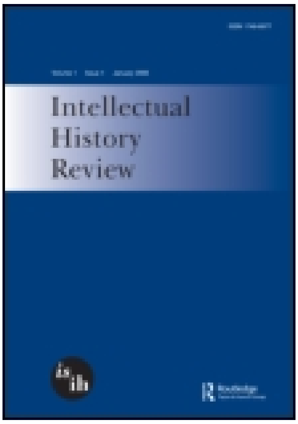

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Spinoza, Boyle, Galileo: Was Spinoza a Strict Mechanical Philosopher?

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Spinoza, Boyle, Galileo: Was Spinoza a Strict Mechanical Philosopher?

Filip Buyse

1. HISTORICAL CONTEXT OF THE BOYLE/SPINOZA-CORRESPONDENCE

Certain texts are known in philosophical literature as the correspondence between Spinoza (1632–1677) and Boyle (1627–1691), even though Spinoza never wrote a single letter directly to Robert Boyle, and Boyle never wrote to Spinoza. The so-called correspondence consists of four letters. Henry Oldenburg served as the intermediary for each letter.

When Robert Boyle's sister Katherine Boyle (1617–1691), better known as Lady Ranelagh, needed a private teacher for her son Richard Jones (1641–1712), she initially thought of John Milton (1608–1674), but turned to the German emigrant Henry Oldenburg (1619–1677) when Milton declined. It was in this context that Boyle met Oldenburg. They remained in close contact for the rest of their lives.

Oldenburg toured Europe with Boyle's nephew for more than two years. After returning to England, he spent some time in his own country. Then, during his return trip from Germany to London, he visited Spinoza in the summer of 1661 at Spinoza's home in Rijnsburg, a small village near Leyden. Back in London, he wrote to Spinoza and invited him to stay in contact. This was the start of a long correspondence[1] between 1661 and 1676 with hiatuses between 1663 and 1665 and between 1665 and 1675. In his very first letter, Oldenburg mentions Boyle's *Certain Physiological Essays* (1661),[2] not mentioning Boyle's name specifically but referring to the text as written by 'an excellent English nobleman, a man of extraordinary learning'. Oldenburg writes, moreover, that 'the English nobleman' had published a new book that he would send to Spinoza. Oldenburg did so a few months later – sending Spinoza the Latin version of the *Physiological*[3] *Essays* (*Tentamina quaedam physiologica diversis temporibus & occasionibus conscripta*) before it was actually published that same year and including a letter asking Spinoza to read and comment on the text, in particular on the experiments Boyle outlined therein.

[1] What is known as the correspondence between Baruch Spinoza and Henry Oldenburg consists of 17 letters from Oldenburg to Spinoza and 11 from Spinoza to Oldenburg.

[2] R. Boyle, 'Certain Physiological Essays', in *The Works of Robert Boyle*, edited by M. Hunter and E.B. Davis (London: Pickering & Chatto, 1999–2000), vol. 2, 1–203.

[3] The term 'physiological' in *Physiological Essays* should be understood in the same sense as 'physical' or simply as that which concerns nature.

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At first glance this strikes one as a very strange request, as Spinoza was not a scientist – at least not in the strict sense of the word. However, two documents provide evidence that Spinoza was much more involved in science than most scholars have assumed. The first is a letter from a medical doctor, the Cartesian Cornelius Bontekoe (1647–1685), discussed for the first time by Jonathan Israel in 2007.[4] In this letter,[5] Bontekoe, a former student at the University of Leyden, remarks that several students from the University of Leyden frequently visited Spinoza. Although many scholars believe, based on letters 8, 9, and 13, that Spinoza taught only one student – his co-habitant Casearius (ca. 1642–1677) – the letter from Bontekoe makes it clear that Spinoza was a professional tutor of the new science.

The second document is a letter by the famous anatomist and geologist Nicolas Steno (1638–1686). In a document discovered in 2000 by Pino Totaro,[6] Steno writes that several students visited Spinoza regularly while Steno was studying at the University of Leyden in 1661, the same year that Oldenburg visited Spinoza. At that time Steno was conducting anatomy dissections under the direction of Franciscus de le Boë Sylvius (1614–1672),[7] who would open the first academic lab in Europe, in Leyden, a few years later. Spinoza thus clearly attended lectures at the University of Leyden, although he was never officially enrolled.

It is likely that Oldenburg noticed Spinoza's interest and involvement in the new science in general and the new physics in particular when he visited him in Rijnsburg. This would explain why Oldenburg asked him to comment on Boyle's scientific experiments.

2. THE DEFINITION OF MECHANICAL PHILOSOPHY

In letter 6, Spinoza responds to Oldenburg's request and apologizes for not reading the whole book, although he had carefully read the second part, in which the experiments were discussed:

1. Two Essays concerning the Unsuccessfulness of Experiments, etc…
2. Some specimens of an Attempt to make Chymical Experiments useful to illustrate the Notions of Corpuscular Philosophy.
   - 2.1 A physical-chymical Essay containing An Experiment with some Considerations touching the different Parts and Redintegration of SALT-PETRE.
   - 2.2 The history of Fluidity and Firmness.

This second part contains two essays, both of which Spinoza critically commented on in his longest existent letter, beginning what is known as the correspondence between Boyle and Spinoza. This correspondence (a correspondence within a correspondence inasmuch as it was always via Oldenburg) consists of letters 6, 11, 13, and 16, written between 1661 and 1663.

[4] J. Israel, 'Spinoza as an Expounder, Critic, and "Reformer" of Descartes', *Intellectual History Review*, 17:1 (2007), 59–78.

[5] C. Bontekoe, *Brief Aan Johan Frederik Swetser, Gesegt Dr. Helvetius, Geschreven en uytgeeven tot een Korte Apologie voor den Grote Philosooph Renatus Descartes* […], ('s Gravenhage, 1680).

[6] See P. Totaro, ' "Ho certi amici in Ollandia": Stensen and Spinoza – science verso faith', in *Niccolò Stenone: Anatomista, geologo, vescovo*, edited by K. Ascani, H. Kermit, and G. Skytte, (Rome: L'Erma di Bretschneider, 2000), 27–38.

[7] See E.D. Baumann, *Francǫois dele Boe Sylvius* (Leiden: Brill, 1949). For information about Sylvius and the University of Leiden around 1661 see also *Dutch Culture in a European Perspective*, vol. 1: 1650 – Hard-Won Unity, edited by W. Frijhoff and M. Spies (Assen: Royal van Gorcum /Palgrave Macmillan, 2004), 319.

Spinoza began his commentary on Boyle's book by criticizing what he took to be Boyle's conclusion[8] in *De Nitro*: namely the idea that nitre (saltpeter) was a heterogeneous compound composed of volatile nitre and fixed nitre, both of which differ from nitre and could be analyzed (*decompositio*) and recombined (*redintegratio*) into saltpeter in the 'redintegration of Nitre' (*experimento de redintegratione nitri*). This 'redintegration experiment' was not original to Boyle. The German chemist J.R. Glauber (1604–1670) had performed the experiment for the first time. Boyle writes in the last section and in the preface to his book that he had not really read Glauber's work, but this assertion is suspect because, as a member of the Hartlib circle, Boyle was in contact with Benjamin Worsley (1618–1677),[9] who visited Glauber's lab in Amsterdam in 1648–1649. In the mid-1650s, Worsley wrote a book on nitre, *De Nitro theses quaedam*, in which he discussed Glauber's redintegration theory. According a letter by Samuel Sorbière, Glauber's lab, only a few blocks away from Spinoza's birthplace, was impressive. According to Steven Nadler,[10] Spinoza most likely visited this lab, which would explain why he writes so knowledgably about the 'redintegration' experiment.

In the first paragraph of his response to Spinoza's letter, Oldenburg asserts that Boyle did not want to give 'a truly philosophical and complete analysis of Nitre'. Rather, he wanted to demonstrate via this experiment that his new philosophy was the true alternative to Peripatetic natural philosophy:[11]

> Before I deal with matters what concern just you and me alone, let me deliver what is due to you on Mr. Boyle's account. The observations which you composed on his short Chemical-Physical Treatise he has received with his customary good nature, and sends you his warmest thanks for your criticism. But first he wants you to know that it was not his intention to demonstrate that this is a truly philosophical and complete analysis of Nitre, but rather to make the point that the common doctrine of Substantial Forms and Qualities accepted in the Schools rests on a weak foundation, and that what they call the specific differences of things can be reduced to the magnitude, motion, rest and position of the parts.[12]

Boyle thereby made it clear that Spinoza had missed the point of his experiments. Moreover, after Spinoza's second letter, Oldenburg repeats (again in the first paragraph) that what was important for Boyle was not the experiment or the process as such but the promotion of a new philosophy. Furthermore, Oldenburg insists that Spinoza should have read the preface, where Boyle had explained the 'true aim' of this work.[13] In this preface, for the first time in his career, Boyle defines the new philosophy he would advocate for the rest of his life:

[8] See letter 6 and letter 13.

