country. They seized for themselves a monopoly of the land ownership and appointed a priesthood from among their own ranks. The priests, in control of education, made the class division of society into a permanent institution and created a system of values by which the people were thenceforth, to a large extent unconsciously, guided in their social behavior.

But historic tradition is, so to speak, of yesterday; nowhere have we really overcome what Thorstein Veblen called “the predatory phase” of human development. The observable economic facts belong to that phase and even such laws as we can derive from them are not applicable to other phases. Since the real purpose of socialism is precisely to overcome and advance beyond the predatory phase of human development, economic science in its present state can throw little light on the socialist society of the future.

Second, socialism is directed towards a social-ethical end. Science, however, cannot create ends and, even less, instill them in human

Albert Einstein is the world-famous physicist.

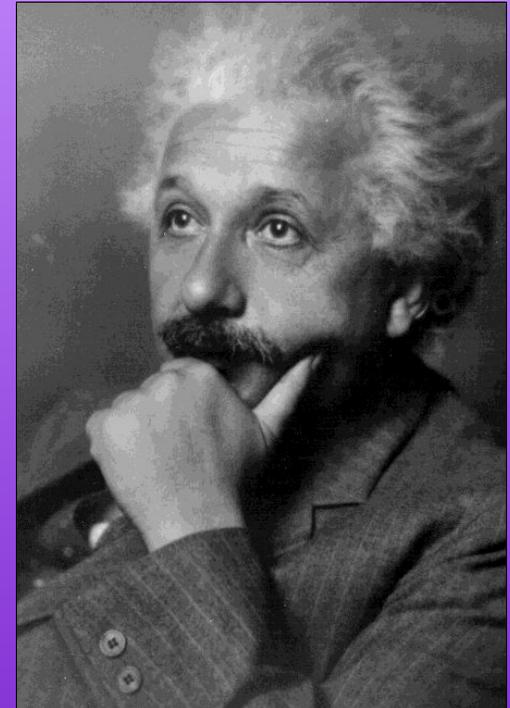
Einstein the Moral Philosopher

Schopenhauer, Spinoza, and Social Ethics

“The most important human endeavor is the striving for morality in our actions. Our inner balance and even our very existence depend on it. Only morality in our actions can give beauty and dignity to life.” (Einstein, 1950)

“I can do what I want, but I cannot want what I want.”
(Schopenhauer)

- On this side of the “veil of Maya,” which is the realm of illusion, there are divisions among individual humans, ethnic groups, nations, etc.
- On the other side of the “veil of Maya,” where ultimate reality is to be found, we are part of a social whole in which the suffering and joy of any one are the suffering and joy of all.

