

The Treatise on Light

Chapter 6: Description of a New World, and the Qualities of the Matter of Which It Is Composed

For a while, then, allow your thought to wander beyond this world to view another, wholly new, world, which I call forth in imaginary spaces before it. The Philosophers tell us that these spaces are infinite, and they should certainly be believed, since it is they themselves who invented them. But in order to keep this infinity from impeding and hampering us, let us not try to go all the way, but rather enter it only far enough to lose sight of all the creatures that God made five or six thousand years ago, and after stopping there in some definite place, let us suppose that God creates anew so much matter all around us that, in whatever direction our imagination may extend, it no longer perceives any place that is empty.

Even though the sea is not infinite, those who are on a vessel in the middle of it can extend their view seemingly to infinity, and nevertheless there is still water beyond what they see. Thus even though our imagination seems to be able to stretch to infinity, and we do not assume this new matter to be infinite, we can assume nevertheless that it fills spaces much greater than those we have imagined. And in order that there be nothing in this assumption that you find objectionable, let us not allow our imagination to extend as far as it could, but purposely confine it to a determinate space

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which is no greater, say, than the Earth and the principal stars in the firmament, and let us suppose that the matter which God has created extends indefinitely far beyond in all directions. For it is much more reasonable to – and we are much better able to – prescribe limits to the action of our mind than to the works of God.

Now since we are taking the liberty of imagining this matter as we fancy, let us attribute to it, if we may, a nature in which there is absolutely nothing that everyone cannot know as perfectly as possible. To this end, let us explicitly assume that it does not have the form of earth, fire, or air, or any other more specific form, like that of wood, stone, or metal; nor does it have the qualities of being hot or cold, dry or moist, light or heavy, or of having any taste, odour, sound, colour, light, or of any other quality in nature of which there might be said to be something which is not known clearly by everyone.

On the other hand, let us not think that this matter is the “prime matter” of the Philosophers, which they have stripped so thoroughly of all its forms and qualities that nothing remains in it which can be clearly understood. Let us rather conceive of it as a real, perfectly solid body, which uniformly fills the entire length, breadth, and depth of this great space in the midst of which we have brought our mind to rest. Thus, each of its parts is so proportional to its size that it could not fill a larger one nor squeeze itself into a smaller one; nor, while it remains there, could it allow another body to find a place there.

Let us add further that this matter may be divided into as many parts and shapes as we can imagine, and that each of its parts can take on as many motions as we can conceive. Let us also

suppose that God does divide it into many such parts, some larger some smaller, some of one shape some of another, as it pleases us to imagine them. It is not that He separates these parts from one another so that there is some void in between them; rather, let us think of the differences that He creates within this matter as consisting wholly in the diversity of the motions He gives to its parts. From the first instant of their creation, He causes some to start moving in one direction and others in another, some faster and others slower (or even, if you wish, not at all); and He causes them to continue moving thereafter in accordance with the ordinary laws of nature. For God has established these laws in such a marvellous way that even if we suppose that He creates nothing more than what I have said, and even if He does not impose any order or proportion on it but makes it of the most confused and muddled chaos that any of the poets could describe, the laws of nature are sufficient to cause the parts of this chaos to disentangle themselves and arrange themselves in such a good order that they will have the form of a most perfect world, a world in which one will be able to see not only light, but all the other things as well, both general and particular, that appear in the actual world.

But before I explain this at greater length, pause again for a minute to consider this chaos, and note that it contains nothing which you do not know so perfectly that you could not even pretend to be ignorant of it. For the qualities that I have placed in it are only such as you could imagine. And as far as the matter from which I have composed it is concerned, there is nothing simpler or more easily grasped in inanimate creatures. The idea of that matter is such a part of all the ideas that our imagination can form that you must necessarily conceive of it, or you can never imagine anything at all.

