Mem. S.A.It. Suppl. Vol. 22, 64

Memorie della
Supplementi

Boscovich's philosophical meditations in the history of contemporary thought

P. Gori

New University of Lisbon (FCSH - IFL)

Abstract. The content of Boscovich's *Theoria philosophiae naturalis* was well-known to his contemporaries, but both scientists and philosophers chiefly discussed it during the 19^{th} century. The observations that Boscovich presented in this text, and that he himself defined as *"philosophicas metitationes"*, soon showed their being a good programme for the forthcoming atomic physics, and contributed to get rid of the mechanistic paradigm in science. In this paper I will go back to some meaningful moments of the history of Boscovich's reception in the era of contemporary philosophy, by referring to what authors such as Popper, Cassirer, Nietzsche and Fechner wrote about him. These thinkers, indeed, particularly stressed the importance of the *Theoria* in the history of Western thought, and showed that it can easily be evaluated beyond the plane of a pure scientific investigation.

1. Introduction

The book published by Boscovich in Venice on 1758 - the well-known *Theoria philosophia naturalis redacta ad unicam legem virium in natura existentium* - has most probably been his main work, even though the results collected into it were not as scientifically effective as those presented in other of his texts. Indeed, in his *Theoria* Boscovich developed an elaborate investigation concerning natural dynamics, with the aim of simplifying the Newtonian paradigm by reducing his three laws to just one[1], but he didn't support his investigation with any experimental result. His work was thus but a collection of "philosophicas metitationes" (*philosophicas meditationes*), as Boscovich himself wrote in the dedicatory epistle opening the first edition of the book (Boscovich 1922). Through these "meditations" -Boscovich added- he outlined a new kind of "Universal Natural Philosophy" (*nuovam quoddam Universae Naturalis Philosophiae*), which deeply influenced the following investigations in physics. One must say that, at the time when Boscovich

[1] For example, Boscovich wrote to his friend G. S. Conti: "Da' fenomeni della Natura, e non da speculazioni metafisiche, convien ricavare le leggi generali, e i principj, da' quali dipendono detti fenomeni. Egli [Newton] credeva che sarebbe un gran fare, se se ne trovassero di questi principj due, o tre da' quali dipendano tutti gli altri, ed io credo di averne ricavato uno solo di una natura in se medesima uniforme, e semplice, e da ció ho preso il titolo della mia opera" [One should deduce both the general laws and the principles on which these events are grounded from natural phenomena, and not from metaphisical speculations. He [Newton] believed that it could be a great result to find just two or three of these principles, from which one can infer all the others; I think I have found only one principle, simple and uniform in regard of its nature, and from this I took the name of my work] (Boscovich 1980, p. 77)

carried on his inquiry, the necessary instruments to test his ideas were not suitable; therefore, the backwardness of 18*th* century science, not enough developed to make experiments whose results could undermine the Cartesian corpuscular theory, prevented Boscovich from completing his study. Nevertheless, one must consider his work of the highest value, at least with regard to the history of science: as L. L. Whyte stated, if the Jesuit's doctrine could not become a verified (through experiment) theory, it was anyway a *"programme for atomic physics* suggesting a way in which a unified theory might one day be reached" (Whyte 1961, p. 105)

The "philosophical" nature of Boscovich's *Theoria* is therefore a good thing, especially if one considers it from an historical perspective concerning contemporary thought. In the era of the mechanical world-description, grounded on both Descartes and Newton's outcomes, it was necessary to find not only new goals, but rather -and first- new guiding lines for the scientific investigation. Furthermore, it could be useful to find also a new perspective for it, which could combine its pure empiricist outcomes with some fundamental philosophical questions. Thus, on one side, Boscovich's work has immediately been subject to several critiques, both from pure scientists (such as Lord Kelvin, whom I will deal with in what follows), and from some thinkers (e.g. Moses Mendelssohn, who, only few years after the publication of the *Theoria*, wrote some critical remarks against the Jesuit's main statements)[2]; however, on the other hand, the idea of a single law of the forces and its several implications excited the interest of other thinkers, and helped some 19*th* century physicists to get rid of the mechanistic paradigm.

The role that Boscovich's investigations played in the development of the experimental practice of contemporary physics has been especially stressed by Karl Popper, in a talk presented in Venice on 1958[3]. During this conference, Popper argued "that science is capable of solving philosophical problems", and, more specifically, "that modern science (...) has something important to say to the philosopher about some of the classical problems of philosophy -especially about the old problem of matter" (Popper 1994, p.112). In stating this, Popper confirmed his idea concerning the problem of the demarcation between philosophy and science. Indeed, he thought that it was not possible to radically distinguish between pure "scientific" and "philosophical" (or "metaphysical") questions, in the sense his Viennese colleagues claimed, i.e. in compliance with a principle of verification showing that any not empirically grounded statement is meaningless, and thus that one can get rid of it[4].

