find this system. M. Leibniz gave this much thought; he had ideas on this, which he unfortunately never communicated to anyone, but even if it could be invented, it seems that there are some unknowns for which no *equation* could ever be found. Metaphysics contains two types of things: the first, that which all people who make good use of their mind, can know; and the second, which is the most extensive, that which they will never know.[46]

Several truths of physics, metaphysics, and geometry are obviously interconnected. Metaphysics is the summit of the edifice; this summit is so elevated that our image of it often is a little blurred. This is why I thought I should begin by bringing it closer to you, so that, no cloud obscuring your mind, you might be able to have a clear and unassailable view of the truths in which I want to instruct you.[47]

CHAPTER ONE: *OF THE PRINCIPLES OF OUR KNOWLEDGE*

I

ON WHAT OUR KNOWLEDGE IS FOUNDED.

All aspects of our knowledge are born from each other and are founded on certain principles whose truth is known without even reflecting on it, because they are self-evident.

Some truths immediately depend on these first principles, and are derived from them as a result of a small number of conclusions only. In that case the mind easily perceives the sequence that has led to them; but it is easy to lose sight of this sequence in the search for truths that can only be reached by a great number of conclusions drawn one from another. There are a thousand examples of this in geometry; it is very easy, for example, to see that the diameter of a circle divides it into two equal parts, because only one conclusion is needed to pass from the nature of the circle to this property. But it is not so easily seen that the square of the ordinate BM is equal to the rectangle of line AB by line BC, although this property results from the

46. This sentence reflects an interchange late in the 1730s between Voltaire and Frederick of Prussia, in which Voltaire made this distinction. See D1376, Voltaire to Frederick of Prussia (15 October 1737) *Oeuvres complètes*, v. 88, 381.

47. Natural philosophers commonly offered a visual representation of the constituent parts of "Knowledge." Du Châtelet certainly knew of Descartes' Tree of Knowledge from his *Principles*, in which metaphysics forms the roots, physics the trunk, and the other sciences (mechanics, medicine, morals), the branches.

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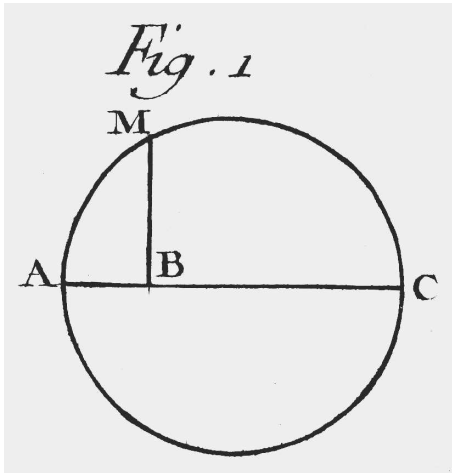

nature of the circle just as in the former case;[48] because there must be several intermediary conclusions before arriving at this last property of a circle. So, it is very important to be attentive to principles, and the manner in which truths result from them, if one does not want to go astray.

II

WHAT A PRINCIPLE IS.

The word *principle* has been much abused; the Scholastics who could demonstrate nothing chose unintelligible words for their principles.[49] Descartes, who sensed how much this manner of reasoning kept men away from the truth, began by establishing that one must only reason from clear ideas; but he pushed this principle too far: for he allowed a lively, internal sense of clarity and evidence to serve as the basis of our reasonings.

ABUSE OF THIS WORD BY M. DESCARTES.

In following this principle, this philosopher made a mistake about the essence of bodies that, according to him, consisted only of extension.[50] He be-

48. *Ordinate* means one of the points of a coordinate, in this case connecting the diameter AC to the exterior of the circle. See figure 1, $BM^2 = AB \times BC$.

49. The *Scholastics*, or *Schoolmen*, for Du Châtelet were catchall words for the thirteenth-century theologians such as St. Thomas Aquinas (1225–1274), who endeavored to reconcile reason and faith for the Catholic Church. In philosophy and physics, they used Aristotle's method of logic, syllogistics, and made his writings part of church dogma.

50. By *extension* she means the size and shape of a body in space.

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lieved that in extension, he had a clear and distinct idea of a body, without troubling to prove the possibility of this idea that we will soon see to be very incomplete, since to it must be added the concepts of the force of inertia, and of the *force vive* (active force). This method, moreover, would only serve to perpetuate disputes, for among those with opposing views, each has this lively and internal sense of what it is they put forward. Thus, no one has to yield, since the evidence is equal on the two sides. So, one must substitute demonstrations for the illusions of our imagination, and not admit anything as truth, except what results incontestably from first principles that no one can call into question, and reject as false all that is contrary to these principles, or to the truths that one has established with them, whatever the imagination might say.

ONE MUST DISTRUST ONE'S IMAGINATION AND ONLY YIELD TO EVIDENCE.

§.3. A little attention to the manner in which one proceeds in science, where certainty is carried to its highest point, will suffice to make one aware of the utility of this method of reasoning. For instance, there is scarcely a clearer idea than that of the possibility of an equilateral triangle, and that the two sides of a triangle, taken together, are much longer than the third. Yet Euclid, this strict reasoner, was not content to appeal just to a lively and internal sense that we have of these truths, but he demonstrated them rigorously, showing what must be done in order to construct an equilateral triangle, and that it implies contradiction to say that two sides of a triangle, taken together, are not greater than the third.

ON THE PRINCIPLE OF CONTRADICTION.

§.4. *Contradiction* is that which simultaneously affirms and denies the same thing; this principle is the first axiom, on which all truths are founded. Everyone readily agrees on this, and it would even be impossible to deny it without lying to one's conscience; for we sense that we cannot force our minds to admit that a thing simultaneously is and is not, and that we cannot *not* have an idea while having it, nor see a white body as if it were black while we see it as white. Even the Pyrrhonists, who claimed to doubt everything, never denied this principle; they effectively denied that reality existed, but they never doubted that they had an idea while they had it in their minds.[51]

51. The Pyrrhonists were followers of the third century BCE Greek philosopher, Pyrrho. They became synonymous with the idea of complete skepticism.

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IT IS THE FOUNDATION OF ALL CERTAINTY.

This axiom is the foundation of all certainty in human knowledge. For, if one once granted that something may exist and not exist at the same time, there would no longer be any truth, even in numbers, and every thing could be, or not be, according to the fantasy of each person, thus 2 and 2 could equally make 4 or 6, or both sums at the same time.

DEFINITION OF THE POSSIBLE AND THE IMPOSSIBLE.

§.5. It follows from this that the impossible is that which implies contradiction; and the possible does not imply it at all. Several philosophers give another definition of the possible and of the impossible, and regard as impossible that which does not give a clear and distinct idea, and as possible that which one can conceive, and which corresponds to a clear idea. This definition if well explained could be accepted, but it is necessary to be very careful that this definition does not induce us to take erroneous and deceptive notions for clear ones. For, it sometimes happens that we form deceptive ideas for ourselves that may appear evident for lack of attention, and because we have an idea of each term in particular, although it is impossible to have any idea of the sentence born from their combination.

EXAMPLES OF DECEPTIVE IDEAS.

Thus, at first one will believe that one understands what is meant by a triangle, if one defines it as *a figure enclosed between two straight lines*, and one thinks that one is speaking of a regular body, when speaking of a body with nine equal sides, because one understands all of the terms that enter into these propositions. Yet, it implies contradiction to say that two straight lines enclose a space and make a figure, and you have seen in geometry that it is impossible for a body to have nine sides, equal and alike.

There is yet another example of these deceptive ideas in the most rapid movement of a wheel, which M. Leibniz used to argue against the Cartesians; for it is easy to show that the most rapid movement is impossible to measure, since in extending any spoke this movement becomes more rapid to infinity. One sees, by these examples, that it is quite possible to believe that one has a clear idea of a thing of which we really have no idea.

So it is absolutely necessary, in order to preserve oneself from error, to verify one's ideas, to demonstrate their reality and not to admit any as incontestable, unless confirmed by experiment or by demonstration, which includes nothing false, or chimerical.

§.6. A very important rule results from the definition of the impossible that I have just given you; it is that when we advance that a thing is impos-

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sible, we are required to show that the same thing is simultaneously asserted and denied, or that it is contrary to a truth already demonstrated. This rule would avoid a great many disputes, if it were followed, for it would at once remove doubt from propositions, and expose the inadequacy of the proofs of those who treat as impossible all that does not conform to their opinions.

One should be just as cautious when maintaining that a thing is possible; for one must be in a position to show that the idea is free of contradiction. Without this condition our ideas are only more or less probable opinions, in which there is no certainty.

