

Boltzmann's Method of Philosophy

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Abstract

The method of Ludwig Boltzmann (1844 – 1906), a great Austrian physicist-philosopher, for solving philosophical problems was described. This brilliant method can be a guiding star in philosophy. His method is not restricted to philosophy of science (scientific philosophy), and indeed it can be used as well in pure philosophy. Theoretical pluralism developed by Boltzmann can be used as a basic assumption in philosophizing the epistemological problems. The Boltzmann's method also saves philosophy from dogmatism. It shows the usefulness of philosophy as well as progress of science, and calls for collaboration of philosophy and science. This collaboration can lead the human to better understanding of the Nature. Boltzmann states how both science and philosophy can go astray in the absence of this collaboration, since they are indeed unit.

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Introduction

Ludwig Boltzmann (1844 – 1906) is well known in both science and philosophy [1]. His international fame is as a physicist due to his great achievements in physics. In addition to the physical importance of such achievements, they are also known by philosophers due to their philosophical importance. Boltzmann's statistical approach is truly brilliant from epistemological point of view. Moreover, statistical interpretation of the second law of thermodynamics made this law universal and of interest in philosophy. In other words, statistical aspect of entropy, a purely physical parameter for study of heat engines, introduced it as a philosophical factor.

However, in addition to the philosophical importance of Boltzmann's achievements in the field of physics, he is also known in the philosophy community due to his natural philosophy. Boltzmann devoted the second part of his active life to philosophy [2-5]. Boltzmann's philosophy was related to the main problem of epistemology, the relationship of existence and consciousness. The lectures of Boltzmann on natural philosophy were very popular and had achieved a considerable attention at that time. His first lecture was an enormous success. Even though the largest lecture hall had been chosen for it, the people stood all the way down the staircase. Students, assistants, professors, ladies had come. The hall was ornated with twigs of silver fires and he received enthusiastic ovations. All the newspapers reported about this event. His mail was full of letters of consent. He even had an audience with Emperor Franz Joseph. The Emperor told Boltzmann that he was glad about his return and that he had heard how crowded his lectures were.

In addition to brilliant natural philosophy of Boltzmann, his method of philosophizing is truly brilliant. Here, it is aimed to introduce this excellent method to the philosophy

community. Thus, the present manuscript focuses on his method instead of the concepts and achievements of his philosophy. Unfortunately, Boltzmann's philosophy including both its method and concepts is not respected in the philosophy community, as it deserves. Most of philosophers know Boltzmann just as a great physicist whose achievements are of interest in philosophy of science (scientific philosophy). This failure can be attributed to a kind of dogmatic views upon most of Boltzmann's theories. Nevertheless, his method of philosophy cannot be subject of such dogmatic objections. In fact, his method of philosophy alone (without the concepts of his natural philosophy, which were occasionally objected) is sufficient to introduce him as a great philosopher. And the aim of the present manuscript is to introduce this aspect to the philosophy community. Since, Boltzmann's writings are not originally familiar to the philosophy community as most of his philosophical writings are incorporated into his scientific works, it is attempted to quote Boltzmann's original words.

Method of philosophizing

When talking about Boltzmann's philosophy, it is usually referred to his dislike of philosophy. It is thought that the whole of his activities in the field of philosophy is to deny and to condemn it, particularly due to the critiques he made against famous philosophers (cf. [6]). Indeed, it is the main reason avoiding appropriate consideration of his philosophy in the philosophy community. Whereas, none of the scientists, who entered into philosophy, has valued philosophy as Boltzmann did. Weak

understanding of Boltzmann's philosophy in the philosophical community is due to misleading of his words merely reported in historical controversies.