On the contrary, Popper believed that a not-experimental inquiry could be scientific as well, but only if it could be susceptible to criticism, and, therefore, in principle *falsifiable*. That's how, for example, the Democritean atomism was: incontrovertibly not susceptible of empirical foundation when the Greek first outlined his description of the elementary particles, but at the same time fundamental as theoretical model for the development of the modern atom theory (see Popper 1935, p. 85).

That -to focus on what fits with this paper- is the case of the theory of matter, since some problems concerning it "were solved, in collaboration, by speculative philosophers, such as Descartes, Leibniz, and Kant, who all helped by proposing important though tentative solutions and thus prepared the way for the work of experimental scientists and theorists of physics such as Faraday, Maxwell, Einstein, de Broglie, and Schrödinger" (Popper 1935, p. 112). Among these philosophers Popper included Boscovich, too, and stressed the pure speculative nature of his epistemology. The Jesuit, anticipated by Kant, carried on in details Leibniz's research programme, a doc-

[2] His statements on this topic has been published on 1759 in the journal "Briefen die neuesten Literatur betreffend", voll. 42, 45, 54, 55 and 56.

[3] The text I will refer to is the revised version of Popper's contribution to the *XII International Conference on Philosophy*, published in Popper 1994.

[4] This, very roughly, is what come out of the discussions of thinkers such as R. Carnap. M. Schlick, and O. Neurath (see Gilles & Giorello 1995, ch. 4).

trine that was "clearly metaphysical" (which, according to Popper's language, means "not-experimental"), and that consisted in "explaining the (Cartesian) extension of bodies with the help of a theory of forces". (ibid., p. 114). The problem that had to be solved was exactly that which Boscovich dealt with in the opening pages of his *Theoria*, i.e. to explain elastic push within a theory of inelastic atoms. To solve this problem, he chose to replace the atoms by Leibnizian centres of repulsive forces, and therefore with Leibnizian unextended points (ibid., p. 115) [5].

Starting from this, and through a complex but linear way of reasoning, one comes to the paradoxical conclusion that matter consists of a void in which there are discrete centres of force, a statement having deep consequences on the definition of the nature of what was once called *res extensa*. Therefore, Boscovich's theory of matter, sketchy anticipated in Kant's *Monadology* (ibid. p. 118 n. 6), forerun "in rough outline the modern theory of extended matter as composed of elementary particles invested with repulsive and attractive forces" (ibid. p. 116), while a second development of "Leibniz's programme of a dynamic explanation of matter" anticipated "the Faraday-Maxwell theory of fields" (ibid.). Popper stressed at the most the passage to the modern experimental theories of matter, and emphasized the fundamental role that some philosophical speculations presented by thinkers like Descartes or Boscovich had in the development of the outcome of 19th physicists. He especially defined both the content of Boscovich's *Theoria* and Kant's statements on nature as "the joint ancestors of all modern theories of the structure of matter" whose achievement has been possible because of the "pure speculative character" of their development, and for "these metaphysical speculations proved *susceptible to criticism*" (ibid., p. 117).

Popper's talk thus emphasized the *metaphysical* nature of Boscovich's investigation (its being a pure speculation), but it also stressed the fact that his theoretical observations concerned topics susceptible to analysis and refutation through experiments. Something that, according to him, is fundamental to the progress of scientific knowledge, since the latter is grounded on exactly this ever lasting comparison between new ideas and views, whose value is directly related with their being susceptible to criticism. Boscovich, as the other thinkers involved in the development of the scientific world description, made possible a discussion "inspired by the wish to understand the world, and by the hope (...) that the human intellect could at least make the attempt to understand it, and could perhaps get somewhere. And an experimental refutation of a speculative solution to one of its problems led to its turning into nuclear science" (ibid.). Therefore, the Jesuit must be taken into consideration as referring point of the history of scientific thought, for the same reason that lead to his disappearance from the Hall of Fame of the big scientists of his era: since he didn't reach any experimental result of high level, his name soon has been forgotten, and today one finds it just in some specialized works or in memories such as this one.

2. Two emblematical cases

Despite of this lack of experimental demonstration, Boscovich's ideas deeply influenced 19th century science, even more than how Popper claimed. For example, two scientists such as Faraday and the above mentioned Lord Kelvin developed their main ideas on matter with reference to the Boscovichean atom theory. Faraday, for example, mentioned Boscovich in an article from 1844, in which he summed up some conclusions of his own investigations. During those years, the English scientist was carrying on his studies concerning both electromagnetic induction and electrolysis, according to which he rejected the notion of action in distance and described electric and magnetic phenomena with reference to the "electro-tonic states" of loaded particles and to "lines of force" respectively. At that time Faraday was trying to overcome the "ordinary

[5] Actually, Boscovich did not (as Popper claims) just replace the atoms with Leibnizian monads. He rather adopted a dynamic model that deprived them of the substantial nature they still had (see Gori 2007, chapter 2, §2.)

atomic theory" according to which there must be a dualism between matter and void, and the bodies are aggregates of particles not touching each other. Since the space between these particles should be void, it was impossible to explain any kind of transmission of electric actions between them, and thus the traditional atomic theory should be abandoned. Moreover, Faraday showed that the idea that the atoms could touch one another was simply unacceptable, too. Thus, he claimed, "the safest course appears to be to assume as little as possible, and in that respect the atoms of Boscovich appear to me to have a great advantage over the more usual notion. His atoms, if I understand alright, are mere centres of forces or powers, not particles of matter, in which the powers themselves reside" (Faraday 1844, p. 140).

