IX. On the system of forces

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upon any fortuitous circumstances. As I have since learned from two well-informed naturalists, that it was commonly believed that the garden spider merely suffered its threads to float in the wind by chance, I thought it might be of some utility to publish the result of my observations.

IX. *On the System of Forces.* By J. C. DELAMETHERIE.
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GEOMETRICIANS, accustomed to precise mathematical demonstration, cannot reconcile themselves to the difficulties which occur in the explanations given by physics to the different phenomena of nature. They prefer the method of the great Newton, which is, to calculate the effects whatever may be the causes; and hence has been introduced the system of forces, which seems to gain ground in a singular manner. Kant is one of the first who announced it in Germany. He distinguishes two kinds of physics, the *dynamic* and *atomist*. He calls atomist physics that which teaches that the primitive parts of matter are composed of atoms or indivisible parts, and which endeavours to explain all the phenomena of nature by the action or impulse of different fluids. The second, which he calls dynamic physics, appears to him preferable. It supposes matter to be composed of molecular always divisible. This matter is actuated by two forces: 1st. the attractive; and, 2d. the repulsive. The atomists consider fluids as composed of small solid molecular. Kant does not admit these solid molecular. Fluids, according to him, are such originally, so that we cannot conceive a part of a fluid which is not fluid. These two forces, according to Kant, produce several other forces, viz. 3d, the caloric force, which is the principle of heat and of all the phenomena ascribed to fire; 4th, the luminous force, which is the principle of light and all the phenomena depending on it; 5th, the electric force, which is the cause of all the phe-

nomena ascribed to electricity ; 6th, the magnetic force, which produces all the phenomena ascribed to magnetism. Consequently all the phenomena of heat, light, electricity, magnetism, according to him, are modifications of the attractive and repulsive force of the first parts of matter, and there exists neither caloric fluid, luminous fluid, electric fluid, nor magnetic fluid. This system has numerous partisans in Germany, and it has even been extended still further. 7th. The galvanic force. Humboldt supposes that the phenomena of galvanism may be explained by a particular force, which he calls the galvanic. Humboldt however always speaks of a galvanic fluid, as several of Kant's pupils speak of the caloric fluid, the luminous fluid, the electric fluid, and the magnetic fluid. But these are mere denominations, which express the unknown causes of the phenomena of heat, light, electricity, magnetism and galvanism. 8th. The vital force, *vita propria*. Blumenbach, to express the phenomena of vitality, supposes a particular force, which he calls *vita propria*. 9th. *Nifus formativus*. The same learned man, to express the formation of organized bodies, supposes a particular force, which he calls *nifus formativus*. This amounts to the same as that called by other philosophers the plastic force.

Barthez believes also, that we ought to consider all the vital functions in man and animals, as produced by peculiar forces and directed according to the primordial laws of a vital principle. "I think I have found, adds he, that there exists in the living muscles a force of the fixed situation of the molculæ and of their fibres (tending to rest) different from the forces of contraction and dilatation (tending to motion), the existence of which has not been before so much as suspected. The forces of the vital principle are inherent in each part of the body which they animate, and exercise there the movements peculiar to that part. The sound method of philosophizing in each natural science admits in them general *occult causes*."

* Nouvelle Mécanique des Mouvements de l'Homme, par Barthez.

As this expression, *occult causes*, which modern philosophy has had so much difficulty to banish, is inconsistent with the generally adopted ideas, I shall here offer some reflections on that subject, as well as on Kant's system of forces. In my opinion, the manner of cultivating natural philosophy ought to be considered under several points of view.

1st. Some confine themselves to a description of the objects and phenomena that occur. The zoologist describes animals, their manner of living, and of reproducing their species. The botanist does the same in regard to plants. The mineralogist in the like manner describes minerals and their external qualities. The physical geographer describes the surface of the earth; and the astronomer the celestial bodies, their movements, &c.

2d. Others go still further. The anatomist explores the internal parts of animals and vegetables, and describes their structure; and the chemist analyzes them, as well as minerals, to discover the principles of which they are formed.

3d. The geometrician calculates the movements and forces of all these beings, independently of the causes by which they may be produced; and he furnishes the mechanist with calculations for constructing and directing his machines.

4th. In the last place, others endeavour to discover the causes of all the phenomena exhibited by these bodies, as well as to explain the mechanism of their different movements. This is the science of physics. But it has so often led men into error, that true philosophers are exceedingly difficult in regard to the explanations it gives. This has induced them to have recourse to the system of forces, by which they express a fact, the effects of which they calculate without attempting to trace them to their causes: as they cannot, for example, yet explain the phenomena of vitality, they express them by the words *vital force*, whatever may be their cause. The vital force, then, is that which produces the phenomena of vitality; but we are ignorant of the manner in which it acts. This is what ought to be understood by the expression *occult causes*. The an-

cients, for example, not being acquainted with the weight of the atmosphere, could not explain why water did not rise in a pump but to a certain height. They said it was the effect of an occult cause; that is to say, of a cause with which they were unacquainted, which was concealed from them, *occulta*.