For instance, his dislike is obviously related to metaphysics, not philosophy. He believes while philosophy is based on metaphysical arguments, no applicable result will be achieved. He just emphasizes the need for a realistic view in philosophizing epistemological problems by comparing the case with waste history of natural science [7], "Likewise, the scientist asks not what are the currently most important question, but 'which are at present solvable?' or sometimes merely 'in which can we make some small but genuine advance?' As long as the alchemists merely sought the philosopher's stone and aimed at finding the art of making gold, all their endeavors were fruitless; it was only when people restricted themselves to seemingly less valuable questions that they created chemistry. Thus natural science appears completely to lose from sight the large and general questions; but all the more splendid is the success when, groping in the thicket of special questions, we suddenly find a small opening that allows a hitherto undreamt of outlook on the whole."

In his view, this perversion is not exclusively related to philosophy, but natural science can also go stray. Since, each of them, philosophy or natural science was misled, there are not capable of respect. In his words [8], "[Questions about the essence of the law of causality, of matter, of force, etc] do not, it used to be said, concern the scientist; they should be left entirely to philosophy. Today this has changed considerably; natural scientists show a great predilection for taking up philosophical questions, and probably rightly so. After all, it is one of the first rules in natural science never to put blind trust in the instruments with which one works, but to test it in every way. Are we then to put blind trust in inborn or historically developed concepts and opinions, all the more so in view of all the examples in which

they have led astray? But when we examine the simplest elements, where is the borderline between natural science and philosophy at which we should stop? I hope that none of the philosophers possibly present will take it amiss or feel reproached if I say frankly that the assignment of these questions to philosophy has perhaps also led to disappointment. Philosophy has contributed remarkably little to the elucidation of these questions. Alone and from its one-sided point of view it could do it just as little as natural science can. If real advances are possible, they are only to be expected from collaboration between the two sciences.”

In other words, his sharp criticism of the majority of previous philosophers does not prevent him from acknowledging the proper domain and positive role of a genuine, progressive philosophy. He gladly references to the irresistible drive of human beings to philosophize and wishes for collaboration between philosophy and natural science. He states [9], “It is because of my firm hope that a congenial collaboration between philosophy and natural science will bring new food to each, indeed that we can achieve a truly consistent exchange of views only by following this path, that I have not avoided philosophical questions here. When Schiller said to the philosophers and natural scientists of his day: ‘Let there be enmity between you, alliance comes too early yet,’ then I am not in disagreement with him I just believe that now the time for alliance has arrived.”

What provides credit for philosophy in Boltzmann system is due to his method of natural science. The controversy appearing between philosophy and natural science is usually due to two main critiques scientists make to philosopher: *(i)* standing on the base of theories, and *(ii)* lack of mathematical considerations and just using descriptive arguments. Both of these methods can be found in Boltzmann’s system. He always emphasizes on the importance of theories and on the need for descriptive

science. Here, Boltzmann's opinions regarding such requirements for the development of human science and the reason why philosophy went astray by misusing of them are given.

In a lecture 'On Significance of Theories', Boltzmann defines theory [10], "I am of the opinion that the task of theory consists in constructing a picture of the external world that exists purely internally and must be our guiding star in all thought and experiment; that is in completing, as it were, the thinking process and carrying out globally what on a small scale occurs within us whenever we form an idea." Then, he describes what make a theory applicable or valuable [11]: "The immediate elaboration and constant perfection of this picture is then the chief task of theory. Imagination is always its cradle, and observant understanding its tutor. How childlike were the first theories of the universe, from Pythagoras and Plato until Hegel and Schelling. The imagination at that time was over-productive, the text by experiment was lacking. No wonder that these theories became the laughing stock of empiricists and practical men, and yet they already contained the seeds of all the great theories of later times: those of Copernicus, atomism, the mechanical theory of weightless media, Darwinism and so on."

Indeed, he tries to show that the mistake of philosophers was not due to devotion to theoretical considerations, which is indeed the task of philosophy, but the big mistake they made was due to proposition of their theories based on purely metaphysical arguments. In his opinion, the problem is due to lack of reality in proposition of philosophical theories. Thus, he called his philosophy realism.