Thus, Faraday chose Boscovich's atomic model, since it seems to him that he got rid of any substantial presupposition and of all the complications involved by this in developing a theory of matter. Moreover, Faraday argued that, while one ordinarily describes atoms by referring to two separate things, i.e. the particle of matter away from the powers (*a*), and the system of powers or forces in and around it (*m*), "then in Boscovich's theory *a* disappears, or is a mere mathematical point", and " the substance consists of the powers or *m*" (ibid. p. 140-141). He thus solved the problem by eliminating the dualism between matter and void, and by identifying the matter with the atmosphere of force, or power[6]. This is a fundamental assumption to get rid of the Cartesian corpuscular theory, and therefore open the way to a new perspective, that will not be grounded on substantial elements anymore, but will rather only refer to mathematical points of a dynamic system. Furthermore, these points come to existence only with the whole system, and are only mere relative stable.

As regards Kelvin, his case is a little more complicate than Faraday's. Even though in his works he quotes Boscovich many times, around the half of the 19th century Kelvin criticized his ideas. In particular, he complained stating that the notion of immediate contact could be rejected and claimed him to be guilty of the end of the 18th century school of physical investigation (see Giordano 1978, p. 72). During those years, Kelvin was persuaded that atomic models must be abandoned, since they were not necessary, but he later changed his mind, and formulated new theories on both atomic powers and the relationship between atom and ether just with reference to Boscovich's *Theoria*. In an article from 1905, then, Kelvin proposed to "consider an atom of ponderable matter intrinsically charged with concentric strata of electricity, vitreous and resinous, of equal electric density at equal distances from the centre". The resinous electricity consisted of equal atoms ("electrions") having property of electric attraction or repulsion (Kelvin 1905, p. 695-696). Kelvin then stated: "My present assumption is Boscovichianism pure and simple", and went on speaking about the force between a single "electrion" and a single atom of ponderable matter, that could be defined "in the line of their centres varying according to the distance". This force, "for distances greater than the radius of the atom is attraction according to the inverse square of distance between the electrion and the centre of atom" (ibid., p. 696)[7].

Faraday and Kelvin are not the only scientists who expressly referred to Boscovich in carrying on their inquiries, but it seems to me that these two examples can be sufficient to show that the *Theoria* deeply influenced 19th century scientific investigations, and that the development of modern physics is strictly

[6] One must nevertheless say that Boscovich only conceived this capital overcoming of the idea of action in distance, but he never expressly stated anything about it. Boscovich never got rid of this idea, and stressed its importance for the description of nature phenomena. "Se non si ammette quella, che chiamano azione *in distans*, che communemente si riggetta, niun punto puo realmente agire in altro punto nella mia teoria: la forza non si tramanda" [If one doesn't admit what is called action *in distans*, which is widely rejected, no one point can actually act on one another in my theory: the force cannot be transmitted] (see Boscovich 1980 p. 70).

[7] This atomic theory, which Kelvin developed in compliance with Boscovich's ideas, has been anticipated in Kelvin 1897, and Kelvin 1902.

connected to the intuitions of the Jesuit. The cases of Faraday and Kelvin not only confirm Popper's claim, according to which Boscovich had a fundamental role in the overcoming of an old theoretical view, and made possible to reach a new scientific *paradigm*, but also stress the fact that who took his work into consideration was the people who did the history of contemporary science, even though Boscovich's ideas were not experimentally demonstrated.