Nevertheless, the Philosophers are so subtle that they can find problems in things that seem extremely clear to other men, and the memory of their “prime matter”, which they acknowledge to be rather hard to conceive, may divert them from knowledge of the matter of which I speak. Thus I should say to them at this point that, unless I am mistaken, the whole difficulty they face with their matter derives only from their wanting to distinguish it from its own proper quantity and from its outward extension, that is, from the property it has of occupying space. In this, however, I am willing for them to think they are right, for I have no

intention of pausing to contradict them. And they should not find it strange that the quantity of the matter that I have described does not differ from its substance any more than number differs from the things numbered. Nor should they find it strange if I conceive of its extension, or the property it has of occupying space, not as an accident, but as its true form and essence; for they cannot deny that it is quite easy to conceive of it in this way. And my purpose, unlike theirs, is not to explain the things that are in fact in the actual world, but only to make up as I please a world in which there is nothing that the dullest minds cannot conceive, and which nevertheless could not be created exactly the way I have imagined it.

Were I to put in this new world the least thing that is obscure, this obscurity might well conceal some hidden contradiction I had not perceived, and thus without thinking I might suppose something impossible. Instead, since everything I propose here can be imagined distinctly, it is certain that even if there were nothing of this sort in the old world, God can nevertheless create it in a new one; for it is certain that He can create everything we imagine.

Chapter 7: The Laws of Nature of This New World

But I do not want to delay any longer telling you the means by which Nature alone is able to untangle the confusion of the chaos which I have been speaking about, and what the Laws of Nature that God has imposed on it are.

Take it then, first, that by “Nature” here I do not mean some deity or other sort of imaginary power. Rather, I use the word to signify matter itself, in so far as I am considering it taken together with the totality of qualities I have attributed to it, and on the condition that God continues to preserve it in the same way that He created it. For it necessarily follows from the mere fact that He continues to preserve it thus that there may be many changes in its parts that cannot, it seems to me, properly be attributed to the action of God, because this action never changes, and which I therefore attribute to Nature. The rules by which these changes take place I call the Laws of Nature.

In order to understand this better, remember that among the various qualities of matter we have supposed that its parts have had various different motions since the moment they were created, and

furthermore that they all touch one another on all sides, without there being any void in between any two of them. From this it follows necessarily that from the time they begin to move, they also begin to change and diversify their motions by colliding with one another. Thus, while God subsequently preserves them in the same way He created them, He does not preserve them in the same state. That is to say, if God always acts in the same way and consequently always produces substantially the same effect, many differences in this effect occur, as if by accident. And it is easy to accept that God, who is, as everyone must know, immutable, always acts in the same way. Without my going any further into these metaphysical considerations, however, I will set out here two or three of the principal rules by which we must believe God to cause the nature of this new world to act, and these will be enough, I believe, to acquaint you with all the others.

The first is that each particular part of matter always continues in the same state unless collision with others forces it to change its state. That is to say, if the part has some size, it will never become smaller unless others divide it; if it is round or square, it will never change that shape unless others force it to; if it is brought to rest in some place it will never depart from that place unless others drive it out; and if it has once begun to move, it will always continue with an equal force until others stop or retard it.

There is no one who does not believe that this same rule is observed in the old world as regards size, shape, rest, and a thousand other things. But the Philosophers have exempted motion from it, which is the one thing that I most explicitly wish to include. Do not think that I intend to contradict them, though: the motion that they speak of is so very different from that which I conceive that it can easily happen that what is true of the one is not true of the other.

They themselves admit that the nature of their motion is very little understood. And trying to make it more intelligible, they have still not been able to explain it more clearly than in these terms: *Motus est actus entis in potentia, prout in potentia est*. These terms are so obscure to me that I am compelled to leave them in Latin because I cannot interpret them. (And in fact the words “motion is the act of a being which is in potency, in so far as it is in potency” are no clearer for being in the vernacular.) By contrast, the nature of the motion that I mean to speak of here is so easily known that

even geometers, who among all men are the most concerned to conceive the things they study very distinctly, have judged it simpler and more intelligible than the nature of surfaces and lines, as is shown by the fact that they explain “line” as the motion of a point and “surface” as the motion of a line.