[9] See W.N. Newman and L.M. Prinzipe, *Alchemy Tried in the Fire* (Chicago and London: University of Chicago Press, 2005), 212–13; W.N. Newman, *Atoms and Alchemy* (Chicago and London: University of Chicago Press, 2006), 210; J.T. Young, *Faith, Alchemy and Natural Philosophy: Johann Moriaen, Reformed Intelligencer, and the Hartlib Circle* (Aldershot: Ashgate Publishing, 1998).

[10] See S. Nadler, *Spinoza: A Life* (Cambridge: Cambridge University Press, 2001).

[11] All citations from Boyle's work are from: R. Boyle, *The Works of Robert Boyle*, edited by M. Hunter and E.B. Davis (London: Pickering & Chatto, 1999–2000). All citations from Spinoza's work are from Spinoza, *Complete Works*, edited by M.L. Morgan and translated by S. Shirley (Indianapolis/Cambridge: Hackett Publishing Company Inc., 2002). All citations in Latin are from: Spinoza, *Opera*, im Auftrag der Heidelberger Akademie der Wissenschaften herausgegeben von Carl Gebhardt (Heidelberg: Carl Winters Universitätsbuchhandlung, 1972 [1925]).

[12] See letter 11.

[13] In letter 16, Oldenburg writes: 'He [Boyle] asks you to consult the preface which he wrote to his Experiments on Nitre, so as to understand the true aim which he set himself in that work: namely, to show that the doctrines of the more firmly grounded philosophy now being revised are elucidated by clear experiments, and that these experiments can very well be explained without the forms, qualities and the futile elements of the Schools.'

> That both parties agree in deducing all the Phaenomena of Nature from Matter and local Motion; I esteem'd that notwithstanding these things wherein the Atomists and the Cartesians differ'd, they might be thought to agree in the main, and their Hypotheses might by a Person of a reconciling Disposition be look'd on as, upon the matter, one Philosophy. Which because it explicates things by Corpuscles, or minute Bodies, may (not very unfitly) be call'd Corpuscular; though I sometimes stile it the Phoenician Philosophy, because some ancient Writers inform us, that not only before *Epicurus* and *Democritus*, but ev'n before *Leucippus* taught in *Greece*, a Phoenician Naturalist was wont to give an account of the Phaenomena of Nature by the Motion and other Affections of the minute Particles of Matter. Which because they are obvious and very powerful in mechanical Engines, I sometimes also term it the Mechanical Hypothesis or Philosophy.

It was not Boyle but the Cambridge Platonist Henry More (1614–1687)[14] who introduced the term 'Mechanical Philosophy' into the English language. However, according to Alan Gabbey,[15] Boyle's definition expressed what most other early modern philosophers would later understand by this term. It is very likely that Spinoza first saw this term in Boyle's book and consequently understood this term in the sense of Boyle's definition, although he himself never used the term 'mechanical philosophy' (*philosophica mechanica*).

Given the factors discussed above, it seems quite unlikely, in opposition to A. Clericuzio's suggestion,[16] that the controversy between Spinoza and Boyle was over Boyle's account of 'the "redintegration" process on the grounds of the chemical properties of the corpuscules as opposed to Spinoza's supposed strict mechanical interpretation. Boyle refers repeatedly throughout the correspondence to the 'true aim' of his book: the promotion of his Mechanical Philosophy. Moreover, in his *Enquiry* (1686),[17] he would refer to this book not as having explained the 'redintegration' process but as being 'against the pretended inexplicable nature of the imaginary substantial forms of the Peripapteticks'.

In the preface[18] to his *Some specimens of an Attempt*, Boyle defines his new philosophy. At the time, the term 'mechanical philosophy' still sounded very odd in all European languages and in Latin. However, a closer look at this definition reveals six key elements:

1. It is about explaining nature and natural phenomena.
2. Its two principles are matter and motion, or more precisely, passive matter and local motion.
3. There is a primary/secondary distinction: secondary affections of bodies should be explained in terms of primary properties.
4. The there is a macro/micro distinction: the qualities of bodies should be explained in terms of the affections of their minute parts.

[14] See H. More, *The Immortality of the Soul*, edited by A. Jacob (Dordrecht: Martinus Nijhoff Publishers, 1987), 4–21. The first version of this book was published in 1659, the second revised edition in 1662.

[15] See A. Gabbey, 'What Was "Mechanical" about "The Mechanical Philosophy"?' in *The Reception of Galilean Science of Motion in Seventeenth Century Europe*, edited by C.R. Palmerino and J.M.M.H. Thijssen, (Dordrecht/Boston/London: Kluwer Academic Publishers: 2004), 11–23.

[16] See A. Clericuzio, *Elements, Principles and Corpuscles: A Study of Atomism and Chemistry in the Seventeenth Century* (Dordrecht: Kluwer, 2000), 143.

[17] See *A Free Enquiry into the Vulgarly Received Notion of Nature* (1686), edited by M. Hunter and E.B. Davis (Cambridge: Cambridge University Press, 1996), 61.

[18] This preface reached the printer at the last minute; it was inserted in the first edition between pages already numbered. As a consequence the preface with the definition dates from 1661 although the *Essays* were written earlier, probably in 1655 or 1656.

5. There is the machine analogy, which functions as a concretization for the invisible, minute parts.
6. The epistemic status of his philosophy is that is of a hypothesis to be validated in one or another way.

To determine whether Spinoza can be regarded as 'a strict mechanical and reductionist philosopher', I will now examine to what extent all these different elements are present and important in Spinoza's philosophy.

3. THE DIFFERENT ELEMENTS OF THE DEFINITION

3.1 *THE TWO CATHOLICK PRINCIPLES: MATTER AND MOTION*

One of the main reasons why Robert Boyle favored his new philosophy, which he opposed in his preface not only to the Peripatetic philosophy but also to the 'chymists', was the economy of its principles. In Boyle's new philosophy there are only two principles (or elements),[19] as opposed to 'the four Peripatetick Elements' and 'the three Chymical Principles'. The two universal or, as he called them, Catholick Principles, are matter and motion, or, more precisely, local motion and passive matter. Richard Westfall[20] rightly remarks that Boyle might have added that by 'matter' mechanical philosophy means 'qualitative neutral stuff, shorn of every active principle and every vestige of perception'.

These two principles clearly echo the work of Galileo (1564–1642). Galileo's observations with his improved version of the Dutch telescope, described in his well-known *Siderius Nuncius* (1610) and in the *Letters on Sunspots* (1613), convinced most natural philosophers that there is only one universal matter common to all bodies in the universe. Likewise, with his revolutionary theory of motion, Galileo reduced what we now call 'change' to one kind of motion: local motion. Consequently, after Galileo, 'motion' was no longer part of the metaphysics of change. The essential new idea in his revolutionary theory of motion was that a body was indifferent (inert) to rest or motion on the horizontal plane.

Galileo's ideas were widely known in England in the early 1660s, having been popularized starting around 1639 by John Wilkins (1614–1672). Wilkins was one of two first secretaries of the Royal Society at the time of the Boyle/Spinoza correspondence.[21] The importance of Galileo's work had already been acknowledged at that time among intellectuals of Boyle's circle. For example, the English mathematician John Wallis (1616–1703) was fully aware of the huge impact of Galileo and his disciples on mechanical philosophy and wrote in a letter to Robert Boyle :

> How much the World and the great Bodies therein, are managed according to the *Laws of Motion*, and *Statick Principles* and with how much more of clearness and satisfaction, many of the more abstruse *Phaenomena* have been slaved on such Principles, within the last century of Years, than formerly they

[19] Boyle, and most seventeenth-century chemists, used 'principle' and 'element' interchangeably.

[20] Cf. R.S. Westfall, *The Construction of Modern Science* (Cambridge: Cambridge University Press, 1977), 41.

[21] John Wilkins was, like Boyle, one of the founding fathers of the Royal Society. And like Henry Oldenburg, he was a secretary of the Royal Society. Henry Oldenburg was secretary of the physical sciences division; John Wilkins was the secretary of the biological sciences division. The Royal Society's website lists all secretaries of the two divisions from 1663 to present at: http://royalsociety.org/about-us/governance/officers/.

> had been; I need not discourse to you, who are well versed in it. For, since that *Galilaeo*, and (after him) *Toricellio*, and others, have applyed *Mechanick* Principles to the salving of *Philosophical* Difficulties; *Natural Philosophy* is well known to have been rendered more intelligible, and to have made a much greater progresse in less than an hundred years, than before for many ages.[22]

It is noteworthy that in 1661 and 1664 Thomas Salusbury published in London the first and second volumes[23] of his *Mathematical collections and translations*.[24] These volumes contained the first biography of Galileo published outside Italy and English translations of most of Galileo's published works and some of his letters. This publication launched much discussion in Boyle's circle on Galileo's theories and experiments. In a letter to Boyle dated October 10, 1665, Oldenburg requested information about the publication of the second volume of Galileo's work .[25] It is likely that his interest was sparked by having read the first volume, which contained English translations of *La Bilancetta* (1586), the *Lettera a Madama Cristina di Lorena* (1615) and the *Dialogo* (1632). Moreover, one of the first letters[26] Oldenburg wrote after he visited Spinoza was to Viviani (1622–1703), Galileo's last pupil and first biographer.