3. The functional model

Before Popper's contribution, the value of Boscovich in the history of scientific thought has been stressed by Ernst Cassirer, who dealt with the *Theoria*, too, but of course from a different point of view. While Popper referred to Boscovich to confirm his own claims concerning the demarcation between scientific and philosophical statements, Cassirer quoted the Jesuit with regard to the history of the notion of *substance* and its replacement with a "functionalist" perspective. However, both Popper and Cassirer dealt with the problem of matter -that is also the ground of Boscovich's investigation-, and agreed in claiming that the solution proposed by the Jesuit represented a turning point for the Western worldview. As regards this last topic, Cassirer's observations seem to be much more philosophically significant than Popper's, since he went beyond questions of mere epistemological methodology. The topic which Cassirer dealt with was indeed the reference to the notion of substance -the ground of the mechanistic paradigm in science, against which wrote for example Ernst Mach (see Mach 1883)- that was still very popular in 19th century physics. What Cassirer stressed at the most in the forth chapter of his *Substance and Function* (1910) was furthermore the notion of atom, once grounded on the testimony of sense organs, and now become a pure mathematical notion. The way to get rid of what Nietzsche called a functionalist "prejudice of the senses" (see *infra*) started with the Democritean atomism, in which the sensuous determinations disappears, and "the substance of the physical body is exhausted in the totality of properties, which arithmetic and geometry (...) can discover and establish in it" (Cassirer 1923, p. 156). Cassirer then noticed that the great advance made by Democritus didn't solve an important contradiction, which "comes from the fact, that the atoms, which are meant to be nothing but rational constructions of thought, have certain properties ascribed to them, which properties are only deduced from analogy with the sensuous bodies of our world of perception" (ibid. p. 158). Thus, the "prejudice" would only be bypassed, but not eliminated. To solve this question one should lead the principles of rational mechanics to their last consequence, and thus reach "that transformation of the concept of the atom, which natural science since Boscovich has carried out" (ibid. p. 159). What does Cassirer mean with these words is well explained in what follows:

"In place of the extended but indivisible particle, there now appears the absolutely simple *point of force*. We see how the reduction of the sensible properties, which was already characteristic of Democritus, has here advanced another step. The *magnitude* and *form* of the atoms have now disappeared; what differentiates them is merely the position, that they mutually determine for each other in the system of dynamic actions and reactions. (...) All independent, self-existent attributes are now completely effaced; what remains is merely the relation of a dynamic coexistence in the law of the reciprocal attraction and repulsion of the points of force. Boscovich urges energetically, and Fechner after him, that force itself (...) resolves into the concept of law and that it is meant to be merely the expression of a functional dependence of magnitudes. The atom, which in its origin goes back to the pure concept of number, here reverts to its origin after manifold transformations; it signifies nothing but the member of a systematic manifold in general. All content, that can be ascribed to it, springs from the relations of which it is the intellectual centre" (Cassirer 1923, p. 159).

These observations catch the value of a very important moment in the history of Western thought, concerning not only the pure scientific plane, but also that of philosophical investigation in the wider sense (which includes epistemology, ethics and aesthetics).

The overcoming of the substantial paradigm involves indeed the possibility of getting rid of any reference to a metaphysical realm, i.e. the plane on which the reality of things, their ontological existence, is grounded. The notion of "substance", lying behind both spiritual and material concepts (soul and atom, to make it clear), has been the main reference point of Western thought since Plato, but during the 19^{th} century it went through a crisis and finally collapsed under the stroke of both modern epistemology and post-idealistic philosophy, which hit not only at the same time, but also deeply interlaced with each other. That notion helped men orientating themselves on both the practical and the theoretical plane. With no reference to it, the individual responsibility becomes huge, and one must make a brave choice, and become the creator of new values, of a new world description involving an orientation that is both theoretical and practical, as well. One must notice that, according to Cassirer, the substance doesn't disappear leaving an absolute void: by revealing its pure metaphysical nature, its being a mere creation of our thought, the substance becomes the reference point of a functional system of relations. Everything that one believed to be permanent and unchanging, such as the atom of matter, is now defined in compliance with this new paradigm, i.e. as the result of a relation between dynamic elements. As regards physics, the atom is replaced with the field of forces, the unstable balance between colliding powers changing at any time and thus generating new constellation of energy. One cannot attribute any kind of existence to the atom, except of a mere relative one, since it's nothing but a mental concept, a "logical postulate" (Cassirer 1923, p. 156), a "label" one uses to mark a relative stable complex in a system of relationships that constitutes it and together with which it constantly changes (Mach 1923, p. 231. , see also Gori 2009, p. 125, 128 f.). Cassirer, then, stressed that this development led to the rejection of the old phenomenical view, according to which one attributed to the atom the characters of the sensory data. The passage to a different description of the old "corpuscle of matter" has thus been a victory over the "prejudice of the senses", and this is something on which a philosopher such as Friedrich Nietzsche agreed with Cassirer, more than one can imagine. Indeed, also the former thought (and stated) that Boscovich gave the decisive push that science needed to develop a new world view. His "philosophical meditations" would then open the way to a pure theoretical investigation, leaving the realm of sensory experiences. According to Whyte (that expressly agrees with both Nietzsche and Cassirer in arguing this), the *Theoria* marked "one of the greatest steps in the emancipation of the human mind from the spell of appearances. Matter is not what it seems" (Whyte 1961, p. 118).

