



## POSITIVISM OF ERNST MACH: VLADIMIR LENIN'S CRITIQUE FROM PHILOSOPHICAL WORK MATERIALISM AND EMPIRIO-CRITICISM

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### **Abstract:**

Philosophical views of Ernst Mach represent the second-generation of Positivism. Developed by the end of the 19th century, Mach's positivism associated with the turning point of Scientific Revolution which marked the emergence of modern science. From Ernst Mach's viewpoint, philosophy was intertwined with natural sciences and turned into its core concepts. He advocated the absolute role of sensation, focused on "*the principle of economy of thought*" definition; opposed atomism and metaphysics. In the philosophical work "*Materialism and Empirio-criticism*", Vladimir Lenin severely criticized Ernst Mach's position of [subjective idealism](#) and philosophical realists.

**Keywords:** positivism, Scientific Revolution, principle of economy of thought, subjective idealism, philosophical realists.

### **1. Introduction**

Positivism, a philosophical movement, asserts that only positivistic methods could provide authentic knowledge to clarify matters of natural science, social science and humanities, rejects knowledge which is neither derived from sensory experience nor based on logical, observative and empirical evidence. Positivism emerged in response to the inability of speculative philosophy and metaphysics which could not solve philosophical problems arisen as a result of scientific development.

The term "*positivism*" was developed in the beginning of 19<sup>th</sup> century by the French sociologist and philosopher Auguste Comte (1789-1857). It has then undergone different progressive phases with various names: Classical Positivism, Empirio-Criticism, Logical Positivism, Logical Empiricism, and finally united in the mid-19<sup>th</sup> century, known as Analytic Philosophy.

Positivism derived from, however, the Philosophy of Enlightenment in France, emphasizing the role of human rationality, and from British Empiricism in 18th century,

represented by David Hume (1711-1776) and Bishop George Berkeley (1685-1753), emphasizing the role of sensation experience. Auguste Comte was influenced by primary exponents during the Enlightenment, such as Denis Diderot (1713-1784), [Jean d'Alembert](#) (1717-1783), etc... His social thoughts, on which he based to orient his doctrine of positivism, was mainly influenced by a French utopian socialist [Claude-Henri, comte de Saint-Simon](#) (1760-1825).

The most lasting contribution of David Hume and Auguste Comte were found through significant development of German Positivism, prior to World War I. Some elements of Kantianism were introduced into positivism by German philosophers. Among the most prominent figures, Ernst Mach (1838-1916) was the one who contributed to establish a new form of positivism which was called empirio-criticism and emerged in the end of 19<sup>th</sup> and beginning of 20<sup>th</sup> century.

Ernst Mach, who was a physicist and late 19<sup>th</sup> century philosopher in Vienna, turned into philosophy of critical spirituality and started doing science. Advocating that scientists should use the most basic concepts for the final result and eliminate sensation-independent things, Mach considered his theory matters in terms of realist and empiricist. The former which was related to his criticism of Newtonian mechanics influenced Einstein and his theory of relativity proposal; the latter led Mach to oppose the atomic theory, since at that time, experimental studies could not acknowledge the existence of atoms, although many chemical and physical phenomenon had to base on atom hypothesis to illuminate.

Ernst Mach, in the Introduction Chapter of his book, *The Analysis of sensations and the relation of the physical to the psychical*, revived David Hume's anti-physical stance, demonstrated that all practical knowledge were a set of concepts built from factors which were data of experience. Having in common with Comte, Ernst Mach opposed Immanuel [Kant's Transcendental Idealism](#) (1724-1804). According to Ernst Mach, the most offensive aspect in Kant's philosophy was the doctrine of *Dinge an sich* claimed by Kant that they were completely incognizable even though they had to be treated as partly sense of human awareness.

Positivism still considered empirical induction the foundation of scientific methods. Ernst Mach himself applied the positivistic philosophy to physical sciences. From this point onwards, he utilized it as a counterweight and antidote to go against Kant's metaphysics and the semi-scientific theory of romanticism.