Boltzmann believes that there is no necessity for a good theory to have mathematical formulae, and descriptive sciences can also provide such a good theory in the absence of any mathematical considerations. He beautifully defines the frame of theory [10]:

“I should not be genuine theoretician if I were not first to ask: what is theory? The layman observes in the first place that theory is difficult to understand and surrounded with a tangle of formulae that to the uninitiated speak no language at all. However they are not its essence, the true theoretician uses them as sparingly as he can; what can be said in words he expresses in words, while it is precisely in books by practical men that formulae figure all too often as mere ornament.”

Although, he was extraordinarily talent in mathematics, and surely he had an excellent skill in mathematics among other physicists of that time (recall that he was appointed as professor of mathematics in University of Vienna), he never took up mathematical problems for their own sake but always with an eye toward application. In his enthusiastic words [12]: “I called theory a purely intellectual internal picture, and we have seen how capable it is of high perfection. How then could it now happen that on continuing immersion into theory one comes to think of the picture as of the really existing thing? ... Thus it may happen to the mathematician that he, always occupied with his equations and dazed by their internal perfection, takes their mutual relationship for what truly exists, and that he turns always from the real world. Then the lament of the poet applied to him as well: that his works are written his heart blood and that highest wisdom borders on highest folly.”

According to this fact, the style of Boltzmann’s writing was different of other physicists; as H. A. Lorentz, the famous theoretical physicists, notes [13], “In many of these [writings] he speaks to us as a physicist seldom does, and reveal to us his entire way of thinking and feeling in words that also bring him closer to our hearts ... Here he shares with us his doubts and his joys; here he captivates us with profound, serious intellect and light-hearted wit; here he carries us along through his consistent mechanical view of Nature, or through his enthusiastic idealism, which moves him to

embellish his works with so many poets' work ... There are contradictions in the pictures painted by him that he does not hesitate to display clearly or even glaringly; yet we feel that they are not irreconcilable, but that they spring from a certain root in the innermost part of his being, and that through them he allows us a deeper look into his mind.”

Historically, it is worth noting that the ingenious Maxwell, who in 1859 had described the velocity distribution of gas molecules in thermal equilibrium, wrote the following in a letter to his colleague Peter Tait in 1873 [14]: “By the study of Boltzmann I have been unable to understand him. He could not understand me on account of my shortness, and his length was and is an equal stumbling block to me.”

If Maxwell found Boltzmann' s papers difficult, it is hardly surprising that many other physicists found them difficult as well! This is probably an important reason why Boltzmann does not – even today – receive as much credit, as he deserves, particularly since most physicists have never read his original papers. This shows the philosophical method he was using to express even his studies in physics.

On the other hand, he criticized the certainty appeared in science due to purely mathematical consideration. Indeed, fencing just in mathematical formula can also lead us stray. In a reply to Wilhelm Ostwald who has used mathematical derivation to express happiness, Boltzmann explains the problem [15], “Why does such a seemingly harmless essay like Ostwald's appear to me to be so dangerous to science? Because it signals a reversion to satisfaction with the purely formal, reversion to the method of so-called philosophers which is so pernicious to progress; to construct theoretical structures out of mere words and phrases and to place value only in their nice formal connections, what was known as the purely logical or even as the a priori approach, but not to take care whether these connections corresponds exactly to

reality and are sufficiently rooted in facts; a reversion to the method of allowing oneself to be governed by preconceived opinions, of bending everything to the same principle of classification, of wanting to see true mathematics in favor of algebraic formulas, true logic in favor of apparently school-correct syllogisms, true philosophy in favor of nonsense decked out to look philosophical, the forest in favor of the trees ...”.

Theoretical Pluralism

Philosophy of theories is the main part of Boltzmann’s philosophical works. During all of his active life devoted to both scientific and philosophical studies, Boltzmann had a particular emphasis on the importance of theories and has mentioned it throughout his writings. His philosophy of theories, which is known as theoretical pluralism, is brilliant among various philosophies [16].

