

Émilie Du Châtelet, *Foundations of Physics*, 1740.

## Chapter 5.

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Footnotes are ours, unless otherwise indicated.

In line with the practice of Bour and Zinsser, Du Châtelet's marginal notes are placed in caps at the beginning/end of the relevant paragraph. Please see the French original for the position of each note in the margin alongside that paragraph.

## Chapter 5. On space

### 72.

The question of the nature of Space is one of the most famous, that has divided ancient and modern Philosophers alike; it is also one of the most essential because of its influence on the most important truths of Physics and Metaphysics.

#### HIGHLY OPPOSED DEFINITIONS OF SPACE

Some have said: *Space is nothing over and above things, it is a mental abstraction, an ideal Being, it is nothing other than the order of things as they coexist, and there is nothing to Space except bodies.* Others have, on the contrary, maintained that *Space is an absolute Being, real, and distinct from the bodies it contains, that it is an impalpable, penetrable extension, lacking solidity, the universal vessel that receives the Bodies that are placed in it; in a word, a sort of immaterial and infinitely extended fluid, in which Bodies swim.* The former group has put forward several metaphysical reasons in support of their opinion. The others have put forward the idea of space that the imagination itself is able to form, and they have defended this idea, that the imagination itself forms, with several objections against the contrary opinion, taken from Phenomena, and especially from the difficulty of nothing but Bodies moving in the absolute plenum.<sup>1</sup>

HALF OF THE PHILOSOPHERS BELIEVED, AND STILL BELIEVE, IN EMPTY SPACE, AND THE OTHER HALF BELIEVE IT TO BE FILLED WITH MATTER.

### 73.

In the past, the view that Space is distinct from matter was held by Epicurus, Democritus, and Leucippus, who regarded space as an incorporeal Being, that is impalpable, and incapable of action or passion. In our day, Gassendi has revived this opinion, and in his book *Concerning Human Understanding* the renowned Locke does not distinguish pure Space from the Bodies that fill it, except by penetrability: this Philosopher derives the true notion of Space from sight and touch, because, he says, we can neither see nor touch it, but we can see and touch Bodies.

THE PRINCIPLE OF SUFFICIENT REASON BANISHES THE VOID FROM THE UNIVERSE.

Mr. Keill, in his *Introduction to True Physics*, as well as all the Disciples of the Book *Concerning Human Understanding*, held this same opinion; he even put forth some Theorems, by which he claims to prove that all matter is strewn with tiny spaces or interstices that are absolutely void, and that there is in Bodies a great deal more void than there is solid matter. But the scattered void<sup>2</sup> is equally in conflict with the principle of sufficient reason as are atoms, and

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<sup>1</sup> See para 76 for elaboration.

<sup>2</sup> Early modern philosophers distinguished between the interstitial void, within bodies, and the intracosmic void, lying between bodies (e.g. in the space between planets).

therefore cannot be accepted; indeed if the little atoms or first particles of matter were swimming in the void, their size and shape would be without sufficient reason; for shape limits extension, and the actuality of any shape becomes comprehensible when one can explain how and why extension is limited. Now, one can readily see that the void does not contain this reason at all, because it contains nothing whereby we can understand why particles have a given shape as opposed to all other possible shapes, and why they are of a particular size. We must therefore seek the reason in their externally surrounding Bodies, for shape is a mode of extension: we are therefore obliged to admit surrounding matter which limits the parts of extension, and which would be the reason for their different shapes; and one must fill the void interstices in order to satisfy the principle of sufficient reason.

TRANSLATION OF LOCKE, PAGE 521, NOTE 2.

Several mathematicians have embraced the opinion of absolute void on the authority of Mr. Newton. This great man believed, in line with Mr. Locke, that one can explain the creation of matter through Space, imagining that God would have rendered several regions of Space impenetrable:<sup>3</sup> one sees in the *General Scholium*, which is at the end of Mister Newton's principles, that he believed that Space was the immensity of God, in the *Opticks* he calls it the God's *Sensorium*; that is to say, it is that through which God is present in all things.