4. The greatest opponent of visual evidence

During the last decades some scholars dealt with Nietzsche's interest for the late 19^{th} century science, and focused on his reading of Boscovich's work, wondering if, and how much, the *Theoria* influenced his thought[8]. Even though their conclusions seem not to be still widely accepted, Nietzsche's interest in modern epistemology should not astonish. Indeed, one can just explain it through a simple historical consideration, for it is not possible to take Nietzsche out of the context of his era, and therefore out of the debate that led to the 20^{th} century scientific worldview (see Gori 2010). The name of Boscovich appears only once in Nietzsche's published works, but its position is really strategic. Nietzsche writes about him in the first chapter of *Beyond Good and Evil*, a section devoted to his criticism towards the substantial notions such as *atom, I* and (free) *will*, and more generally to the mechanistic paradigm in physics[9]. As regards the first of these notions, one reads:

"As for the materialistic atomism, it is one of the best refuted theories there are (...) thanks

[8] See for example Schlechta & Anders (1962), Stack (1981), Small (1986), Whitlock (1996) and Gori (2007).

[9] Nietzsche's critical remarks are in compliance with Mach's statements from the same years (see Gori 2009).

chiefly to the Pole Boscovich: he and the Pole Copernicus have been the greatest and most successful opponents of visual evidence so far. For while Copernicus has persuaded us to believe, contrary to all the senses, that the earth does *not* stand fast, Boscovich has taught us to abjure the belief in the last part of the earth that 'stood fast' -the belief in 'substance', in 'matter', in the earth-residuum and particle-atom: it is the greatest triumph over the senses that has been gained on earth so far" (Nietzsche 1886, §12) [10].

As I wrote in commenting Cassirer's excerpt, Nietzsche too focuses on the liberation from the sensory experiences, which according to him are the ground of a world description that doesn't fit with the inner structure of reality. Nietzsche's idea is that mechanism uses notions such as that of "matter " or "cause and effect", claming that they describe the true essence of things, while they are but "conventional fictions for the purpose of designation and communication -*not* for explanation" (ibid. §21). Moreover, he stresses at the most the fact that these concepts are grounded on *prejudices* that are both *sensual and psychological*, leading to a description of natural becoming in terms of human being's way of acting. Both touch and eyesight are especially the senses which one relies on at the most, but they are not truthful in a pure ontological sense, i.e. they at least limit our knowledge of the inner dynamic of the world[11]. According to Nietzsche, mechanism is but a description of reality, since the latter is, so to say, translated in another language, and therefore *falsified*[12]. In arguing this, Nietzsche quotes Boscovich, for he thinks that, among the scientists, he first has been able to go beyond the limits of a worldview that was too deeply grounded on sensory experiences.

Nietzsche presented these ideas some years before *Beyond Good and Evil*, in a letter written to Peter Gast (pseudonym of Heinrich Köselitz) and concerning Robert Mayer's book *Die Mechanick der Wärme* (1867), which Gast sent to his friend on 1881. On 20 March 1882, Nietzsche wrote to Gast that, in his opinion, Mayer was "a great specialist -and nothing more", and called him "coarse and naïve (...) when it comes to more general constructions". Moreover, Nietzsche contrasted Boscovich's observations with that of Mayer, claiming the former to be much more important and original:

"If something has been well and truly disproved, he [Mayer] says it is due to the 'material' prejudice -even if the disproving comes not from an idealist but from a mathematician-from Boscovich. Boscovich and Copernicus are the two greatest opponents of optical observation. With effect from him [Boscovich] there is no 'matter' anymore -except as a source of popular relief. He has thought the atomistic doctrine through the end. *Gravity* is certainly not a 'property of matter', simply because there is no matter. The *force of gravity* is, like the *vis inertiae*, certainly a manifestation of force, simply because force is all there is! Now the *logical* relation between these phenomena and others -for example, heat- is still not at all clear. But if one goes along with Mayer in still believing in matter and in solid corporeal atoms, then one cannot decree that there is only *one* force. The kinetic theory must attribute to atoms, besides motional energy, the two forces of cohesion and gravity. And this is what *all* materialist physicists and chemists do! -and Mayer's best adherents as well. *Nobody* has abandoned the idea of gravity! Ultimately

[10] Incidentally, one can also note that Mendlev on 1870 connected Boscovich with Copernicus, too, by writing that "Boscovich together with Copernicus is the just pride of the Western Slavs" (Whyte 1961, p. 121).

[11] See Nietzsche's note 14 [79] 1888 in KSA 13: "In order to sustain the mechanistic theory of the world, we always have to include a proviso about the use we are making of two fictions: the concept of motion (taken from the language of our senses) and the concept of the atom = unity (originating in our psychological 'experience'). Its prerequisites are a *sensual prejudice* and a *psychological prejudice*. The *mechanistic* world is imagined the only way that eye and fingertips can imagine a world (as 'being moved'), in such a way that it can be calculated".

[12] The notion of "falsification" in Nietzsche has been widely discussed (see for example Clark 1991 Hussain 2004 and Riccardi 2012).

even Mayer has a second force in the background, the *primum mobile*, God, -besides motion itself. And he certainly needs God!" (KSB 6 *Brief an Köselitz*, 20. März 1882).

