

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

Translated by Katherine Brading *et al.*¹ at the University of Notre Dame and Duke University. Footnotes are ours except where otherwise indicated.

Du Châtelet's marginal notes are placed in **{bold}** in the closest appropriate place in the text. Please see the French original for the position of each note in the margin alongside the paragraph. Figures are available in the original text, and online via the BNF.

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 of Metaphysics.

{Highly opposed definitions of Space.} Some have said: *Space is nothing over and above things,*² *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 intangible, 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.* **{Half of the Philosophers believed, and still believe, in empty Space, and the other half believe it to be filled with matter.}** 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 is able to form, and they have supported this idea using many objections against the contrary opinion; these objections are taken from the Phenomena, and above all from the difficulty there is with Bodies moving in the absolute plenum.³

73. In the past, the view that Space is distinct from matter was held by Epicurus, Democritus, and Leucippus, who regarded Space as a Being that is incorporeal, intangible, and incapable of action or passion. In our day, Gassendi has revived this opinion, and in his *Essay 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 see and touch Bodies.

Mr. Keill, in his *Introduction to True Physics*, as well as all the Disciples of the *Essay*

¹ Monica Solomon, Anne Seul, Penelope Brading.

² The French reads “l’Espace n’est rien hors des choses”, which we might translate more literally as “Space is nothing outside of things”.

³ See para 76 for elaboration.

Concerning Human Understanding, held this same opinion. He even provided some Theorems by which he claims to prove that all matter is permeated 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. **{The principle of sufficient reason banishes the void from the Universe.}** But this interstitial void⁴ is equally in conflict with the principle of sufficient reason as are atoms, and 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 only 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 rather than all other possible shapes, and why they are of a particular size. We must therefore seek this reason in the external Bodies that surround them, for shape is a mode of extension: we are therefore obliged to admit a surrounding matter that limits the parts of extension and would be the reason for their different shapes; thus one must fill the void interstices in order to satisfy the principle of sufficient reason.

Several mathematicians have embraced the opinion of the absolute void on the authority of Mr. Newton. This great man believed, in line with Mr. Locke **{*Translation of Locke, page 521, note 2*}**, that one can explain the creation of matter through Space, envisaging that God would have rendered several regions of Space impenetrable.⁵ **{Mr. Newton's singular opinion on Space.}** One sees in the *General Scholium*, which is at the end of Mr. Newton's *Principia*, that he believed that Space was God's immensity; in his *Opticks* he calls it God's *Sensorium*; that is to say, the means by which God is present in all things.

74. Mr. Clarke **{*Commercium Epistolicum*}** has taken great pains 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

⁴ Early modern philosophers distinguished between the interstitial void, within bodies, and the intracosmic void, lying between bodies (e.g. in the space between planets). The French reads "le vuide disseminé".

⁵ 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.

real Being and subsistent without the 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 themselves: therefore there would not have been any sufficient reason why God would have placed the Universe in the place 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 situation among themselves.

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 by 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, since the reason for the place of the Universe in Space and the reason for the limit of extension are neither in the things 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. {Difficulties arising from the opinion of pure Space.} 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. Raphson⁶ 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.

76. {Three principal objections against the plenum, to which it is easy to respond.} Three principal objections are made against the absolute plenum, and they can be easily addressed. The first relies on the apparent impossibility of motion 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

⁶ Joseph Raphson (1648 – 1715) , author of “De Spatio Reali seu Ente Infinito” (1697) and “Demonstratio de Deo” (1710) <https://mathshistory.st-andrews.ac.uk/Biographies/Raphson/>

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 were, 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 motion, 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 motion 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 motion. But this void is all that is proven by those experiences on which the invincible objections against the plenum are based.

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 reveal to you the source of the mistakes that have been made about the nature of Space, and prevent you from making them in the future.

We feel that, once we consider two things as different, and when we distinguish them the one from the other, in our minds we place one external to⁷ the other; thus, everything that we consider to be different from us we see as external to us; there are many examples of this. If in our imagination we represent to ourselves 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 represent it as being external to ourselves because we know that it is different from us; likewise, if we represent two men ideally, or even the same man twice, we place them external 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 to this union of things, and this notion we call *Extension*. Thus we give extension to a line, insofar as we pay attention to several diverse parts which we see as existing external to one another, which are united together and which are for this reason a single whole.

It is indeed true that diversity and union engender in us the idea of extension, and that several Philosophers have wanted to treat our soul as something extended because they noticed in it several different faculties that nevertheless constitute a single subject. In this they were mistaken: to regard attributes and modes of a Being as separate Beings, existing external to one another, is

⁷ We translate “hors de” as “external to”. It might also be translated as “outside of”.

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 external to one another and are *one* through their union, all extension has parts that exist external to one another and are *one*; and once we represent to ourselves parts both diverse and unified we have the idea of an extended Being.