MR. NEWTON'S SINGULAR OPINION ON SPACE.

74.

COMMERCIIUM EPISTOLICUM.

Mr. Clarke has taken a great deal of trouble to support the opinions of Mr. Newton, as well as his own views on absolute Space, against Mr. Leibniz, who maintained that Space was nothing but the order of coexisting things.

DISPUTE BETWEEN MR. LEIBNIZ AND DOCTOR CLARKE ON SPACE.

Certainly if one consults the principle of sufficient reason that I established in the first chapter, one cannot help but acknowledge that Mr. Leibniz was right to banish absolute Space from the Universe, and to regard the idea that several Philosophers believe they have, as an illusion of the imagination. For, not only would there not be, as we have just seen, any reason to limit extension; but, if Space is a real Being and subsistent without Bodies that could be placed in it, it makes no difference in which part of this homogeneous Space one places them, as long as they keep the same order among them: therefore there would not have been any sufficient reason why God would have placed the Universe in the location where it is now, rather than in any other, since he could have placed it 10,000 leagues further away, and put the East where the West is; or indeed he could have reversed it, so long as he kept things in the same place in relation to each other.

Mr. Clarke was well aware of the force of this argument, and he was unable to counter it with anything other than that the simple will of God was the sufficient reason for the place of the Universe in Space, and that there was nothing more to it. But one can easily see that this admission undermines his view, and lays bare the weakness of his case; for God would not be able to act without reasons within his own Understanding, and his will must always be determined with reason. Thus being obliged to resort to an arbitrary will of God, which is not based upon sufficient reason, is to be reduced to the absurd. Therefore, the reason for the place of the Universe in Space, and the reason for the limit of extension being neither in the things

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<sup>3</sup> See the second edition of Coste's translation of Locke's *Essay* for the footnote on Newton, and for discussion see Bennett and Remnant (1978), "How matter might at first be made", *Canadian Journal of Philosophy*, Supp Vol 4:1.

themselves, nor in the will of God, one has to conclude that the hypothesis of the void is false, and that there is no such thing in Nature.

Mr. Leibniz's reasoning against absolute Space is therefore irrefutable, and one is forced to abandon this Space, if one does not wish to renounce the principle of sufficient reason; that is to say, to renounce the foundation of all truth.

75.

There is another great absurdity to deal with concerning the opinion about absolute Space, which is that all of the attributes of God suit it; for this Space, if it were possible, would be truly infinite, immutable, uncreated, necessary, incorporeal, and omnipresent. It is starting from this supposition that Mr. Raphson<sup>4</sup> sought to demonstrate geometrically that Space is an attribute of God, and that it expresses his infinite and limitless essence; and this indeed follows very naturally from the supposition of absolute Space, once one has admitted it.

DIFFICULTIES ARISING FROM THE OPINION OF PURE SPACE.

76.

THREE PRINCIPAL OBJECTIONS AGAINST THE PLENUM TO WHICH IT IS EASY TO RESPOND.

There are three principal objections against the absolute plenum, and they can be easily addressed. The first relies on the apparent impossibility of movement in the plenum; the second, on the different weights of different Bodies; and the third, on the resistance of matter as a result of which Bodies moving in the plenum must quickly lose their motion.

We can say in response to the first Objection that motion is possible in the plenum because of circular motion, whereby the surrounding parts replace each moving Body by occupying the place it gives up. The second Objection is based on the supposition that all matter is heavy, but this is entirely false; for according to the principle of sufficient reason, heaviness is the effect of collision with surrounding matter. Now, this matter is not itself heavy; for if it was, it would have to have recourse to other matter with which it would collide, and so on to infinity, and therefore this objection, based as it is on the general heaviness of matter, cannot stand. Finally, the third Objection takes into account only dead and motionless matter, and so the arguments that are made about resistance are very solid. But they prove nothing if you consider matter that is animated by movement, as in fact it is; for very fine and subtle matter can move with such speed that it will not bring any perceptible resistance to the movement of Bodies placed in it; thus, there will be a physical void, which will be the Phenomenon resulting from this matter being so fine-grained and in such very rapid movement. But this void is all that is proven by those experiences on which are based the invincible objections against the plenum.