This strong criticism towards Mayer clearly shows why Nietzsche was appreciating Boscovich so much. The Jesuit is indeed seen as the main upholder of a "dynamic world description" contrasting the Newtonian mechanism so popular during the whole 19^{th} century. The atomic theory maintained by the scientists who was following this paradigm (whose Mayer has been an important upholder) was grounded on the idea of a solid particle, a corpuscle of matter, which Nietzsche describes as the last manifestation of the "belief in souls" characterizing Western thought. According to him, one must therefore abandon this notion to finally get science rid of any reference to a religious-oriented perspective (Nietzsche 1886, §12 and 17). If one not completely rejects this "prejudice", science could easily fall again in the net of the metaphysics, since one cannot carry out any demonstration or argument without reference to God as creator and supporter of the world-order.

Moreover, what Nietzsche states in this excerpt make possible to well understand his view concerning natural science. The idea that *there's no matter, but only force* is very common in his writings (mostly notebooks) from 1883 onwards, and is the ground of his mature observations up to his mental collapse. Furthermore, once again with reference to the *Nachlass*, one can see that the notion of "force" (*Kraft*) and the natural dynamics that Nietzsche describes in compliance with Boscovich's statements are the ground of many important topics of his thought. In particular, they are crucial for the development of the idea of *will to power* and play a fundamental role in the formulation of the eternal recurrence theory, which Nietzsche first elaborated on the cosmological plane, as a pure description of natural becoming (see Abel 1998 and Gori 2007, ch. 2 and 3).

On 1883 Nietzsche wrote to Peter Gast once more, confirming his idea on the value of Boscovich's observations and telling the friend something about his first interest for the *Theoria*:

"In those days I was studying the atomist doctrine up to the quartos of the Jesuit Boscovich, who was the first man to demonstrate mathematically that, for exact science of mechanics, the premise of solid corporeal atoms is an *unusual* hypothesis: an axiom which now has *canonical* validity among natural scientists trained in mathematics" (KSB 6, *Brief an Köselitz*, Ende August 1883).

This letter says something about Nietzsche's first interest in Boscovich's book. Indeed, even though he speaks about the Jesuit only after 1882, one can date his first reading of the *Theoria philosophiae naturalis* back to 1873, when Nietzsche was a young professor at the University of Basel (see Gori 2007 p. 51 ff.). During those years Nietzsche gave several lectures on the pre-Platonic thinkers, and particularly displayed interest in the ancient philosophers that dealt with the inner characters of matter (with special regards to Democritus's atomism), and in the description of natural dynamics. Karl Schlechta and Anni Anders, in their work from 1962, stressed the fact that Nietzsche's interest in the main topics of 19^{th} century natural science grew during the 1870, and that he soon made some selected readings concerning them. The year 1873 has been an important one for all of that, since Nietzsche found in the University library many books on chemistry and physics; among the volumes that he borrowed, one finds the names of H. Kopp, A. Spir, F. Zöllner and, actually, R. Boscovich (see Crescenzi 1994). Finally, it's almost certain that Nietzsche first read about the Jesuit's main work in G. Fechner's *Über die phisikalische und philosophische Atomenlehre* (1864)[13], a book quoted by F.

[13] Schlechta and Anders write that, together with the *Theoria*, Nietzsche borrowed a dissertation concerning the critical remarks that Moses Mendelssohn made on 1759. This short writing, titled *Anmerkungen über den Auszug, und die Kritik eines berlinischen Herrn recenzenten das Boscovichische System betreffend* and pubished in Freiburg on 1772, disappeared after the last Nietzsche's loan (Schlechta & Anders 1962, p.

A. Lange in his *Geschichte des Materialismus* (1866), one of the most important texts for Nietzsche's philosophical education[14].

Fechner's book is very interesting (most of all in the light of both Popper and Cassirer's remarks) and useful to understand how Boscovich has been popularized in 19th century philosophy. In the *Atomenlehre* Fechner expounded some recent physical theories concerning the characters of the primary elements of matter, and stressed at the most Boscovich's atomic theory, by quoting many passages from the *Theoria* in which the Jesuit presented it in details. Fechner's statement was indeed that the work of the Jesuit has been the reference point for a quite new perspective concerning matter (a "philosophical atomism"), which some of his contemporary's ideas were in compliance with. Starting from the pure speculative observations presented by Boscovich, one can get rid of the old worldview, which described the atoms as little material masses, and thus develop a new, *dynamic*, theory of matter (Fechner 1864, p. 117 ff. and 150 ff). In tracing the historical development of this new paradigm in physics, Fechner claimed that Boscovich played a key role, exactly as Popper will later do (ibid. p. 229 ff.). Furthermore, as the neo-positivist thinker after him, Fechner stressed the role played by Kant as intermediate between the Jesuit and Leibniz, too, and then stated that they all presented pure philosophical observations (ibid. p. 224).