§.7. The principle of contradiction has always been used in philosophy. Aristotle, and after him all philosophers used it, and Descartes used it in his philosophy to prove that we exist. For it is certain that this one who doubted that he existed would have in the fact of his very doubt a proof of his existence, since it implies contradiction that one might have an idea whatever it be, and consequently a doubt, while at the same time not being in existence.

THE PRINCIPLE OF CONTRADICTION IS THE FOUNDATION OF ALL NECESSARY TRUTHS.

This principle suffices for all necessary truths, that is to say, for the truths which can only be determined in a single way, for this is what is meant by the term *necessary*. But when contingent truths are concerned, that is to say, when a thing can exist in various ways, none of its determinations is more necessary than another, then another principle becomes necessary, because that of contradiction no longer applies. Thus, the Ancients, who did not know this second principle of our knowledge, were wrong on the most important points of philosophy.

OF THE PRINCIPLE OF SUFFICIENT REASON.

§.8. The principle on which all contingent truths depend, and which is neither less fundamental nor less universal than that of contradiction, is *the principle of sufficient reason*. All men naturally follow it; for no one decides to do one thing rather than another without a sufficient reason that shows that this thing is preferable to the other.

IT IS FUNDAMENTAL TO ALL THE CONTINGENT TRUTHS.

When asking someone to account for his actions, we persist with our own question until we obtain a reason that satisfies us, and in all cases we feel that we cannot force our mind to accept something without a sufficient reason,

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that is to say, without a reason that makes us understand why this thing is what it is, rather than something completely different.

ABSURDITIES THAT RESULT FROM THE NEGATION OF THIS PRINCIPLE.

If we tried to deny this great principle, we would fall into strange contradictions. For as soon as one accepts that something may happen without sufficient reason, one cannot be sure of anything, for example, that a thing is the same as it was a moment before, since this thing could change at any moment into another of a different kind; thus truths, for us, would only exist for an instant.

For example, I declare that all is still in my room in the state in which I left it, because I am certain that no one has entered since I left; but if the principle of sufficient reason does not apply, my certainty becomes a chimera, since everything could have been thrown into confusion in my room, without anyone having entered who was able to turn it upside down.

Without this principle there would not be identical things, for two things are identical when one can substitute one for the other without any change to the properties which are being considered. This definition is accepted by everyone. Thus, for example, if I have a ball made out of stone, and a ball of lead, and I am able to put the one in the place of the other in the basin of a pair of scales without the balance changing, I say that the weight of these balls is *identical*, that it is the same, and that they are identical in terms of weight. Yet something could happen without a sufficient reason, and I would be unable to state that the weight of the balls is identical at the very instant when I find that it is identical; since a change could happen for no reason at all, happen in one and not the other; and, consequently, their weights would no longer be identical, which is contrary to the definition.

Without the principle of sufficient reason, one would no longer be able to say that this universe, whose parts are so interconnected, could only be produced by a supreme wisdom, for if there can be effects without sufficient reason, all might have been produced by accident, that is to say, by nothing.

THIS PRINCIPLE IS THE ONLY THING THAT CAUSES US TO DIFFERENTIATE WAKING FROM SLEEPING.

What sometimes happens in dreaming gives us the idea of a fabulous world, where all events could happen without sufficient reason.

I dream that I am in my room, busy writing; all of a sudden my chair changes into a winged horse, and I find myself in an instant a hundred leagues from the place where I was with people who have been dead for a

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long time, etc. All of this cannot happen in this world, since there would not be sufficient reason for all these effects; for when I leave my room, I can say how and why I leave it, and I do not go from one place to another without passing through intermediary places. Yet all these chimeras would be equally possible if effects could exist without sufficient reason; it is this principle that distinguishes dreaming from waking and the real world from the fabulous world that is depicted in fairy tales. Thus, those who deny the principle of sufficient reason are the inhabitants of a fabulous world that does not exist, but in the real world, all must happen according to this principle.[52]

In geometry where all truths are necessary, only the principle of contradiction is used. In a triangle, for example, the sum of the angles can only be determined in a single manner, and they absolutely must be equal to the sum of two right angles. But when it is possible for a thing to be in several states, I cannot be sure that it is in one state rather than another, unless I do give a reason for that which I affirm. Thus, for example, I can be sitting, lying down, or standing, all these determinations of my situation are equally possible, but when I am standing, there must be a sufficient reason why I am standing and not sitting or lying down.

ARCHIMEDES FIRST USED THIS PRINCIPLE IN MECHANICS.[53]

Archimedes, in passing from geometry to mechanics, recognized the need for sufficient reason; for, wanting to demonstrate that a pair of scales with arms of equal length loaded with equal weights would rest in equilibrium, he showed that in this equality of the arms and weights, the scales must stay at rest, because there was not sufficient reason why one of the arms should tilt rather than the other.

BUT IT IS M. LEIBNIZ WHO MADE EVIDENT ALL THE EXTENSION AND USEFULNESS OF IT.

M. Leibniz, who was very attentive to the sources of our reasoning, took this principle, developed it, and was the first who stated it clearly, and who introduced it into the sciences.

It must be acknowledged that one could not have rendered the sciences a greater service, for the source of the majority of false reasoning is forget-

52. This categorical statement is very provocative, as French and English natural philosophers rejected this Leibnizian principle. It is the principle that Voltaire later ridiculed in his tale of *Candide* (1759). Nineteenth- and early twentieth-century scientists used it as described here by Du Châtelet as a fundamental premise of their work, the presumption that there is a particular demonstrable cause of any given phenomenon.

53. Archimedes was the Greek mathematician of the third century BCE.

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ting sufficient reason; and you will soon see that this principle is the only thread that could guide us in these labyrinths of error the human mind has built for itself in order to have the pleasure of going astray.

So we should accept nothing that violates this fundamental axiom; it keeps a tight rein on the imagination, which often falls into error as soon as it is not restrained by the rules of strict reasoning.

DIFFERENCE BETWEEN THE POSSIBLE AND THE ACTUAL.

§.9. It is necessary to distinguish between the possible and the actual. You have seen before that all that does not imply contradiction is possible, but is not actual. It is possible, for example, that this square table might become round, but this will perhaps never happen. Thus, all that exists being necessarily possible, one can conclude possibility from existence, but not existence from possibility.

So in order that a thing might be, it is not sufficient for it to be possible; this possibility must also be actualized, and this is called *existence*. Now a thing cannot come to exist without a sufficient reason, by which an intelligent being might understand why this thing becomes actual, having been possible before. Thus, a cause must contain not only the principle of the actuality of the thing of which it is the cause but also the sufficient reason for this thing, that is to say, what makes it possible for an intelligent being to understand why this thing exists. For any man who makes use of his reason must not be content with knowing that a thing is possible and that it exists, but he must also know the reason why it exists. If he does not see this reason, as often happens when things are too complicated, he must at least be certain that one could not demonstrate that the thing in question cannot have sufficient reason for its existence. Thus, in all that exists there must be something making it possible to understand why something that exists could exist; this is what is called *sufficient reason*.

THE PRINCIPLE OF SUFFICIENT REASON BANISHES FROM PHILOSOPHY ALL THE REASONING OF SCHOLASTICISM.

§.10. This principle banishes from philosophy all the reasonings of Scholasticism; for the Scholastics accepted that nothing happens without a cause, but they would allege as causes *plastic natures*, *vegetative souls*, and other meaningless words. But once it has been established that a cause is good only insofar as it satisfies the principle of sufficient reason, that is to say, insofar as it contains something making it possible to show how and why an effect can happen, then it becomes impossible to substitute these grand words for ideas.

For instance, when it is explained why plants appear, grow, and last,

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and that the cause advanced for these effects is a vegetative soul found in all plants, a cause of these effects is indeed advanced;[54] but it is a cause that is not admissible at all, because it contains nothing that helps us to understand how the vegetation of which I seek the cause operates. For assuming the existence of this vegetative soul does not promote understanding of why the plant that I am considering has a particular structure rather than any other, nor how this soul can give shape to a mechanism such as that of this plant.

IT IS THE FOUNDATION OF MORALS.

§.11. The principle of sufficient reason is also the foundation of the rules and customs founded only on what is called *propriety*. For the same men may follow different customs, they may determine their actions in many ways; and when one chooses to prefer those which are most reasonable over others, the action becomes good and could not be condemned; but the action is said to be unreasonable as soon as there are sufficient reasons for not committing it, and it is certainly on these same principles that one custom may be judged better than another, that is to say, when it has more reason on its side.

