

NEWTON TO LEIBNIZ

Cambridge, 16 October 1693

To the celebrated Gottfried Wilhelm Leibniz:

Isaac Newton sends greetings

As I did not reply at once on receipt of your letter, it slipped from my hands and was long mislaid among my papers, and I could not lay hands on it until yesterday. This vexed me since I value your friendship very highly and have for many years considered you as one of the leading geometers of this century, as I have also acknowledged on every occasion that offered. For although I do my best to avoid philosophical and mathematical correspondences, I was however afraid that our friendship might be diminished by silence, and at the very moment too when our friend Wallis has inserted into his imminent new edition of his *History of Algebra*⁸ some new points from letters which I once wrote to you by the hand of Mr. Oldenburg,⁹ and so has given me a handle to write to you on that question also. For he asked me to reveal a certain double method which I had there concealed by transposed letters. And so I have been compelled to expound as briefly as possible my method of fluxions which I had concealed by this sentence: *given an equation involv'ing any number of fluent quantities to find the fluxions, and conversely*. I hope indeed that I have written nothing to displease you, and if there is anything that you think deserves censure, please let me know of it by letter, since I value friends more highly than mathematical discoveries . . . [.]

Huygens is a master, and his remarks on my discoveries are brilliant.¹⁰ The parallax of the sun is less than I had concluded it to be,¹¹ and it would seem [in his view] the motion of sounds is perhaps more rectilinear. But some very fine matter seems to fill the heavens. For since celestial motions are more regular than if they arose from vortices and observe other laws, so much so that vortices contribute not to the regulation but the disturbance of the motions of planets and comets; and since all phenomena of the heavens and of the sea follow precisely, so far as I am aware, from nothing

⁸ John Wallis's *A Treatise on Algebra, both Historical and Practical* (1685) appeared in a Latin edition as *De Algebra Tractatus: Historicus et Practicus* in 1693 from an Oxford publisher.

⁹ Newton wrote a letter on 24 October 1676, a portion of which he had Oldenburg send to Leibniz.

¹⁰ This refers to Huygens's *Treatise on Light*, which Leibniz mentions in his letter to Newton above (see n. 2 above).

¹¹ Newton discusses this issue in the first paragraph of his fourth letter to Bentley (see p. 102 of this volume).

but gravity acting in accordance with the laws described by me; and since nature is very simple, I have myself concluded that all other causes are to be rejected and that the heavens are to be stripped as far as may be of all matter, lest the motions of planets and comets be hindered or rendered irregular. But if, meanwhile, someone explains gravity along with all its laws by the action of some subtle matter, and shows that the motion of planets and comets will not be disturbed by this matter, I shall be far from objecting. As for the phenomena of colors, the so-called apparent colors as well as the fixed, I conceive myself to have discovered the surest explanation, but I refrain from publishing books for fear that disputes and controversies may be raised against me by ignoramuses.¹² The Newton whose works meet your eye in the catalogues of published books is someone else. My aim in these pages has been to give proof that I am your most sincere friend and that I value your friendship very highly. Farewell.

LEIBNIZ TO HARTSOEKER PUBLISHED IN
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Hanover, 10 February 1711

You speak, sir, as if you knew not what I mean by *conspiring motions*; and ask, whether what I call so, be not the same thing with rest? I answer, it is not. For rest does not tend to make or preserve the cohesion of the parts that are at rest; and though two bodies remain one by another, they make no effort to continue to remain together, whether they touch one another, or not: but when there is a *conspiring motion* in their parts, which is disturbed by a separation, some strength is required to overcome that obstacle. Nor is it necessary that in the *conspiring motions* the parts should not change their distance. They may very well change it, provided that spontaneous change be quite another thing than a violent change, which would occasion a separation, and disturb those motions: and the parts of bodies resist a separation, not because they have a tendency to be divided; for in such a case they would resist still, if they were altogether at rest, which is contrary to what I maintain; but because they have a considerable motion, which must be disturbed by a separation. If those parts tend to a separation of themselves, they help any one who would separate them;

