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RESEARCH ARTICLE

The role of infinitely small particles in Cartesian physics

Gyula Kistüttősi

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Abstract

In Cartesian physics the rejection of the atomism is the consequence of denying the vacuum. The motion of finitely small and rigid bodies in the space without vacuum can only be limited. The multifarious and variable motion assumed by mechanical philosophy is not possible due to geometrical restraints. Therefore the change of the physical bodies or sets of bodies is indispensable.

If we suppose that in Cartesian physics the shape and size of primary bodies is constant, chaotic motion is only possible if a certain proportion of the bodies are indefinitely small as opposed to finitely small atoms. These indefinitely small particles build up sets of bodies able to change their shape within the gaps between larger bodies.

Consequently, rejecting atomism and assuming indefinite divisibility by Descartes does not mean that primary bodies change their shape and size as part of the physical processes but only that there exist indefinitely small particles besides the finitely small bodies that are similar to atoms.

Keywords

Cartesian Science · Divisibility · Void · Atomism

Gyula Kistüttősi

Department of Philosophy and History of Science, Budapest University of Technology and Economics, Egry József u. 1., Budapest, H-1111, Hungary
e-mail: gyula@landamotor.hu

Introduction

In this paper, an aspect of Descartes' Physics has been examined, which, although often referenced, has not been studied in depth yet. In *Principles of Philosophy* Part II, Descartes discusses the indefinite (infinite) divisibility of matter.[1]"We likewise discover that there cannot exist any atoms, … For however small we suppose these parts to be, yet because they are necessarily extended, we are always able in thought to divide any one of them into two or more smaller parts…" (Descartes, [1, II.20]). Why did Descartes reject atomism? Why was the question of divisibility so important for Descartes that he devoted a separate point to it? In the first part of this study, the common characteristics of, and the differences between, atomist and Cartesian physics have been reviewed. It has been argued that both the atoms and Descartes' corpuscles are indivisible bodies of unchanged size and shape, and that changes in the shape of simple bodies are therefore also inconceivable in Cartesian physics. It has been assumed that the "indefinite divisibility of matter" entails the existence of point-like bodies. Furthermore, it has also been argued that atoms could only perform limited motion in a void. Lastly, the fact that various motions of small bodies in a void, as assumed by mechanical philosophy, are possible if a certain proportion of the small bodies is infinitely small, has been proved. It has been argued that this is the main reason why Descartes took a stand against the atomist theory.

1 Descartes and the atomists

1.1 Common features and differences

Throughout his life, Descartes took great care to distinguish his own philosophy from the atomist doctrines, which were revisited in the seventeenth century. Both Descartes' theory and atomist theories explained the phenomena of the world with the motion of small and imperceptible bodies (Garber, [4, p. 117]). Some of Descartes' readers categorized him as an atomist be-

[1] Descartes reserves the term "infinite" for God alone and refers to created things as "indefinite." Cf. *Principles of Philosophy* Part I 26-27 for more detail. For the sake of convenience, the term "infinite divisibility" is used, which is more in accordance with recent terminology.

cause of the following three common points between his theories and those of the atomists: (**a)** the motion of various small bodies is responsible for sensory properties, such as color, heat, and taste; (**b)** the universe is infinite and contains an indefinite number of worlds with their own suns and stars; and (**c)** not only celestial bodies, but plants and animals had also evolved out of an initial chaos in a "purely natural way" (Garber, [4, pp. 118–119]). Descartes was familiar with atomist theories and must have indeed been influenced by atomist thinking.[2]

Nevertheless, in his later works, he consciously took a stand against atomists.[3] One of his motives could have been the pride that he took in his own discoveries (Garber, [4, p. 119]). Another motive could have been that he did not want his theory to be confused with the atomist theories that, in certain aspects, were contrary to the Christian doctrines. However, the sources do not allow us to decide whether Descartes shared the atomist point of view regarding the indivisibility of atoms at the beginning of his relationship with Beeckman. Although he used the term "atom" at certain points, he did not use it in the exact atomist sense of the word. However, his dismissal of atomism had become evident by 1630 (Garber, [4, p. 121]).