Thus, also Fechner emphasised the speculative nature of Boscovich's statements, but at the same time showed their value for the development of the new perspective of physical investigations that he found widely discussed during his era, and that he himself supported[15]. Fechner's book is thus fundamental to understand Nietzsche's view in reading Boscovich's *Theoria* for the first time, and therefore to better interpret what he stated in *Beyond good and evil*. In this work, Nietzsche repeats what he read in the *Atomenlehre* (and later in Lange), claiming that Boscovich has been a turning point in the history of the atomic theory, since he has been the first in presenting an anti-metaphysical description of matter. This is what one reads also in two notes that Nietzsche wrote before 1886, and that are closely related with the published statements. In the first of them, Nietzsche claims that Boscovich "first destroyed the superstition of matter, with his theory of the mathematical character of the atom" (KSA 9, 15[21] 1881), while in the second he states not to believe in "matter", and claims that Boscovich is "one of the greatest turning point, as Copernicus" (KSA 11, 26[432] 1884). Of course, Nietzsche's interest for Boscovich is pure theoretical: he indeed attacks the mechanistic worldview and the bad metaphysics that follows from it, since it's the last residuum of a philosophy that believes in substances, a perspective that rose from Plato and the Aristotelic Scholastic. To get rid of all this "shadows of God" (as Nietzsche calls them in *Gay Science*, §108), would mean to open a space of action that would be beyond any kind of dualism, beyond any claim of absolute and immutable truths, or, in other words, "beyond good and evil" (Nietzsche 1886, Preface). In the scientific debate of his time Nietzsche finds the ground ideas of a worldview of this kind, and then refers to them to sustain his own position. Therefore, his philosophy must not be seen as distinguished from (or, worst, against) scientific thought, but rather deeply grounded on it. As regards, then, Boscovich's "philosophical meditations", Nietzsche gives values to them beyond their experimental foundation. According to him, whether or not the Jesuit had the instruments to testify his theory of matter is

130). The dissertation is not so relevant on the theoretical plane, since one cannot find into it any observation that can be directly linked to what Nietzsche states in his later writings; nevertheless, this book is important on the historical plane, for it's one more element connecting Boscovich's work with contemporary thought.

[14] As regards the influence of Lange on Nietzsche's thought, see Stack 1983 and Salaquarda 1978. Lange speaks about Boscovich only in the second edition of his book (1882), and in doing so he explicitly refers to Fechner (see Lange 1882 p. 249 ff.).

[15] One must then remember that Cassirer quotes Fechner as the other (with Boscovich) reference point for the development of a functional theory of matter (see *supra*).

not really important; the value of the *Theoria* is indeed its being helpful to change a worldview, to provide the ground of a new perspective in physics. That is to say, after Boscovich one must consider the dynamic (relational) side of nature, instead of the atomic (substantial) one, in a way close to what happened after Copernicus with regards to the relationship between the Earth and the Sun. This overturning of perspective is what interests Nietzsche at the most in evaluating Boscovich, and this can be demonstrated also by stressing a detail of the published excerpt, i.e. Nietzsche's defining him "Pole". This can of course be a mere mistake made by Nietzsche, but since in youth he's been a good philologist, and he would thus be very careful in avoiding oversights such as this, one must at least discuss the possibility that he made it on purpose. Moreover, one must consider that Nietzsche was giving a great value to the Polish nationality, and that he himself stated to be Pole many times[16]. Therefore, claiming Boscovich to be Pole, besides pooling him with Copernicus even more (the latter was born in Poland for real), would emphasise his importance. One can find a more revealing claim on this in another note in which Nietzsche speaks about his ancestors, since he refers to the "right of the Polish noble of turning with just his veto the decision of an assembly; an the Pole Copernicus, as I can see, did the greatest and worth use of this right against the decision and the evidence of all other men" (KSA 9, 21[2] 1882). One can therefore argue that, by writing "Pole", Nietzsche was referring to the skill of a man of standing himself alone out of a crowd, of affirming his own ideas against many others, since his word is much more worthy as that of the others. That's why, then, even Boscovich can be defined "Pole": such as Copernicus, he stated an idea against the theoretical notion popularly adopted from his contemporaries (the belief in "matter"), he expounded a worldview that went beyond the limits of the more common Newtonian description, and thus opened the way to a new *revolution* against visual evidence.