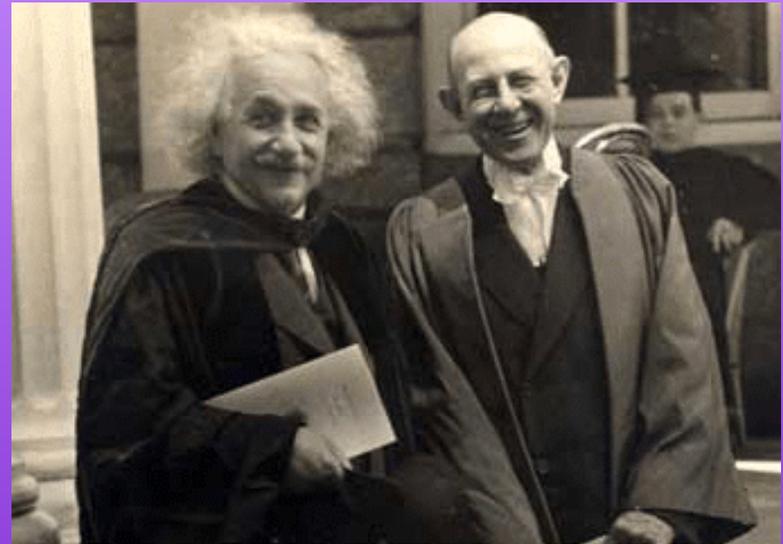


Schopenhauer, Spinoza, and Social Ethics

“As far as I can see, there is one consideration [that] stands at the threshold of all moral teaching. If men as individuals surrender to the call of their elementary instincts, avoiding pain and seeking satisfaction only for their own selves, the result for them all taken together must be a state of insecurity, of fear, and of promiscuous misery. If, besides that, they use their intelligence from an individualist, i.e., a selfish standpoint, building up their life on the illusion of a happy, unattached existence, things will be hardly better. . . .

The solution of this problem, when freely considered, is simple enough, and it seems also to echo from the teachings of the wise men of the past always in the same strain: All men should let their conduct be guided by the same principles; and those principles should be such, that by following them there should accrue to all as great a measure as possible of security and satisfaction, and as small a measure as possible of suffering.”

(Einstein, 1938)



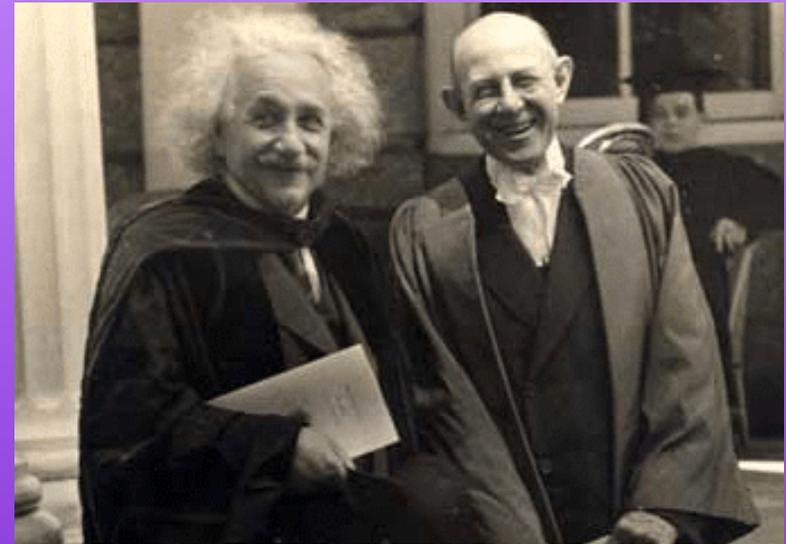
Einstein and Swarthmore President Frank Aydelotte at Commencement, 1938