It is commonly believed that Cartesian physics differs from the atomist doctrines in at least two important points, i.e., it assumes the infinite divisibility and denies vacuum. But how exactly does Descartes' view differ from the atomist theories? Let us first examine the issue of vacuum. The fundamental assumption of atomist doctrines is that atoms move in vacuum. As Descartes rejected the existence of occult entities, he had to explain the phenomena with the collision and pressure of particles. Hence, he had to accept the theory of vortex motion. However, vortex motion would not have operated in vacuum.[4] Therefore, Descartes, as opposed to atomists, denied the existence of vacuum.

It is important to emphasize that once Descartes had taken a stand to deny vacuum, it also had a bearing on the divisibility of matter. In the next section, how the infinite divisibility of matter inevitably follows from the rejection of the existence of vacuum and the assumption of irregular motion has been discussed.

1.2 Bodies in Cartesian physics

According to atomist theories, the world is made up of atoms: small, invisible, and indivisible bodies that are unchanged over time. Mechanical philosophy also assumes the existence of small and invisible bodies. Both the theories hold that the movement of these bodies is responsible for the phenomena of the sensual world.[5] The atoms themselves remain unchanged during the phenomena. What are the corpuscles of mechanical physics like? What does "the infinite divisibility of matter" mean in mechanical philosophy? Is it possible that according to Cartesian physics, the bodies themselves change during the phenomena? Here, special or extraordinary events (such as the creation of the world or the fraction of the particles of light) are not considered, but the typical behavior of the bodies. Or does "the infinite divisibility of matter" signify that atoms, i.e., finitely small bodies are not the only group that exist?

Here, the latter interpretation is presumed to be correct. Atoms as the only finitely small particles do not exist, but there are bodies of homogeneous material that only differ in size and shape. These bodies (*corpuscles* in the Cartesian terminology) exist continually over time, similarly to atoms. *In my interpretation the difference between corpuscules and atoms is that corpuscules can not be only finitely small, but also infinitely small particles* (so-called *point-like bodies*).[6] Mechanical philosophy explains all the phenomena with the motion of small bodies. Therefore, changes in these bodies during motion cannot be among the phenomena employed for explanation. We have to assume that these bodies are relatively constant both in terms of their shape and size. However, it does not mean that they cannot divide under certain circumstances or that they are uniform in size or shape. *In Cartesian physics, the bodies com-*

[2] See Garber for more detail, e.g. "Descartes was by no means alone in opposing the philosophy of the schools. As I noted earlier, there had been numerous attacks on the Aristotelian natural philosophy by the time Descartes learned his physics at school, various varieties of Platonism, Hermeticism, the Chemical Philosophy of Paracelsus, among other movements. But most important to understanding Descartes was the revival of ancient atomism. . . . the ancient atomists. . . attempted to explain the characteristic behavior of bodies, not in terms of substantial forms, but in terms of size, shape, and motion of the smaller bodies, atoms, that make up the grosser bodies of everyday experience,. . . " (Garber, [5, p. 287]).

[3] See, e.g., in 1644, *Principles of Philosophy* (Descartes, [3, II.20])

[4] ". . . whereas in *La Lumiere* Descartes was reluctant to reject the existence of a void, in the Principles the nonexistence of a void becomes one of the central principles of his philosophy of nature. The shift is important because it eliminates, I think, a potential gap in his theory. In *La Lumiere* Descartes restricted his attention to that determinate region between the earth and the stars of the principal heaven because he was uncertain whether a void existed *beyond* this region. A natural question arises here, however: *If* a void exists beyond this region, how would this affect Descartes' cosmogony (especially his theory of vortex motion)? Such a question reveals a potential gap in Descartes' account in *La Lumiere*. In the *Principles*, however, there is and can be no void *anywhere* in the universe. Hence, the question never arises and the gap disappears." (Lynes, [8, p. 70])

[5] See the positions of Clarke and Lynes: "The speculations about matter on which Descartes' theory of matter and, subsequently, his concept of science depend include the assumption that the size, shape and motion of small particles of matter would be adequate to explain all their physical effects, including the physical effects on our sensory faculties which stimulate sensations." (Clarke, [2, p. 262]) or ". . . Descartes develops a 'corpuscularian' theory of matter – i.e., matter consists of an indefinitely large number of small parts, . . . such that the behavior of collections of these small parts is a function of the behavior of the smaller parts of which they are composed." (Lynes, [8, p. 59])