OF THE PRINCIPLE OF INDISCERNIBLES. HOW SUFFICIENT REASON FOLLOWS FROM THIS

§.12. From this great axiom of sufficient reason is born another that M. Leibniz calls *the principle of indiscernibles*. This principle banishes from the universe all similar matter, for if there could be two pieces of matter absolutely similar and identical, so that one might be put in the place of the other without it causing the slightest change (this is what is meant by entirely identical) there would be no sufficient reason why, for instance, one of these particles was placed on the Moon and the other on the Earth, since changing them and placing the one which is on the Moon on the Earth, and the one which is on the Earth on the Moon, all things would remain the same.

IT BANISHES ALL SIMILAR MATERIAL FROM THE UNIVERSE.

So one is obliged to recognize that the least particles of matter are discernible, or that each is infinitely different from all others, and that it could not be used in a place other than the one it occupies without disturbing the whole universe. Thus, each particle of matter is meant to have the effect that it produces, and from this, diversity is born, which is found between two grains of sand just as between our globe and that of Saturn, this diver-

54. This is an idea from Aristotle.

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sity reveals to us that the wisdom of the Creator is no less admirable in the tiniest being than in the biggest.

The infinite diversity that reigns in nature is evident to us as far as our organs can sense. M. Leibniz, who advanced this truth first, had the pleasure of seeing it confirmed by the very eyes of those who denied it, on a walk with Madame the Electress of Hanover, in the garden of the Heurenausen.[55] For this philosopher, having stated that two entirely similar leaves could never be found in the almost innumerable quantity of those which surrounded them, several of the courtiers fruitlessly spent part of the day in this search, and could never find two leaves that did not have perceivable differences, even to the naked eye.

There are other objects that their smallness makes us see as alike, because we see them confusedly, but microscopes discover their differences for us. Thus experiments, which are not necessary for the truth of this principle, confirm it again.

OF THE LAW OF CONTINUITY.

§.13. From the axiom of sufficient reason there follows yet another principle, called *the law of continuity*, it is again to M. Leibniz that we are indebted for this principle, which is one of the most fruitful in physics. It is he who teaches us that nothing happens at one jump in nature, and a being does not pass from one state to another without passing through all the different states that one can conceive of between them.

The principle of sufficient reason is easily found in that truth, for each state in which a being finds itself must have its sufficient reason why this being is in this state rather than in any other, and this reason can only be found in the preceding state. Therefore this antecedent state contained something which gave birth to the current state that followed it, so that these two states are so completely interconnected it is impossible to put another state between the two. For if there was a state possible between the current state and that which immediately preceded it, the nature of the being would have left the first state without yet being determined by the second to abandon the first. Thus, there would be no sufficient reason why it should pass to this state rather than to any other possible state. Thus no being passes from one state to another without passing through the intermediate states, in the same way as one does not go from one city to another without traveling along the road between the two.

55. Leibniz told this story often, about Sophie, Electress of Hanover (1630–1714), and their walk in her garden at Herrenhausen (Du Châtelet spelled it incorrectly), probably around 1685.

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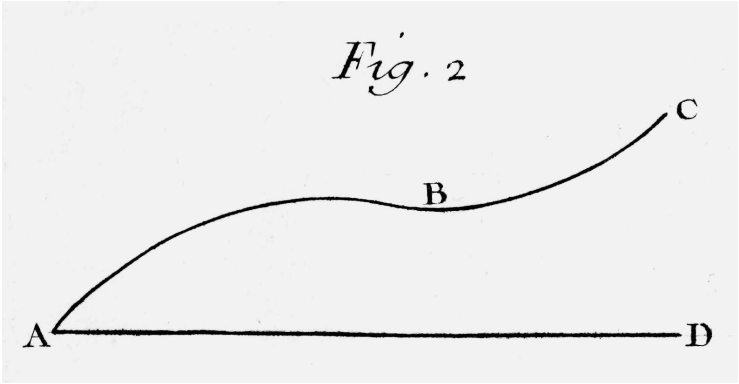
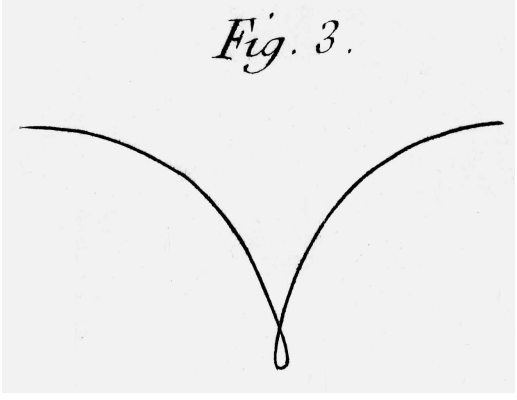


EXAMPLES OF THIS LAW IN GEOMETRY.

In geometry where everything happens in the greatest order, it can be seen that this rule is observed with an extreme exactitude, for all the changes which occur in lines that are one, that is to say in a line that is the same, or in those which together make up one and one whole only, all these changes, I say, exist after the figure has passed through all the possible changes that lead to the state it acquires. Thus, a line that is concave toward an axis, as line AB toward axis AD, does not become convex without passing through all the states between concavity and convexity, and through all the degrees that can lead from one to the other; thus concavity begins to diminish by infinitely small degrees up to point B, where the line is neither concave, nor convex, a point that is called the point of inflection. At this point the concavity ends and the convexity begins, and at this point B an infinitely small line parallel to axis AD forms; beyond this point B, the convexity begins and increases by infinitely small degrees, as mathematicians know.



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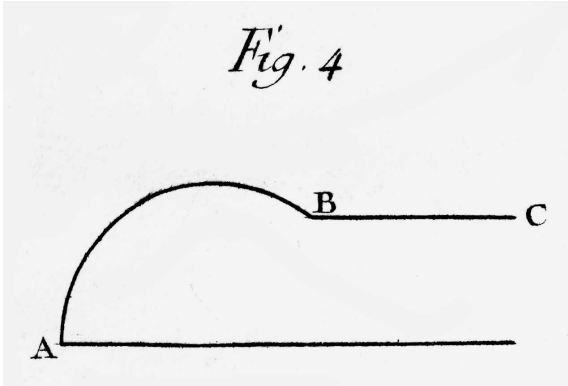

The points of retrogression found in many curves and that might appear to violate this law of continuity—because the line appears to end at this point and retrogress quickly in a contrary direction—do not, however, violate it at all; for it can be shown that at these points of retrogression nodes are formed as in figure 3,[56] in which it is clearly seen that the law of continuity is followed, for these nodes being diminished to infinity, in the end take the form of a perceivable point.

The law of continuity is not found in mixed figures, of which one cannot say that they form a true whole, because they have not been produced by the same law but are composed of several pieces, as if one added to the arc of a circle AB a straight line BC in order to make a single figure ABC. These figures violate the law of continuity, because the law by which one describes a circle AB ends at B and contains nothing in it that might give birth to line BC, but at point B another law begins, according to which line BC is described, and this second law bears no relationship to the first, which described circle AB.

The same thing happens in nature as in geometry, and it was not without reason that Plato called the Creator, *the eternal Geometrician*.[57] Thus, there are no angles properly speaking in nature, no inflexion nor abrupt retrogressions; but there are gradations in everything, and all prepares well in advance for changes that must be experienced, and goes by slight changes to the state it must be in. Thus a ray of light that is reflected on a mirror does not suddenly retrogress, and does not make an acute angle at the point of

56. *Nodes* had more than its specific astronomical meaning in the eighteenth century. It was a general term that could also be synonymous with a small loop, or knot.

57. Du Châtelet studied the dialogues of Plato (429–347 BCE), the Greek philosopher, during her time at Cirey.

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reflection; but it passes to the new direction that it takes on being reflected through a small arc that leads it imperceptibly and through all the possible degrees between the two extreme points of incidence and reflection.

It is the same with refraction. The ray of light does not break at the point that separates the medium it penetrates and that which it leaves behind, but it begins to inflect before having penetrated the new medium; and the beginning of its refraction is a small curve that separates the two straight lines it describes in traversing two heterogeneous and contiguous mediums.

THIS PRINCIPLE SERVES TO DEMONSTRATE THE LAWS OF MOTION.

§.14. By this law of continuity the true laws of motion can be found and demonstrated, for a body that moves in any direction whatever could not move in an opposite direction without passing from its first movement to rest through all of the intermediate degrees of retardation, in order to pass again, by imperceptible degrees of acceleration, from rest to a new movement that it must experience.