Boltzmann himself with modesty noted that the idea suggesting ‘there is no ultimate theory’ has also been previously mentioned by different philosophers and scientists, such as Kant and Maxwell. What is obvious is that none of his predecessor thinkers understood the importance and significance of the fact described by Boltzmann, i.e. ‘theory just as a representation’. Referring to previous thinkers is merely due to Boltzmann’s modesty, or perhaps to achieve a credit for his philosophy in the presence of his obstinate opponents. In the very manner that he used Mach’s opinion: “Mach himself has ingeniously discussed the fact that no theory is absolutely false either, but each must gradually be perfected, ...” [17]. However, Boltzmann was the

first one who formulates and makes clarification on the concept of so-called theoretical pluralism.

Theoretical pluralism says that a scientific theory is nothing more than a representation of the Nature. Indeed, it is not possible to know nature via discovery of its law describing why the natural phenomena are in the way they are, and why they show themselves to us the way we observe. In fact, such ultimate science (knowledge) is not attainable to human. As Boltzmann says two questions falls out of human understanding: why we are here, and why we are in the present. There is no hope for science, and also philosophy, and generally human sciences to answer these questions.

In the light of theoretical pluralism, it is possible to clarify the terminology of this context. The laws of nature are the original laws, which the natural phenomena obey from them, and cannot be discovered by human. But, the laws of physics are those invented by human to explain the natural phenomena. Thus, a theory is not discoverable, but should be invented by human mind.

In this direction, a scientific theory will not be complete or definitively true. In other words, even an apparently successful theory may be replaced by a better one. On the other hand, different theories, with contradiction in respect to each other, can successfully explain a single natural phenomenon. A theory is initially a free creation of the theorist who proposed it from a purely personal perspective, metaphysical presuppositions, theoretical options, preferences for a certain type of mathematical language, and the dismissal of some observational data. In Boltzmann's opinion, as all theories are, to some extent, free creation of the theorists, it is not possible to find a theory formulated from the mere observation of natural phenomena.

In this direction, Boltzmann, once again, values philosophy to note that philosophers were ahead of natural scientists to understand this issue. In his expression [18], "Hertz

makes physicists properly aware of something philosophers had no doubt long since stated, namely that no theory can be objective, actually coinciding with nature, but rather that each theory is only a mental picture of phenomena, related to them as sign is to designatum. From this it follows that it cannot be our task to find an absolutely correct theory but rather a picture that is, as simple as possible and that represents phenomena as accurately as possible. One might even conceive of two quite different theories both equally simple and equally congruent with phenomena, which therefore in spite of their difference are equally correct. The assertion that a given theory is the only correct one can only express our subjective conviction that there could not be another equally simple and fitting image.”

Since there is no ultimate theory, a completely true one, it is necessary to find good theories. The aim of a theory is to explain a natural phenomenon, thus, a good theory is the one which is simple. Consequently, our task is to seek for better theories in accordance with their applicability, not to find truer ones.

Anti-dogmatism

One of the most interesting features of Boltzmann’s philosophical view was his opinion against dogmatism. In other words, he emphasizes on dogmatism as a dangerous poison for human sciences including both natural science and philosophy, and particularly epistemology. He notes [19], “Simple consideration as well as experience show that it is hopelessly difficult to find the right pictures of the world by mere guessing into the blue. Rather, the pictures always form slowly from individual lucky ideas by fitting. Rightly epistemology turns against the activities of the many

lighthearted producers of hypothesis who hope to find a hypothesis explaining the whole of nature with little effort, as well as against the dogmatic and metaphysical derivation of atomistics.”

Objection of atomism was an obvious dogmatism, which Boltzmann had to oppose it. Very interestingly, he even has an anti-dogmatic view on atomism, which he throughout his life fought to show the existence of atoms. He notes that even atomism is not such ultimate law worth dogmatic belief, [20], “The reproach that the observed immutability of atom, lasting only limited time, has been generalized without reason would certainly be justified if one tried to prove, as used to be done, the immutability of atoms a priori. We include it [immutability] in our picture merely to represent as many phenomena as possible ... We are ready to drop immutability in cases where another assumption would represent the phenomena better.”

