

Caput II. Newton and *vis centripeta*

Vis centripeta est, qua corpora versus punctum aliquod, tanquam ad centrum, undique trahuntur, impelluntur, vel utcunque tendunt. Centripetal force is, on which side the body is turned some point, as the direction toward the centre from all sides dragging, pushing or whenever stretching, is Newton's opening sentence to define centripetal force

Newton, age 21; is admitted to Trinity College, Cambridge University. Lacking funds, he takes small jobs and gets-along. After three years at Trinity, he is awarded a scholarship. The Great Plague advances across England. There is a second wave. Newton does not return to Cambridge until April 1667. He writes of his experience :

By considering how to interpolate certain series of Dr. Wallis¹ I found the Rule...for reducing any power or dignity of any Binomium into an approximating Series, & in the following Spring, before the Plague...forced me from Cambridge, I found how to do the same thing by continual division & extraction of roots...

What constitutes a centrifugal force (an object moving *from* the centre) and a centripetal force (an object moving *to* the centre) were fierce debates among mid-17th Century mathematicians and astronomers. Consider the solar system. If planets circle about the sun, why do the planets stay in orbit and not move away?

The debate raged on both sides of the English Channel. Christiaan Huygens² of Leiden University used the term "centrifugal force" in his 1659 paper *De Vi Centrifuga, Of Centrifugal Force*. In response, Newton combined Kepler's laws of planetary motion³ with Huygens central theme and proposed centripetal force as a reciprocal agent. Newton coined the term **vis centripeta, centripetal force** in his unpublished manuscript on the discussion of gravity to Edmund Halley⁴, *De motu corporum in gyrum, Of Circular Movement of a Body*

Huygens supported Gottfried Leibniz⁵. Both men supported René Descartes⁶. Newton dismissed Leibniz's celestial mechanics as senseless. Descartes used algebra versus calculus. Newton's **Definitio 5**, of **vis centripetal** is quoted :

Vis centripeta est, qua corpora versus punctum aliquod, tanquam ad centrum, undique trahuntur, impelluntur, vel utcunque tendunt.

Huius generis est gravitas, qua corpora tendunt ad centrum terrae; vis magnetica, qua ferrum petit magnetem; et vis illa, quaecunque sit, qua planetae perpetuo retrahuntur a motibus rectilineis et in lineis curvis revolvi coguntur. Lapis, in funda circumactus, a circumagente manu abire conatur; et conatu suo fundam distendit, eoque fortius quo celerius revolvitur; et quamprimum dimittitur, avolat. Vim conatui illi contrariam, qua funda lapidem in manum perpetuo retrahit et in orbe retinet, quoniam in manum ceu orbis centrum dirigitur, centripetam appello. Et par est ratio corporum omnium, quae in gyrum aguntur. Conantur ea

omnia a centris orbium recedere; et nisi adsit vis aliqua conatui isti contraria, quo cohibeantur et in orbibus retineantur, quamque ideo centripetam appello, abibunt in rectis lineis uniformi cum motu. Projectile, si vi gravitatis destitueretur, non deflecteretur in terram, sed in linea recta abiret in coelos; idque uniformi cum motu, si modo aeris resistentia tolleretur. Per gravitatem suam retrahitur a cursu rectilineo et in terram perpetuo flectitur, idque magis vel minus pro gravitate sua et velocitate motus. Quo minor fuerit eius gravitas pro quantitate materiae, vel major velocitas quacum projicitur, eo minus deviaabit a cursu rectilineo et longius perget.

Isaac Newton. [Philosophiae Naturalis Principia Mathematica](#), Book I, Definitio 5

- Footnotes:**
1. **John Wallis**. 3 December 1616 - 8 November 1703. English. Mathematician, assisted in development of infinitesimal calculus. Introduced the symbol: ∞ to represent the concept of infinity
 2. **Christiaan Huygens**. 14 April 1629 - 8 July 1695. Dutch. Mathematician, physicist and astronomer. Studied optics and rings of Saturn, discovered the moon Titan
 3. **Johannes Kepler**. 27 December 1571 - 15 November 1630. German. Mathematician and astronomer. Modified Nicolaus Copernicus's circular planet orbit to elliptical path. Kepler's three laws described orbital motion. First law states planets move in elliptical orbits with the Sun at one focus. Second law states the radius vector of a planet sweeps out equal areas in equal times. The third law relates the distances of planets from the Sun to velocity of orbital periods, i.e.; closer to the Sun, the faster velocity and vice versa. Newton in 1687 correlated Kepler's laws with own laws of motion and law of universal gravitation. Kepler helped fund publication of Newton's *Principia Mathematica*
 4. **Edmund Halley**. 8 November 1656 - 25 January 1742. English. Mathematician, astronomer and natural philosopher. Correlated transit of Venus could be used to calculate distance between the Earth, Venus and Sun. Used Newton's laws of motion to determine periodicity of comet, named : *Halley's Comet*
 5. **Gottfried Leibniz**. 1 July 1646 - 14 November 1716. German. Mathematician, philosopher and diplomat
 6. **René Descartes**. 31 March 1596 - 11 February 1650. French. Mathematician and philosopher. Invented the Cartesian coordinate graph, the x and y axes