THE PRINCIPLE OF CONTINUITY PROVES THAT THERE ARE NO PERFECTLY HARD BODIES IN THE UNIVERSE.[58]

§.15. This law shows that there is not a perfectly hard body in nature, for in the collision of perfectly hard bodies this gradation could not take place because the hard bodies would pass all at once from rest to movement, and from movement in one direction to movement in an opposite direction. Thus, all bodies have a degree of elasticity that renders them capable of satisfying this law of continuity which nature never violates.

§.16. It follows from what I have just said that when the conditions that give birth to a property come to change to other conditions from which another property must be born, so that finally these conditions become the same or identical, the property which resulted from the initial conditions must change by the same gradation into the property that is a continuation of the later conditions into which the first happened to change.

Geometry furnishes an infinity of examples that confirm and clarify this rule. The ellipse and the parabola, for example, describe very different lines, but when one makes the determinations of an ellipse vary (which are the conditions that render an ellipse possible) in order to make them approach those of the parabola, the properties of the ellipse also vary continually and

58. In the eighteenth century and in subsequent science, it had to be presumed that there could be no completely hard bodies in nature. Bodies were presumed to be *elastic*, meaning that their shape would be affected by an impact with another body, but that this shape would be resumed after the impact.

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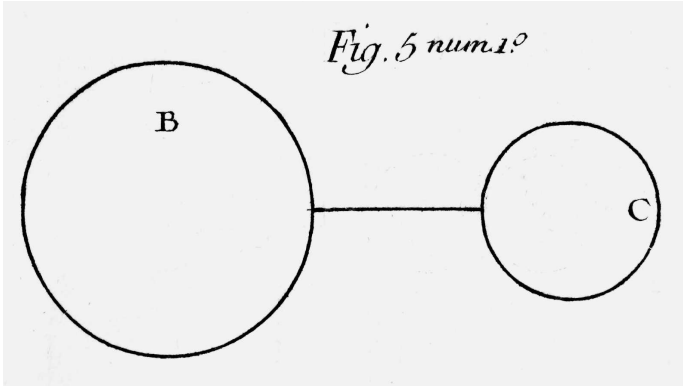

approach those of the parabola up to the point where finally the lines become the same. Thus, one of the foci of the ellipse remaining immobile, if the other moves away continually, the new ellipses that will be produced will continually become more like the parabola, and they finally will coincide with it, when the distance between the foci has become infinite. Thus, all the properties of the parabola will agree with those of an ellipse the foci of which will be infinitely distant, and the parabola can be considered as an ellipse whose foci are infinitely distant. By this same principle a decreasing movement finally becomes rest, and that ever-diminishing inequality turns into equality, so that rest may be considered as a very small movement, and equality as an infinitely small inequality. So, whenever this continuity of event does not obtain, it must be concluded that there are mistakes in the reasoning one has used.

DESCARTES' MISTAKE IN NOT HAVING PAID ATTENTION TO THIS LAW.

§.17. Descartes, for example, would have reformed his laws of motion had he paid attention to this law. He began by establishing as a first law that two equal bodies colliding with equal speeds must rebound with the same speed, and this is very true, for there being no reason why one of the two should continue in its path rather than the other, and these bodies being unable to penetrate each other or stay in repose, because the force of their equal speeds would be lost, which cannot happen, they must necessarily both rebound with the same speed with which they collided.

But M. Descartes' second law of motion and almost all the others are false, because they violate the principle of continuity. The second, for example, states that if two bodies B and C collide with equal speeds, but that body B is bigger than body C, then only body C will rebound and body B will continue on its path, both with the same speed that they had before the collision. This rule is denied by experience, and it is false because it is not

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in accord with the first rule of motion, or with the principle of continuity, for in always diminishing the inequality of the bodies, the effect that is a result of the inequality must always approach that which is a result of their inequality (§.16.), so that always diminishing the size of the largest body, its speed toward C must also diminish and finally become null when a certain proportion between B and C has been reached, beyond which point the inequality having completely vanished, the effect produced by the inequality of the two bodies will begin. That is to say, that then the movement of the greater body B will begin in an opposite direction, and the bodies will rebound with the same speed, according to the first law of M. Descartes. Thus, the second law cannot obtain since, according to this second law, although one may diminish the size of B and make it approach C so that the difference might be almost unassignable, the results will nonetheless remain very different and not be at all similar, which is totally contrary to the law of continuity. For when the inequality disappears, the effect creates a great jump, since the movement of body B changes direction all at once, passing through all the intermediary stages at one jump, while only an imperceptible change happens in the size of this body, which is nonetheless the cause of the great change that happens in the direction of its movement: thus the effect is greater than the cause. It can be seen by this example how important it is to pay attention to this law of continuity and in this way to imitate nature, which never transgresses this law in any of its operations.

CHAPTER TWO

Of the existence of God

THE STUDY OF PHYSICS LEADS US TO KNOWLEDGE OF A GOD.

§.18. The study of nature raises us to the knowledge of a supreme Being; this great truth is, if possible, even more necessary for good physics than for ethics, and it must be the foundation and the conclusion of all the research we make in this science.

PRÉCIS OF THE PROOFS OF THIS GREAT TRUTH.[59]

So, I believe that it is indispensable to begin by placing before you a précis of the proofs of this important truth, by which you will be able to judge its self-evidence for yourself.

59. Du Châtelet proceeds to give a combination of Cartesian and Leibnizian proofs of the existence of God.

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§.19.1. Something exists, since I exist.

2. Since something exists, something must have existed from all eternity, otherwise nothingness, which is but a negation, would have produced all that exists, which is a contradiction in terms, for that is saying a thing has been produced, and yet not acknowledging any cause for its existence.

3. The Being that has existed from all eternity must exist necessarily and not owe its existence to any cause. For if it had received its existence from another Being, that other Being would have caused its own existence, and then, it is he of whom I am speaking, and it is God, or else he would owe his existence to another. It is easily seen, when ascending thus to infinity, that it is necessary to arrive at a necessary Being that exists by its own volition, or else admit that there is an infinite chain of Beings which, all together, will not have any external cause for their existence (since all Beings belong in this infinite chain) and that, each in particular, will have no internal cause, since none exists by its own volition, and they owe their existence to one another in an infinite gradation. Thus, it is supposing a chain of Beings that separately have been produced by one cause, and which all together have been produced by nothing, which is a contradiction in terms. So there is a Being that necessarily exists, since it implies contradiction that such a Being does not exist.

4. All that is around us is born and dies successively; nothing enjoys a necessary state, everything is successive, and we succeed one another. So there is only contingency in all the beings that surround us, this is to say, that the contrary is equally possible and does not imply contradiction (for this is what distinguishes a contingent being from a necessary being).[60]

5. All that exists has a sufficient reason for its existence. The sufficient reason for the existence of a being must be within it, or outside it. Now the reason for the existence of a contingent being cannot be within it, for if it carried the sufficient reason for its own existence, it would be impossible for it not to exist, which is contradictory to the definition of a contingent being. So the sufficient reason for the existence of a contingent being must necessarily be outside of it, since it cannot have it within itself.

6. This sufficient reason cannot be found in another contingent being, nor in a succession of such beings, since the same question will always arise at the end of this chain, however it may be extended. So it must come to a necessary Being that contains the sufficient reason for the existence of all contingent beings, and of its own, and this Being is God.

60. Du Châtelet explains the distinction between *necessary* and *contingent* in chapter 1, §.7.

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The attributes of God

HE IS ETERNAL.

§.20. The attributes of this supreme Being follow from the necessity for its existence.

Thus, it is eternal, that is to say, it had no beginning and it will never have an end, for if the necessary Being had begun, it would have had to act before being, in order to produce itself, which is absurd, or something must have produced it, which is contrary to the definition of the necessary Being.

It cannot have an end, because the sufficient reason for its existence residing in itself, it can never abandon it; furthermore, what is contrary to a necessary thing implies contradiction and is consequently impossible. So it is impossible for the necessary Being to cease existing, just as it is impossible for 3 times 3 to make 8.

IMMUTABLE.

It is immutable, for if it changed, it would no longer be what it was, and consequently it could not have existed necessarily. Moreover, each successive state must have its sufficient reason in a preceding state, that one in another, and so on. Now, as in the necessary Being one would never reach the last state, since that Being never began, any successive state would be without sufficient reason, if it were susceptible to succession; thus, there cannot be change or succession in a necessary Being.

SIMPLE.

It follows clearly from what has just been said that the necessary Being cannot be a compound Being, which only exists as far as its parts are linked, and which can be destroyed by the dissociation of these same parts, and consequently the Being existing by its own volition is a simple Being.