¹² Newton is presumably referring here to his discussion of colors in his optical papers from the 1670s. The "book" he wrote on this and related topics, the *Opticks*, was not published until 1704.

thing from affirming that there are some things of which no reason can be given, which is contrary to the first principles of reasoning: it is just as if somebody had denied the axiom, which Archimedes made use of in his book *de Aequiponderantibus*,¹⁵ viz., that a balance, when everything is equal on both sides, remains in an *equilibrium*, under pretense that things are not sufficiently understood, and that perhaps the balance undergoes some alteration without any reason for it.

Thus the ancients and the moderns, who own that gravity is an *occult quality*, are in the right, if they mean by it that there is a certain mechanism unknown to them, whereby all bodies tend towards the center of the earth. But if they mean that the thing is performed without any mechanism by a simple *primitive quality*, or by a law of God, who produces that effect without using any intelligible means, it is an unreasonable occult quality, and so very occult, that it is impossible it should ever be clear, though an angel, or God himself, should undertake to explain it.

The same ought to be said of *hardness*. If any one acknowledges that the mechanism, which occasions hardness, is unknown to him, he is in the right; but if he pretends that hardness proceeds from any other cause than mechanism, and if he has recourse to a primitive hardness, as the assertors of atoms do, he recurs to a quality that is so occult, that it can never be made clear; that is, to a thing both unreasonable and contrary to the first principles of reasoning, since he owns that there are some natural things that have no natural cause.

Those are also guilty of the same fault who admit an indifference of *equilibrium*, as if the will could be determined, when all things are equal on both sides both inwardly and outwardly. Such a case never happens: there is always a greater inclination on one side than on the other; and the will is always inclined by some reason, or disposition, without being necessitated; and I dare say that many faults committed in arguing proceed from not duly observing this great principle, that *nothing happens without a sufficient reason for it*. A principle, the force and consequences whereof have not been sufficiently considered by Descartes, and many other great men. That principle is sufficient to destroy the *vacuum*, the atoms, and the occult qualities of some philosophers, and even the first element of Descartes, with his globes, and many other fictions.

¹⁵ Leibniz may have had this edition of Archimedes in mind: *Archimedeus Panta Sosomena. = Archimedis Opera quae Exstant: Novis Demonstrationibus Commentariisque Illustrata*, ed. David Rivault Flurance (Paris, 1615).

Thus, sir, you see why God could not create atoms, that is, bodies hard by their own nature, bodies of a primitive and insuperable hardness not to be accounted for; as he could not create planets that should move round of themselves, without any cause that should prevent their removing through the tangent: for a miracle at least must keep the planet in, and prevent the separation of the parts of the hard body, if a mechanical or intelligible cause does not do it. Granting the possibility of atoms, and the impossibility of a *vacuum*, I don't see why we should be forced to have recourse to a first element, that is, to a matter altogether fluid. Why may we not suppose space to be filled up with a matter that has different degrees of fluidity and tenacity, as I believe it is the nature of all matter?

Nor do I see why hard bodies should necessarily receive all their motion from fluid bodies, especially from a mass altogether fluid, or from our first element. For all matter being equally susceptible of motion, and equally incapable of producing it in itself, the most solid bodies may receive it, as well as those that are most fluid. Nay, it might be said, that the motion communicated to some few hard bodies may serve to account for the motion of many fluid bodies; and consequently, that it is anterior in order. For a solid body, thrown into a fluid, puts it into motion and produces a kind of circulation necessary to fill up the place which otherwise would remain empty behind the solid body; and that circulation forms a kind of vortex that has some affinity with that which we conceive round the lodestone [i.e. magnet].