As with Galileo and Boyle, Spinoza accepts only one kind of motion. In the scolie of proposition 6 of the second part of his *Principles of Cartesian Philosophy* (1663), he argues that there is only local motion (*motus localis*). In the same scolie he refutes the four different sorts of change (*motus*) distinguished by the Peripatetics, arguing that there is only one kind of motion because 'we admit nothing but what we clearly and distinctly conceive.' He defines local motion in definition 8 of the second part of his *Principles of Cartesian Philosophy* as 'the transfer of one part matter, or of one body, from the vicinity of those bodies that are immediately contiguous and are regarded as at rest, to the vicinity of other bodies'. Furthermore, for Spinoza, 'rest' is not just a privation of motion. In the scholium of proposition 11 of *PPCII*,[27] he writes that 'what we say about motion must also be understood about rest', indicating clearly that rest, like motion, is to be understood as something positive. This idea is also present in the inaugural dissertation on '*Matter, and Its Affections: Motion and rest'* (1660) by Spinoza's best friend, Lodewijk Meijer (1629–1681),[28] who also wrote the preface to Spinoza's interpretation of Descartes' *Principles* at his demand.

[22] See 'Letter from Wallis to Boyle (25 April 1666)', in *The Correspondence of Robert Boyle*, edited by M. Hunter, A. Clericuzio and L. Prinzipe, 6 vols (London: Pickering & Chatto, 2001), vol. 3, 1666–1667, 142.

[23] See N. Wilding, 'The Return of Thomas Salusbury's Life of Galileo (1664)', *British Journal for the History of Science*, 41:2 (2008), 241–65.

[24] T. Salusbury, *Mathematical collections and translations* …, vol. 1 & 2 (London: printed by William Leybourn, 1661–1665).

[25] Oldenburg writes: 'I was but yesterday with Mr Thompson, who uses to acquaint me with the new Books, that come abroad, but he neither then, nor afore, told me any thing of Galilaeo's second Tome: but I shall aske him about it, God willing, the next time I passe that away.' See Hunter, Clericuzio and Prinzipe, *Correspondence of Robert Boyle*, vol. 2, 549.

[26] See 'Letter 242, Oldenburg to Viviani (28 October 1661)', in *The Correspondence of Henry Oldenburg*, edited and translated by A.R. Hall and M.B. Hall, 12 vols (Madison: University of Wisconsin Press, 1966), vol. 1, 443.

[27] In this paper I will use the following abbreviations to refer to Spinoza's work: *PPC* = Principles of Cartesian Philosophy (*Principia Philosophiae Cartesianae*), *CM* = Metaphysical Thoughts (*Cogitata Metaphysica*), *E*= Ethics (*Ethica*), *Ep* = Letters (*Epistolae*), *KV* = Short Treatise (*Korte Verhandeling*), *TIE* = Treatise on the Emendation of the Intellect (*Tractatus de Intellectus Emendaione*), *TP* = Political Treatise (*Tractatus Politicus*), *TTP* = Theological-Political Treatise (*Tractatus Theologico-Politicus*).

[28] See 'Appendix 2: Meyer's Dissertation', in *Principles of Cartesian Philosophy*, translated by S. Shirley and introduction and notes by S. Barbone and L. Rice (Indianapolis/Cambridge: Hackett Publishing Company, 1998), 144–59.

These similarities notwithstanding, Spinoza had a very different conception of matter than Boyle and other contemporaries. First, for Spinoza, there is not and has never been matter without motion, as he makes clear in his letter to Ehrenfried Walther von Tschirnhaus (1651–1708).[29] In this letter, he reasons that there can be no 'passive' matter because if there were, according to the law of inertia we would need an extra-natural cause which had put that nature in motion. This is impossible in Spinoza's system because for him there simply is no extra-natural. Spinoza's Nature is an absolutely infinite individuality that implies everything. So for Spinoza, instead of matter AND motion there is only motion-IN-matter or matter-IN-motion.

In Spinoza's *PPC* we find the same idea, although here it is much more hidden. At the beginning of the second part, Spinoza presents a definition of motion, and in the first remark of this definition he gives the definition of a body. The definitions are literally copied from Descartes, but Spinoza states them at the beginning of the second part, whereas Descartes, in contrast, states them much later, in paragraph 25 of the second part of his *Principles*, after having mentioned numerous times that a body is essentially an extended thing, a *res extensa*. Thus Spinoza makes the circularity of both Cartesian definitions very explicit, since motion is a transport of a piece of matter (or a body) and a body is that which is transported. Thus, for Spinoza, matter and motion are interwoven.

Spinoza rigorously applies the theory of local motion in his *PPC*. Descartes postponed the publication of *Le Monde*[30] after having heard of the second condemnation of Galileo in 1633, (the year Spinoza was born). In his *Le Monde*, Descartes' Copernicanism was openly exposed. However, in the *Principia* (1644) this Copernicanism disappeared[31] completely. Instead, Descartes adopted an ultra-relativistic theory of motion that allowed him to argue that the earth was in motion or in rest.

Spinoza's *PPC* originated with an interpretation of the second part of the *Principle*s (transcribed from a private course for Casearius) and a third unfinished part. Spinoza added the first part only after the explicit demand[32] of his friends from Amsterdam. In the second part of the *PPC*, Spinoza discusses the same subjects that Descartes had discussed previously but does not discuss the relativistic theory of the motion of the earth, which Descartes had explained in paragraph 30 and to which he even added an illustration. According to Alexandre Koyré,[33] the 'odd and peculiar' theory of motion of the *Principles* was not originally a theory of Descartes, who adopted this 'mask' in order to reconcile the motion of the earth with the official doctrine of the Roman Church after the case of Galileo. As a result, Cartesian mechanics became 'self-contradictory and obscure'.

Apparently Spinoza had noticed what Ferdinand Alquié[34] calls Descartes' 'relativité totale', since in his interpretation he completely skipped this theory of motion of the earth and Descartes' illustration. Moreover he eliminates the ultra-relativism in Descartes' theory of motion in five remarks that he adds to Descartes' definition of local motion. For Descartes, motion is doubly relative: both to immediately contiguous bodies and to the person who regards these bodies as at rest. Spinoza, however, stresses in his commentary that there is only one set of a limited

[29] See letter 81.
[30] The *Traité du monde et de la lumière* was published posthumously in 1664.
[31] See D. Garber, *Descartes' Metaphysical Physics* (Chicago: University of Chicago Press, 1992).
[32] See letter 8.
[33] See A. Koyré, *Galileo Studies*, translated by J. Mepham (Atlantic Highlands, NJ: Humanities Press, 1978).
[34] See Descartes, *Œuvres philosophiques*, textes établis, présentés et annotés par Ferdinand Alquié, 3 vols (Paris: Classiques Garnier, 1963–1973), vol. 2, 1638–1642, 173.

number of contiguous bodies and asserts that these surrounding bodies should not be regarded as at rest by one single person but should be 'universally regarded as at rest'.

Another difference separates Spinoza's concept of matter from that of Boyle. According to Spinoza, the corporeal substance (a term used exclusively to indicate the attribute of extension) is only one of the infinite attributes of nature, all of which express the essence of God. For Spinoza, in contrast to Boyle, the corporeal substance and the thinking substance are essentially one and the same substance, conceived from different attributes. Therefore, in Spinoza, the psychic is not rigidly excluded from the physic as it is for Boyle and other mechanical philosophers. For Spinoza, body cannot completely be reduced to its mechanical properties because ontologically body and idea are one and the same thing (*res*) conceived from different attributes. Reducing the body to its mechanical properties would violate Spinoza's 'panpsychism'.

3.2 *NATURE*

According to Boyle's definition, the object of study of Mechanical Philosophy is 'all the Phaenomena of Nature'. Spinoza has a very different concept of nature than Boyle and other mechanical philosophers. As he remarks in a note in Chapter Six of his *Theological-Political Treatise* (1670), Spinoza does not mean by nature 'simply matter and its modifications, but infinite other things besides matter'. Phenomena traditionally considered to be incorporeal, such as emotions (*affecta*)[35] and memory[36] have a corporeal aspect for Spinoza. Moreover, Man and God are not completely distinct from Nature. Indeed, for Spinoza, God is identical with Nature: *Deus sive Natura*. Nor are the human body or the human mind distinct from Nature; as Spinoza indicates several times,[37] Man is part of Nature and has not been created by a God distinct from Nature but rather has been generated[38] by Nature. Man is not an 'empire within an empire' (*imperium in imperio*).[39]

With the first sentences from the preface of *E4*, Spinoza indicates that man is part of nature because man, like everything else in nature, is governed by laws of nature. Galileo discovered the first fundamental law of modern physics: the law of free fall. However, Galileo did not know the term 'natural law'; nor did he use the terms 'Law of Nature' or 'Physical Law' in his original writings, although they are often found in translations of his work. Instead, he presented his results in the form of numbered theorems, propositions, lemmas, and corollaries, connected by mathematical demonstrations. Furthermore, Galileo preferred to paraphrase relations using terms like 'ratio and proportion' (*ragione*) or principle (*principio*), rather than using mathematical formulas.