5. Conclusions

At the end of this investigation, that led trough more that one century of history of thought[17], one can see which role Boscovich played in the development of modern epistemology, and then check that he has been a reference point for authors involved in several areas of interest. One can therefore argue that the content of the *Theoria*, even though presented in such an abstract and speculative form, has anyway been the ground of a new worldview, a new paradigm for both physical investigations (on the speculative and on the experimental plane), and epistemological studies (involving science and philosophy). Popper and Fechner stressed the first topic at the most, even though their views was quite different, while Cassirer and, even more, Nietzsche, draw from the same text other conclusions. The latter, in particular, showed the existential, ethic and aesthetic value of a "dynamical world-description", whose ground has been first presented by Boscovich in his *Theoria*. The possibility of developing so many and different ideas from this book comes from the "metaphysical" (*á la* Popper) or "philosophical" character of its content. Thus, the value of the *Theoria* would be its leaving the space for a pure philosophical interpretation, and therefore opening the way to a new description of reality, since this book is not bound into the limits of an experimental practice. If Boscovich had written another treatise on the nature of matter, he probably would not have added anything significant to all the other contributions of experimental science. Because of his "metaphysical" work, rather, his name become part of the

[16] In *Ecce Homo, Why I am so Wise* 3, for example, Nietzsche claims himself to be "a Polish nobleman *pur sang*, with which not a drop of bad blood is mixed, least of all German blood", and defines the Pole as "the noblest [race] there has ever been on earth".

[17] It seems that the fame of Boscovich did not last more than that period of time. Lange, trough Fechner, wrote that the Jesuit's main outcomes have been first received in French at the beginning of the 19^{th} century (Lange 1882, p. 248) and then, as written above, Popper has probably been the last important thinker who dealt with him.

history of Western thought, even though later and in a narrow way.

References

Abel, G. 1998, Nietzsche. Die Dynamik der Willen zur Macht und die ewige Wiederkehr, De Gruyter, Berlin/New York

Boscovich, R.G. 1980, Lettere a Giovan Stefano Conti, a c. di G. Arrighi, Firenze

Boscovich, R.G. 1922, A Theory of Natural Philosophy, Open Court, Chicago/London [1763]

Cassirer, E. 1923 Substance and Function, Dover, New York [1910]

Clark, M. 1991, Nietzsche on Truth and Philosophy, Cambridge University Press

Crescenzi, C. 1994, Nietzsche-Studien, 23, 388

Faraday, M. 1844, The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science, 24, 136

Fechner, G. 1864 Über die phisikalische und philosophische Atomenlehre, H. Mendelssohn, Leipzig

Gilles, D., Giorello, G. 1995, La filosofia della scienza nel XX secolo, Laterza, Roma-Bari

Giordano, E. 1978, 'Giornale di Fisica, XIX, 64

Gori, P. 2010, Scienza & filosofia, 3, 108

Gori, P. 2009, Nietzsche-Studien, 38, 111

Gori, P. 2007, La visione dinamica del mondo. Nietzsche e la filosofia naturale di Boscovich, La Cittá del Sole, Napoli

Hussain N., 2004, European Journal of Philosophy, 12/3, 326

Kelvin, 1905, Philosophical Magazine, ser. 6, X/60, 695

Kelvin, 1902, Philosophical Magazine, ser. 6, III/15 257

Kelvin 1897, Nature, 56, 84

Lange, F.A. 1882, Geschichte des Materialismus, Reclam, Leipzig

Mach, E. 1923, Populär-wissenschaftliche Vorlesungen, Brockhaus, Leipzig [1896]

Mach, E. 1883, Die Mechanik in ihrer Entwickelung: historisch-kritisch dargestellt, Brockhaus, Leipzig

Nietzsche, F. 1886 Jenseits von Gute und Böse

Nietzsche, F. Sämtliche Werke. Kritische Studienausgabe, 15 Bde., hrg. von G. Colli, M. Montinari, De Gruyter, Berlin (1980) [KSA]

Nietzsche, F. Sämtliche Briefe, Kritische Gesamtausgabe, 8 Bde., hrg. von G. Colli, M. Montinari, De Gruyter, Berlin (1986) [KSB]

Popper, K. 1994, Philosophy and Physics: the influence on theoretical and experimental physics of some metaphysical speculations on the structure of matter, in: Id., The Myth of the framework, Routledge, London

Popper, K. 1935, Logik der Forschung, Springer, Wien

Riccardi, M. 2012, Teorie e pratiche della verità in Nietzsche, P. Gori & P. Stellino (ed.) ETS, Pisa (in press)

Salaquarda, J. 1978, Nietzsche-Studien 7, 236

Schlechta, K., Anders A. 1962, Friedrich Nietzsche. Von der verborgenen Anfängen seines Philosophierens, Stuttgart-Bad Cannstad

Small, R. 1986, Philosophy and Phenomenological Research 46 419

Stack, G. 1983, Lange and Nietzsche, De Gruyter, Berlin

Stack, G. 1983, Pacific Philosophical Quarterly 62, 69

Whitlock, G. 1996, Nietzsche-Studien 25, 200

Whyte, L.L. 1961, Roger Boscovich, S.J., F.R.S., 1711-1787: Studies of his Life and Work on the 250^{th}h Anniversary of his Birth, L. L. Whyte (ed.) London and New York