It ought not to be said, that the universe is like an animal endued with life and intelligence: for then one might be apt to believe that God is the soul of that animal; whereas he is *intelligentia supramundana*, and the cause of the world: and if the universe was unlimited, it would be a collection of animals and other beings, but it could not be a single animal.

Your first element is not more susceptible of life and intelligence than any other bulk of matter; and since it is not organized, it is not fit it should have any perception, which must always answer the actions of organs, if you will have nature to act orderly and coherently.

You say, sir, that it is impossible for us to apprehend how a substance comes to have life and perception: and you are in the right, when the question is about particulars and the beginning of things. But perhaps you will own that the thing is more intelligible in my system of the *pre-established harmony*, by conceiving that our spiritual substances do naturally represent what happens in that part of matter to which they are united.

I have sufficiently answered those who objected to me that such a system was inconsistent with *free will*; for God knowing what men's minds would freely choose in time, adapted their bodies to it before hand. Mr. Jaquelot, who raised such an objection against me by word of mouth, was satisfied with my answer, as he owned in his book against Mr. Bayle: nay, he has cleared it with an elegant comparison. I have answered Father Lami's objection in the same manner; and my answer has been inserted in the *Journal des Sçavans*. When Mr. Bernoulli was Professor at Groningen, he maintained some theses, wherein he vindicated my opinion concerning the *pre-established harmony*.¹⁶

To conclude, the imperfections observable in the universe are like the dissonances of an excellent piece of music, which contribute to render it more perfect, in the opinion of the best judges. And therefore it cannot be said that when God created the world he made an imperfect machine. It is true, there are some machines in this world, that have not always, and from the beginning, [had] all the perfection that they are capable of.

I return you many thanks, sir, for your good wishes about the beginning of the New Year; and I wish you may long contribute to the improvement of the sciences, being with great zeal,

SIR,

Your most humble, and most obedient servant,
Leibniz

NEWTON TO THE EDITOR OF THE MEMOIRS OF
LITERATURE, UNPUBLISHED
London, circa May 1712

Sir

In your weekly paper dated 5 May 1712 I meet with two letters, one written by Mr. Leibniz to Mr. Hartsoeker, the other by Mr. Hartsoeker to Mr. Leibniz in answer to the former. And in the letter of Mr. Leibniz I meet with some things reflecting upon the English; I hope you will do them

¹⁶ See M. Jaquelot, *Entretiens de Maxime et de Themiste, ou, Réponse à l'Examen de la Théologie de Mr. Bayle* (Rotterdam, 1707); Pierre Bayle's most famous work is the *Dictionnaire Historique et Critique* (Rotterdam, 1697). Bayle and Leibniz were famous interlocutors. Due to François Lami's criticisms of Leibniz's conception of the pre-established harmony, Leibniz wrote a draft of a reply to Lami in 1702. Leibniz also corresponded in the fall of 1698 with the mathematician and physicist Johann Bernoulli.

the justice to publish this vindication as you have printed the reflexion. He writes thus: "It may be said in a very good sense that every thing is a continual miracle, that is, worthy of admiration, but it seems to me that the example of a planet which goes round and preserves it[s] motion in its orbit without any other help but that of God, being compared with a planet kept in its orbit by that matter which constantly drives it toward the sun, plainly shows what difference there is between reasonable natural miracles and those that are properly so called or supernatural; or rather between a reasonable explication, and a fiction invented to support an ill-grounded opinion. Such is the method of those who say, after Mr. de Roberval's Aristarchus,¹⁷ that all bodies attract one another by a law of nature which God made in the beginning of things. For alleging nothing else to obtain such an effect and admitting nothing that was made by God whereby it may appear how he attains to that end, they have recourse to a miracle, that is, to a supernatural thing, which continues forever, when the question is to find out a natural cause."¹⁸ Thus far Mr. Leibniz. I know not what just occasion there was for this reflexion in a discourse foreign to this matter, but it's plain this was intended against some in England and I hope to make it as plain that it was undeserved. For the true state of the case is this. It has been proved by some that all bodies upon the surface of the earth gravitate toward the earth in proportion to the quantity of matter in each of them; that the moon tends toward the earth and all the planets toward one another by the same law; and that by this tendency all their motions are performed. These things have been proved by mathematical demonstrations grounded upon experiments and the phenomena of nature: and Mr. Leibniz himself cannot deny that they have been proved. But he objects that because *they allege nothing else to obtain such an effect* (he means a tendency of all bodies towards one another) *besides a law of nature which God made in the beginning of things and admit nothing that was made by God* (he means no vortices) *whereby it may appear how God attains to that end, they have recourse to a miracle, and that is, to a supernatural thing which continues for ever, when the question is to find out a natural cause*. Because they do not explain gravity by a