Edgar Zilsel showed that the concept of a physical law in fact originates in the juridical metaphor:[40] specifically, in the theological idea of God as lawgiver. Spinoza inherited the concept of laws of nature from Descartes and later from Boyle, who transformed Galileo's 'laws imposed

[35] See the definition of *affecta* at *E3* def. 3.
[36] See *TIE*, 83 and the scholium of proposition 18 of *E2*.
[37] See for instance: the third paragraph of the third chapter of his *TTP*, the scholium of *E4*p57 and letter 32.
[38] See letter 6.
[39] See the preface of *E3* and paragraph 6 of chapter 2 of the *TP*.
[40] See E. Zilsel, 'The Genesis of the Concept of Physical Law', in *The Social Origins of Modern Science*, edited by D. Raven, W. Krohn, and R.S. Cohen (Dordrecht : Kluwer, 2000), 96–121.

by God upon Nature'[41] into 'laws of nature'. However, the idea of 'universal laws of nature'[42] becomes extremely important in his philosophy. Spinoza repeatedly stresses that everything, including human beings, is determined by the universal laws of nature (*leges, et regulas naturae universales*). Moreover, for Spinoza, there are no exceptions to these laws; there are no miracles.[43]

Robert Boyle repeatedly criticizes this kind of identity between Nature and God in his *A Free Enquiry into the Vulgarly Received Notion of Nature*.[44] The *Enquiry* was published much later, in 1686, although Boyle writes in his preface that he wrote this work mainly in the 1660s, an assertion confirmed in 1996 by Michael Hunter and Edward B. Davis.[45] In this text, Boyle refutes the idea of *natura naturata*,[46] an important element in Spinoza's metaphysics,[47] because 'the creator differs too little by far from a created (not to say imaginary) being'. Spinoza would certainly have interpreted this as a critique of his concept of nature because, as he writes to Oldenburg in the Boyle/Spinoza correspondence,[48] he does 'not differentiate between God and Nature in the way all those known to me have done'. Piet Steenbakkers[49] has rightly remarked that there is a good deal of anti-Spinozism throughout the *Enquiry*, although Spinoza's name is never mentioned explicitly. It is likely that Boyle wrote this book with Spinoza in mind.

3.3 *THE DISTINCTION BETWEEN PRIMARY AND SECONDARY AFFECTIONS*

3.3.1 THE POINTS OF AGREEMENT BETWEEN BOYLE AND SPINOZA

So far, most commentators who have discussed the Boyle/Spinoza correspondence[50] directly contrast Boyle with Spinoza. Henri Daudin opposes 'l'expérimentateur, le technician' to 'le philosophe métaphysicien'; Boas Hall opposes the 'rationalist' to the 'empiricist' and Antonio Clericuzio opposes 'the radical mechanist' to the 'chemist'. In my view, however, the fact that Boyle and Spinoza corresponded indicates first and foremost that they fundamentally agreed on the subjects they discussed – although there are indeed differences, which I will touch on below. As two examples will make clear, Boyle and Spinoza refused to discuss subjects on which they fundamentally disagreed.

[41] See Galileo's *Letter to the Grand Duchess Christina* (1615) and *Letter to Castelli* (1613) in *The Essential Galileo*, edited and translated by M.A. Finocchiaro (Indianapolis/Cambridge: Hackett Publishing Company, 2008), 103–45.

[42] In his letter 13 to Oldenburg, Spinoza exclusively uses the term 'the laws of mechanics' (*Leges Mechanicae*).

[43] See chapter 6 of the *TTP*.

[44] *A Free Enquiry into the Vulgarly Received Notion of Nature*, edited by M. Hunter and E.B. Davis (Cambridge: Cambridge University Press, 1996 [1686]).

[45] See E.B. Davis and M. Hunter, 'Boyle's *Free Enquiry*' in *A Free Enquiry*, xxiii.

[46] See *A Free Enquiry*, 22, 51.

[47] See *EIp29s* and *KV*, I, Cap. VIII and IX.

[48] See letter 6.

[49] See P. Steenbakkers, 'Een vijandige overname: Spinoza over *natura naturans* en *natura naturata*', in *Spinoza en de scholastiek*, edited by G. Coppens (Leuven: Acco, 2003), 35–52.

[50] The most important writings on the Spinoza/Boyle correspondence are: C.A. Crommelin, *Spinoza's natuurwetenschappelijk denken* (Leiden: E.J. Brill, 1939); H. Daudin, 'Spinoza et la science expérimentale: sa discussion de l'expérience de Boyle', *Revue d'histoire des sciences et de leurs applications*, PUF, 2:2 Janvier–Avril (1949); A.R. Hall and M.B. Hall, 'Philosophy and Natural Philosophy: Boyle and Spinoza', in *Mélanges Alexandre Koyré*, edited by R. Taton and F. Braudel, 2 vols (Paris: Hermann, 1964), vol. 2, 241–56; E. Yakira, 'Boyle et Spinoza', *Archives de Philosophie*, 51 (1988), 107–24; A. Clericuzio, 'A Redefinition of Boyle's Chemistry and Corpuscular Philosophy', *Annals of Science*, 47 (1990), 561–89; P. Macherey, 'Spinoza lecteur et critique de Boyle', *Revue du Nord*, 77 (1995), 733–74; Clericuzio, *Elements, Principles and Corpuscles*, 138–42; S. Duffy, 'The Difference Between Science and Philosophy: The Spinoza-Boyle Controversy Revisited', *Paragraph*, 29:2 (2006), 115–38.

First, Spinoza does not engage with Boyle in any significant way on the existence of a vacuum. Oldenburg tries in several letters to launch a discussion on the vacuum, as in letter 14, in which Oldenburg writes with enthusiasm about Boyle's air-pump, but Spinoza never really responds, even though Oldenburg emphasizes that these experiments were 'warmly welcomed' by philosophers who, like Spinoza, were plenists. For Spinoza, as for Descartes, there simply is no such thing as a vacuum, as this 'clearly follows from the fact that nothing has no properties'. Boyle realized that Spinoza did not want to discuss this question, postponing it in letter 16 to another occasion – an occasion that would never take place.

Likewise, in his correspondence with Spinoza, Boyle does not engage with Spinoza's ideas about the general relation between God, nature, and man or about other metaphysical subjects, even though Spinoza's metaphysics was already well-developed at the time and, as is clear from the first letter[51] from Oldenburg to Spinoza, Oldenburg and Spinoza had discussed such metaphysical topics in Rijnsburg. Boyle, likewise, had written a text containing his ideas about interpretations of Spinoza's metaphysics. Indeed, Boyle described this text not as a text on Spinoza but as a 'text against Spinoza'. In this polemic text[52] – the only text in which Boyle actually mentions Spinoza's name – Boyle criticizes and categorically refutes Spinoza's stance on the existence of miracles, his arguments against divine teleology, his idea that God has no will, his identification of God with nature, and so on.

Boyle wrote this text later on in the 1670s, after the publication of the *Theological Political Treatise* (1670), but he could have written it during the period of the correspondence, for Spinoza already had these ideas at that time and had discussed them with Oldenburg during his visit. Based on letter 21 (1665) it is obvious that Boyle and Oldenburg continued to discuss Spinoza's ideas: 'Mr. Boyle and I often talk about you, your learning and your profound reflections.' Even after the publication of the *TTP* (1670), Oldenburg continued to inform Spinoza about Boyle's publications and Spinoza continued to show interest in Boyle and his publications. Although Boyle could have sent his 'text against Spinoza' to Spinoza to discuss their disagreements, he did not. Moreover, he never published the text.