NEITHER THE WORLD NOR OUR SOUL CAN BE A NECESSARY BEING.[61]

§.21. The world we see cannot be the necessary Being, for it is composed of parts and there is a continual succession in it, which is absolutely contradictory to the attributes I have just shown belong to a necessary Being.

By the same reasoning, neither matter nor the elements of matter can be the necessary Being.

61. Du Châtelet is using *soul* in the Cartesian sense of a thing separate from the body, having the properties of mind.

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Nor can our soul be this necessary Being, for its perceptions, changing continually, it is in perpetual variation, but the necessary Being cannot vary. So our soul is not the necessary Being.

So the Being existing of its own volition is a Being different from the world we see, from the matter of which this world consists, from the elements which make up this matter, and from our soul; and it contains in itself the sufficient reason for its existence and of all the beings who exist.

THE NECESSARY BEING, THIS IS TO SAY, GOD, MUST BE UNIQUE.

§.22. It is easy to see by all that has been said that there can be only one necessary Being, for if there were two Beings that existed necessarily and independently of each other, each could exist alone, and consequently neither the one nor the other would exist necessarily.

§.23. It is evident that all that is possible does not exist, and that an infinity of things that could happen do not happen at all. Alexander, for example, instead of destroying the Empire of the Persians, could turn his armies against the peoples of the occident [west], or live peaceably in his kingdom. In a word, he could take an infinity of courses of action different from the one he took, which would have given rise to an infinity of combinations that were then possible and that would have produced events all different from those that occurred. This applies to the events contained in novels. They could happen if another succession of things took place; these are the stories of a possible world that lacks actuality, for each succession of things constitutes a world differing from all others by the events specific to it. Thus one can conceive of a succession of causes leading to the events in *Zaïde*, or those in the Queen of Navarre, for these events are possible, and they only lack actuality.[62] Similarly, one can conceive of possible universes, with other stars and other planets; and, as the different relationships of these universes can be combined in an infinity of ways, there are an infinity of possible worlds, only one of which actually exists.

When nothing had yet been produced, and none of these possible worlds existed, they all equally had the potential to come into existence; and they waited, so to speak, until an external force chose them, and made them actual. For what does not exist can only contribute to its existence ideally; that is to say, insofar as it contains certain determinations that the rest

62. *Zaïde* (1671) was a novel by Marie-Madeleine Pioche de la Vergne (1634–93), Countess de La Fayette. "Queen of Navarre" suggests *The Heptaméron* by Marguerite de Navarre (1492–1549), first published in 1558.

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do not contain, and that can lead an Intelligent Being to choose it in order to give it existence.

There must be a sufficient reason for the actuality of the world we see, since an infinity of other worlds were possible. This reason can only be found in the differences that distinguish this world from all other worlds. This means, then, that the necessary Being must have envisaged all the possible worlds, considered their diverse arrangements and their differences, so as to be able to determine afterward to give actuality to the one that pleased him most.

GOD IS AN INTELLIGENT BEING.

The distinct representation of things constitutes understanding. Now the necessary Being who must have envisaged all the possible worlds before creating this one is therefore an intelligent Being, whose understanding is infinite, for all the possible worlds contain all the possible arrangements of all things possible. Thus, this Being we call God is an intelligent Being who sees not only all that actually happens but all that could happen in any possible combination of possible things; for all that is possible enters into the worlds that he contemplates never-endingly, and that are acted out, so to speak, before him.

AND HIS INTELLIGENCE IS INFINITELY BEYOND OURS.

§.24. As succession is an imperfection attached to the finite, there is no succession in the perceptions of God, who envisages at once all the worlds possible with all their possible changes; and as there are in our ideas an infinity of confused things, which we do not distinguish because of their multiplicity, the ideas that God has of things being infinitely distinct, they are infinitely different from ours, as would be, more or less, the idea that we have of the Moon in relation to the one a man who had lived a long time on that planet would have of it. The way in which God sees and envisages all possible things is, thus, incomprehensible to us. Thus we cannot form for ourselves a distinct idea of Divine understanding; it is like creation, among the things impossible for us to comprehend and deny. Let us always remember, when we wish to comprehend God's understanding, this child St. Augustine saw on the seashore who tried to put the ocean into a hazelnut shell; and this will give us some faint idea of the presumption of a being whose understanding is finite, and who wants to form a clear idea of the understanding of the Creator.[63]

63. The story of St. Augustine of Hippo (354–430), the child, and the nutshell have no basis in fact. However, it was the most popular representation of this Doctor of the Christian Church

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HE IS FREE.

§.25. The choice that God made among all possible worlds of the world we see is a proof of his liberty, for having given actuality to a succession of things that contributed nothing of its own power to its existence, there is no reason preventing him from giving existence to other possible successions in the same category with regard to the possibility of actualization. So he chose the succession of things that constitute this universe to make it actual, because this succession pleased him most: He was the absolute master of his choice. The necessary Being is thus a free Being; for to act following the choice of one's own will is to be free.[64]

INFINITELY WISE.

§.26. But the choice he made of this world he did not make for no reason, for supreme intelligence will not behave without intelligence. Now since we judge here on Earth that a being is more or less intelligent according to whether he decides by reasons more or less sufficient, God, being the most perfect of all beings, none of his actions can be without a sufficient reason. So he had his own reason for determining to create a world, and this reason is the satisfaction he found in imparting a portion of his perfections, and the reason that determined him to give actuality to this world rather than to any other was the greater perfection he found in this one. But this reason is not outside of God, nor antecedent to him; he finds it in himself, it is part of his intelligence. For all the possible worlds being sequences of coexisting and successive things, these successions possess different degrees of perfection, according to whether they are more or less well linked and whether they tend more or less harmoniously to a general end. Now the contemplation of perfection is the source of pleasure in intelligent beings, for what has the most perfection pleases more, and a reasonable being only desires things in proportion to the perfections he notes in them. But as our understanding is limited, and we are liable to be wrong in the judgments we make, we often mistake an apparent perfection for a real perfection. In contrast, God, seeing things with an infinite understanding, cannot be deceived

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in medieval European manuscripts. Augustine, puzzling over the possibility of the Trinity while walking at the seashore, questioned a child who was patiently filling a hole in the sand with water from the sea, nutshell by nutshell. Told by the saint that he would never complete the task, the child announced that he would complete his task before the man would ever understand the nature of three persons in one God. Augustine interpreted this answer as a sign from God. See James J. O'Donnell, *Augustine: A New Biography* (New York: HarperPerennial, 2006), 287–88. I am grateful to my colleague, the biblical scholar Edwin Yamauchi, for this reference.

64. Du Châtelet also made this her definition of human free will in her essay "On Liberty," which probably was originally intended for the *Foundations* but now exists only in manuscript.

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by appearances, nor choose the bad because he failed to recognize the best; thus, he distinguishes among all possible worlds the best and the most perfect, and this greater perfection is the sufficient reason for the preference he gave to this world over all the other possible worlds. Thus the necessary Being is infinitely wise, for only a Being whose wisdom is infinite is able to choose what is most perfect.

§.27. It is in this infinite wisdom of the Creator that final causes, a principle so fruitful in physics, which some philosophers have tried to banish from it very inappropriately, originate; all indicates a design and it is to be blind, or to want to be, not to perceive that the Creator has intended, in the least of his works, purposes that he always achieves and that Nature unceasingly works to carry out. Thus, this universe is not in chaos, it is not a disordered mass without harmony and without connection, as some ranters would persuade us; but all its parts are arranged with infinite wisdom, and none could be transplanted or removed without harming the perfection of the whole.

In studying nature, one discovers some part of the intentions and the art of the Creator in the construction of this universe. Thus Virgil was right to say *Felix qui potuit, rerum cognoscere causas*,[65] since the knowledge of causes raises us to the level of the Creator and allows us to enter into the mystery of his designs by showing us the admirable order that prevails in the universe and the relationships of its different parts, which are not just necessary relationships of position, such as being above and below; but relationships of a design, of which everything carries the imprint. And the more the world ages, the further men take their discoveries, and the more one finds a design marked in the fabric of the world and of the least of its parts.

THIS WORLD IS THE BEST OF THE POSSIBLE WORLDS.

§.28. So this world is the best of the possible worlds, the one where the greatest variety exists with the greatest order, and where the largest number of effects is produced by the simplest laws. It is the universe that occupies the top of the pyramid,*[66] and that has nothing above it, but a real infinity below it which decreases in perfection and that consequently did not deserve to be chosen by an infinitely wise Being.