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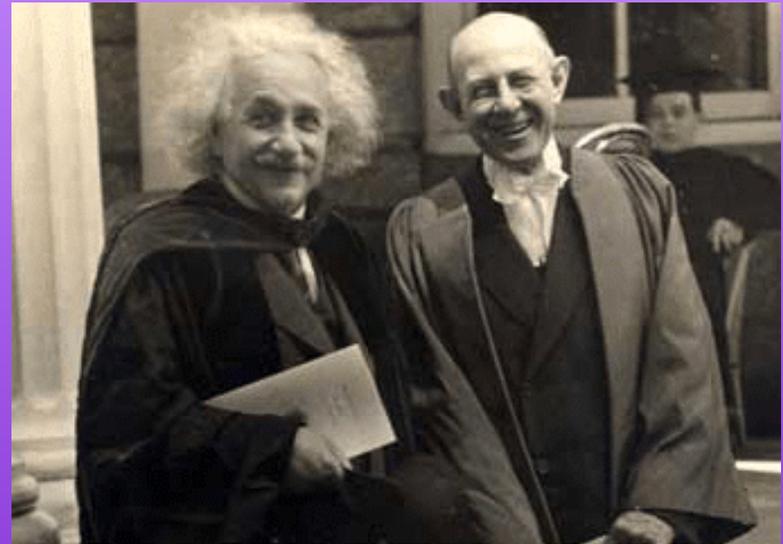
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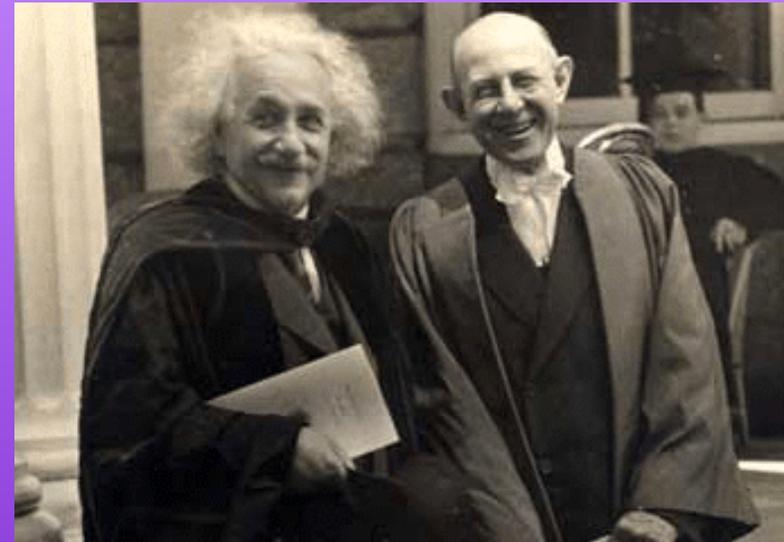
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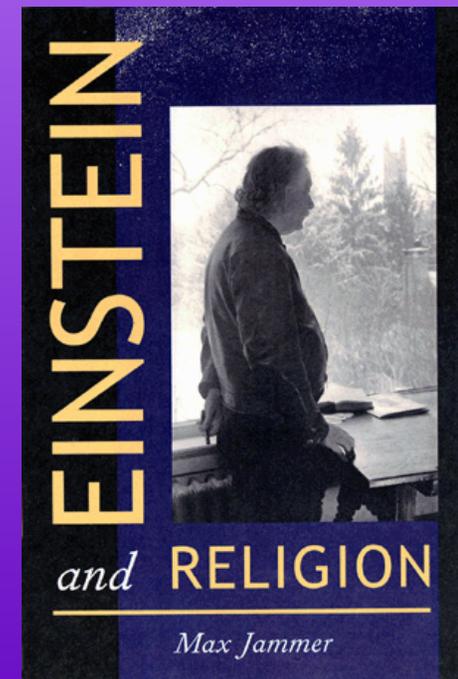
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Einstein the Theologian