In the like manner we ought only to understand by the word *force* the cause of a general fact, whether this cause be known or not. This is the acceptation in which the word was understood by Newton. He observed that all bodies had a tendency towards each other, and he called the cause of this general phenomenon attractive force, or attraction. He observed also, that in certain circumstances they repelled each other; and he called the cause of this second general phenomenon repulsive force, or repulsion. This mode of expression may be applied to all the grand phenomena of nature, and we may use the word *force* in the following different senses: *Luminous force*, the cause of the phenomena of light; the *caloric force*, the cause of the phenomena of heat; the *electric force*, the cause of the phenomena of electricity; the *magnetic force*, the cause of the phenomena of magnetism; the *galvanic force*, the cause of the phenomena of galvanism; the *sonorous force*, the cause of the phenomena of sound; the *capillary force*, the cause of the phenomena of capillary attraction; the *force of affinities*, the cause of the phenomena of affinity; the *dissolving force*, the cause of the phenomena of solution; the *consolidating* (*solidifiante*) *force*, the cause of the phenomena of solidity; the *crystallizing force*, the cause of the phenomena of crystallization; the *vital force*, the cause of the life of animals and vegetables; the *generative force*, the cause of the generation of animals and vegetables; the *nutritive force*, the cause of nutrition; the *muscular force*, the cause of muscular motion; the *sympathetic force*, the cause of sympathetic movements; the *concocting force*, the cause which assimilates morbid humours. The number of these forces might be greatly extended if we employ

employ that term to express the cause of a general phenomenon.

The geometer calculates the effects of those forces which he employs, as he does algebraic signs instead of numbers to simplify his operations; but if he wishes afterwards to obtain results, he must give to these signs their real values. In the like manner, if he wishes to have a physical result, he must assign a value to the word *force* which he employs. The philosopher endeavours to discover the causes of these forces; but he is so often deceived, and gives so many false explanations, that we are always inclined to consider as bad those which he assigns. We must not, however, fall into the opposite excess, and ascribe to the word *force* an acceptance which it ought not to have. Let us imitate the wisdom of Newton: "All bodies, says he, have a tendency towards each other; that tendency I call attraction, attractive force; but it may be the effect of an impulsion, or of some other cause which is unknown to us." He says the same thing of repulsive force. Let us apply this to all the forces before mentioned. The sonorous force, for example, has certainly as its cause some agitation in the sonorous body, and the atmospheric air by which it is surrounded. This is a certain fact, though we cannot yet explain all the phenomena exhibited by sonorous bodies. The case is the same with the luminous, electric, magnetic, caloric, and galvanic forces. The phenomena of heat, light, electricity, magnetism, galvanism, have as causes the movements of particular fluids; and, though we are not yet able to determine the nature of all the movements of these fluids, we know that their action is in the inverse ratio of the squares of the distances.

Réil has shown that the *nîsus formativus* of Blumenbach ought to be considered, as I have said, as a real force of crystallization. In general the formation of organized bodies, their increment, their nutrition, is nothing but this force of crystallization. It has formed all minerals; the globe itself, and the whole universe. It is also the consolidating

dating power, or that which gives solidity to all bodies. The force of crystallization is consequently a force which acts in the most general manner in nature; that is to say, among existing beings. Attraction itself is the effect of the action of the gravific fluid, and repulsion is the effect of the repulsive fluid or caloric. The philosopher acknowledges that he is yet ignorant of the manner in which all these fluids act: he is only acquainted with some of their laws.

This acceptance of the word force leaves every possible latitude to the calculations of geometry (which form the physico-mathematical sciences), and does not violate the principles of sound philosophy. The expression *occult causes*, explained in this manner, can give no offence. But if people should persist to consider force as a quality independent of the action of all matter, fluid or not fluid, this would be a mere metaphysical abstraction.

X. *Observations on the Satellites of the Georgium Planet, and the two innermost Satellites of Saturn.* By Dr. J. H. SCHROTER, F. R. S. &c. From *Neuere Beytrage zur Erweiterung der Sternkunde.* 1798.

I WAS prevented by various speculations, during the hours of observation, from directing the thirteen or twenty-seven feet reflectors to the Georgium Sidus till the 19th of February 1797, when about eight o'clock in the evening I looked at it through the thirteen feet reflector, with a magnifying power of almost 200. It appeared very plainly as a planet of mensurable diameter, having a pale white light; and in a little time, when the eye became accustomed to the instrument, several very small stars were perceptible around it. Two of these, being the nearest, in *a* and *b* (Plate VI, fig. 1), were a little clearer, though it was with some difficulty they could be distinguished. The largest, *a*, was to the north-