77.

HOW WE FORM THE IDEA OF SPACE AND ITS PROPERTIES.

It will not be without use to examine here how we came to form our ideas of extension, Space, and continuity; this examination will serve to help you discover the source of the mistakes that have been made about the nature of Space, and help prevent you from making them in the future.

We feel that, once we consider two things to be different, and when we distinguish one from the other, in our minds we place one external to the other; thus, everything that we consider

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<sup>4</sup> Joseph Raphson (1648 – 1715), author of “De Spatio Reali seu Ente Infinito” (1697) and “Demonstratio de Deo” (1710). URL = <http://www-history.mcs.st-and.ac.uk/history/Biographies/Raphson.html>

to be different from us we see as external to us; there are many examples of this. If we imagine a structure that we have never seen before, we represent it as external to ourselves, even though we know well that the idea we have of it exists within us, and that there is perhaps nothing of this structure existing external to our idea. But we still think of it as being external to ourselves because we know that it is different from us; in the same way, if we represent ideally two men, or even the same man twice, we place them externally to one another, because we cannot force our mind to imagine that they are *one*, and *two*, at the same time.

It follows from this that we cannot represent to ourselves several different things as being one, without this resulting in a notion that is attached to this diversity and union, and this notion we call *Extension*. Thus we give extension to a line, insofar as we pay attention to several distinct parts which we see as existing externally to one another, which are united together and which are for this reason a single whole.

It is indeed true that diversity and unity engender in us the idea of extension, that several Philosophers have wanted to classify the soul as something extended, because they noticed in it several different faculties that nevertheless constitute a single subject; and this is where they went wrong: regarding attributes and modes of a Being as separate Beings, existing external to one another is to abuse the notion of Extension; for these attributes and modes are inseparable from the Being that they modify.

Since we represent to ourselves in extension several things that exist externally to each other, and that are *one* through their union, all extension has parts that exist externally to one another and which are *one*, and once we represent to ourselves things that are both diverse and unified we have the idea of an extended Being.

#### 78.

Once we pay attention to this notion of extension, we see that the parts of extension, when considered abstractly and without taking into account either limits or shapes, do not have to have any internal differences; they must be similar, and differ only in number. For since, in order to form the idea of extension, we consider only the plurality of things and their union (from which their existence external to one another originates), and we exclude every other determination (all the parts being the same with respect to plurality and unity), we can substitute one in the place of another without destroying these two determinations, the plurality and the unity (which are the only determinations to which we pay attention), and so any two parts of extension can differ from each other only in being two not one. So all of extension must be conceived of as uniform, homogeneous, and having no internal determination that distinguishes one part from another, since if we place these parts however we wish, the result will always be the same Being, and that is how we arrive at the idea of absolute Space, which we consider to be homogeneous and indiscernible.

This notion of extension is still that of a geometrical body; for if we divide a line into as many parts and howsoever we wish, reassembling the parts will always result in the same line, no matter the transposition of the parts: it is the same for surfaces and for geometrical bodies.

#### 79.

When we have formed a Being in our imagination from the diversity of the existence of many things and of their union, extension, which is this imaginary Being, seems distinct from all that is real, from which we have separated it by abstraction. We imagine that this Being can subsist by itself, because in conceiving it we do not at all need the other determinations that the Beings might contain, since we considered these Beings only insofar as they are diverse and united. Our mind perceives these determinations apart, which constitute this ideal Being that we call

*extension*, and thus conceives of the other qualities that we have mentally separated and that are no longer a part of our idea of this Being. Therefore, it seems as though we import all of these things into this ideal Being; we house them there and extension receives and contains them, as a vessel receives liquid that is poured into it. Thus, as long as we consider the possibility that many different things may exist together in this abstract being we call *extension*, we form the idea of Space, which is nothing other than the idea of extension joined with the possibility of restoring to the coexistent and unified Beings, from which the idea was formed, the determinations that we had already stripped from them by abstraction. Thus, we are right to define Space, *the order of Coexisting things*, that is to say, the resemblance in the manner in which Beings coexist. For the idea of Space arises from our attending solely to their manner of existing externally to one another, and representing to ourselves that this coexistence of several Beings produces a certain order or resemblance in their manner of existing; and so once one of these Beings is taken to be the first, another becomes the second, another the third, and so on.  
SPACE IS THE ORDER OF CO-EXISTING THINGS.

