

# Science in Classics

## 经典中的科学

### Tutorial 2: Newton



# This lesson

- Discussion: Part I (on Text 2)
- Discussion: Part II (extension)



# Discussion (Part I)

## **Group 1: Basic units (Definitions)**

Read Definition I.

- 1a. How was density defined in secondary school? Compare “Definition I” with this definition of density, what else has Newton’s “Definition I” told you?
- 1b. What do you think is length? What is time?

## **Group 2: Weight and Weightlessness (Axioms, Laws)**

- 2a. Use Corollary VI to explain weightlessness in a falling lift and a spacecraft.
- 2b. How does an astronaut measure his/her own mass when orbiting around the earth?

## **Groups 3 and 4: Universality and Universal Quality (Rules of Reasoning)**

- 3a. Explain why Rule II is about universality of natural laws.
- 3b. Rule III is about universal qualities. Use electric charge as an example to explain what it means by “admit neither intension nor remission of degrees” and “belong to all bodies within the reach of our experiments”.

## **Group 5: Attributes of the Being (General Scholium)**

- 4. In Para. 33, how does Newton argue that God is always (eternal) and everywhere (omnipresent)? Is his argument correct or wrong?

## **Group 6: Gravity and Spirit (General Scholium)**

- 5a. In Para. 34, Newton said, “And to us it is enough that gravity does really exist, and act according to the laws which we have explained”. What purpose is fulfilled so Newton said “enough”?
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## DEFINITION I.

*The quantity of matter is the measure of the same, arising from its density and bulk conjunctly.*

Thus air of a double density, in a double space, is quadruple in quantity; in a triple space, sextuple in quantity. The same thing is to be understood of snow, and fine dust or powders, that are condensed by compression or liquefaction; and of all bodies that are by any causes whatever differently condensed. I have no regard in this place to a medium, if any such there is, that freely pervades the interstices between the parts of bodies. It is this quantity that I mean hereafter everywhere under the name of body or mass. And the same is known by the weight of each body; for it is proportional to the weight, as I have found by experiments on pendulums, very accurately made, which shall be shewn hereafter.

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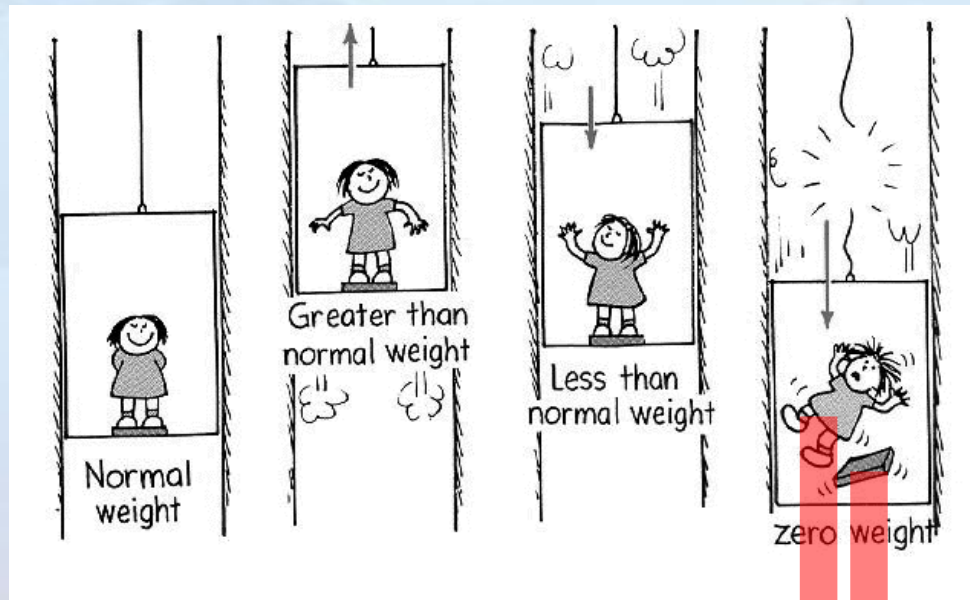
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## COROLLARY VI.