[6] Garber identifies atomist influences in Cartesian theory, "Descartes' physics wound up retaining a number of crucial features of the physics he was taught in school, and differing from the world of the atomists; most notably, Descartes rejected the indivisible atoms and empty spaces . . . But Descartes' rejection of the forms and matter of the schools, and his adoption of the mechanist program for explaining everything in the physical world in terms of size, shape, and motion of the corpuscles that make up bodies, is hardly conceivable without the influence of atomist thought." (Garber, [5, pp. 287–288])

posing the world are of various sizes and shapes, but, similar to atoms, during collisions, they behave as constant and solid bodies made up of perfectly homogeneous material.[7]

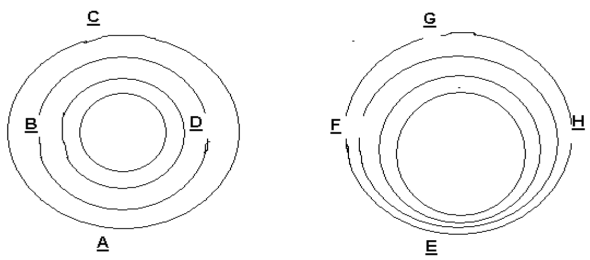

Fig. 1. Rings of circularly moving bodies in *Principles of Philosophy*, II. 33-34.

1.3 Divisibility

If, as it has been argued, Cartesian physics assumes that corpuscles are unchangeable, two questions need to be answered. 1. What does the "infinite divisibility of matter" exactly mean and 2. Why was it necessary for Descartes to declare the indefinite divisibility of matter?

It is easy to see that certain finitely small bodies (e.g., cubes) are also able to fill the space without vacuum. *Assuming the indefinite divisibility of matter was necessary for Descartes not only to explain the filling of space without vacuum, but also the motion in this space.* The ring of circularly moving bodies can only operate in certain cases if we assume the indefinite divisibility of matter. Descartes wrote the following in *Principles of Philosophy* II. 34:

"It must however, be admitted that in the case of this motion we come upon something the truth of which our mind perceives, while at the same time being unable to grasp exactly how it occurs. For what happens is an infinite, or indefinite, division of the various particles of matter; and the resulting subdivisions are so numerous that however small we make a particle in our thought, we always understand that it is in fact divided into other still smaller particles. For it is impossible for the matter, which now fills space G successively to fill all the spaces between G and E, which get gradually smaller by countless stages, unless some part of that matter adjust its shape to the innumerable different volumes of those spaces. And for this to come about, it is necessary that all its imaginable particles, which are in fact innumerable, should shift their relative positions to some tiny extent. This minute shifting of position is a true case of division." (Descartes, 1996, II.34)

In the previous section, it has been argued that corpuscles in Cartesian physics are bodies of unchangeable shape and size. How can we reconcile this statement with the one that the ring of circularly moving bodies can only operate if matter "gets gradually smaller" and changes its shape in accordance with the space available? Are the corpuscles constant or do they change their shape and size? One possible answer is that these bodies are unchangeable in certain cases and are indefinitely divisible in others.[8] In the narrowing arm of the ring, bodies divide into infinite parts, and then reunite in the widening arm. Therefore, on the one hand, we can state that the size of the bodies changes during the motion (so that motion would be possible) and, on the other hand, we can consider that the motion of constant bodies explains the various phenomena. However, the other possible answer seems to offer a better solution. We do not assume that the size and shape of the moving bodies change within the ring of circularly moving bodies. Rather, we presume that a part of the bodies is *ab ovo* infinitely small, and the presence of these point-like bodies makes motion possible within the ring of circularly moving bodies.[9] At the same time, we can state that neither point-like nor larger bodies change their shape or size, which means that, similar to atoms, they are constant during physical processes.[10]