**80.**

We see well that this ideal Being, extension, which we form from the plurality and the unity of all these Beings, must appear to us as a substance. For, insofar as we imagine several things existing together, and stripped of all internal determinations, this Being appears to be enduring.<sup>5</sup> And insofar as it is possible by an act of our understanding, to restore to these Beings the determinations that we have stripped from them by abstraction, it seems to the imagination that we are importing something that had not been there before; and so this Being appears to be modifiable. Thus, we are led to represent Space as a substance independent of the Beings that are placed in it.

**81.**

THAT WHICH WE CALL CONTINUOUS.

We call a Being *continuous* when its parts are arranged one after another, such that it is impossible to place others in a different order between two of them, and in general we conceive of continuity whenever we cannot place anything between two parts. Thus, we say that the shine of a mirror is continuous, because we cannot see any unpolished parts between the parts of the glass that interrupt its continuity, and we call the sound of a trumpet continuous when it does not cease, and when we cannot put other sounds between any two. But when two parts of extension simply touch and are not joined to each other, in such a way that there is no internal reason why we could not separate them or put something else between them, such as cohesion or pressure from surrounding Bodies, so we call them *contiguous*. Thus, in the case of contiguity, parts are separated in actuality, in contrast to the continuum, where the separation is no more than a possibility. Two hemispheres of lead, for example, are two actual parts of the sphere of which they are two halves, that is actually separated and divided into two parts, which will become contiguous if we place them one next to the other so that there is nothing in between them. But if we were to reunite them by fusion into a single whole, then this whole would become a continuity, and its parts would then simply be possible, insofar as one conceives that it is possible to separate this sphere into two hemispheres, as they were before the fusion.

From this we understand that Space must appear to be continuous; for we introduce Space whenever we represent to ourselves the possibility of several Bodies A, B, C, coexisting.

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<sup>5</sup> What we have translated as “enduring” here could be taken as “persisting.” Contextually, the topic here is extension’s apparent persistence through change.

Now, if the Bodies are not contiguous, we can place one or several between two of them, and thereby we introduce Space between the two. Thus, we must consider Space to be continuous, whether the contiguous coexistence of bodies A, B, C, is actual, or whether it is simply possible.

The principle of sufficient reason shows us, as I explained above, that this contiguity is actual, and that there cannot be void Space, so that the Beings that exist, coexist, in such a way that it is impossible to put anything new into the Universe.

**82.**

Likewise, Space must appear to us to be void and penetrable. It appears void to us so long as we disregard all of the internal determinations of coexisting things; for then it seems to us that there is nothing left in this Space. And it appears penetrable to us because, being able to apply our attention to the manner of existing, and to the internal determinations of existing Beings, we then see, besides the Space that is their manner of existing externally to one another, several things that we did not notice before when we only considered this Space by itself. As a consequence, it must seem to us as though these things had entered into it, and that they had been placed there by an external Agent.

**83.**

Space must also appear immutable to us because we feel that we can restore to different Coexisting things the determinations that we had previously stripped from them. And we also feel that we can never conceive that we would be unable to restore these determinations to them. Therefore, we cannot remove Space, since there must always remain the same thing that we would have removed, that is to say, the Extension that is capable of receiving these determinations. Thus, once we have stripped these coexisting Beings of all of their determinations, we can no longer abstract, nor form for ourselves, an ideal Being, which contains less than the one that we had already created in preserving only the coexistence of Beings. For, to consider nothing but the manner of existing is the least abstraction<sup>6</sup> that we can do, and we must either keep it or represent *nothing at all*. Space must therefore seem immutable; from this it follows that it must seem eternal, since we can never remove it.