78. Once we pay attention to this notion of extension, we perceive that the parts of extension, when considered abstractly and without taking into account either their limits or their shapes, must not 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 are paying attention), and so any two parts of extension can differ from each other only in being two and not one. So all of extension must be conceived of as being uniform, homogeneous, and having no internal determination that distinguishes one part from another, since if we place these parts howsoever 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 thus formed a Being in our imagination from the diversity of the existence of several things and of their union, extension, which is this imaginary Being, seems to us distinct from all that is real, from which we have separated it by abstraction. We envisage that this extension can subsist by itself, because in conceiving it we have no need of the other determinations that the Beings can contain, since we consider these Beings only insofar as they are diverse and united. Because our mind perceives these determinations separately (those which constitute this ideal Being that we call *extension*), and then conceives the other qualities (that we have mentally separated from it, and that are no longer part of the idea we have of this Being), it seems to us that we import all these things into this ideal Being, and that we house them there, and that extension receives and contains them as a vessel receives liquid that is poured into it. Thus, as long as we consider the possibility that several different things can exist together in this abstract Being we call *extension*, we form the notion of Space, which is nothing other than the notion of extension joined to the possibility of restoring to the coexistent and unified Beings (from which the notion was formed) the determinations that we had previously stripped from

them by abstraction. **{Space is the order of coexisting things.}** 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 originates from our attending solely to their manner of existing external to one another, and representing to ourselves that this coexistence of several Beings produces a certain order or resemblance in their manner of existing; so that once one of these Beings is taken to be the first, another becomes the second, another the third, and so on.

80. We see well that this ideal Being, extension, that we form from the plurality and the union of all these Beings, must appear to us to be a substance. For, insofar as we envisage several things existing together, and stripped of all internal determinations, this Being appears to us to be enduring. 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 was not there before. And so this Being appears to us 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 next to one another such that it is impossible to put other parts between two in another order, and in general we conceive of continuity wherever 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, then we call them *contiguous*. Thus, in contiguity the separation of the parts is actual, whereas in the continuum it is only possible. Two hemispheres of lead, for example, are two actual parts of a sphere that is actually separated and divided into two parts, of which they make the two halves. They 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, this whole would become a continuity, and its parts would then be simply possible (insofar as one conceives that it is possible to separate this sphere into two hemispheres, as 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. 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 any void Space, so that existing Beings coexist in such a way that it is not possible to put anything new into the Universe.

82. Likewise, Space must appear to us to be void and penetrable. It appears void to us insofar as we abstract 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 at the same time to the manner of existing and to the internal determinations of existing Beings, we then perceive, besides the Space that is their manner of existing external to one another, some things that we did not notice before when we considered this Space alone; and as a consequence it must seem to us as though these things had entered into it, and had been placed there by an external Agent.

83. Space must also appear immutable to us. For we feel that we can restore to different Coexisting things the determinations that we had previously stripped from them, and we even feel that we can never conceive that we would be unable to restore these determinations to them. Therefore, we cannot remove Space, since the very thing that we would have removed must always remain, 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 that contains less than the one we had already created in preserving only the coexistence of Beings. For to consider the manner of existing, and nothing but that, is the least abstraction 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 to us infinite, for we admit as much Space as we conceive could possibly exist. Now, since Coexisting 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 these coexisting things external to one another, so we in effect conceive of them to infinity, and hence Space must appear an Extension that is infinite and limitless.

85. Here, then, is the origin of all the properties we give 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 does or can exist.

86. {Usefulness of abstractions.} Our mind therefore 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 thinking is very useful, for the imagination rescues the Understanding and helps it contemplate its idea, so long as 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 we do not imagine that anything exists resembling these abstractions of our mind, these fictions help us to find new truths and new relations. For our mind rarely has enough strength to contemplate that which is Abstract⁸ in the Concrete⁹ without being distracted by the multiplicity of things that it must represent to itself. Also, all of the Sciences, and especially Mathematics, are they not full of these sorts of fictions, that 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 make use of 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 several Problems of Astronomy where the solution would become much more difficult using Copernicus's system, because we can in these instances substitute one hypothesis for the other without damaging the truth.

87. We could consider Extension without paying attention to the determinations of the Beings that constitute it, and in this way would acquire our idea of Space. However, since the Abstract cannot subsist without anything Concrete, 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 the things themselves; it is a Being formed by abstraction from them that does not subsist external to things, but yet is not the same thing as the subjects from which we abstracted it, for these subjects contain an infinity of things that we ignored in forming the idea of Space. **{Space is to Beings, as the number is to numbered things.}** 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

⁸ Du Châtelet: We call *Concrete* the subject from which we make the abstraction, and *Abstract* that which we separate from this subject by this abstraction.

⁹ The French reads: "les Abstraits dans les Concrets".

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

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. For if we do not know where the true reason for the change lies, we also do not know 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 on the boat does not change; 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 walked around on the boat, he would change his relative location and his absolute location at the same time.

Since location is nothing but a Being's manner of existing with several others, we see well that the location is not the placed thing itself, but differs from it as an abstract thing from its

concrete counterpart.¹⁰ For 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.

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 that can fit with this distance from the locations that we took to be fixed in order to draw these lines. In the same way, in Astronomy we determine the locations of the 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 assemblage 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 town 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 from it; 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.

¹⁰ The French reads “comme un abstrait de son concret.”