The Philosophers also posit many motions which they believe can occur without any body’s changing place, such as those they call *motus ad formam*, *motus ad calorem*, *motus ad quantitatem* (motion with respect to form, motion with respect to heat, motion with respect to quantity) and countless others. For my own part, I know of no motion other than that which is easier to conceive of than the lines of geometers, by which bodies pass from one place to another and successively occupy all the spaces in between.

In addition, the Philosophers attribute to the least of these motions a being much more solid and real than they do to rest, which they say is merely a privation of motion. For my part, I conceive of rest as a quality also, which should be attributed to matter while it remains in one place, just as motion is a quality attributed to matter while it is changing place.

Finally, the motion of which they speak has a very strange nature in that all other things have as a goal their perfection, and strive only to preserve themselves, whereas it has no other end or goal than rest, and contrary to all laws of nature it strives of itself to destroy itself. By contrast, the motion I suppose follows the same laws of nature as do generally all the dispositions and qualities found in matter. This includes those that the Schoolmen call *modos et entia rationis cum fundamento in re* (modes and beings of thought based in the thing) as well as those they call *qualitates reales* (their real qualities), in which I frankly confess I cannot find any more reality than in the others.

I put forward as my second rule that when one of these bodies pushes another it cannot give the other any motion except by losing as much of its own motion at the same time; nor can it take away any of the other’s motion unless its own is increased by the same amount. This rule, together with the preceding, accords very well with all those observations in which we see one body begin or cease to move because it is pushed or stopped by another. For, having assumed the previous rule, we are free from the difficulty in which the Schoolmen find themselves when they wish to explain why a stone continues to move for some

time after leaving the hand of the person who threw it. For we should ask instead, why does the stone not continue to move forever? Yet the reason is easy to give. For who can deny that the air in which it is moving offers it some resistance? We hear it whistle when it divides the air, and if a fan, or some other very light and extended body, is moved through the air, we shall even be able to feel by the weight in our hand that the air is impeding its motion rather than keeping it moving, as some have wanted to say. Now suppose we refuse to explain the effects of the air's resistance in line with our second rule, thinking that the more a body can resist the more it is capable of stopping the motion of others, as we might initially be persuaded perhaps. We will then have great difficulty explaining why the motion of this stone is diminished more in colliding with a soft body which offers moderate resistance than when it collides with a harder body which resists it more. Likewise, we shall find it hard to explain why, as soon as it has exerted itself a little against the latter, it immediately turns around, rather than stopping or interrupting its motion. But if we accept this rule, there is no difficulty here at all. For it tells us that the motion of one body is not retarded by its collision with another in proportion to how much the latter resists it, but only in proportion to how much the latter's resistance is surmounted, and to the extent that, in obeying the law, it receives into itself the force of motion that the former gives up.

Now although, in most of the motions we see in the actual world, we cannot perceive that the bodies that begin or cease to move are pushed or stopped by some others, we have no reason to judge that these two rules are not being followed exactly. For it is certain that such bodies can often receive their agitation from the two elements of air and fire, which are always found among them without being perceptible (as has just been said), or that they may receive it from the ordinary air, which also cannot be perceived by the senses. It is certain too that they can transfer this agitation sometimes to the grosser air, and sometimes to the whole mass of the earth; and when dispersed therein, it also cannot be perceived.

But even if everything our senses ever experienced in the actual world seemed manifestly contrary to what is contained in these two rules, the reasoning that has taught me them seems so strong that I cannot help believing myself obliged to suppose them in the new world that I am describ-

ing to you, for what more firm and solid a foundation could one find to establish a truth, even if one wished to choose it at will, than the very firmness and immutability which is in God?