¹⁷ See n. 14 above.

¹⁸ Each of Newton's paraphrases of Leibniz's original letter is very nearly exact; they have not been altered to correspond exactly to Leibniz's text, except in the case of the phrase "reasonable natural miracles," which I have altered both in the original and in Newton's quotation to match Leibniz's original French.

mechanical hypothesis, he charges them with making it a supernatural thing, a miracle and a fiction invented to support an ill-grounded opinion and compares their method of philosophy to that of Mr. de Roberval's Aristarchus, which is all one as to call it romantic [i.e. fictional]. They show that there is a universal gravity and that all the phenomena of the heavens are the effect of it and with the cause of gravity they meddle not but leave it to be found out by them that can explain it, whether mechanically or otherwise. And doth it deserve to be scouted with the language of a supernatural thing, a miracle, a fiction invented to support an ill-grounded opinion, and a method of philosophy after Mr. Roberval's romance?

But Mr. Leibniz goes on. "The ancients and the moderns, who own that gravity is an occult quality, are in the right, if they mean by it that there is a certain mechanism unknown to them whereby all bodies tend towards the center of the earth. But if they mean that the thing is performed without any mechanism by a simple primitive quality or by a law of God who produces that effect without using any intelligible means, it is an unreasonable and occult quality, and so very occult that it is impossible that it should ever be done though an angel or God himself should undertake to explain it." The same ought to be said of hardness. So then gravity and hardness must go for unreasonable occult qualities unless they can be explained mechanically. And why may not the same be said of the *vis inertiae* [force of inertia] and the extension, the duration and mobility of bodies, and yet no man ever attempted to explain these qualities mechanically, or took them for miracles or supernatural things or fictions or occult qualities. They are the natural, real, reasonable, manifest qualities of all bodies seated in them by the will of God from the beginning of the creation and perfectly incapable of being explained mechanically, and so may be the hardness of primitive particles of bodies. And therefore if any man should say that bodies attract one another by a power whose cause is unknown to us, or by a power seated in the frame of nature by the will of God, or by a power seated in a substance in which bodies move and float without resistance and which has therefore no *vis inertiae* but acts by other laws than those that are mechanical: I know not why he should be said to introduce miracles and occult qualities and fictions into the world. For Mr. Leibniz himself will scarce say that thinking is mechanical as it must be if to explain it otherwise be to make a miracle, an occult quality, and a fiction.

But he goes on and tells us that God *could not create planets that should move round of themselves without any cause that should prevent their removing through the tangent*. For a miracle at least must keep *the planet in*. But certainly God could create planets that should move round of themselves without any other cause than gravity that should prevent their removing through the tangent. For gravity without a miracle may keep the planets in. And to understand this without knowing the cause of gravity, is as good a progress in philosophy as to understand the frame of a clock and the dependence of the wheels upon one another without knowing the cause of the gravity of the weight which moves the machine is in the philosophy of clockwork; or the understanding of the frame of the bones and muscles and their connection in the body of an animal and how the bones are moved by the contracting or dilating of the muscles without knowing how the muscles are contracted or dilated by the power of the mind, is [in] the philosophy of animal motion.