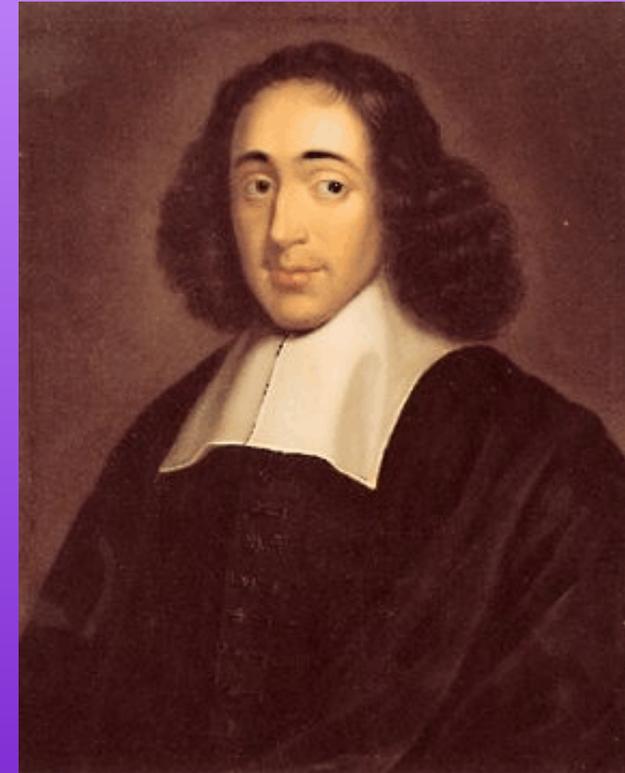
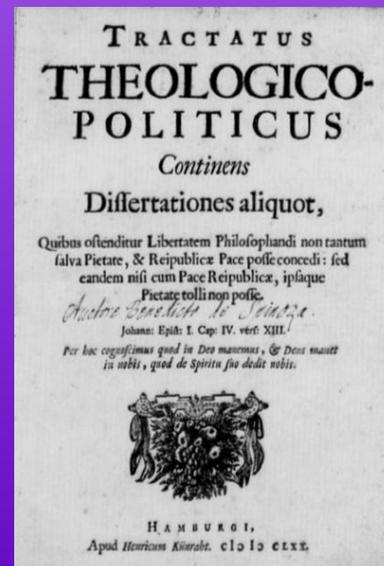
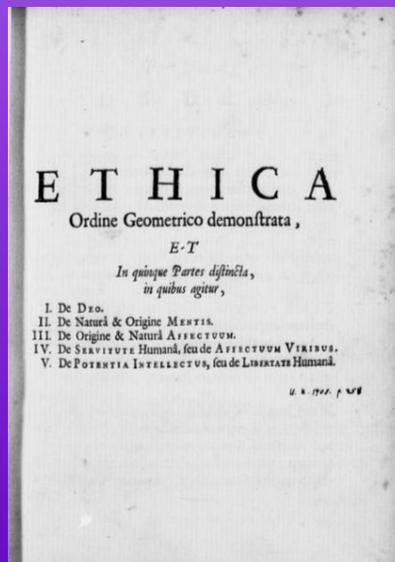
See: Max Jammer. *Einstein and Religion: Physics and Theology*.
Princeton University Press, 2002.



Spinoza, Schopenhauer, and “Cosmic Religion”

“Science without religion is lame; religion without science is blind.” (Einstein, 1940).

- Monism
- Determinism
- No “anthropomorphic” God
- God as Logos – The Universe in Its Law-Governed Aspect



Baruch Spinoza (1632-1677)

In Einstein's Own Words

Albert Einstein. “Remarks Concerning the Essays Brought together in this Co-operative Volume.” In *Albert Einstein: Philosopher-Scientist*. Paul Arthur Schilpp, ed. The Library of Living Philosophers, vol. 7. Evanston, IL: The Library of Living Philosophers, 1949.

The reciprocal relationship of epistemology and science is of noteworthy kind. They are dependent upon each other. Epistemology without contact with science becomes an empty scheme. Science without epistemology is—insofar as it is thinkable at all—primitive and muddled. However, no sooner has the epistemologist, who is seeking a clear system, fought his way through to such a system, than he is inclined to interpret the thought-content of science in the sense of his system and to reject whatever does not fit into his system. The scientist, however, cannot afford to carry his striving for epistemological systematic that far. He accepts gratefully the epistemological conceptual analysis; but the external conditions, which are set for him by the facts of experience, do not permit him to let himself be too much restricted in the construction of his conceptual world by the adherence to an epistemological system. He therefore must appear to the systematic epistemologist as a type of unscrupulous opportunist: he appears as realist insofar as he seeks to describe a world independent of the acts of perception; as idealist insofar as he looks upon the concepts and theories as free inventions of the human spirit (not logically derivable from what is empirically given); as positivist insofar as he considers his concepts and theories justified only to the extent to which they furnish a logical representation of relations among sensory experiences. He may even appear as Platonist or Pythagorean insofar as he considers the viewpoint of logical simplicity as an indispensable and effective tool of his research.