*If bodies, any how moved among themselves, are urged in the direction of parallel lines by equal accelerative forces, they will all continue to move among themselves, after the same, manner as if they had been urged by no such forces.*

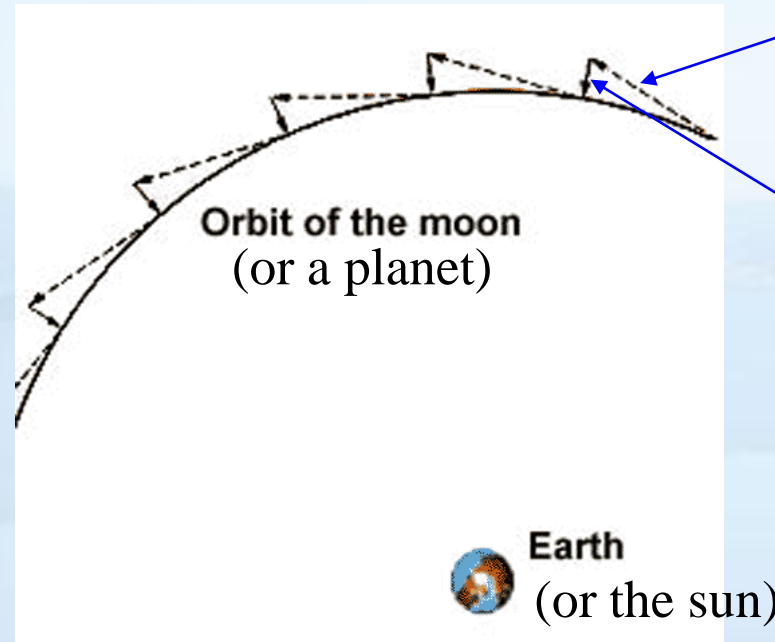
For these forces acting equally (with respect to the quantities of the bodies to be moved), and in the direction of parallel lines, will (by Law II) move all the bodies equally (as to velocity), and therefore will never produce any change in the positions or motions of the bodies among themselves.



Same acceleration



Planetary motion is not natural. It is a combination of two kinds of motion.



First law

Gravity causes acceleration:  
Second law







# Guess what it is!

*You will  
shake it!*







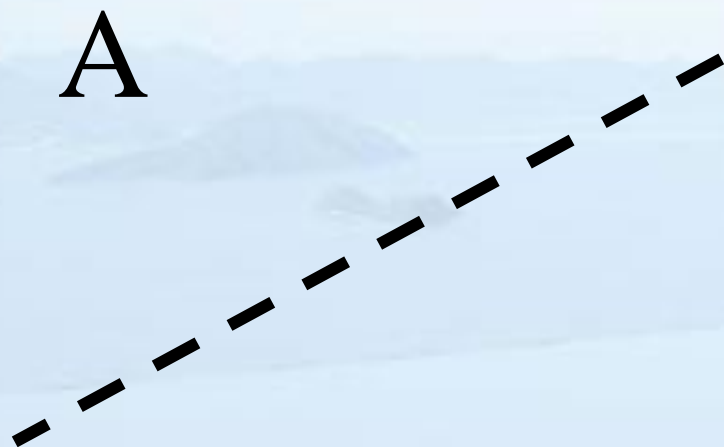


Move it up  
and down









B

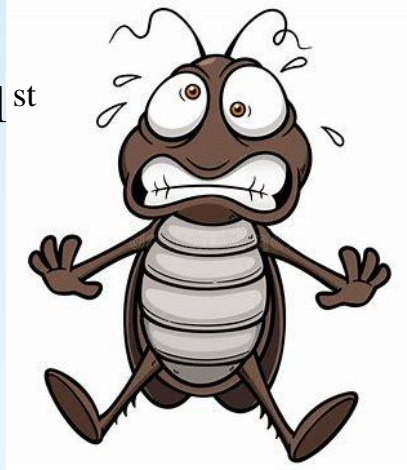




How can I get rid of it? Beat it?



Newton's 1<sup>st</sup>  
law is  
working!



Stretch your arm  
very fast!



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## RULE I.    A single phenomenon

*We are to admit no more causes of natural things than such as are both true and sufficient to explain their appearances.*

To this purpose the philosophers say that Nature does nothing in vain, and more is in vain when less will serve; for Nature is pleased with simplicity, and affects not the pomp of superfluous causes.

## RULE II.    Many phenomena of the same kind

*Therefore to the same natural effects we must, as far as possible, assign the same causes.*

As to respiration in a man and in a beast; the descent of stones in *Europe* and in *America*; the light of our culinary fire and of the sun; the reflection of light in the earth, and in the planets.