We can therefore conclude that Boyle and Spinoza did not discuss questions on which they fundamentally disagreed but only on questions on which they were in basic agreement. What were these questions? Spinoza and Boyle basically agreed that natural phenomena should be explained 'without having recourse to inexplicable forms, real Qualities, the four Peripatetick Elements, or so much as the three Chymical Principles'. Instead, they wanted to explain all observable qualities in terms of motion, form, and other mechanical qualities of bodies. Indeed, Spinoza remarked that he could hardly believe that the 'true aim' of Boyle's redintegration experiment was to demonstrate this central idea of Mechanical Philosophy:

> For my part I did not imagine – indeed, I could never have been convinced – that the learned gentleman [Boyle] had no other object in view in his Treatise on Nitre than merely to demonstrate that the puerile and frivolous doctrine of Substantial Forms and Qualities rests on a weak foundation. But being convinced that it was the esteemed Boyle's intention to explain to us the nature of Nitre, that it was a heterogeneous body consisting of fixed and volatile parts, I intended in my explanation to show (as I think I have more than adequately shown) that we can quite easily explain all the phenomena of Nitre, such as are known to me at least, while regarding Nitre as a homogeneous body, not heterogeneous.[53]

[51] See letter 1.
[52] See R. Boyle, "Notes for a paper against Spinoza". The Boyle Collection, Boyle Papers, volume 3, manuscript document, Fols. 102–3 (2 leaves), RB/1/3/18, 1670s–1680s, London, Archive of the Royal Society.
[53] See letter 13.

For several reasons, the redintegration experiment of saltpeter was the ideal experiment to demonstrate that this central idea of the Mechanical Philosophy was correct and enough to convince Boyle's adversaries. First, as Boyle explained in the first section of his book, saltpeter was considered to be a general substance found everywhere in nature as well as in factories. Therefore, according to Boyle, what is true for saltpeter should be true for all substances. Second, at the time, the redintegration experiment was an ideal experiment to demonstrate that a substance was composed of corpuscles and could be recombined, which is also a central idea of the Mechanical Philosophy. Third, nitre was interesting not only to early chemists but also to alchemists. According to Glauber, mixed nitre was a 'hermaphroditic substance' containing both a volatile substance that he called volatile nitre (spirit of nitre) and a solid caustic substance that he called fixed nitre. Thus, mixed nitre was a kind of universal solvent, the so-called alkahest, a very important question among alchemists of the seventeenth century.

3.3.2 BOYLE AND THE DISTINCTION BETWEEN PRIMARY AND SECONDARY AFFECTIONS

In his definition of Mechanical Philosophy, Boyle makes a distinction between what he calls primary and secondary affections. This distinction has been well-known since Locke's work;[54] however, it was Locke's master Boyle who introduced the terminology in English in section XII of *De Nitro*: 'And first, this experiment seems to afford us an instance by which we may discern that Motion, Figure, and Disposition of parts, and such like primary and mechanical affections (if I may call them) of Matter, may suffice to produce those more secondary Affections of Bodies which are wont to be called Sensible Qualities.' After having explained the redintegration phenomenon in *De Nitro*, Boyle shows that he can explain the different effects on the five senses in a mechanical way.

The distinction between qualities is present in other works of important early modern philosophers such as Descartes (1596–1650) and Hobbes (1588–1679), although they use different terminology. Importantly, the distinction's first appearance since antiquity is in a work of Galileo's *Assayer* (*Il Saggiatore*), published in October 1623:

> Now I say that whenever I conceive any material or corporal substance, I immediately feel the need to think of it as bounded, and as having this or that shape; as being large or small in relation to other things, and in some specific place at any given time; as being in motion or at rest; as touching or not touching some other body; and as being one in number, or few, or many. From these conditions I cannot separate such a substance by any stretch of my imagination. But that it must be white or red, bitter or sweet, noisy or silent, and sweet or foul odor, my mind does not feel compelled to bring in as necessary accompaniments. Without the senses as our guides, reason or imagination unaided would probably never arrive at qualities like these. Hence I think that tastes, odors, colors, and so on are no more than mere names so far as the object in which we place them is concerned, and that they reside only in the consciousness. Hence if the living creature were removed, all these qualities would be wiped away and annihilated. But since we have imposed upon them special names, distinct from those of the other and real qualities mentioned previously, we wish to believe that they really exist as actually different from those.[55]

[54] The French translator of the *Il Saggiatore*, Christiane Chauviré, remarks in her Ph.D dissertation that in chapter 8 of Book 2 of his *Essay Concerning Human Understanding*, Locke retakes quite the same analyses of sensible qualities and reproduces exactly the same analyses of heat as in Galileo's *Assayer*. See C. Barrès-Chauviré, 'L' "essayeur de Galilée" (*Il saggiatore*)', thèse 3e cycle Philosophie: Paris 1, 1975, LX.

[55] See Galileo, 'The Assayer', in *Discoveries and Opinions of Galileo*, translated with an introduction and notes by S. Drake (New York: Anchor Books, 1957), 217–81.

In this passage Galileo makes clear that there is a real distinction (*veramente e realmente da quelli diverse*) between primary accidents (*primi e reali accidenti*) and secondary affections (*diverse affezioni secondo*). Primary accidents are accidents that bodies in themselves have. Other affections of bodies, in contrast, exist only in the minds of human beings and living animals. These affections do not refer to anything that exists in the corporeal world. Thus, for Galileo, words referring to these secondary affections are mere names (*un puro nome*). Without living bodies, Galileo continues, there would not be any secondary affections in the world.

Peter Anstey argues that 'Galileo foreshadowed the distinction in *The Assayer*' but that 'there is no evidence that his brief discussion there had any impact on Boyle or his contemporaries.'[56] I would point out, first, that Galileo's explanation of heat with the distinction between qualities is not brief; indeed it is an important element of his book. Second, Galileo did not 'foreshadow' the distinction; rather, he defined it, explained it, illustrated it with many examples, and went on to apply it in later, widely-known books. Third, there are indications that these ideas must have influenced Boyle and his contemporaries, although they were indeed, like Galileo, familiar with atomistic theories of qualities, which I will discuss below.

There is evidence that some of the most influential philosophers known to Spinoza had a more than an accidental relation with Galileo. Moreover, most of these philosophers studied Galileo's work, in conjunction with the development of their own natural philosophy. They absorbed his ideas, and were not only influenced by his revolutionary ideas on motion and his revolutionary astronomy but also by his doctrine of qualities. Famous examples are Hobbes, Descartes, and Huygens, not to mention Boyle himself. All of them were able to read Italian and Latin; thus there is no question of a language barrier between them and Galileo's work.

When Galileo died, Boyle happened to be in Florence,[57] making his Grand Tour (1639–1644) with his brother Francis and his private teacher, the French Calvinist Marcombes. The young Boyle writes in his autobiography, *Philaretus*,[58] that he read the works of 'the great star-gazer'. Moreover, his private tutor was, through marriage, family[59] to Jean Diodati (1576–1649), who was in close contact with his cousin Eli Diodati (1576–1661), Galileo's correspondent and close friend.[60] Based on his Geneva notebook,[61] discovered in 1995 by L.M. Prinzipe,[62] it is certain that the young Boyle studied the Ptolemaic universe and Aristotle's element theory. In his teaching, Marcombes opposed this theory to modern views. Consequently, it is likely that Marcombes discussed Galileo's doctrine of qualities and his defense of Copernicanism. Later in his

[56] See P.R. Anstey, *The Philosophy of Robert Boyle* (London: Routledge, 2000), 24.

[57] See S. Sambursky, 'The Influence of Galileo on Boyle's Philosophy of Science.' in *Actes du Symposium International des Sciences Physiques et Mathématiques dans la Première Moitié du XVIIe Siècle*, 16–18 June 1958, Florence/Paris, 1960, 142–46 and R.E.W. Maddison, 'Galileo and Boyle: A Contrast.' in *Saggi su Galileo Galilei*, edited by C. Maccagni, 2 vols (Florence: G.Barbera, 1967), vol. 2, 348–61.

[58] Robert Boyle wrote his *Account of Philaretus during his Minority* in 1648 or 1649.

[59] Isaac Marcombes was the second husband of Madeleine Burlamacchi (1608–1665) who was the daughter of Jean Diodati's sister, Anne Diodati (1578–1634).

[60] S. Garcia, *Élie Diodati: un homme de réseau au service de la cause galiléenne*, Thèse de doctorat, Université de Lausanne, 2003, 34.

[61] The small octavo notebook now comprises 109 folios that contain three folding tables: one calendrical table, a second showing 'the qualities and combinations, etc., of the four elements', and a third entitled 'A Figure of the Construction of the World', which shows the Ptolemaic universe. See M. Hunter, *Boyle: Between God and Science* (New Haven and London: Yale University press, 2009), 53.

[62] See L.M. Prinzipe, 'Newly Discovered Boyle Manuscripts in the Royal Society Archive. Alchemical Tracts and His Student Notebook', *Notes Rec. R. Soc.*, London, 49:1 (1995), 49–70.

life, Boyle read Galileo's work mainly via translations by Marin Mersenne (1588–1648), one of his favorite authors.