The concept that metaphysics went beyond all experience and physical world of positivists, in the 19<sup>th</sup> century, like August Comte, later Ernst Mach and even empiricists like Rudolf Carnap (1891-1970) and Moritz Shlick (1882-1936), led to the rejection of metaphysical knowledge possibility. Positivism of Ernst Mach argued that science encompassed the entire economic summaries of events (results of experiments). He did not accept the theory of unobservable objects such as atomic theory of Ludwig Blotzmann (1884-1906), only a few years before Albert Einstein (1879-1955) used Blotzmann's work to prove the existence of atom. However, just after World War I, when a group of physicists, mathematicians and philosophers found the Vienna Circle

which was led by Moritz Schlick, Ernst Mach's positivism developed into Logical positivism and had a wide range of influence.

The philosophy of Ernst Mach inherited Berkeley's ideological views, which also set experience as the starting point. However, the British Empiricist tradition had not met the demands of Ernst Mach and his fellows, therefore, philosophy of Ernst Mach proposed to take neutral objects beyond the opposition between materialist and idealist standpoints. In this respect, Ernst Mach inherited the idea of positivism, and transformed this positivism into a new form after its emergence in France and England more than 60 years ago.

The philosophical roots of Ernst Mach's thought were upheld by Lenin in *Materialism and Empirio-criticism*. Accordingly, Ernst Mach's opposition to materialism which stated that the feeling was derived from the causal impact of objects, things, and the natural world on our senses, "*are deprived of their entire sensible content and are converted into naked abstract symbols...*" was pointed out by Lenin that this is a literal repetition of Berkeley who said that matter is a naked abstract symbol.

In Section 6, "Introductory remarks: anti-metaphysical", *The Analysis of sensations and the relation of the physical to the psychological*, Mach affirmed:

*"... Then, is correct that the world consists only of our sensations. In which case we have knowledge only of sensations, and the assumption of the nuclei referred to, or of a reciprocal action between them, from which sensations proceed, turns out to be quite idle and superfluous. Such a view can only suit with a halfhearted realism or a half-hearted philosophical criticism."* (Mach, 1914, p.12)

Through the above paragraph, Lenin believed that Ernst Mach plagiarized Berkeley's idea, especially the two subjective idealistic points of this British philosopher which are "*we sense only our sensations*" and "*world consists only of my sensations*". Ernst Mach's ideology also had an interaction with some English and French representatives. Karl Pearson (1857-1936), an English mathematician and philosopher, received Ernst Mach's favorable reviews and agreement of all key epistemological points. Karl Pearson concluded that "*real things*" were "*sense-impressions*", determinedly disputed materialism, and considered himself a descendant of Berkeley and David Hume. According to Lenin, the idealistic philosophy of Karl Pearson was far completer and more insightful than Ernst Mach's. Ernst Mach also expressed his concurrence with two French scientists Pierre Maurice Marie Duhem (1861–1916), a theoretical physicist, mathematician, philosopher of science, and Henri Poincaré (1854–1912), a mathematician, theoretical physicist, and a philosopher. Both of these French philosophers are the leaders of the so-called "*scientific criticism*", and assumed things as "*groups of sensations*" or something similar. Together with this group is the theory of Empirio-Criticism, which leads to realism standpoint from which Ernst Mach emerged. Ernst Mach was also influenced by Kant's empirical idealism. However, it was the late nineteenth-century achievements in science that had an important impact on his

doctrine. The science and philosophy in Ernst Mach's theory that were essentially interwoven had created two bright and dark bands in his Positivism.

After criticizing the premises of Ernst Mach's Positivism, Lenin focused on criticizing the main content of this doctrine. He started by criticizing Ernst Mach's notion of the object of science, the feeling.