## RULE III.

*The qualities of bodies, which admit neither intension nor remission of degrees, and which are found to belong to all bodies within the reach of our experiments, are to be esteemed the universal qualities of all bodies whatsoever.*

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This Being governs all things, not as the soul of the world, but as Lord over all; and on account of his dominion he is wont to be called *Lord God παντοκράτωρ*, or *Universal Ruler*; for *God* is a relative word, and has a respect to servants; and *Deity* is the dominion of God not over his own body, as those imagine who fancy God to be the soul of the world, but over servants. The Supreme God is a Being eternal, infinite, absolutely perfect; but a being, however perfect, without dominion, cannot be said to be Lord God; for we say, my God, your God, the God of *Israel*, the God of Gods, and Lord of Lords; but we do not say, my Eternal, your Eternal, the Eternal of *Israel*, the Eternal of Gods; we do not say, my Infinite, or my Perfect: these are titles which have no respect to servants. The word *God*<sup>3</sup> usually signifies *Lord*; but every lord is not a God. It is the dominion of a spiritual being which constitutes a God: a true, supreme, or imaginary dominion makes a true, supreme, or imaginary God. And from his true dominion it follows that the true God is a living, intelligent, and powerful Being; and, from his other perfections, that he is supreme, or most perfect. He is eternal and infinite, omnipotent and omniscient; that is, his duration reaches from eternity to eternity; his presence from infinity to infinity; he governs all things, and knows all things that are or can be done. He is not eternity or infinity, but eternal and infinite; he is not duration or space, but he endures and is present. He endures for ever, and is every where present; and by existing always and every where, he constitutes duration and space. Since every particle of space is *always*, and every indivisible moment of duration is *every where*, certainly the Maker and Lord of all things cannot be *never* and *no where*. Every soul that has perception is, though in different times and in different organs of sense and motion, still the same indivisible person. There are given successive parts in duration, co-existent parts in space, but neither the one nor the other in the person of a man, or his thinking principle; and much less can they be found in the thinking substance of God. Every man, so far as he is a thing that has perception, is one and the same man during his whole life, in all and each of his organs of sense. God is the same God, always and every where. He is

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Hitherto we have explained the phenomena of the heavens and of our sea by the power of gravity, but have not yet assigned the cause of this power. This is certain, that it must proceed from a cause that penetrates to the very centres of the sun and planets, without suffering the least diminution of its force; that operates not according to the quantity of the surfaces of the particles upon which it acts (as mechanical causes use to do), but according to the quantity of the solid matter which they contain, and propagates its virtue on all sides to immense distances, decreasing always in the duplicate proportion of the distances. Gravitation towards the sun is made up out of the gravitations towards the several particles of which the body of the sun is composed; and in receding from the sun decreases accurately in the duplicate proportion of the distances as far as the orb of Saturn, as evidently appears from the quiescence of the aphelions of the planets; nay, and even to the remotest aphelions of the comets, if those aphelions are also quiescent. But hitherto I have not been able to discover the cause of those properties of gravity from phaenomena, and I frame no hypotheses; for whatever is not deduced from the phaenomena is to be called an hypothesis; and hypotheses, whether metaphysical or physical, whether of occult qualities or mechanical, have no place in experimental philosophy. In this philosophy particular propositions are inferred from the phenomena, and afterwards rendered general by induction. Thus it was that the impenetrability, the mobility, and the impulsive force of bodies, and the laws of motion and of gravitation, were discovered. And to us it is enough that gravity does really exist, and act according to the laws which we have explained, and abundantly serves to account for all the motions of the celestial bodies, and of our sea.

And now we might add something concerning a certain most subtle Spirit which pervades and lies hid in all gross bodies; by the force and action of which Spirit the particles of bodies mutually attract one another at near distances, and cohere, if contiguous; and electric bodies operate to greater distances, as well repelling as attracting the neighbouring corpuscles; and light is emitted, reflected, refracted, inflected, and heats bodies; and all sensation is excited, and the members of animal bodies move at the command of the will, namely, by the vibrations of this Spirit, mutually propagated along the solid filaments of the nerves, from the outward organs of sense to the brain, and from the brain into the muscles. But these are things that cannot be explained in few words, nor are we furnished with that sufficiency of experiments which is required to an accurate determination and demonstration of the laws by which this electric and elastic Spirit operates.

