

## **Denis Diderot. Philosophical principles on matter and movement**

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I don't know in what sense philosophers have supposed that matter was indifferent to movement and to rest. What is very certain, is that all bodies gravitate upon each other, that all particles of bodies gravitate upon each other, that in this universe, all is in translation or in *nisu* (effort), or in translation and *in nisu* at once.

This supposition of philosophers resembles those of geometers who admit points without any dimension, lines with neither length nor depth, surfaces without thickness, or perhaps they speak of rest of one mass relative to another. Everything is in relative rest in a vessel beaten by the storm. Nothing is in absolute rest, not even aggregative molecules, nor this vessel, nor the body that it encloses.

If they do not conceive of the tendency to rest more than movement in a body of any kind, they apparently look at matter as homogenous. They make an abstraction from all qualities which are essential to it; they consider it as inalterable in the instant almost indivisible from their speculation. They reason from relative rest of one aggregate to another aggregate, they forget that while reasoning from the inertness of a body to movement or to rest, a block of marble tends toward its dissolution. It is what they annihilate by thought and general movement which animates all bodies and the particular action of one upon the other, which destroys them all. It is how this inertness, false in itself but temporary, has not made the laws of movement erroneous.

*The body, according to some philosophers, is, in itself without action and without force.* This is a terrible falsity, strongly contrary to all good physics, to all good chemistry. By itself, by the nature of its essential qualities, whether considered as a molecule or as a mass, it is full of action and force.

*For you to represent movement, they add, in addition to existing matter, it is necessary for you to imagine a force which acts on this matter.* This is not so. The molecule endowed with one quality appropriate to its nature, by itself is an active force. It exercises itself upon another molecule which is exercised upon it. All these paralogisms hold to the false supposition of homogeneous matter. You who imagine, matter at rest as well, can you

imagine fire at rest? Everything in nature has its diverse action, as does this heap of molecules that you call fire. In this heap that you call fire, each molecule has its nature, its action.

Here is the true difference between rest and movement: it is that absolute rest is an abstract concept that does not exist in nature, and that movement is a quality as real as length, width, and depth. Is it important to me what goes on inside your head? Is it important to me that you look at matter as homogeneous or heterogeneous? Is it important to me that, creating an abstraction of its qualities, and only considering its existence, you see it in rest? Is it important to me that you consequently search for one cause, which moves it? You will do as much as you please with geometry and metaphysics. But I who am a natural scientist and chemist, who works with bodies in nature and not from my head, I see them existing, diversely, adorned with properties and actions and acting in the universe as in the laboratory--where one spark is no longer found beside three molecules combined with saltpeter, carbon and sulfur, without a necessary explosion following.

Gravity is not a *tendency to rest*; it is a tendency to local movement.

*So that matter would be moving, it is said still, an action, a force is necessary*; yes, either exterior to the molecule, or inherent, essential, or interconnected with the molecule, and constituting its nature from an igneous, aqueous, nitrous, alkaline, sulfurous molecule. Regardless of this nature, it follows force, its action outside of it, action of other molecules on it.

*Force acting on a molecule exhausts itself*. Inner force of the molecule does not. It is immutable, eternal. These two forces can produce two types of *nisus*. The first, a *nisus* which ends; the second, a *nisus* which never ends. It is therefore absurd to say that matter has a real opposition to movement.

Quantity of force is constant in nature, but the sum of *nisus* and the sum of translations are variable. The greater the sum of *nisus*, the smaller the sum of translations; the greater the sum of translations, the smaller the sum of *nisus*. The incineration of a city suddenly spreads the sum of translations with a prodigious quantity.

An atom moves the world. Nothing has more truth, as much as the atom is moved by the world. Since the atom has its own force, it cannot be without effect.

As a natural scientist, we must never say, 'a body is a body'; because we are no longer doing natural science; it is to make abstractions which do not lead to anything.

We must not confound action with mass. There can be great mass and small action. There can be small mass and great action. One molecule of air might shatter a block of steel. Four grains of powder are sufficient for dividing a rock.

Yes, without doubt, when an homogeneous aggregate is compared to another aggregate of similar homogeneous matter, when we speak of action and reaction of these two aggregates, their relative energies are in direct relation to mass. But when it is a matter of heterogeneous aggregates, there are no longer the same laws. There are as many diverse laws as there are varieties of force, interconnected with and appropriate to each molecule, elementary and constitutive of bodies.

*The body is resistant to horizontal movement.* What does that mean? It is well known that there is a force general and common to all molecules of the globe we inhabit, a force which pushes against bodies according to a certain perpendicular direction, or approximately, to the surface of the globe. But this general and common force is contradicted by a hundred thousand others. Heating a tube of glass makes gold leaves flutter. A hurricane fills air with power. Heat volatilizes water; volatilized water carries with it, molecules of salt. While this mass of brass pushes against the earth, the air acts on it, changing its initial surface into a metallic chalk, beginning the destruction of this body. What I say of masses must be understood of molecules also.