All activities of Ernst Mach are consistently associated with philosophy. Although his passion was arithmetic and physics, he also dedicated himself to philosophy, to read and became influenced by the writings of Kant, Berkeley, and Hume; many scientific works of Ernst Mach were imbued with philosophical spirit. At the end of the 19<sup>th</sup> century, natural science had reached a new development; however, while many scientists still maintained a natural mechanical standpoint, and few moved to irrationalism, Ernst Mach did not follow these trends but found his new foothold for scientific development. He finally chose positivism and desired that empirical philosophy could be used as a tool of cognition and a solution to scientific achievements at that time.

Ernst Mach's positivism argued that the objective of philosophy was not to set up an aggregate system which is used for systematizing all specific knowledge, but to set up a scientific cognitive theory.

In terms of epistemology, the basic premises of Ernst Mach's positivism, accordingly, are explicitly presented in his first philosophical writings - *History and Root of the Principle, of the Conservation of Energy*. In 1911, Ernst Mach wrote in his work:

Now, the problem of science can be split into three parts:

- 1) The determination of the connexion of presentations. This is psychology.
- 2) The discovery of the laws of the connexion of sensations (perceptions). This is physics.
- 3) The clear establishment of the laws of the connexion of sensations and presentations. This is psychophysics. (p.91)

While recalling this premise of Ernst Mach, Lenin pointed out: Ernst Mach asserted that the object of physics is not the objects or things which are sensed by images, but the relationship between the domains of emotion. From here, Ernst Mach even refused to admit objective reality. In Mach philosophy, problems of cognition were considered from the standpoint of extreme psychologicalism and gradually shifted to subjectivism.

Determining the objective of science was to establish theory about feeling and factor. Therefore, Lenin focused on this theory.

Right in the Preface to the first version of *The Analysis of sensations and the relation of the physical to the psychological*, Ernst Mach identified the importance of analyzing sensations:

*“The frequent excursions which I have made into this province have all sprung from the profound conviction that the foundations of science as a whole, and of physics in*

*particular, await their next greatest elucidations from the side of biology, and especially from the analysis of the sensations."* (Mach, 1914, pp.vii-viii)

In this important work, Ernst Mach introduced the notion that all knowledge derived from sensations; therefore, phenomena that were scientifically studied could only be understood in terms of experience or sensations through phenomenal observations. This stance led to the position that there is no statement in natural science accepted unless it could be experimentally verified. Mach's strict verification criteria made him reject metaphysical concepts such as absolute ideas of time and space, prepared for Einstein's theory of relativity.

Lenin, in philosophical work *Materialism and Empirio-criticism*, restated idea of Ernst Mach that sensations are not "symbols of things". In contract, the 'thing' is rather "a mental symbol for a complex of sensations of relative stability. Not the things (bodies) but colours, sounds, pressures, spaces, times (what we usually call sensations) are the real elements of the world". (Lenin, 2010, p.40)

Lenin clarified further:

*"Mach explicitly states here that things or bodies are complexes of sensations, and that he quite clearly sets up his own philosophical point of view against the opposite theory which holds that sensations are "symbols" of things (it would be more accurate to say images or reflections of things). The latter theory is philosophical materialism."* (Lenin, 2010, p.41)

Although Ernst Mach did not conceal the derivation of idealism, his explanations of the feeling still could not go beyond metaphysics and the scientific method persistence in mental processes when he developed the theory of sensations. Lenin pointed out the incompleteness and confusion of Ernst Mach when he, on the one hand, believed that objects were a complex of sensations, if they went beyond that, they would become metaphysics, which is an idle and superfluous assumption; on the other hand, he believed that sensations are connected with definite processes in the organism. Ernst Mach, in Section 6, Chapter XI, *The Analysis of sensations and the relation of the physical to the psysical*, stated:

*"If I can imagine that, while I am having sensations, I myself or someone else could observe my brain with all the necessary physical and chemical appliances, it would then be possible to ascertain with what processes of the organism sensations of a particular kind are connected..."* (Mach, 1914, pp.242-243)

Lenin supposed this statement of Ernst Mach that "he mechanically jumbles fragments of Berkeleianism with the views of natural science, which instinctively adheres to the materialist theory of knowledge..." (Lenin, 2010, p. 45). The ideology of Ernst Mach which considered sensations as a precedent, bodies were complexes of sensations was stated

from the perspective of idealism, but averred that *"The question is natural enough, if we start from the commonly current physical conception which represents matter as the immediately and undoubtedly given reality out of which everything, inorganic and organic, is constructed"*. (Mach, 1914, p.243)

This explained why Lenin imitated "Recent positivism" to refer to the philosophy of Ernst Mach.

After realizing that his first point of view which was idealist positivism might be biased towards [solipsism](#), Ernst Mach made corrections to those notions by theory of elements. Theory of world elements was Ernst Mach's ambition to go beyond the metaphysical framework including materialism and idealism, to find an epistemology and methodology of combining several aspects of natural sciences, and to find common ground of natural sciences.

If Ernst Mach, in 1872, standing on idealism, stated that: the world consisted only of our sensations, then in 1883, in the work *The Science of mechanics A critical and historical account of its development*, he invented new term called elements. Ernst Mach (1919), in *Section II. The Relations of Mechanics to Physiology, Chapter V* of this mentioned book, argued about elements:

*"All physical knowledge can only mentally represent and anticipate compounds of those elements we call sensations. It is concerned with the connection of these elements. Such an element, say the heat of a body A, is connected, not only with other elements, say with such whose aggregate makes up the flame B, but also with the aggregate of certain elements of our body, say with the aggregate of the elements of a nerve N. As simple object and element N is not essentially, but only conventionally, different from A and B, the connection of A and B is a problem of physics, that of A and N a problem of physiology. Neither is alone existent; both exist at once. Only provisionally can we neglect either. Processes, thus, that in appearance are purely mechanical, are, in addition to their evident mechanical features, always physiological, and, consequently, also electrical, chemical, and so forth."* (p.507)

This argument of Ernst Mach could also be found in his prior work *The Analysis of sensations and the relation of physical to the psychical*.

The elements A B C..., therefore, are not only connected with one another, but also with K L M. To this extent, and to this extent only, do we call A B C..., sensations, and regard A B C as belonging to the ego. In what follows, wherever the reader finds the terms "sensation", "sensation-complex", used alongside of or instead of the expressions "element", "complex of elements", it must be borne in mind that it is only in the connexion and relation in question, only in their functional dependence, that the elements are sensations. In another functional relation they are at the same time physical objects. (Mach, 1914, p.16)

Thus, depending on the relations, the "elements" might either be sensations or physical object. In order to increase his persuasion, Ernst Mach pointed that:

*"A color is a physical object as soon as we consider its dependence, for instance, upon its luminous source, upon other colors, upon temperatures, upon spaces, and so forth. When we consider, however, its dependence upon the retina (the elements K L M..., it is a psychological object, a sensation."* (Mach, 1914, p.17)

Ernst Mach continued convincing that: *"Matter is for us not what is primarily given. What is primarily given is, rather, the elements, which, when standing to one another in a certain known relation, are called sensations"*. (Mach, 1914, p.243)

He also described in this work: *"What in every-day life we call matter is a definite kind of connexion between the elements"*. (Mach, 1914, p. 243)

Ernst Mach believed that he had a way to certify his philosophy of sensations with that assertion. In general, what are the elements? Ernst Mach continually repeated that they were sensations. When he said that objects and the world was a complex of elements, he also meant about complex of sensations. Because the sensations belonged to the ego, the element also belongs to the ego, Ernst Mach (1914) asserted:

*"When I cease to have the sensation green, when I die, then the elements no longer occur in the ordinary, familiar association. That is all."* (pp. 23-24)