END OF THE MATHEMATICAL PRINCIPLES.

# Discussion: Part II



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## ~~**The Principia as a book about the universe**~~

6. ~~What understanding of the universe did Newton have? (e.g. description of its structure, description of the motions, meanings of the universe)~~

## **Newton ~ Plato?**

7. How are Newton and Plato alike in their philosophies?

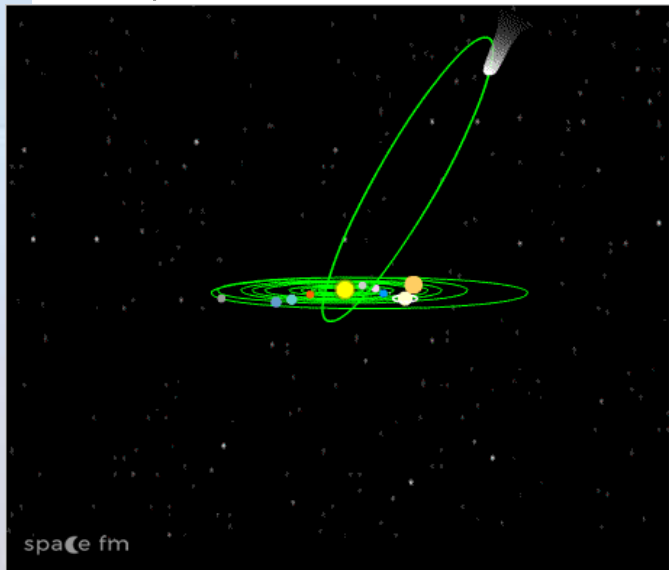
## ~~**Newton /= Plato?**~~

8. ~~How are Newton and Plato different in their philosophies?~~

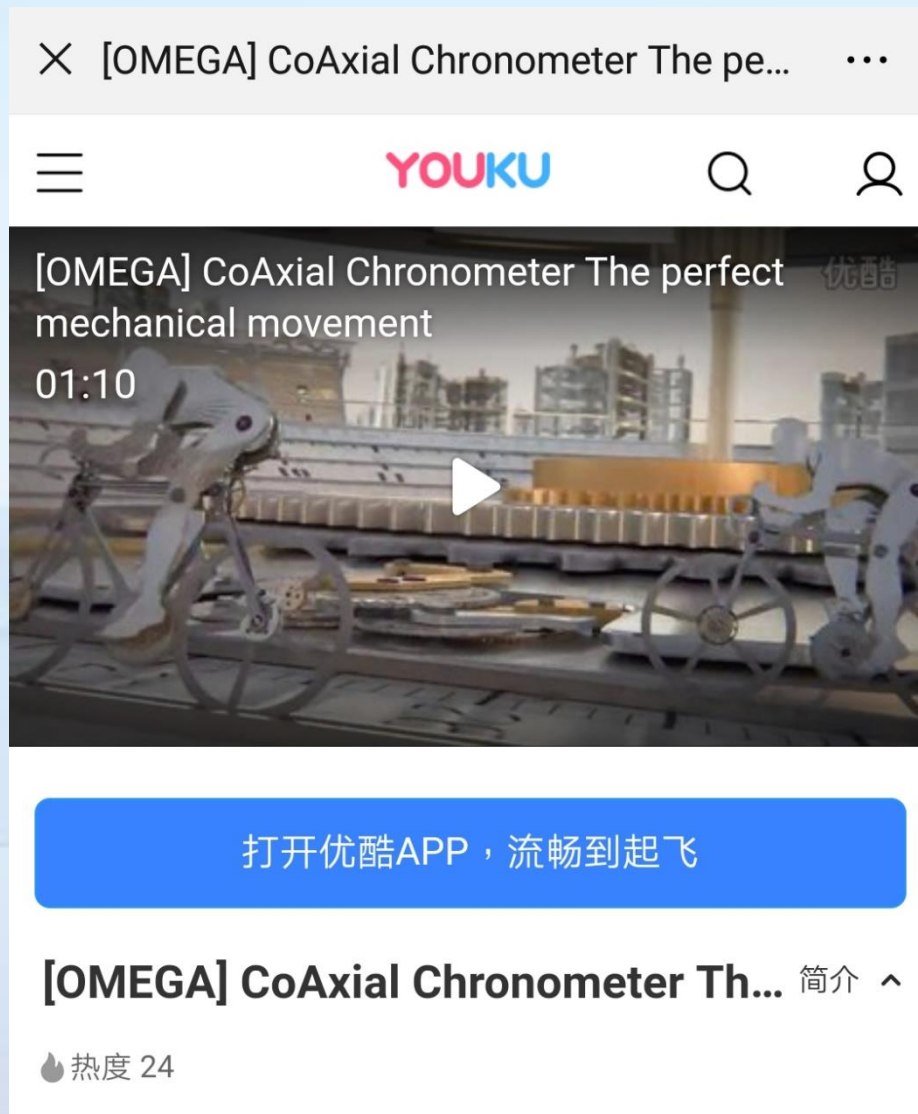
## **Superiority of Newton**

9. Was Newton more correct than the scientists/natural philosophers before him?

The six primary planets are revolved about the sun in circles concentric with the sun, and with motions directed towards the same parts, and almost in the same plane. Ten moons are revolved about the earth, Jupiter and Saturn, in circles concentric with them, with the same direction of motion, and nearly in the planes of the orbits of those planets; but it is not to be conceived that mere mechanical causes could give birth to so many regular motions, since the comets range over all