65. "Happy is he who understands the cause of things," from the Roman poet Virgil's *Georgics* (29 BCE), 2.490.

66. Du Châtelet contributed the following note: "*M. Leibniz continuing in his Théodicée the Dialogue between Boethius and Valla, introduces the Priest of Apollo, who wants to know the origin of the misfortunes of Sextus Tarquinus, and who seeks this origin in the Palace of the destinies, a pyramid consisting of all the possible worlds, in which this one, in which Tarquinus committed the crimes that led to Roman liberty, occupied the top."

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THE IMPERFECTIONS OF THE PARTS CONTRIBUTE TO THE PERFECTION OF ALL IN THIS UNIVERSE.

All the objections drawn from the evils prevalent in this world vanish by this principle.[67] God allows them in the universe insofar as they enter into the best succession of possible things and from which they could not be removed without removing some perfections from the whole; for all the universe is tied together, the least event is caused by an infinity of others that preceded it, and an infinity of others are caused by it, and will arise from it. Therefore, an event should not be judged apart from and outside of the relationship and succession of things; but it must be judged in relation to the entire universe, and by the effects it produces in all places and at all times. For to want to judge by an apparent evil the perfection of the universe is to judge an entire painting by a single stroke of the brush, and it is a chimera to imagine that all imperfections may be removed and everything stay the same or become more perfect. The imperfection in the part often contributes to the perfection of the whole; for when many rules must be obeyed at once to reach a general perfection, the rules often contradict and generate unavoidable exceptions from which arise imperfections in the part, which nonetheless contribute to the most perfect whole that may be brought about.[68] The human eye, for instance, could not see the least parts of an object without losing sight of the whole; we would see a few points very distinctly if our eyes were microscopes, but in so doing we would lose the whole. Therefore, our sight must be less distinct to be proportionate to our needs, since distinguishing the least parts and a total view of the whole cannot be combined; for it is more useful to us to see the entire object than to distinguish all its points one after the other. Thus it is a chimera to believe that the eye of man would have been more perfect if it had distinguished the least parts of things, since, on the contrary, such an ability would have been almost useless to us.

The general will of God undoubtedly goes to the good and to the perfection of each thing in particular; but his consequent will, which is the result of all his previous acts of will, and which alone can be made actual, goes to the good and the greatest perfection of the whole, to which the perfection of the parts must yield.

It is true that we cannot see all of this grand tableau of the universe, nor show in detail how the perfection of the whole results from the apparent imperfections we believe we see in some parts, for this would require en-

67. Here Du Châtelet deals with the ultimate metaphysical and theological contradiction: the problem of a perfect Creator creating the imperfect, the ultimate Good creating evil.

68. Voltaire mocked this aspect of Leibniz's metaphysics in his tale of *Candide*.

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visaging the entire universe and being able to compare it with all the other possible universes, which is an attribute of the Divinity (§.23). But our powerlessness in this respect cannot make us doubt that the supreme Intelligence has chosen the best world to which to give existence, for the necessary Being who is self-sufficient and who has no need for anything outside himself cannot have had other ends in the creation of this universe than to impart a portion of his perfections to his creatures, and to make a work worthy of himself, since he would have done something derogatory to himself and to his perfections if he had produced a world unworthy of his wisdom.

A consequence of the linkage between the parts and the whole is that all imperfection cannot be removed from man; man is a finite being, bounded and limited in all by his essence. How many evils happen to us because our understanding is limited, because we cannot know everything, understand everything, or be wherever our presence is necessary? But these are faculties the creature could not have without becoming a God; thus, the imperfections in the creature, a succession of his limitations, are necessary imperfections.[69]

THE SUPREME BEING IS INFINITELY GOOD.

§.29. It follows from all I have just said that the supreme Being is infinitely good; for having determined to create a world to which to impart a portion of his infinite perfections, he determined to grant actuality to the best succession of possible things. He granted to each thing in particular as much essential perfection as it could receive; and by his wisdom he directed the evils that would be inevitable in this succession of things to the greater good.

AND INFINITELY POWERFUL. HIS UNDERSTANDING IS THE PRINCIPLE OF THE POSSIBILITY, AND HIS WILL, THE SOURCE OF THE ACTUALITY OF THINGS.

§.30. He is infinitely powerful; for God having, for all eternity, envisaged all that is possible, his understanding is the source of all possibility, and as nothing can ever become possible other than what God conceived of as such, and nothing being actual except what he was pleased to grant existence to, he is the principle of the possibility and the actuality of all that is actual and possible.

§.31. God is the absolute Master of this succession of things to which

69. Du Châtelet continued to think about the distinctions between God and man; she explored it fully in her *Examinations of the Bible*, and mentioned it again in the *Discourse on Happiness*, both of which she was working on in this same period, 1735–39.

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he has granted existence. He can change it and annihilate it, but (as we have seen) a contingent being cannot give itself existence, nor can it conserve it for a moment by its own force. Thus the reason for continuous existence cannot lie in the creature, who can neither begin nor continue to be but by the will of the Creator, which it needs at all times to sustain itself in the actuality that he has given it.

CHAPTER FOUR

Of hypotheses

THE USEFULNESS OF PROBABILITIES IN PHYSICS.

§.53. The true causes of natural effects and of the phenomena we observe are often so far from the principles on which we can rely and the experiments we can make that one is obliged to be content with probable reasons to explain them. Thus, probabilities are not to be rejected in the sciences, not only because they are often of great practical use, but also because they clear the path that leads to the truth.

USE OF HYPOTHESIS.

§.54. There must be a beginning in all researches, and this beginning must almost always be a very imperfect, often unsuccessful attempt. There are unknown truths just as there are unknown countries to which one can only find the good route after having tried all the others. Thus, some must run the risk of losing their way in order to mark the good path for others; so it would be doing the sciences great injury, infinitely delaying their progress, to banish hypotheses as some modern philosophers have.

MISUSES OF HYPOTHESES BY THE DISCIPLES OF DESCARTES.

§.55. Descartes, who had established much of his philosophy on hypotheses, because it was almost impossible to do otherwise in his time, gave the whole learned world a taste for hypotheses; and it was not long before one fell into a taste for fictions. Thus, the books of philosophy, which should have been collections of truths, were filled with fables and reveries.

THE DISCIPLES OF M. NEWTON HAVE FALLEN INTO THE OPPOSITE EXCESS.

M. Newton, and above all his disciples, have fallen into the opposite excess: disgusted with suppositions and errors that they found filled books of philosophy, they rose up against hypotheses and tried to make them suspect

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Emilie 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 3. Of Essence, Attributes and Modes

32. Since I will be obliged to employ the terms *essence*, *modes*, and *attributes* often in this Work, and since it is quite common for those who utter them to have very different ideas of their meaning, I think that it will not be useless to define these ideas, and to teach you what you should understand by these words; for very important truths in Physics depend upon the true notions of essence and attribute.

33. That which is impossible cannot exist, for one calls impossible that which implies contradiction. Now if what implies contradiction could exist, one thing could both be, and not be at the same time: which is demonstrated as false for all people.

34. All that is possible can exist, for given that a thing contains nothing that is contradictory, one can imagine nothing that opposes the possibility of its existence. The possibility of things depends, therefore, on the non-contradiction of their determinations; and when a thing contains nothing that is contradictory, this alone suffices for its possibility. A triangle, for example, can be drawn because it is not at all contradictory that three lines may be joined at their ends and enclose a space; thus, whether or not in fact we draw a triangle, the triangle remains equally possible. The drawing executes that which was already possible, but it adds nothing new. This brings to light the need to distinguish, as I have done above, between actual and possible. All that is possible is not actual, although all that is actual is possible. Thus, there must be an external cause for actuality (that is to say, for existence) which is the complement of possibility. Without actuality a Being would remain eternally in the realm of the possibilia (if I may express myself in this way), and would never come into existence.

[1] Aaron Wells, John Hanson, Penelope Brading.

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35. {Definition of that which we call a Being.} Therefore one calls *a Being* that which can exist, and whose determinations do not imply any contradiction, whether this Being exists, or whether it is only possible. For we often speak of past or future Beings, and as a result give the name *Being* to all that is possible, whether it exists or not. But we call a *Being of reason,* or *chimera*, that which implies contradiction and can never exist, that is to say, that which is impossible.