In fact, Boltzmann was sacrifice of the scientific dogmatism of his time. According to Flamm [21], “Boltzmann was a martyr to his ideas”. Unfortunately, the objections made to him were not scientific discussions, but mere dogmatisms. This is obvious from the objections made to him regarding atomism, since they just were positivism beliefs. In other words, Mach defended his philosophical opinion. According to Max Planck, who was initially opponent to Boltzmann and later converted and used his approach, says [22], “Against the authority of men like Ostwald, Helm, and Mach there was not much that could be done.”

Unfortunately, dogmatism still exists in both science and philosophy. Boltzmann tried to destroy dogmatic views in both scientific and philosophical thoughts throughout his life. Appearance of dogmatism in philosophical thoughts is common, since it existed throughout the history of philosophy. Boltzmann tried to desolate it by introducing a

realistic view in epistemology via his natural philosophy and particularly his theoretical pluralism.

Scientific dogmatism was also mentioned by him, as well as possible dogmatism appearing in philosophy due to blind belief in a theory. Not only the dogmatic objection of atomism, but also dogmatic view about thermodynamics and its second law were common that time. Before Boltzmann's view, all physical laws had to be strictly deterministic and universally valid. The most of physicists believed in this view for thermodynamics. They believed that the second law of thermodynamics was a basic axiom handed down from God, which one had to accept as the starting point of any thermodynamic consideration. Whereas, Boltzmann used a statistical interpretation of the second law, about 50 year before the statistical interpretation of quantum mechanics.

Similar dogmatisms still exist in science, and particularly in cosmology. Since the significant progress of astrophysics flatten the path for using cosmological theories in explaining epistemological problems, indeed such scientific dogmatism are not tied with classical philosophical dogmatism. It is now believed (by some cosmologists) to avoid the appearance of such scientific-philosophical dogmatism in cosmology and epistemology, which is the main obstacle in the progress of science and philosophy and in general human knowledge, is just to use Boltzmann's view [23].

Final Remark

In conclusion, any attempt in epistemology without taking into account Boltzmann's philosophy is in vain. Indeed, Boltzmann's theoretical pluralism is the basic

foundation for proposition of any theory in epistemology. In other words, it is needed basically to know, in the light of Boltzmann's theoretical pluralism, that we just make a picture of the world, existence, and universe by proposing a theory. Otherwise, with aiming to find ultimate theory or discovering the law of nature, it just leads to dogmatism. Thus, it is necessary to learn the meaning of a theory (from Boltzmann's philosophy of theories), as basic alphabets of epistemology, since theory is the powerful (and indeed the only) tool in epistemology.

Conclusions

The Boltzmann's method for philosophizing epistemological problem is an efficient one in philosophy, since it is able to lead towards real advancements. It is indeed a general method in philosophy to investigate the philosophical problems. This method leads to a realistic imagination of the Nature and avoids from dogmatic belief on a human-made theory. The interesting features of Boltzmann's method of philosophy can be summarized as:

1. A philosophical or scientific theory is nothing more than "a representation of the Nature", not an ultimate law generated by God and thus it is unchangeable.
2. Since, our theories are simple representations invented by us, the Nature can be explained by different theories as well, even they are apparently opposite to each other.
3. In the light of the above-mentioned points, there is no ultimate law (theory) in human sciences, worth dogmatic belief. Thus, what we need to understand the Nature is saving ourselves from such dogmatic views to go toward the truth.

4. Nothing is more practical than theory. Thus, there is reproach to philosophy as it is a purely theoretical science. However, it is necessarily needed to use a realistic view in the way of proposing theories.
5. Similar to the above point, study of the Nature and proposition of epistemological theories based on merely metaphysical arguments will lead us astray. This is a false method employed by most of philosopher, which should be modified.
6. There is no need to use mathematical formulae to express a theory. A good theory is not defined by the language of its presentation. A good theoretician simply expresses his theory by linguistic words. In other words, a good theoretician should be able to explain his theory descriptively.
7. Believing in certainty of mathematics will lead us to dogmatism. Mathematics also as a human-made language will fence us in its frame. Indeed, it is the defect of science, which should be assisted by philosophy.

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