In this paper, the difference between "bodies" and "parts of matter" or between "the divisibility of bodies" and the "divisibility of matter" in Cartesian physics have not been examined. *It has been merely assumed t hat the "indefinite divisibility of matter" does not indicate that corpuscles would change their shape and size during physical processes, but rather that upon the creation (or evolution) of the world, not only finitely small, but also point-like bodies, were formed out of matter.* If we accept this hypothesis, we may understand why Descartes rejected atomism, and may not be forced to abandon our theorem that corpuscles do not change during physical processes. Descartes conceives bodies differently from the atomists. He holds that point-like bodies exist, and that their presence in the ring of cir-

[7] Garber's description of the atoms also holds true with respect to Descartes' corpuscles. The difference is that the latter can not only be finitely, but also infinitely small. Still, they are as indivisible and unchangeable as atoms, "In denying the possibility of a vacuum, Descartes rejected one of the central doctrines of atomist tradition… Another central atomist doctrine fares little better on Descartes' conception of body. Important to the atomists was the view that the world of bodies is made up of indivisible and indestructible atoms. …Atoms are, thus, indivisible unchangeable bodies, the ultimate parts into which bodies can be divided and from which they can be constructed." (Garber, [5, p. 300])

[8] Garber holds that bodies are indefinitely divided under given circumstances. However, he fails to offer an explanation as to what they are under different circumstances or what happens to them after being divided, "Descartes has no arguments intended directly to show that all bodies are naturally divisible. But he does think that in certain circumstances, at least, bodies are actually divided ad infinitum, or, as he might put it, ad indefinitum. To understand the grounds for this claim we must consider a circumstance he discusses in Pr II 33." (Garber, [4, p. 125])

[9] See Garber's opinion, "… the matter going in such a path must actually be divided into indefinitely small parts, … " (Garber, [4, p. 126])

[10] We must not forget that bodies may divide at times, but we consider these cases unique and extraordinary.

cularly moving bodies makes motion possible.[11]

If "the indefinite divisibility of matter" entails the existence of point-like bodies rather than the change in the bodies during physical processes, we must show that this assumption is in fact necessary for motion to develop in a void. Both Descartes and Garber categorically stated that infinitely small bodies are required for motion in a void. However, neither Descartes (who, in my opinion, saw the problem of motion clearly) nor Garber (who recognized the significance of point-like bodies) offered a detailed explanation as to why motion was impossible in a space filled without vacuum with finite bodies, e.g., atoms. The question is not only how bodies are able to move in the narrowing arm of the ring of circularly moving bodies, but also how motion can get started at all. In the following section, it has been proved that it is indispensable for motion in a void that a *considerable proportion of* the bodies filling the space are *infinitely small.* This is the reason why it was important for Descartes to clearly differentiate himself from the atomists.

2 How is the random motion of small particles possible in a void?

Let us consider how motion is generally possible in a matter filling the space without vacuum. We must realize that motion, or even setting the bodies into motion, will be limited. *In the following section, the conditions under which the notion that "extensive bodies filling the whole space may only have a random motion governed by mechanical laws in a void" can be true have been examined.*

2.1 Motion can either be discrete or continuous

Discrete motion signifies that at successive but separate points in time, bodies fill the space without a void. As the place that the particle may take up in the consecutive moments is not determined, it might as well be possible that particles move into places far from the ones occupied by them in the preceding moment, provided a geometrical configuration gets created, in which they perfectly fit into. For example, we can consider it as a discrete motion, when in a space filled with cubes, the cubes occupy the neighboring places in a series of leaps.

Motion is continuous when a body can only occupy contiguous places and only in a continuous way. This means that it shall perambulate all the points in between. Descartes conceived motion in this latter sense. *Motion is continuous according to Descartes, and that only contiguous places can be occupied and discrete motion is ruled out. At the same time, this also asserts that if contiguous bodies are unable to move in a way that would allow for a given body to perfectly fill the resulting new space, motion may only start in a limited way.* However, the likelihood of this case, i.e., contiguous bodies perfectly filling the space occurring during motion, is minimal.

