

Three concepts of cause in Newton's thought

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Since the ancients (according to Pappus) considered *mechanics* to be of the greatest importance in the investigation of nature and science and since the moderns—rejecting substantial forms and occult qualities—have undertaken to reduce the phenomena of nature to mathematical laws, it has seemed best in this treatise to concentrate on *mathematics* as it relates to natural philosophy. (*Principia mathematica*, preface to first edition, 1687)

Definitions to *Principia mathematica*

Definition One

Quantity of matter [quantitas materiae] is a measure of matter that arises from its density and volume jointly.

...I mean this quantity whenever I use the term 'body' or 'mass' in the following pages.

Definition Four

Impressed force is the action exerted on a body to change its state either of resting or of moving uniformly straight forward.

This force consists solely in the action and does not remain in the body after the action has ceased.

Definition Five

Centripetal force is the force by which bodies are drawn from all sides, are impelled, or in any way tend, toward some point as to a center.

One force of this kind is gravity, by which bodies tend toward the center of the earth; another is magnetic force, by which iron seeks a lodestone; and yet another is that force, whatever it may be, by which the planets are continually drawn back from rectilinear motions and compelled to revolve in curved lines.

Thus far I have explained the phenomena of the heavens and of our sea by the force of gravity but I have not yet assigned a cause to gravity. Indeed, this force arises from some cause that penetrates as far as the centers of the sun and the planets without any

diminution of its power to act, and that acts not in proportion to the quantity of the *surfaces* of the particles on which it acts (as mechanical causes are wont to do) but in proportion to the quantity of *solid* matter, and whose action is extended everywhere to immense distances, always decreasing as the squares of the distances [...] (*Principia mathematica*, General Scholium, second edition, 1713)

It is inconceivable that inanimate brute matter should, without the mediation of something else, which is not material, operate upon and affect other matter without mutual contact, as it must be, if gravitation in the sense of Epicurus, be essential and inherent in it. And this is one reason why I desired you would not ascribe innate gravity to me. That gravity should be innate, inherent, and essential to matter, so that one body may act upon another at a distance through a vacuum without the mediation of anything else, by and through which their action and force may be conveyed from one to another, is to me so great an absurdity, that I believe no man who has in philosophical matters a competent faculty of thinking can ever fall into it. Gravity must be caused by an agent acting constantly, according to certain laws; but whether this agent be material or immaterial, I have left to the consideration of my readers. (Newton to Bentley, 25 February 1692/3)

Every sentient soul, at different times and in different organs of senses and motions, is the same individual person. There are parts that are successive in duration and coexistent in space, but neither of these exist in the person of man or in his thinking principle, and much less in the thinking substance of God. Every man, insofar as he is a thing that has senses, is one and the same man throughout his lifetime in each and every organ of his senses. God is one and the same God always and everywhere. He is omnipresent not only in power, but in substance: for power cannot subsist without substance. [Omnipraesens est non per *virtutem* solam, sed etiam per *substantiam*: nam virus sine substantia subsistere non potest.]* In him all things are contained and move, but he does not act on them nor they on him. God experiences nothing from the motions of bodies; the bodies feel no resistance from God's omnipresence. (*Principia mathematica*, General Scholium, second edition, 1713)

*For comparison, the always reliable Emilie du Châtelet has: "Il est présent partout, non seulement *virtuellement*, mais *substantiellement*, car on ne peut agir ou l'on n'est pas." (Newton 1749, tom 2, 177)

The reconstructed argument

- (1) a substance, S, acts at point P
- (2) a substance cannot act where it is not substantially present
- (3) therefore, S is substantially present at P