Descartes, like Spinoza, never mentions Galileo by name in any of his published works. However, this does not necessarily mean that he was unfamiliar with Galileo or that he was not influenced by Galileo's philosophy. According to Adrien Baillet (1649–1706),[63] Descartes was in Italy at the end of 1623. At that time, he was already very interested in physics, so he must have heard of Galileo's work, published in October of the same year and immediately extremely popular. According to Domenico Bertoloni Meli,[64] there is no doubt that Descartes encountered the *Assayer*. Moreover, it is likely that Descartes learned of the ideas in Galileo's book via his conversations and correspondence with the Dutch mechanical philosopher Isaac Beeckman (1588–1648). The atomist Beeckman knew the *Assayer* and wrote about it in his scientific autobiography.[65]

Hobbes, with whom Boyle had a debate about experiments at the time of the Boyle/Spinoza correspondence, was obviously very well acquainted with Galileo's work. Several scholars[66] have convincingly demonstrated Galileo's influence on Hobbes's philosophy. Douglas M. Jesseph[67] points out that Hobbes's *De Corpore* (1655) is deeply indebted to Galileo and that some of the ideas from the *Assayer* (1623) are also present in Hobbes's book. In the *Epistle Dedicatory* of *De Corpore* Hobbes remarks that 'Galileus was the first that opened to us the gate of natural philosophy universal, which is the knowledge of the nature of motion. So that neither can the age of natural philosophy be reckoned higher than to him.' Hobbes even met Galileo when he visited Italy in November 1635.[68] Spinoza was familiar with Hobbes's work. He had the Elzevir edition of *De Cive* (1647) in his library[69] and the ideas of Hobbes were discussed in his circle. E. Curley argued that Spinoza must have read the *Leviathan* before 1670 since his friend Abraham Van Berkel (1639–1686) translated this work into Dutch in 1668.[70] Moreover, the difference between the physics in the *PPC* and the *Physical Treatise* of the *Ethics* and similarity between the physics in the *Physical Treatise* and *De Corpore* suggests that Spinoza must have also read *De Corpore* (1655), published in Amsterdam in 1668 by Joannem Blaeu as the first book of Hobbes's *Opera philosophica*.

Huygens (1629–1695), Holland's most famous mathematician and physicist, was strongly influenced by and based much of his own work on Galileo.[71] Spinoza knew Huygens quite well, especially when Spinoza lived in Voorburg between and 1664 and 1669. Based on letter 26, it is clear that Spinoza visited and borrowed books from Huygens's library.[72] In the same letter, Spinoza writes that Huygens told him some 'wonderful things' about microscopes and

[63] See A. Baillet, *Vie de Monsieur Descartes* (Paris: Éditions de La Table Ronde, 1946), 52–9, 91.

[64] D.B. Meli, *Thinking with Objects: The Transformation of Mechanics in the Seventeenth Century* (Baltimore: Johns Hopkins University Press, 2006), 137.

[65] See *Journal tenu par Isaac Beeckman de 1604 à 1634*, edited by C. De Waard, tome 3: 1627–34, 223.

[66] See for instance: R. Tuck, *Hobbes* (Oxford: Oxford University Press, 1989) and F. Brandt, *Thomas Hobbes's Mechanical Conception of Nature* (Copenhagen: Levin & Munksgaard, 1928).

[67] See D.M. Jesseph, 'Galileo, Hobbes, and the Book of Nature', *Perspectives on Science*, Special Issue: *Galileo in Paris*, 12:2 (2004), 191–211.

[68] See Garcia, *Élie Diodati*, 86.

[69] See J.M.M. Aler, *Catalogus van de bibliotheek der vereniging Het Spinozahuis te Rijnsburg* (Leiden: E.J. Brill, 1965).

[70] See E. Curley, "Kissinger, Spinoza, and Genghis Khan", in *The Cambridge Companion to Spinoza*, edited by D. Garrett (Cambridge: Cambridge University Press, 1996), 315–42.

[71] See C.D. Andriesse, *Huygens: The Man Behind The Principle* (Cambridge: Cambridge University Press, 2010), xi.

[72] C. Huygens had the *Opere di Galileo Galilei* (Bologna, 1656) in his library.

telescopes made in Italy. Spinoza discussed Jupiter's satellites and the rings of Saturn with Huygens. Galileo was the first to observe certain structures around Saturn but Huygens, with a better telescope, observed that these were in fact the rings of Saturn. Furthermore, Spinoza criticized Descartes' views on the 'ears of Saturn' because this was based on Descartes' false preconceptions. Clearly, the discussions between Spinoza and Huygens did not solely concern astronomical questions but involved the nature of objects observed by optical instruments, misconceptions, wrong assumptions, the difference between appearance and reality, and so on.

3.3.3 SPINOZA AND THE DISTINCTION BETWEEN QUALITIES

In his letter 6 (1661/1662) Spinoza criticizes Boyle's list of the most general qualities of bodies or the qualities bodies have by virtue of being a body as being far too broad. In the first paragraph, Spinoza insists that Boyle should make a much more strict distinction between what he called intrinsic (*quae naturam ut in se est*) properties of bodies and extrinsic qualities attributed to bodies. Extrinsic qualities are understood as related to the senses (*non ut in se est, sed prout ad sensum humanum refertur*) and only properties like motion, rest, and their laws (*motus, quies, et eorundem leges*) are intrinsic.

The Galilean distinction between intrinsic and extrinsic affections has important implications for Spinoza, who applies this new doctrine of qualities in all his works[73] throughout his life in order to explain several important and typical aspects of his philosophy. Already, in *Metaphysical Thoughts* (1663), he applies this principle of relativity in order to clarify that 'true' and 'good' are to be understood in a relative sense. As he argues in Chapter 6 of the first part of the appendix of the *Principles of Cartesian Physics*, true is 'not a transcendental term' and there is no 'metaphysical good' or 'absolute evil'. For Spinoza, it makes no sense to speak about 'true gold'. Gold in itself is not true or untrue (at least not in the non-figurative sense of the word). Likewise, he argues that good and bad are only relative terms: 'Each single thing can be called good or bad at the same time in different respects.' Furthermore, in order to explain the extrinsic character of 'true' he refers to the example of the colour 'white': 'If you go on to ask what is truth other than a true idea, ask also what is whiteness other than a white body. For the relation is the same in both cases.' Apparently, Spinoza seems to conceive moral as well as epistemological categories as extrinsic qualities that we attribute to things, which things-in-themselves do not have.

In the same passage of *Metaphysical Thoughts*, Spinoza creates a clear structure in the text while applying this principle of relativity. He discusses first true/false, then good/bad, and finally perfect/imperfect. Indeed, he uses the same structure when applying the principle of relativity in the preface to the fourth part of the *Ethics*. In this preface he underlines once more the relative character of these categories.[74] Furthermore, he refers in this preface to the appendix of the first part where he had illustrated the principle with many concrete examples. Here, the way he applies the principle of relativity is very similar to Hobbes in *De Cive*[75] and very different from Descartes. This indicates the possible influence of Hobbes (Spinoza also had *De Cive* in his library).

Spinoza refers in the demonstration of proposition 16 of *E2* to the examples of the appendix of *E1*. This is a very important proposition, and throughout his *Ethics*, Spinoza refers to it numerous

[73] See for example letter 32 (1665) and letter 54 (1674)
[74] See also *TIE* 12.
[75] See Chapter 7 of the first part of *The Elements of Law* and *De cive*, III.3.1.

times.[76] According to this proposition and its two corollaries, the primary sensible ideas that the mind has of the affections of the bodies do not present the external bodies in itself. According to Galileo, these ideas of 'qualities residing in external objects have no real existence in us, and outside ourselves are mere names'.[77] For Spinoza, though, these ideas of affections are real modes that represent the body as well as the external body. That said, these ideas present the external bodies only partially, to the extent that they affect the thinker's own body. Furthermore, these ideas are confused because they represent two bodies at the same time. Moreover, according to the second corollary, they are far more representative of the actual status of the thinker's own body than of the affecting external body. Thus, Spinoza calls these ideas mutilated and confused ideas and identifies them with inadequate ideas (*ideae inadaequatae sive multilatae et confusae*). As in Galileo, therefore, there is in Spinoza nothing in reality corresponding with these ideas of affections. To have these ideas is to have knowledge of the first kind, which is necessarily inadequate, whereas knowledge of the second and third kind is adequate knowledge.

3.4 *THE MACRO/MICRO DISCTINCTION*

In his definition, Boyle does not present his new philosophy as new. On the contrary, he refers to atomism as far back as he can go. First he mentions Democritus (ca. 460 BCE–ca. 370 BCE) and his supposed teacher Leucippus (first half of 5th century BCE). Moreover, he refers to a certain Phoenician, Mochus, who was believed to be an atomist prior to Leucippus.

In his preface, in which he explains the 'true aim' of his philosophy, Boyle refutes the Peripatetic doctrine of qualities based on the existence of real qualities and substantial forms. In this polemic text he opposes the 'Peripatetick and vulgar Doctrines' to the atomists. Despite the differences, which he regards as metaphysical, he aims to unite two schools of philosophy into one common project. Considering atomists like Gassendi (1592–1655),[78] who believed that atoms and void really exist, and Cartesians for whom there are no atoms or vacuum in which atoms move, Boyle argues that both schools refute 'the general and superficial account of the Phaenomena of Nature from certain substantial Forms, which the most ingenious among themselves confess to be Incomprehensible, and certain real Qualities'. And both, he continues, 'the Cartesians and the Atomists explicate the same Phaenomena by *little Bodies* variously figur'd and mov'd'. So, the essential point of Boyle's corpuscular philosophy, a name he favored over Mechanical Philosophy, is not only to explain qualities in terms of primary qualities of bodies but in terms of the mechanical qualities of the corpuscles, or minute particles, of these bodies.