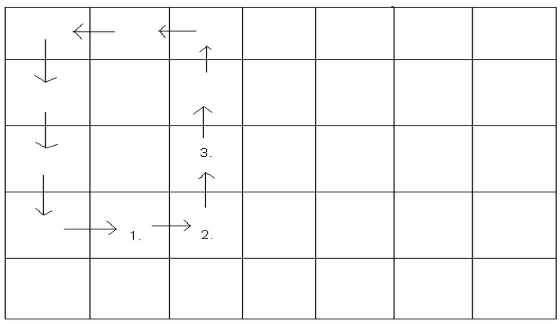

Fig. 2. Motion in discrete space. Cube 1 may not get in the place of Cube 2 or Cube 2 in that of Cube 3 continually, only by leaps

2.2 The deformation of bodies as a precondition of motion

Unlikely as it may sound, the idea of contiguous bodies rolling on one another is exactly how mechanical philosophy wants to explain the phenomena occurring in the world. In a space filled with bodies of various shapes, bodies moving in different directions and at different speeds collide with one another, transfer a part of their quantity of motion to each other, and change their direction of movement upon impact. In Descartes' physics (beyond, or rather, prior to the mechanical impact rules), a very important condition was introduced to the system to limit the freedom of motion. Motion is possible if no vacuum is generated in the interim, which means that there must be a fitting body next to each resultant gap, and this causes problems. Let us, for instance, examine the roll of two balls over one another. What guarantees that in their direct neighborhood, there is a properly positioned particle of the right shape with the ability of filling the resultant gap and is unrestricted in its motion? Clearly, there is no such guarantee. In all likelihoods, what we will find is a particle next to the balls that fits in the former gap and thus has a completely different shape.

In fact, a properly wedged system cannot move. Descartes' world is made up of particles of various shapes rather than balls of different sizes. They are unable to roll over one another once their surfaces meet. Furthermore, they will hold each other and block each other's motion at the same time. *Because of the geometrical constraints, this system is incapable of movement.*[12]

Bodies (or at least some of them) need to be able to change

[11] In Garber's view, the existence of point-like bodies is necessary for motion in a void, "The actual division of matter into indefinitely small parts, then, is required so that in moving, the incompressible and inexpandable material substance not produce a vacuum, a place void of body. This view, that matter must be indefinitely divisible and sometimes indefinitely divided in order to prevent a vacuum, goes back to Descartes' *World* and to the correspondence that precedes it." (Garber, [4, p. 126])

[12] Lynes prompts the question that he fails to answer, "How can the parts move incessantly unless there are empty spaces between them? … Descartes' response to this query is both interesting and cautious. He admits that he would have difficulty responding if he had not recognized by diverse experiences that the movements in the world are in some sense circular…" (Lynes, [8, p. 59])

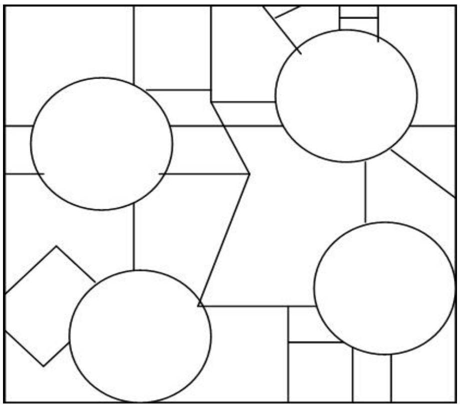

Fig. 3. A wedged system.

their shape to move. Lynes asserted at various points that particles of the first element are capable of doing so.[13] However, he made different statements at other times.[14] We can interpret Descartes' position correctly if we consider extension, i.e., size, as a body's unchanged property, defined in terms of length, breadth, and depth. Descartes more specifically stated, "…but each substance has one principal property which constitutes its nature or essence, and to which all its other properties referred. Thus, extension in length, breadth and depth constitutes the nature of corporeal substance; ..." (Descartes, [3, I.53]) Accordingly, "extension" measured in the three spatial dimensions is a body's constant property. *Hence, deformation as a possibility must be dismissed.*[15]

2.3 Continuous motion of rigid bodies in a void

Let us suppose that small bodies cannot be deformed. In this case, the rigid bodies either do not move and the whole system is at permanent rest, or continuous but non-vacuum motion is possible only if **a)** everything moves together, so that the position of the parts is constant relative to each other; **b)** everything moves in one vortex; **c)** everything moves in several embedded vortices; and **d)** motion arises from the shift of concentric spherical shells relative to each other. Further embedded concentric spheres may also be formed within the spherical shells in which the similarly embedded spherical shells may shift relative to each other.