Now these two rules follow manifestly from the sole fact that God is immutable and that, acting always in the same way, He always produces the same effect. For on the assumption that He placed a certain amount of motion in matter in general at the first instant He created it, we must admit either that He preserves the same amount of motion in it, or not believe that He always acts in the same way. If we assume, in addition, that from this first instant the various parts of matter, in which these motions are found unequally dispersed, began to retain them or transfer them from one to another, according as they had the force to do so, then we must of necessity hold that God causes them to continue always doing so. And that is what these two rules specify.

I shall add as a third rule that, when a body is moving, even if its motion most often takes place along a curved line and, as we said above, it can never make any movement that is not in some way circular, nevertheless each of its parts individually tends always to continue moving along a straight line. And so the action of these parts, that is the inclination they have to move, is different from their motion.

For example, if we make a wheel turn on its axle, even though its parts go in a circle (because, being joined to one another, they cannot do otherwise), nevertheless their inclination is to go straight ahead, as appears clearly if one of them is accidentally detached from the others, for as soon as it is free its motion ceases to be circular and continues in a straight line.

By the same token, when a stone is swung in a sling, not only does it fly straight out when it leaves the sling, but while it is in the sling it presses against the middle of it and causes the cord to stretch. This shows clearly that it always has a tendency to go in a straight line and that it goes in a circle only under constraint.

This rule rests on the same foundation as the other two, and depends solely on God's conserving everything by a continuous action, and consequently on His conserving it not as it may have been some time earlier but precisely as it is at the very instant He conserves it. So, of all motions, only motion in a straight line is entirely simple and has a nature which may be grasped wholly in an instant. For in order to conceive of such motion it

is enough to think that a body is in the process of moving in a certain direction, and that this is the case at each determinable instant during the time that it is moving. By contrast, to conceive of circular motion, or any other possible motion, it is necessary to consider at least two of its instants, or rather two of its parts, and the relation between them. But so that the Philosophers (or rather the Sophists) do not find the opportunity here to engage in their useless subtleties, note that I am not saying that rectilinear motion can take place in an instant; but only that all that is required to produce it is found in bodies in each instant that may be determined while they are moving, whereas not everything that is required to produce circular motion is present. [. . .]

According to this rule, then, we must say that God alone is the author of all the motions in the world in so far as they exist and in so far as they are straight, but that it is the various dispositions of matter that render the motions irregular and curved. Likewise, the theologians teach us that God is also the author of all our actions, in so far as they exist and in so far as they have some goodness, but that it is the various dispositions of our wills that can render them evil.

I could set out many further rules here for determining in detail when and how, and by how much, the motion of each body can be diverted and increased or decreased by colliding with others, that is, rules that comprise all the effects of nature in a summary way. But I shall be content to tell you that, apart from the three laws that I have explained, I wish to suppose no others but those

that most certainly follow from the eternal truths on which mathematicians have generally supported their most certain and most evident demonstrations: the truths, I say, according to which God Himself has taught us He disposed all things in number, weight, and measure. The knowledge of these truths is so natural to our souls that we cannot but judge them infallible when we conceive them distinctly, nor doubt that if God had created many worlds, they would be as true in each of them as in this one. Thus those who know how to examine the consequences of these truths and of our rules sufficiently will be able to recognise effects by their causes. To express myself in scholastic terms, they will be able to have *a priori* demonstrations of everything that can be produced in this new world.

And so that there will be nothing to prevent this, we shall, if you please, assume in addition that God will never perform a miracle in the new world, and that the intelligences, or rational souls, which we might later suppose to be there, will not disrupt the ordinary course of nature in any way.

Nevertheless, after this, I do not promise to set out exact demonstrations of everything I say. It will be enough for me to open up the way for you to find them yourselves, when you take the trouble to look for them. Most minds lose interest when one makes things too easy for them. And so as to present a picture which pleases you here, I must use shading as well as bright colours. So I shall be content to continue with the description I have begun, as if my intention were simply to tell you a fable.