To explain why not continue calling sensations but elements, Ernst Mach (1914) says:

*"...these elements are called sensations. But as vestiges of a onesided theory inhere in that term, we prefer to speak simply of elements, as we have already done"*. (p. 22)

Therefore, according to Ernst Mach, the invention of elements was to prove that his theory was not one-sided! Not only that, Ernst Mach argued that through this theory of elements, the opposition between psychology and physics, or between idealism and materialism would not exist any longer. Ernst Mach (1914) continued arguing: *"The antithesis between ego and world, between sensation (appearance) and thing, then vanishes, and we have simply to deal with the connexion of the elements"*. (p.14)

When proposing argument about elements, Ernst Mach intended to make a new impression: saying complex of sensations made people easy to think about subjective, psychological, and one-sided properties; while saying complex of elements could overcome those. Ernst Mach (1914) explained as below paragraph:

*"Thus, perceptions, presentations, volitions, and emotions, in short the whole inner and outer world, are put together, in combinations of varying evanescence and permanence, out of a small number of homogeneous elements."* (p.22)

Not only that, Ernst Mach believed that, once sensations were replaced by elements, science task would be the studying of relations of elements instead of

studying about relations of sensations. *"The aim of all research is to ascertain the mode of connexion of these elements"*. (Mach, 1914, p.22)

Prior to Ernst Mach's explanations, in *Materialism and Empirio-criticism*, Lenin disclosed the essence of this new theory: *"...it is not one-sidedness we have here, but an incoherent jumble of antithetical philosophical points of view"*. And *"...since you base yourself only on sensations you do not correct the "one-sidedness" of your idealism by the term 'element' ... "if elements are sensations, you have no right even for a moment to accept the existence of "elements" independently of my nerves and my mind"* (Lenin, 2010, p.54-55).

A deep dive on Ernst Mach's perspective, elements were classified neither material nor spiritual and went beyond the opposition of idealism and materialism. Elements were just considered whether psychical or physical ones when applied to specific relations, moreover, elements were "sensations" only in these conjunctions. He explained: *"In what follows, wherever the reader finds the terms "sensation", "sensation-complex", used alongside of or instead of the expressions "element", "complex of elements", it must be borne in mind that it is only in the connection and relation in question, only in their functional dependence, that the elements are sensations"*. (Mach, 1914, p.16)

According to Lenin, the fact that "elements" term was input into Ernst Mach's theory still could not conceal his subjective idealism, and even more important than that, his solipsism, when elements were considered as sensations; but when elements were not considered as sensations, they were meaningless. When relying on natural sciences to justify the existence of physical and psychological elements, Mach exposed his embarrassment. On the one hand, he tried to prove *"sensations are elements"*; on the other hand, he could not deny that the existence of physical objects (such as *light*) affected and caused sensations as viewpoint of natural sciences. Therefore, Lenin fairly asserted that *"the trick with the word "element" is a wretched sophistry"*. Even though Ernst Mach raised many explanations, his position was always *"Bodies do not produce sensations, but complexes of elements (complexes of sensations) make up bodies"*. (Mach, 1914, p.29)

Lenin pointed out, *"discovery of the world-elements"* of Ernst Mach and his fellows which legitimated that *"elements"= something new, both physical and psychical at the same time; then a little correction is surreptitiously inserted: instead of the crude, materialist differentiation of matter (bodies, things) and the psychical (sensations, recollections, fantasies) we are presented with the doctrine of "recent positivism" regarding elements substantial and elements mental."* (Lenin, 2010, p. 56-57), could only be derived from Berkeley's idealism *"there is not a trace here of recent philosophy, or positivist philosophy, or of indubitable fact. It is merely an old, old idealist sophism"* (Lenin, 2010, p.59)