We can forbear from the examination of Point **a)** because Descartes did not interpret motion as the motion of a whole, but as the shift of the parts relative to each other. Point **b)** is the basic case of Point **c),** which was rejected by Descartes when he discussed about the creation of the world. That is, within the great vortex, he considered the Sun and the fixed stars as the centers of smaller embedded vortices. Thus, we can presume that Points **c)** and **d)** are similar and only differ in structure, provided we consider that the vortices consist of concentric rings. It is in favor of Point **c)** that Descartes imagined the vortices in a plain, and that in this way, interlooped vortices are possible, which is not true if concentric spheres are assumed. However, Point **d)** allows for much more variation, as neither the direction nor the speed of rotation of various spherical shells is defined, and speed and direction may even be totally independent of each other. However, theories **a)–d**) limit the freedom of motion. It is no longer considered that mechanical rules alone govern the motion of particles. Radial movements are impossible. Bodies cannot leave the vortex, or can do so under specific circumstances only, and can neither change their places occupied within the vortex. The motion of the bodies relative to each other is in fact the motion of the surfaces of the respective vortices.

It follows that these models are not in accordance with Descartes' texts. Although they do make motion possible without vacuum, they fail to ensure that particles move randomly while colliding with each other accidentally. Instead, they predefine paths that the particles are unable to leave.

3 Why are point-like bodies necessary for motion in a void?

Having dismissed the possibility of discrete motion, the deformation of bodies, and the assumption that only vortex-type motion is possible, we will need to find another solution. In *Principles of Philosophy* II.33, Descartes explains his theory of the rings of circularly moving bodies. How can Descartes' physics

[13] "The matter which has broken off the surfaces of (E2) would have acquired a much more rapid motion than those of (E2) and would have become capable of dividing and changing their shape at every moment in order to adapt themselves to the places into which they must fit around these (E2). Descartes calls this matter of the first element (E1)." (Lynes [8, p. 63]) or "Matter of the first element (E1) fills all the interspaces that the parts of (E2), being spherical, leave around them. However, there are more parts of (E1) than are required to fill these places' (Lynes [8, p. 63]) or 'It differs from (E2) in its size, figure, and movement – the parts of (E1) are smaller than those of (E2); they adapt more easily than those of (E2) and consequently have no determinate figure (while (E2) are spherical;…" (Lynes, [8, p. 70])

[14] "It is important to remember that for Descartes (Law 1) does not pertain only to motion/rest but size and figure as well. For example, if x has a certain magnitude, it will never become smaller unless it is divided in some way." (Lynes, [8, p. 61]) or "… in *La Lumiere* it is not entirely clear why the smallest parts of (E1) are so easily adaptable as to change figure at every moment. But in the *Principles* these parts are now described as extremely slender in figure which, coupled with Descartes' rule about surface areas (i.e., the more surface area a body has, assuming the equality of size and speed, the more easily it is divisible by other bodies it meets and hence adaptable) helps clearly to explain this adaptability." (Lynes, [8, p. 71])

[15] Not everybody shares this view. According to Grosholz, individuation is realized not in geometric, but in kinematic terms: "In Part II, §23-§64, the discussion of motion and its laws in the *Principles* …, Descartes disqualifies shape as a principle of unity in physics. Instead, physical unity, whose seat is the activity of God, is defined in kinematic terms. Physics require specifically physical principles of individuation which geometry cannot provide. For the items of geometry, while unities are not individuals but equivalence, constructed by means which make no appeal to motion." (Grosholz, [6, p. 121]) or "Either these parts are individuated by geometric principles, by shape, an alternative he wants to deny; or they are kinematically individuated. But then he has presupposed the very individuation he sought to explain. Indeed, Descartes' definition of motion itself involves an appeal to the parts of matter as already available. Then it appears that, while motion requires available parts (certainly the monolith of inert *res extensa* cannot be moved), the availability of parts (*qua individuated matter*) requires motion. All that can save Descartes from this circularity is individuation of *res extensa* by geometric principles alone." (Grosholz, [6, p. 122])