Every molecule must be considered as currently animated by three types of actions: the action of gravity or gravitation, the action of its force interconnected with and belonging to its watery, fiery, airy, and sulfurous nature, and the action of all other molecules on it. And it might be possible that these three actions would be convergent or divergent. Convergent, then the molecule is endowed with its strongest action. In order to give an idea of the greatest possible action, it would be necessary to therefore say, to give a bunch of absurd suppositions, to place a molecule in a totally metaphysical situation.

In what sense can one say that a body resists all the more with movement as its mass is greater? It is not in the sense that the more its mass is great, the more its pressure against an obstacle is weak. No daily laborer (*crocheteur*) wouldn't know the opposite effect. It is only relevant to a direction opposed to its pressure. In this direction, it's certain that it resists

all the more with its movement as its mass is greater. In the direction of gravity, it's not less certain that its pressure or force, or tendency to movement, grows in relation to its mass. What then does all this signify? Nothing.

I am not surprised to see a body fall, any more than to see flame raise itself up, any more than to see action in water in every sense and to see it with weight in relation to its height and its base in a way that with a mediocre quantity of fluid, I can break the most solid vases, just as one sees steam dissolve the hardest bodies in Papin's machine, and raise the heaviest bodies in a pneumatic machine (*la machine a feu*). But I halt my eyes on the universal mass of bodies; I see everything in action and reaction; everything being destroyed under one form, everything being recomposed under another: from sublimations, dissolutions, combinations of all types, phenomena incompatible with the homogeneity of matter: from which I conclude that it is heterogeneous, that an infinity of diverse elements exist in nature; that each of these elements by its diversity has its individual force, innate, immutable, eternal, indestructible, and that these interconnected forces of bodies act outside of the body; wherefrom arises movement or rather universal fermentation in the universe.

What do the philosophers of whom I refute here, the errors and paralogisms, do? They attach themselves to a single and unique force, perhaps, common to all the molecules of matter; I say, *perhaps*; because I will not be surprised that there was in nature, such a molecule which, joined to another, rendered the resulting mixture lighter. Always in the laboratory, an inert body is volatilized by an inert body. And when those who only consider all action in the universe as that of gravitation, in having inferred inertness from matter to rest or movement, or rather, the tendency of matter to rest, they believe to have resolved the question, when they have not even grazed it.

When the body is looked at as more or less resistant, and not as weighing or tending towards a center of gravity (an ancient formulation of gravity), a force is already recognized, an interconnected and appropriate action; but it has many others, between which some are, in every sense, exerted, and the others have particular directions.

The supposition of a being of any kind placed outside the material universe is impossible. We must never suppose likewise, because one can never infer anything from these suppositions.

Everything that is said of the impossibility of the growth of movement or of speed, carries weight against the hypothesis of homogenous matter. But what is this fact to those who infer

movement in matter, from its heterogeneity? The supposition of a homogenous matter is strongly subject to other absurdities.

If one does not insist on considering things his head, but in the universe, he will convince himself by the diversity of phenomena, from the diversity of elementary matter, from the diversity of forces, from the diversity of actions and of reactions, from the necessity of movement; and all these accepted truths, he says no more, 'I see matter as existing; I see it first of all at rest'; because he will sense that this is to make an abstraction from which one can not conclude anything. Existence entails neither rest nor movement; but existence is not the only quality of rest.

All natural scientists who suppose matter indifferent to movement and to rest, have no clear ideas of resistance. In order that they may conclude something of resistance, it would be necessary that this quality should have exerted itself indistinctly in every sense, and that its energy was the same according to every direction. So this would be an inner force, such as that of every molecule; but this resistance varies as much as there are directions in which the body can be pushed. It is greater vertically than horizontally.

The difference between gravity and the force of inertia: it is that gravity does not equally resist, in all directions; instead, the force of inertia resists equally, in all directions.

And why would the force of inertia not bring about the effect of retaining the body in its state of rest and in its state of movement, and by the single notion of resistance proportionate to the quantity of matter[?] The notion of pure resistance is applied equally to rest and to movement: to rest when the body is in movement; to movement, when the body is in rest. Without this resistance, there would be no shock before movement nor would it be stopped after this shock; because the body would be nothing.

In the experiment of the ball suspended by a thread, gravity is destroyed. The ball pulls the thread, as much as the thread pulls the ball. Thus the resistance of bodies comes from the force of inertia alone.

If the thread would pull the ball more than gravity, the ball would ascend. If the ball was pulled more by gravity than by the thread, it would descend. Etc. Etc.