**84.**

It must also appear infinite, for we introduce as much Space as we conceive the possible existence thereof. Now, since Coexistent things stripped of all determinations, such as we conceive of them in order to form the idea of Extension and of Space, do not contain anything that would prevent us from continuing to place coexisting things external to one another, so we in effect conceive of them to infinity, and for this reason Space must appear an Extension that is infinite and limitless.

**85.**

Here, then, is the origin of all the properties that we attribute to Space, when we say that it is one homogeneous, uniform, continuous Extension, that it is self-subsistent, penetrable, immutable, eternal, infinite, etc., in short, the universal vessel that contains all things. But with a little attention we see that all of these alleged properties, as well as the Being in which we suppose them to exist, have no reality but in the abstractions of our mind, and that nothing like this idea

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<sup>6</sup> By “least abstraction” her likely meaning is that we abstract as far as possible from ideas of actual things in the order of coexistence.

does or can exist.

**86.**

#### USEFULNESS OF ABSTRACTIONS.

Our mind thus has the power of forming, by abstraction, imaginary Beings that contain only the determinations we want to examine, and of excluding from these Beings all other determinations by means of which they can be conceived in another manner. This way of meditation is very useful, for the imagination rescues the Understanding and helps it contemplate its idea, provided only that we take care that the imagination does not mislead us. For imaginary notions, which are infinitely helpful in the search for truths that depend on determinations (which constitute these Beings that the imagination has formed), become very dangerous when we take them for realities. Thus, when we want to measure a distance, we can represent it to ourselves as a Line with neither width nor thickness, and without any internal determination. Similarly, we can consider a width, an extension, without thickness when we do not want to consider the rest. Provided that we do not imagine that there exists anything resembling these abstractions of our mind, these fictions help in finding new truths and new relations, for our mind rarely has enough force to contemplate that which is Abstract in the Concrete<sup>7</sup> without being distracted by the multiplicity of things that it must represent to itself. Also for all of the Sciences, and especially Mathematics, are they not full of these sorts of fictions which are one of the greatest secrets of the art of invention, and one of the greatest resources for the solution of the most difficult Problems that the Understanding alone often cannot attain? Thus, we must resign ourselves to using these imaginary notions whenever we can substitute them in place of real notions without prejudicing truth, just as we use Ptolemy's system to resolve many Problems of Astronomy where the solution becomes much more difficult when using Copernicus's system, because we can in these instances substitute one hypothesis for the other without damaging the truth.

**87.**

While we could consider Extension without paying attention to the determinations of the Beings that constitute it, and in this way acquire our idea of Space, however, since the Abstract cannot subsist without a Concrete thing, that is to say without a real and determined Being from which we are abstracting, it is certain that there is Space only insofar as there are real and coexistent things; and without these things there would be no Space. However, Space is not these things themselves; it is a Being formed by abstraction that does not subsist at all over and above things, but yet is not the same thing as the subjects from which we abstracted it, because these subjects contain an infinity of things that we ignored when forming the idea of Space. Thus, Space is to real Beings as Numbers are to numbered things, which become alike and each form a unit with respect to their Number, because we abstract the internal determinations of these things, and consider them only insofar as they make a multitude, that is to say, several units. For without a multitude of things that we count, there would be no real and existing Numbers, but only possible Numbers. Thus, just as there are no real units more than there are actually existing things, neither are there any actual parts of Space except for those designated by actually existing extended things. And we can admit parts into actual Space only insofar as there exist real Beings that coexist together. Therefore, those who wanted to apply to actual Space the demonstrations that

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<sup>7</sup> Du Châtelet: We call *Concrete* the subject of our act of abstracting, and *Abstractions* what we separate from this subject by means of abstraction.

they had deduced concerning imaginary Space could not help but lose themselves in labyrinths of errors from which they could find no way out.

SPACE IS TO BEINGS, AS THE NUMBER IS TO NUMBERED THINGS.

**88.**

DEFINITION OF LOCATION.