It is obvious that Boyle was inspired by atomism even though he never called himself an atomist. Spinoza also shows much sympathy for atomists, although he categorically refuted the existence of indivisible parts[79] or atoms and vacuum. Indeed, only once does Spinoza mention the term 'atomists' in all of his work, including his correspondence. In this passage Spinoza nonetheless shows much sympathy for 'Atomists or defenders of the atoms'. Why?

[76] See for instance: the scholium of *E2p18*, the explication at the end of *E3*, the scholium of *E4p1*, the proofs of *E2p19*, *E2p23*, *E2p26*, *E2p47*, *E3p18* and *E3p27*.
[77] See Drake, *Discoveries and Opinions*, 277.
[78] Also Gassendi knew Galileo's *Assayer*. See P. Redondi, 'Rendez-vous à Arcetri. A propos de la Correspondance entre Gassendi et Galilée', in *Gassendi et la modernité*, edited by S. Taussig (Turnhout: Brepols Publishers NV, 2008), 83–104.
[79] See letter 12 from Spinoza to Lodewijk Meijer, written in 1663.

Spinoza mentions 'atomists' in the last paragraph of his correspondence with Hugo Boxel. His discussion with Boxel does not concern atomism but the existence of spectres and ghosts. However, as Spinoza closes the discussion, he makes the association between ghosts and entities such as 'occult qualities, intentional species, substantial forms'. The problem with these 'bits of nonsense' – which he associates in this passage with the entire Platonic and Aristotelian tradition – is that they, like ghosts, have an unintelligible relation with matter. In Peripatetic philosophy a body is a hylomorphic composite of primary matter and a substantial form. Spinoza opposed this to the doctrine of the atomists, who explained natural phenomena, in contrast, by means of mechanical properties of atoms.

A good example of Spinoza's rather atomistic way of conceiving bodies is his definition of a body or a physical individuality (*unum corpus, sive Individuum*) found in his *Physical Treatise* between propositions 13 and 14 of the second part of the *Ethics*. Here, Spinoza defines a body-in-itself, opposed to the body according to the senses. This goes against his earlier definition in the *PPC* of the body as the piece of matter that is transported by referring to the surrounding bodies of the same level but by referring to the internal relation of its parts at the micro-level. A body is not the piece of matter which is transported but a whole consisting of parts characterized by a mutual relation of motion and rest, which are in turn also composed of parts. It is important to note that this relation is of a physical nature. Spinoza referred to this ratio when he insisted that Boyle takes only a limited number of the most general properties of bodies. It is noteworthy that at that moment he used the term 'rules or laws' (*motus, quies, et eorundem leges*). In the *Ethics* he prefers the term 'ratio' (*motûs, et quietis rationem*) which, according to Alexandre Matheron,[80] should be understood as a physical law.

According to most scholars, the distinction between primary properties and secondary qualities in Galileo goes back to the atomism of antiquity. Moreover, according to Pietro Redondi,[81] Galileo's supposed atomism was the major reason for his condemnation by the Vatican in 1633. Galileo's doctrine of qualities did not allow for an explanation of transubstantiation. According to the scholastic theory of that time, transubstantiation in the Eucharist is possible because there is a change of substance without a change in appearances, based on the theory of real qualities and substantial forms. In contrast, according to the atomistic theory, this is impossible due to the close relation between mechanical properties of bodies and their observable qualities.

The problem of transubstantiation became an important question after the Council of Trent (1545–1563). Descartes introduced the notion of 'superficies' in his *Principles* in order to solve this problem. He defined 'superficies' as the surface of the body belonging neither to the body nor to the environment and argued that during the Eucharist there is a change of substance, but that the appearance remains the same because the superficies are maintained. Frédéric De Buzon and Vincent Carraud argue that Descartes did not need this notion in his physics, which made this concept even 'caduque'.[82] But Descartes wrote in his letter to Mersenne[83] that he was obliged to explain this problem and, moreover, that this problem could only be solved by his philosophy, as it was only his philosophy that fully conformed to the Catholic faith. However, as J.R. Armogathe has shown,[84] Descartes never published his physics of the Eucharist.

[80] See A. Matheron, *Individu et communauté chez Spinoza* (Paris: Les Éditions de minuit, 1988).
[81] See P. Redondi, *Galileo eretico* (Torino: Einaudi, 1983).
[82] See F. De Buzon and V. Carraud, *Descartes et les "Principia" II - Corps et mouvement* (Paris: PUF, 1994), 60–1.
[83] Descartes' letter to Mersenne of the 25th of October 1630.
[84] See J.R. Armogathe, 'L'explication physique de l'Eucharistie' in *La nature du monde - Science nouvelle et exégèse au XVIIe siècle* (Paris: PUF, 2007), 149–73.

All he actually did was respond to the questions of clergymen like Mersenne (1588–1648), Arnauld (1612–1694), and Mesland.

In his final text on this question Descartes refers to the Council of Trent, and he remarks that he would prefer not to write down what he really thought: 'J'aimerais mieux exposer mes conjectures de vive voix que par écrit.'[85] Descartes was clearly afraid ('Je craindrais d'être accusé de témérité si j'osais déterminer quelque chose à ce propos') to express his own views on this question, just as he was also afraid to express his own views on the motion of the earth. As a consequence, the introduction of the concept of superficies was exactly like his ultra-relativistic theory of motion of the earth – an element of a mask[86] to hide what he really thought, after the Galileo affair. Despite Descartes' efforts, the Catholic Church condemned him in 1663, the year Spinoza published his *PPC*.[87] The reports of the two experts consulted by the Holy Office, Johannes Augustinus (Tartaglia) and Stephanus Spinula, serve to show that these two elements played a crucial role in Descartes' condemnation.

Spinoza simply skips the passage on superficies just as he had skipped the passage on the motion of the earth, although he thoroughly discusses the topics Descartes discussed before and after these paragraphs. Apparently Spinoza noticed that Descartes introduced these two elements in his book for politico-theological reasons. Indeed, this operation was totally consistent with what he would later write in his *TTP* (1670). In the *TTP* the distinction between philosophy and theology is a central issue.

3.5 *THE ANALOGY OF THE MACHINE*

Another element of Boyle's definition of Mechanical Philosophy is the machine analogy. Boyle makes a distinction between the micro and macro level, in which all observable qualities at the macro level are the result of processes at the micro level. Mechanical philosophers invented invisible mechanisms of invisible corpuscles to make manifested natural phenomena intelligible. In order to make these invisible relations more concrete, Boyle applied the analogy of the machine, using specifically the clock as his main example, which appealed to the intuitions of the technical culture of his time. There are numerous examples in which Boyle applies this analogy in his works. Spinoza, in contrast, applies the machine analogy very rarely, even though many of the philosophers with whom he was familiar, either from the literature (such as Descartes), from his correspondences (such as Boyle and Leibniz), or those he knew personally (like Huygens) used the machine analogy explicitly. Why might this be the case?

The fact that Spinoza does not use the machine analogy reveals something about his natural philosophy. For Spinoza, a body is not to be conceived as an artefact made by a creator (a designer God) with a certain purpose. Indeed, in one of his first letters to Oldenburg,[88] Spinoza states that human bodies are not created but generated. And in the scholium of *E3p2*, Spinoza states that the mechanism of the human body surpasses in complexity all that has been put together by human art, and consequently it cannot be conceived as a machine.

[85] See C. Adam et P. Tannery (eds.), Œuvres de Descartes (Paris: Cerf, 1897–1913), V, 184.
[86] See F. Buyse, 'Le "démasquement" de Descartes par Spinoza dans *Les Principia Philosophiae Cartesianae*', *Teoria*, 2 (2012).
[87] J.R. Armogathe, 'La première condamnation des oeuvres de Descartes, d'après des documents inédits aux archives du Saint-Office', in *Nouvelles de la République des Lettres* (Napoli : Prismi II, 2001), 103–37.
[88] See letter 4.