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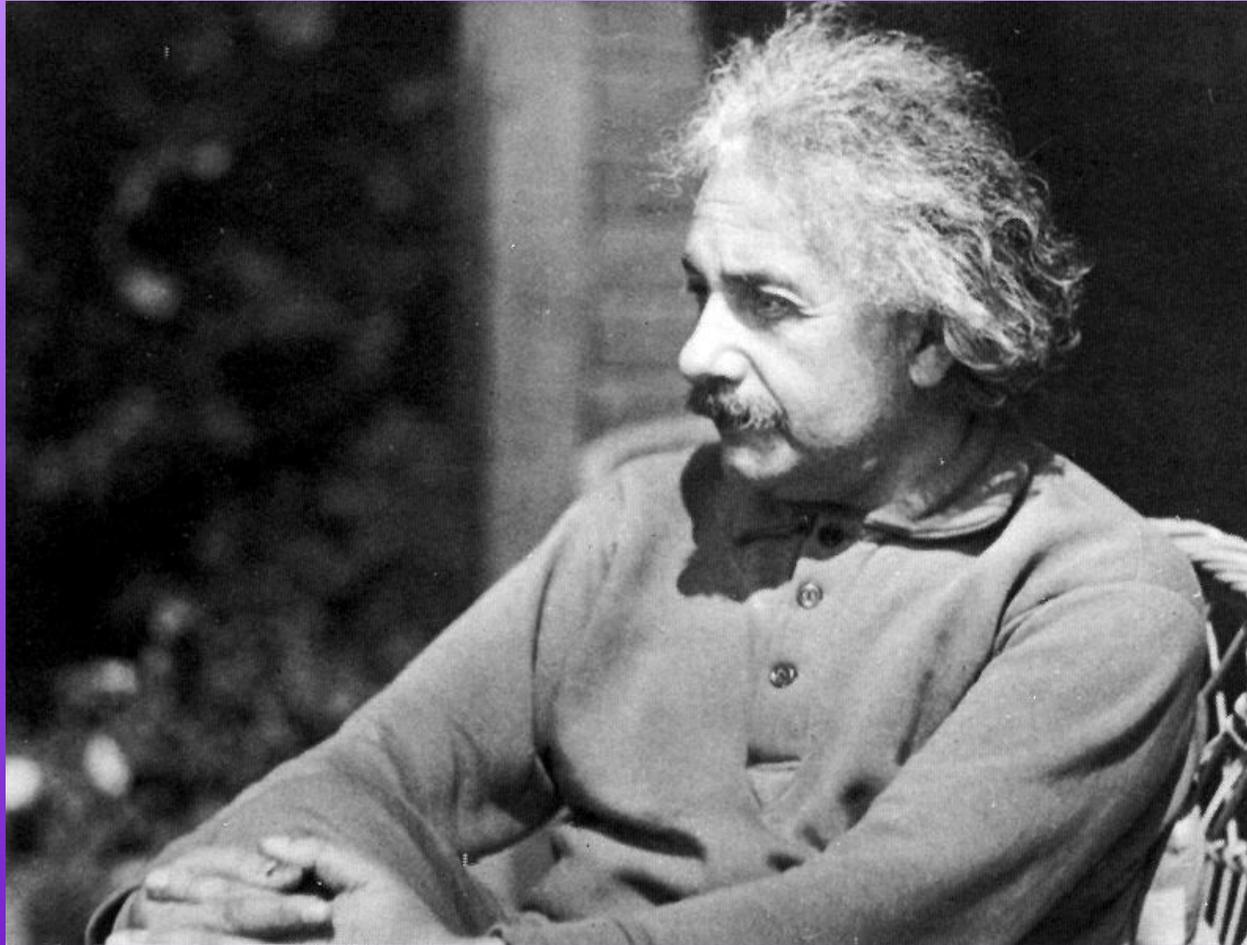
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Einstein on the relationship between philosophy and science (1950)



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