be saved by the ring of circularly moving bodies, which is nothing but a local vortex both in terms of time and space? Why did Descartes deny the existence of finitely small bodies (atoms)? Why does he assert that matter is indefinitely divisible, which means that it has no such small units that cannot be divided further? We assumed that certain parts of the matter were infinitely divided upon the creation of the world, and that a significant part of the bodies filling the world are such particles divided into the extreme (point-like bodies). The gaps between larger bodies are not necessarily filled with finitely small bodies, but clusters of these point-like bodies. In this case, only the volume and not the shape of the clusters filling the gaps will be defined, and the clusters will be able to fill the gaps with changing geometrical properties. That is, it can be stated that although bodies themselves are not flexible and cannot be deformed, their clusters can be deformed. In principle, we can define the minimum percentage of indefinitely small particles necessary to achieve this. This interpretation is supported by Point II.34 of *Principles of Philosophy,* that analyzes the formation of rings of circularly moving bodies and talks about the preconditions for such formation, as well as Point II.35, "… that I am not here speaking of the whole of this matter, but merely of some part of it." (Descartes, [3, II.35])

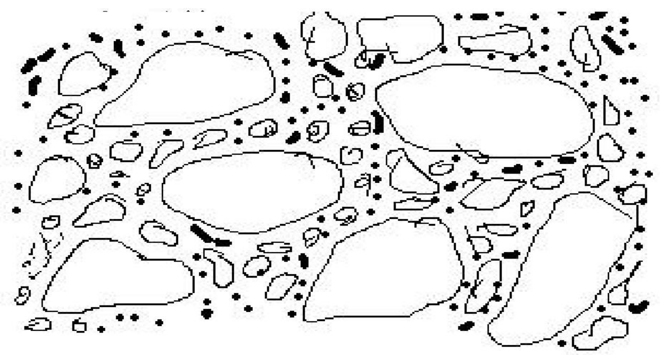

Fig. 4. Particles of various sizes tightly filling the space. Motion is made possible by the smaller or even indefinitely small particles in between. *Cf.* Descartes's example of a tub filled with wine and grapes in *Dioptrica*.

4 Conclusions

In this study, it has been shown that the corpuscles of Cartesian physics are rigid and generally unable to change their form and size. Furthermore, it is not possible for the corpuscles to change their size while in motion, especially if no impact affects them (they do not collide with each other, but move "evenly" in a ring of circularly moving bodies).

We should resolve the contradiction between the "infinite divisibility of matter" and the constancy of the corpuscles by assuming the existence of point-like bodies. The argument that the "infinite divisibility of matter" entails the change in the form and size of the bodies during physical processes is presumed to be wrong.

It has been proved that in a void, finitely small bodies would only be able to perform regular vortex motions. The random motion of Cartesian rigid bodies is possible if a given proportion of them are infinitely small, i.e., point-like. These point-like bodies make up the *clusters of matter with the ability of deformation* between the larger bodies. Although finitely small bodies are able to fill a given space at a given time without vacuum, this system is incapable of a varied motion with a high degree of freedom. It follows that rejecting vacuum and allowing the existence of atoms rule out each other. *If Descartes did commit to denying vacuum, he could not but commit to the indefinite divisibility of matter and to allowing the existence of infinitely small, point-like bodies, all of which inevitably led to the denial of atomism.*

Thus, it can be concluded that the existence of infinitely small bodies is necessary whenever the paths of motion change, and not only when the ring of circularly moving bodies is of an eccentric design, as illustrated in Figure 1. However, it is advisable to add a remark to Descartes' example. In Descartes' physics, it is not individual bodies but a mass of bodies that move in a given cross-section within the ring of circularly moving bodies (or during motion, in general). *It is wrong to think that only one body passes through a cross-section of a ring at any time and that this body will "actually" divide.* It is more appropriate for us to visualize the ring as a river in which a mass of water particles flows, constantly adapting to the changing watercourse (the external surface of the ring of circularly moving bodies) and the whirling deposits (larger bodies in the ring of circularly moving bodies). We can find explicit references to all these statements in *Principles of Philosophy* II.34–35.

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