parts of the heavens in very eccentric orbits; for by that kind of motion they pass easily through the orbs of the planets, and with great rapidity; and in their aphelions, where they move the slowest, and are detained the longest, they recede to the greatest distances from each other, and thence suffer the least disturbance from their mutual attractions. This most beautiful system of the sun, planets, and comets, could only proceed from the counsel and dominion of an intelligent and powerful Being. And if the fixed stars are the centres of other like systems, these, being formed by the like wise counsel, must be all subject to the dominion of One; especially since the light of the fixed stars is of the same nature with the light of the sun, and from every other systems: and lest the systems of the fixed stars should, by their mutual attractions, be mutually disturbed, he hath placed those systems at immense distances one







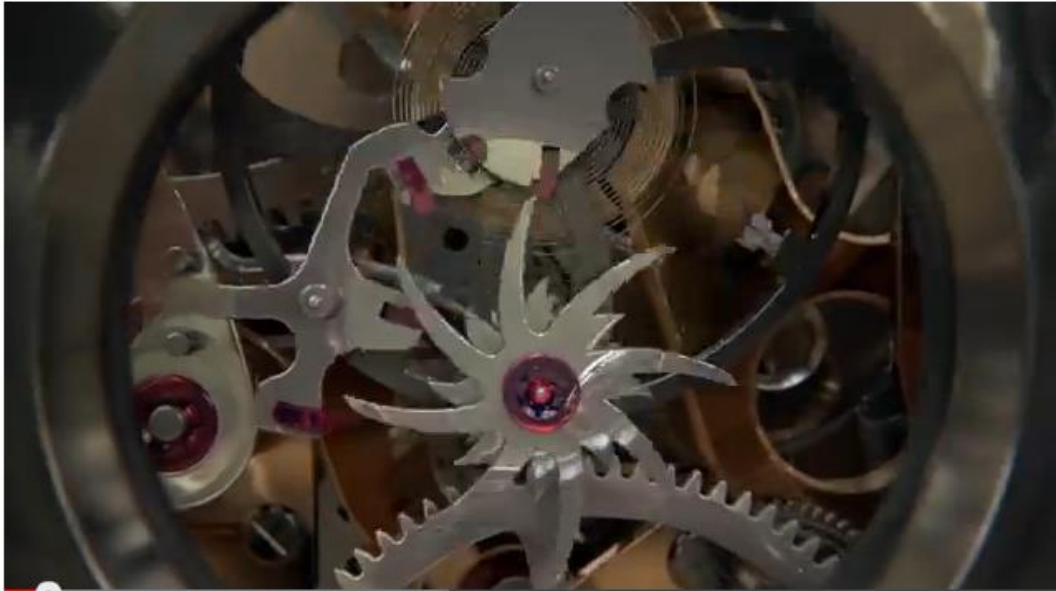
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# Reminder

- Deadline of Reflective Journal: 21 May, 9:00pm (Saturday).
  - $\geq 400$  words in English.
  - Submit your work on Moodle.