The fact that Spinoza did not use the paradigm of the machine probably stemmed from his lack of interest in machines. He would not have used machines to explain nature, which he regarded as perfect. I will provide three examples to illustrate this. First, as previously mentioned, Spinoza did not respond to Oldenburg's letter[89] describing Boyle's famous air pump.[90] Second, he does not show much interest in Huygens's pendulums when Oldenburg asks for information in his letter of 28 April 1665. For a seafaring nation such as Holland, these pendulums were extremely important and extremely sophisticated machines, as they were used to determine longitude while at sea. Huygens invented these pendulum clocks based on the work of Galileo, as he notes in the appendix of his letter 399 (letter 400).[91] Spinoza wrote to Oldenburg[92] that he had seen these machines in Huygens's house but does not show much interest in them.[93] Third, Spinoza was not convinced that Huygens's machine for polishing dioptrical lenses was any more effective than polishing lenses by hand.[94] Here again, Spinoza is not curious, and even not interested: 'for experience has taught me that in polishing spherical plates a free hand yields safer and better results than any machine.' In both examples, Spinoza even goes so far as to write to Oldenburg that the does not know the machine and does not want to know it.

The fact that Spinoza applies the analogy of the machine not only reveals something about his natural philosophy. It also reveals something about the evolution of his philosophy: In his proto-*Ethica*, the *Short Treatise*, he applies the analogy of the clock[95] when he explains the relation between the parts and the whole. In the corresponding passage of the *Ethics*, in contrast, the analogy of the clock disappears. Moreover, Spinoza only uses the term 'clock' twice in all of his work, in his early work, the *Short Treatise*.

3.6 *THE HYPOTHESES*

And now I arrive at the discussion of the sixth and final element of the definition. Boyle presents his Corpuscular Philosophy as a hypothesis that, by definition, should be validated. This, for Boyle, is an important element of his definition. For Mechanical Philosophers, validation by means of experimentation was not only important to 'verify their Assertions', but was also

[89] See letter 14, written in 1663.

[90] See S. Shapin and S. Schaffer, *Leviathan and the Air-pump: Hobbes, Boyle, and the Experimental Life* (Princeton, NJ: Princeton University Press, 2011).

[91] C. Huygens writes in letter 400, to an unknown individual: 'An exquisite and simple method for measuring time lapses was brought into use by astronomers about 27 years ago. A weight was hung on a thread and swung back and forth in equal lapses of time. There is no doubt that Galileo was the pioneer of this invention because he was the first to mention the isochronism of these oscillations. I started to concentrate on how these oscillations could be made persistent and the effort of counting be eliminated, so that it would be apt to measure any lapse of time one wishes to measure. In the beginning of this year 1657 I achieved both goals with the invention of a new clock of which I will now describe the composition and functioning.'

[92] See letter 30.

[93] According to Martial Gueroult ('La physique des corps et du Corps humain', in *Spinoza II – l'âme* (Paris: Aubier-Montaigne, 1974), 143–89.), Spinoza's simplest bodies (*corpora simplicissima*) should be conceived as single pendulums, and the other bodies as compound pendulums. This hypothesis has been severely criticized by Gilles Deleuze (Cours Vincennes: Infini actuel-éternité, confrontation avec le commentaire de Guéroult - Logique des relations (10/03/1981) at www.deleuze.com), according to whom Spinoza's simplest bodies should not be conceived as oscillating pieces of matter but as differentials.

[94] See letter 32.

[95] See chapters 1 and 6 of part I of the *KV*.

important in order to explain and to 'illustrate' the Mechanical Philosophy, that is, in order to convince people of the validity their position. As Boyle argued, there is a need for experiments, 'Since the Mechanical Philosophers have brought so few Experiments and the Chymists are thought to have brought so many on of behalf of theirs'.

Antonio Clericuzio concludes that the 'contrast between Spinoza and Boyle was not that of rationalist versus experimental philosopher, since Spinoza never actually denied the importance of experiments'.[96] This is clearly a refutation of A.R. Hall and M.B. Hall, who had indicated precisely this difference as the main point of controversy between Boyle and Spinoza. Likewise, according to Alan Gabbey,[97] Spinoza's controversy with Robert Boyle was essentially about methodology and the role of experiment. However, in my view, there is no doubt that Spinoza denies the importance of the sort of experiments Boyle described in his book.

Spinoza does this not because he dislikes science but because the experiments are not scientific enough. Spinoza argues that Boyle's experiments are not quantitative enough[98] and are too much based on the ideas of sensible qualities, which for Spinoza are necessarily inadequate and are the only source of inadequate ideas.[99] For example, Spinoza argues that certain motions that might be important are either too slow or too fast for human observation.[100] For Spinoza it is therefore an illusion to think that all circumstances in scientific experiments such as those in Boyle's book can be controlled. Second, he asserts that these scientific experiments are redundant for two reasons: first, because Descartes and Bacon (1561–1626) had already definitively proven the mechanical doctrine of qualities and, second, because casual experience (*experientia vaga*)[101] already demonstrates that mechanical principles are correct. Therefore, we do not require any of Boyle's scientific experiments (*experimentum*). Finally, in letter 13, Spinoza makes explicit that the mechanical principles should be accepted before doing experiments, suggesting that Boyle is far too empirical for Spinoza. Moreover, in his comments on *Fluidity*,[102] Spinoza states that 'one can never confirm it by chemical experiment or any other experiment, but only by demonstration and by calculating.'

The fact that the difference in epistemology is a main point of controversy between Boyle and Spinoza seems to be confirmed by the conclusion of their intermediary Oldenburg, who could follow the discussion from a privileged point of view. In the final paragraph of the Boyle/Spinoza correspondence,[103] Oldenburg concludes that both philosophers are 'both in agreement

[96] A. Clericuzio, *Elements, Principles and Corpuscles*, 138–43.
[97] A. Gabbey, 'Spinoza and Mechanical Philosophy', Conference on Mechanics and Natural Philosophy, Grenoble, 17–19 November 2005.
[98] See letter 6.
[99] See proposition 35 and 41 of *E2*.
[100] See letter 13.
[101] Spinoza here applies the terminology: '*experientia vaga*' and '*experimentum*'. He uses the same terminology in his *Treatise on the Emendation of the Intellect*. There he defines 'casual experience' (*experientia vaga*) as 'experience that is not determined by intellect, but is so called because it chances thus to occur, and we have experienced nothing else that contradicts it, so that it remains in our minds unchallenged'. Spinoza defines '*experientia vaga*' also in Scholium 2 of *E2p40*: 'From individual objects presented to us through the senses in a fragmentary (*mutilate*) and confused manner without any intellectual order [see *Cor.Pr.* 29, II]; and therefore I call such perceptions "knowledge from casual experience".' P.F. Moreau remarked that we already find the distinction between *experientia* and *experimentum* in the dispute between P. Grassi and Galileo. See J.P. Moreau, *Spinoza - L'expérience et l'éternité*. (Paris: PUF, 1994), 264.
[102] See letter 6.
[103] See letter 16.

on the main point', alluding to the mechanical doctrine in qualities of bodies which I discussed above. Oldenburg then closes the discussion and encourages Spinoza, with his 'keen mathematical mind, to continue to establish basic principles', and Boyle 'to confirm and elucidate them by experiments and observations repeatedly and accurately made'. These admonitions refer to what Oldenburg apparently regarded as the main disagreement between the two parties: Spinoza's deductive (geometrical) method versus Boyle's inductive (experimental) method. Previously, in letter 11, Oldenburg had written to Spinoza that 'Boyle belongs to the class of those who do not have much trust in their reason as not to want phenomena to agree with reason.' Apparently, he subsequently realized that on this main point of disagreement the water was too deep.

4. CONCLUSION

In an influential article on the Boyle/Spinoza correspondence, A. Clericuzio categorizes Spinoza's philosophy as 'strictly mechanical and reductionist'. To examine whether Spinoza actually was a strict Mechanical Philosopher, we need a definition of Mechanical Philosophy, since as Dijksterhuis showed,[104] the term 'mechanical' can have different meanings that might make the discussion completely obscure.

There is evidence that Spinoza first read a definition of Mechanical Philosophy in the preface of a book by Robert Boyle, sent to him by Oldenburg. This definition from the *Physiological Essays* captures quite well what early modern philosophers understood by 'Mechanical Philosophy'. An analysis of this definition reveals six essential elements of Mechanical Philosophy. An examination of these elements in relation to Spinoza's work shows that the categorization of Spinoza as a strict mechanical and reductionist philosopher, in this sense of Boyle's definition, is very problematic.

Within the framework of a discussion of the definition of Mechanical Philosophy, I have shown, first, that the Boyle/Spinoza correspondence was, for Spinoza, essentially about the nature of nitre. In contrast, for Boyle what was ultimately as stake was the promotion of a new philosophy: Corpuscular Philosophy, a name he favoured for Mechanical Philosophy. Second, I have shown that Boyle's definition of Mechanical Philosophy echoed several important ideas in Galileo's natural philosophy and that the Galileo affair played a role in the background of Spinoza's interpretation of Descartes' *Principia*. Spinoza skipped two passages from Descartes' work, which had obviously been introduced after the Vatican's case against Galileo in order to hide Descartes' own views.

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[104] See E.J. Dijksterhuis, *Clio's stiefkind*, edited by K. van Berkel (Amsterdam: Uitgeverij Bert Bakker, 1990), 169–92.