We call the *location* or the *place* of a Being its determined manner of coexisting with other Beings. Thus, when we pay attention to the manner in which a table exists in a room with the bed, the chairs, the door, etc., we say that this table has a place; and we say that another Being occupies the same place as this table when it obtains the same manner of coexisting that the table had with all the Beings.

This table changes place when it obtains another situation with respect to the same things that we regard as not having changed place at all. Thus, in order to make certain that a Being has changed its place, and in order for this change to be real, the reason for its change, that is to say the force that produced it, must be in the Being at the moment at which it moves, and not in the coexisting Beings. This is because if we ignore where the true reason of change lies, we also ignore the reason why these Beings changed place. It is for this reason that, properly speaking, we do not have any demonstration that decides whether it is the Sun that turns around the Earth, or the Earth around the Sun; because the appearances are the same in the two suppositions.

**89.**

OF ABSOLUTE LOCATION AND OF RELATIVE LOCATION.

We ordinarily distinguish the location of a body into *absolute location* and *relative location*; the *absolute location* is the one that suits a Being insofar as we consider its manner of existing with the entire universe considered as immobile; and its *relative location* is its manner of coexisting with some particular Beings. Thus, we can conceive of change of absolute location without change of relative location; this happens when a certain quantity of Beings change their absolute location without changing their situation with respect to one another, such as a man who sails on a boat, for example. For if neither this man, nor anything on the boat, moves while the boat travels away from the shore, the relative location of this man and of everything that is on this boat does not change at all; but their absolute location changes at each moment, because all the parts of this boat equally change their manner of existing with respect to the shore which we regard as immobile. However, if this man walks on the boat, he changes his relative location and his absolute location at the same time.

Since location is nothing but a Being's manner of existing with many others, we see well that the location is not the placed thing itself; but it differs from the placed thing as an abstract thing from its concrete counterpart.<sup>8</sup> This is because when we consider the location of a Being, we abstract all its internal determinations and those of its coexistents, and we then consider only their present manner of coexisting and the possibility of their coexisting in several other manners. In the same way, we abstract the shape and the size of Bodies, and we consider their location as a point. For, since we determine the manner of existing of a Being by its distance from other coexisting things, and since these distances are measured by straight lines, the extremities of lines being points, the location should be considered as a point.

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<sup>8</sup> The literal French here is "it differs from the placed thing as an abstract thing from its concrete." The language of counterparts is intended to clarify this difficult phrase.

**90.**

**HOW WE DETERMINE THE LOCATION OF A BEING.**

We determine a location by the distances of a Being from two or more coexisting Beings, these distances not suiting any other Being at that moment. Thus, for example, we determine a location on the surface of the Earth by the intersection of the lines of longitude and latitude, because there is only one point for which this distance, from location that we took to be fixed in order to draw these lines, could be associated. It is by the same manner that in Astronomy we determine the location of Stars by the intersection of two circles.

**91.**

We perceive that a Being has changed location when its distance from other Beings, which are immobile (at least for us), is changed. Thus, we made the catalogs of fixed stars in order to know whether a Star changes location, because we regard the others as fixed, and indeed they effectively are relative to us.

**92.**

**WHAT WE CALL PLACE.**

We call *place* the assembly of several locations, that is to say all the locations of the parts of a Body taken together. Thus, we say, the place of a book in a library from which it is pulled out, because we see that in this place all the parts of this book could exist there together. And we say: *the place is not big enough* for this book when we see that only some parts of this book could exist there together.

**93.**

**WHAT SITUATION IS.**

Finally, we call *situation* the order that several coexistent non-contiguous things maintain through their coexistence, such that taking one of them as the first, we give a situation to others that are far away in relation to that one. Thus, taking a house in a city as the first, all the others acquire a situation with respect to this house, because they are separated from each other, and because we can determine their situation by their distance from that which we took as the first. Therefore, two things have the same situation with respect to a third when they are at the same distance; and it is for this reason that we say that all the points on a circumference have the same situation with respect to the center, insofar as we can put the same extension between them.