*"Principle of economy of thought"* was proposed by Ernst Mach in the 1970s. Ernst Mach referred the term "Principle of economy of thought" to his books *History and Root of the Principle, of the Conservation of Energy, The Science of mechanics a critical and historical account of its development, then The Analysis of sensations and the relation of the physical to the psychical...* This was the fundamental principle of theory of knowledge in Mach philosophy. Ernst Mach had a reason for his proposition for this principle. The principle

stemmed from the German economist Hermann Gossen (1810-1858) and his theory of demand and thought of marginal utility, which was elaborated to economic theory of marginal utility by the economists of the Vienna school (Austria). From the theory of this economic factor analysis, he applied to the field of consciousness, and called manpower, especially the intellectual power of scientists, economic activity. However, he was mostly influenced by the theory of evolution of Jean-Baptiste Lamarck (1744-1829), a French naturalist, and Charles Robert Darwin (1809-1882), a famous English naturalist, who discovered and demonstrated that all species of life have descended over time from [common ancestors](#) through natural selection. Under the influence of theory of evolution, Ernst Mach argued that human should adapt to the environment to maintain life, and, human activities of thinking and sciences were the biological reaction to that process. These activities must be in simplest sense so that the struggle of existence could be effective.

Ernst Mach (1914) discussed about this principle:

*"If, in conformity with the stimulus given by Darwinism, we conceive of all psychical life including science as biological appearance, and if we apply to the theory the Darwinian conceptions of struggle for existence, of development, and of selection. The theory is inseparable from the hypothesis that each and every psychical entity is physically founded and determined."* (p.49-50)

Ernst Mach considered that the level of human awareness through the stages of humanity development from savage to modern human beings reflected human adaptation to environment and represented the applied process the above principle.

The core value of this principle was that nature and purpose of science were to satisfy necessities of survival, therefore, science must follow the principle of economy of the energy of thought or principle of economy of thought, which meant, the expenditure of amount of thought must be the least to accomplish a maximum result, which was similar to economic activity. Thus, he considered the simplicity and economics of thought in describing, predicting real experience as a measure of the evaluation of cognitive and scientific activities. Through this description, scientific forecast for the law of nature, bolstered human beings to adapt better for environment, was simpler and more economical than the description through direct experience. Therefore, the economy of thought, which enhanced human adaptation to environment, was the ultimate goal of awareness and science. Thereby, he rejected all speculative thoughts that were metaphysical, religious and fideistic.

Lenin, after studying "Principle of economy of thought" and the ambition of Ernst Mach, pointed out the nature of the problem that:

*"The reason is that if the principle of economy of thought is really made "the basis of the theory of knowledge", it can lead to nothing but subjective idealism...the absurdity, the subjectivism of applying the category of "economy of thought" here. Human thought is*

*"economical" when it correctly reflects objective truth, and the criterion of this correctness is practice, experiment and industry." (Lenin, 2010, p.170)*

Lenin declared the motive for the principle of the economy of thought when Ernst Mach mentioned in his theory of perception was the denial of objective truth, which meant the denial of the foundations of Marxism. However, if the objective reality was not given to man by his sensations, where was *"the "principle of economy" if not from the subject?"* (Lenin, 2010, p.171). Was it because of this point, Lenin agreed with Wunt (1832-1920) – a German philosopher and psychologist – to call Mach Ernst *"Kant turned inside out". Kant has a priori and experience, Mach has experience and a priori, for Mach's principle of the economy of thought is essentially apriorist"*. (Lenin, 2010, p.172).

The objections of Ernst Mach to atomic theory which became one of his most famous legacies expressed in his bio-psychological perspective of science. However, in Materialism and Empirio-criticism, this issue was rarely mentioned.