36. {Beings have variable and constant determinations.} When we consider the Beings that surround us, we notice in them both variable and constant determinations: a rock, for example, is sometimes hot and sometimes cold, but it is always hard, composed of parts, and heavy. The hardness, the heaviness, the divisibility are therefore the constant determinations of the Being that we call a rock; and the heat, the color, etc., are its variable determinations. Thus, the Pendulum Clock that is on this mantelpiece always has the same wheels, the same spring, etc., but the situation of the different parts amongst themselves varies at every moment while the clock is going. Similarly, the sides and the angles of a triangle remain constant, whether one inscribes the triangle within a circle, or circumscribes it around this circle, or drops a perpendicular from its apex to its base.

37. When one carefully considers the constant determinations, and compares them with each other, one notices that some depend so much on others that they could not subsist or even occur in the Being without the initial determinations, whereas the initial determinations do not depend on one another at all and do not mutually determine one another; they are only such that they can subsist together and be combined without destroying each other. **{What essence is, and in what it consists.}** One sees, for example, that three sides and three angles are equally the permanent and invariable determinations of a triangle; however, with more attention, one perceives that when two right lines are joined at their ends, they do not at all determine one another, and they can make an angle, or not make one; and they can make an angle of one size or another; but, once this angle and these two sides are determined, the other two angles and the third side are also determined; and one absolutely must make them the size that these initial determinations require, for every other way is impossible. Thus, the third side and the two other angles of a triangle depend on the initial two sides and the angle that they make.

38. When one wants to conceive how a Being is possible, it is not the variable determinations that one must consider, for these determinations, which subsist only sometimes, cannot number among those that constitute a Being, since this Being can subsist despite their variations.

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Nor can one posit, in order to conceive this Being, the constant determinations that follow and are themselves determined by other determinations that precede them. For one wants to know here how the Being is possible, and what makes it possible. One must therefore assemble determinations of this Being that do not conflict with one another, and that do not follow necessarily from other antecedent determinations (as, for example, two of the sides and the subtended angle in a triangle; for since the third side and the two other angles are not possible unless the two sides and the angle made from them are posited, one must posit the two sides and this angle prior to the third side and the other two angles). Thus, the primordial determinations are those which constitute the essence of a Being.

Since a Being becomes possible by its essence, when one wants to know the possibility of a Being one must know its essence, that is to say, the way in which this Being can come about: thus, the essence is the first thing that one is able to conceive in a Being; and no Being could subsist without essence.

39. {The attributes or properties arise from the essence.} All that is deduced from the essence belongs constantly to the Being, and it is this that we call *attribute* or *property*. Nothing that conflicts with the essence of a Being, that is to say, with the primordial and essential determinations, could be found in that Being, but all that is not contradictory to these determinations can be found in it, although it is not always found there; and this is the origin of attributes, and of variable properties, or modes. For example, it conflicts with the essence of a triangle for it to have four sides, because the essence of a triangle excludes the fourth side; but it does not conflict at all with this essence for the triangle to be divided in two by a line taken from the apex to the base.

All that is found in a Being must therefore relate to the essential and primordial properties, or to the attributes, or to the modes. Thus, the essential and primordial properties, or the essence of a triangle, are two sides and the subtended angle; its attributes are one side and two angles; and its modes are to be inscribed, circumscribed, etc.

40. The primordial properties and the attributes are constantly in the Being and never leave it. But the modes can either be in it or not, and it is only their possibility that is necessary and invariable.

41. There is no primitive and intrinsic reason why the essential determinations of a Being are found in this Being. For, these determinations being that which one is first able to conceive in the Being, one can there conceive some other prior thing on which the first determinations

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themselves depend. Thus, for example, there is a first and internal reason why the equilateral triangle has its three angles equal; but there is no reason at all why its three sides are equal. For these three equal sides are what one takes for demonstrating the equality of the three angles: for a triangle is determinable in several ways; it can be equilateral, or scalene; but it is I who determines it to be equilateral, in making its three sides equal. **{Difference between essential determinations and attributes.}** There are essential determinations of a Being, like the givens in a problem, that are simply possible determinations that neither contradict nor cancel each other; and that, by their combination, give rise to some new determination that one must look for. If these first determinations, that we call the *determinants*, had an intrinsic reason why they are together, the problem would be over-determined; **{Plate 1. Fig. 5, number 2}** to find, for example, the fourth side *L* of a trapezoid, one would give more determinations than are needed for the solution to the problem in giving the three sides *A*, *B*, and *C* and the three angles *o*, *u*, and *r*, since the three sides *A*, *B*, *C* with the two angles *o* and *u* suffice to determine all that is proper to this trapezoid; and the third angle *r* being itself already determined by these givens, it must not be listed among these determinants. For these givens do not have any intrinsic determinations, and their magnitude can vary, and be such that he who poses the problem decides accordingly; but the angle *r* is determined by the three sides *A*, *B*, *C*, and the two angles *o* and *u* and its magnitude cannot vary.

42. It is evident from this that the properties or attributes have their sufficient reason in the essential determinations; for since once these essentials are posited the properties also are, one can understand by the nature of these essential determinations why the attributes or properties are as they are, rather than otherwise. **{Fig. 5, number 2}** Thus, one sees that the magnitude of the angles *r* and *s* and of side *L* of the trapezoid *A*, *B*, *C*, *L*, follow from the magnitude of the three other sides, and from the two other angles that are the essential determinations of the trapezoid *A*, *B*, *C* and that are its essence; and as these essential determinants vary, the attributes or properties necessarily vary also: they are the unknowns of a problem that must have their sufficient reason in the givens, since without this it would be impossible to solve the problem and determine them.

43. {That which we call modes.} Modes are the limitation of the subject of which they are the modes: everything that is not in conflict with the essential determinations, even though the essential determinations do not determine them, is a *mode*. **{Their possibility but not their actuality arises from the essence.}** Thus, one can understand through these essential determinations, why a mode is possible, but not why it becomes actual. For if the essential determinations contained the reason for the actuality of the modes, the modes would become

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attributes, since it would be impossible for them not to be found in the Being.

44. Thus the simple possibility of modes finds its sufficient reason in the essence; but their actuality depends either on other antecedent modes, or on exterior Beings, or on both at the same time.

Neither can the attributes contain the reason for the actuality of the modes, for that which is based in the attributes is originally based in the essence, upon which the attributes depend; and thus the actual modes would be necessary and immutable like the attributes themselves, if the reason for their actuality was found in the attributes. Now, since this reason can be found neither in the essence nor in the attributes of a Being: if it is found in the Being itself, it must be based in the antecedent modes (for a Being has only its essence, its attributes, and its modes); if it is not in the Being itself, it must be found in exterior Beings; and if only one part of this reason is found in the Being, the rest must be found in the exterior Beings. This is so that the reason for the actuality of the modes becomes sufficient.

An example will clarify all of this. The given position of the parts of a Clock, for example, does not depend on its essence, for it can change; the possibility of this position derives solely from the essence: but its actuality comes from the preceding position; and if an external agent made the wheels of this Clock turn, the actuality of the new position that these parts would acquire would depend in part on this external Being, which applies its force to make the wheels move, and in part on the preceding position, in which it found the wheels of this Clock before making them turn.

The movements of the human Body can also serve as an example; for all the movements that I can make with my arm are possible through my essence; but the actuality of any movement, depends in part on the exterior objects that are determining me, and in part on the previous situation of my arm.

45. Since the essence consists in the assemblage of several non-conflicting determinations to make a single Being, one sees that the possibility of the actual essences is necessary, and that it implies a contradiction to say that there has been a time when an essence that is at present possible has been impossible, because this would require that one thing can be possible and impossible at the same time. **{These essences are necessary.}** The essence of a triangle, for example, consists in there being nothing conflicting in three given lines, of which two taken together are longer than the third, enclosing a space, and one can never conceive that this becomes impossible, without admitting that the same determinations could be self-conflicting and not self-conflicting at the same time.

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46. {They are invariable like numbers.} In the same way that essences are possible for all eternity, they are invariable. For, if in the place of one of the determinations that constitute the essence of a Being, one substitutes another determination that can subsist with the others (for without that, this substitution of determination could not take place), one will have a new Being; but the first will not have been changed due to this, either in its possibility or in its essence. Thus, for example, if in the place of one of the sides of a triangle, one puts two others, one neither destroys nor changes due to this the essence of the triangle; but one makes a four-sided Figure, that is to say, a Being of a new kind.