Ernst Mach and his fellow Wilhelm Ostwald (1853-1932), who was a leading figure in the studies of physical chemistry, were the most prominent opponents of atomic theory in physics and chemistry. Wilhelm Ostwald even tried to determine the basic chemical laws such as Law of Constant Proportions and Law of Multiple Proportions without the support from atomic theory. Because from the perspective of a positivist, atom was only considered as science fiction and worst of all, illegal hypothesis due to its nature of invisibility. Even some idealist positivists pursued the idea of useful fictions which might reach to a limit and believed that the concept of atom, along with mathematical concept of infinity and its causes, freedom, economic factors, and such other things, were completely fictional. The anti-atomic chain in the minds of the positivists, including Ernst Mach, was an extreme expression of their obsession regarding anything unobservable. However, with the undeniable tremendous success of the advancements of micro research in physics and chemistry, positivistic thought has been heavily criticized, not only by some contemporary philosophers. But also by outstanding scientists such as Ludwig Boltzmann, an Austrian and Max Planck (1858-1947), a German, who were the leading theoretical physicists pioneering the offence against Ernst Mach and Wilhelm Ostwald.

In *Materialism and Empirio-criticism*, when considering the views of Ernst Mach about space and time, Lenin pointed out the idealistic absurdity of this philosopher. Lenin also pointed out the mistake of Ernst Mach when he was against atomism. In Chapter V, Section 3, Article II. The relations of Mechanics to Physiology, *The Science of mechanics A critical and historical account of its development*, Ernst Mach considered: *"space and time are well-ordered systems of sets of sensations."* (Mach, 1919, p.506). According to Lenin, this view of Ernst Mach *opens the door for fideism* and came to counter-scientific conclusions. Ernst Mach's view of space and time related to his assumption that, if molecules, atoms, or chemical elements in general could not be sensed, they are just the *"purely ideological"* things. Because, once Ernst Mach denied the objective existence of space and time, obviously there is nothing that forces us to imagine atoms existing in

space! In the meantime, Lenin pointed out that from 1872 to 1906, natural sciences explored and discovered - at least preliminarily discovered - electronic, in three-dimensional space. The material object that natural science studied only existed in three-dimensional space, and therefore, the molecules of that object, which were too small to see, still existed in an inevitable manner "*in that three-dimensional space*". (Lenin, 2010, p.181)

For more than 100 years since the publication of scientific and philosophical works, Ernst Mach has brought to the history of Western philosophy as well as the whole world a new, special feature that creates a strange nuance of post-classical positivism. He was a subjective idealist philosopher, philosophical realist of the transitional generation between early modern and modern science. The philosophical views of Ernst Mach were upheld by Lenin, thereby, contributed to the protection and development of Marxist philosophy, and brought a new shape to philosophical materialism.

However, there must also be objective evaluations of major contributions to physics, philosophy and physiology of Ernst Mach. In physics, the speed of sound bears his name, as he was the first to systematically study supersonic motion. He also made important contributions to understand the Doppler effect. His critique of ideas of Newton's absolute space and time was the inspiration for young Einstein, who believed Ernst Mach to be the philosophical precursor to relativistic theory. His systematic skepticism with old physics is equally important for generation of young German physicists.

In philosophy, he is best known for his influence on the Vienna Circle (which was formerly named Ernst Mach Verein), because of his famous anti-metaphysical attitude, his stand against atomism, and in general, his approach to positivism about epistemology. It is important to note that some of these influences are currently being reviewed and considered both more difficult and complex than before. Although philosophers now and then have been commenting on the connection between science with philosophy, Ernst Mach was the one who has connected the division; he is the founder of philosophy of science.

In psychology, he studied the relationship of our sensations with external stimuli. Space, time, color, sound, once to be physical fields, are now also researched by psychologists and defined that they are not only physical world but also the elements of experience inside of us. Nowadays psychologists consider Ernst Mach the founder of the Gestalt theory as well as the discoverer of neurological inhibition. The most important thing is that, although in the 20<sup>th</sup> century, he was well-known by philosophers for his influence on physics and physical philosophy, his influence on psychology was also the main drive of the philosophy of science.

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