Thus, the Scholastics were right to say that essences are like Numbers: nothing is more accurate than this comparison, that is even a kind of demonstration that clarifies marvelously this doctrine of essences; for, to make a number, one combines some units, the combination of which is not necessary, but only possible. Now, if you remove one of these units, or if you add one to them, you will have another number; thus nothing can be removed, nor added to a number, *salvo Numero*, without the destruction of this number. It is the same with essences; some determinations that are not necessarily together, but that are not in conflict with one another, constitute the essence; and whether you remove one from or add one to it, the essence is no longer the same, it is no longer the same Being; but from it originates the essence of another Being very different from the first.

47. {Attributes are incommunicable.} It follows furthermore from what was said about the foundation of the attributes that they are incommunicable: for having their sufficient reason in the essence, it is impossible to transport them elsewhere; and one can find in a subject only those attributes that flow from its essence. **{From where it follows that thought cannot be an attribute of matter.}** This ends the famous dispute among the Philosophers, as to whether God could have given thought to matter or not. For it follows necessarily from the Doctrine of essences, that there cannot be any properties in a subject except those that originate from its essence, that is to say, from the Combination of its essential and invariable determinations. All Philosophers avow that matter, *qua* matter, that is to say, as extended and impenetrable, cannot form a thought; but they say*, that God has perhaps given to matter the attribute of thought, even if it does not have it through its essence, and that thus, just as one does not know what it pleased God to do, one cannot know either whether that which thinks in us is matter or not*. **{Locke, *Of Human Understanding*.}** Since they avow that thought is not founded in the essence of matter, and that it is not an attribute of matter, neither can it have been communicated to matter, since by the Doctrine of essences, attributes are incommunicable, and they must all have their foundation

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in the essence: it is therefore impossible for thought to be an attribute of matter.

48. I said in the preceding Chapter (§30) that God's understanding was the source of all that is possible, but as this matter is of ultimate importance in Physics, I think it is necessary to clarify it here.

{In which way Divine understanding is the source of all that is possible.} Divine understanding is the source of all that is possible, because all possible things with all their possible determinations are contained therein. But the essences of things (that is to say, the first determinations by the combination of which they become possible, and from which all their properties flow) have their foundation in the principle of contradiction: they are possible because it does not imply any contradiction that such or such determinations can be assembled in such or such a way. Thus the essence of a Circle consists in a Line of which all the points are equally distant from another point that we call the center; now it does not imply any contradiction that a Line can be turned around a fixed point to describe a Circle, and it is impossible to conceive that this has ever implied a contradiction. Thus, the essences of things are not arbitrary, and they do not depend upon God. For, if things were possible only because God wanted it that way, they would become impossible if he wanted it another way; that is to say, all would be possible and impossible at the same time, which is a contradiction in terms. Thus to say that essences do not depend upon God is to say simply that God cannot make them contradictory, which is not a negation of power. **{The essences, that is to say, the possibility of things, does not depend on the will of God.}**

{The opinion that the essences of things are arbitrary inevitably leads to absurdity.} If one agreed that the essences of things depended upon the will of God, yet another very palpable contradiction would follow; for given that God's understanding consists in the representation of the possible, if the possibility of things depended upon his will, one would have to say that God has been without understanding while his will was occupied in creating the possible. Yet there would not then have been any reason why he would have been able to decide to bestow possibility upon certain things rather than others, since he did not know them. Thus, it is as if one were saying that the understanding or the representation of things was in God before the understanding and the representation of things, which is a contradiction in terms.

49. Although the essence of things does not depend upon God, nevertheless it does not follow that there is anything outside of him; for the ideas that represent the possibility of things are essential to God, and his understanding contains everything that is possible, and everything that is not found there is impossible. Thus, Divine understanding is the eternal region of truths, and

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the source of possibilities, in the same way that his will is the source of actuality and of existence.

{The actuality of things depends upon the will of God.} One must therefore say that the actuality of things depends upon the will of God. For having given existence to this World rather than to any other possible World, the World exists because God willed it, and another would exist if he had willed it otherwise. But the possibility of things has its source in the understanding of God, who necessarily conceived all that is possible from all eternity, but not in his will, which can only be determined as a consequence of what his understanding represents. Thus, one must not admit anything as true in Philosophy when one cannot give any reason for its possibility other than the will of God, for this will does not enable one to understand how a thing is possible. Thus, one cannot conceive how such a great man as Descartes was able to think that essences were arbitrary, since this opinion is entirely overthrown by the principle of contradiction, which he himself had posited at the beginning of his Philosophy.

50. **{How one must judge which properties pertain to a Being.}** Thus when it is a question of admitting some properties in a Being, one must see if this property follows from its essence, that is to say, from the primordial determinations that make it possible; for insofar as a Being is considered alone, one must show its intrinsic possibility by the principle of contradiction, and its external possibility, or its actuality, by the principle of sufficient reason, and from there deduce the attributes of this Being, and the modes to which it is susceptible. And when one considers this Being as placed in the order of things, and linked[2] with the other Beings that surround it, one must show how a Being depends upon its neighbor, and which causes gave actuality to the modes that were simply possible when the Being was considered as isolated and outside the order of things. It is in this way that God executed his will, and that one must seek to give reason to things in Philosophy.

This single truth of the immutability of essences at a stroke banishes from Philosophy all precarious hypotheses, and all the monsters arising from the imagination of men, which have so held back the progress of the Sciences and of the human mind. Such are the primitive forces of the Scholastics that were to be found in matter with no reason other than the will of God. Such would be attraction if one wanted to make it an inherent property of matter. Such is, finally, as I said above (§47), the idea of the famous Locke on the possibility of thinking matter.

[2] We follow Bour and Zinsser's translation of "lié" as "linked" (see §130). Note that "lier" can be translated with a range of connotations, from weak to strong.

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51. **{Of Substance.}** By this principle of the immutability of essences, one can explain what Substance is. Substance is something that the whole world talks about and for which no one has yet given a good definition.

{Definition of Substance by the Scholastics.} The Scholastics defined Substance, *Ens quod per se subsistit & sustinet accidentia*, that is to say, *a Being that subsists by itself & is the sustainer of accidents*. But when one wants to know what it is *to subsist by itself, to sustain accidents, and the way in which they are sustained*, one receives nothing in response but new words to define, and to which no distinct idea is attached.

Descartes did not get much further than the Scholastics on this subject, for he defined Substance, *a Being that exists such that it has no need of any other Being for its existence*. Now one sees well that this returns to the *per se subsistere* of the Scholastics, and that furthermore, if one takes this definition rigorously, the only true Substance will be God, since all Creatures subsist through him, and since he alone subsists through himself.

{Mr. Locke's idea on Substance.} Mr. Locke himself dwelt upon the imaginary notion of Substance, such as the senses and the imagination have given to the common people. He says **{Locke, Book II, ch. 23}**: *that Substance is nothing other than a subject that we do not know, and that we suppose to be the sustainer of the qualities whose existence we discover, and that we do not believe can subsist,* sine re substante, *without something that sustains them, and that we give to this sustainer the name Substance which, rendered clearly in French means, that which is beneath, or that which sustains*. One sees easily that this notion of Substance is entirely confused, as Mr. Locke himself admits, and that it is nothing other than a kind of comparison that has some resemblance to the true notion.

Other Philosophers have denied the distinction between Modes and Substances, believing that all that belongs to the Being was equally necessary, and that the Modes become the Substances, and that the Substances become the Accidents, depending upon how one thinks of them, thus confusing Grammatical nouns that are Substances by fiction with the true Substances of Nature. Thus, when I say *white*, I express a mode; but I make of it a Substance by fiction when I say *whiteness*, even though whiteness can never be a true Substance.

52. **{The true notion of Substance.}** We saw above (§36) that each Being has constant determinations that remain always the same while the Being subsists, and variable determinations that change while the others endure. We saw furthermore that the attributes flow necessarily from the essential determinations, as does the possibility of the modes, of which the actuality alone is variable (§§39 & 43). Now it follows from this, that the essential determinations are the sustainer of the Being, whence this *substratum*, which has so embarrassed

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the Philosophers; for the essential determinations being removed, the attributes fall as though in ruins, just as do the modes, and so the Being no longer exists, it is no more.

{Every Being that endures and is modifiable is a Substance.} Thus, the essence is the source of the attributes and of the possibility of the modes; therefore it is like the support and the sustainer of all that can suit the Being; and one can define Substance, *that which conserves the essential determinations and the constant attributes, while the modes in it vary and succeed one another*, that is to say, a durable and modifiable subject: for insofar as it has an essence and properties that flow therefrom, it endures and continues to be the same, and insofar as its modes vary, it is modifiable. But a Being that is not at all modifiable is an accident, such as white, for example; for the least modification of this color changes it into another, and it cannot be modified without being changed.

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