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Renaissance Science: Rediscovering the Wonders of the Natural World

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Opinion Article

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ABOUT THE STUDY

In the 11th century CE, Persian polymath Ibn Sina (Avicenna) agreed with Philoponus' theory that "the moved object acquires an inclination from the mover" as an explanation for projectile motion. Ibn Sina then published his own theory of impetus in The Book of Healing (c. 1020). Unlike Philoponus, who believed that it was a temporary virtue that would decline even in a vacuum, Ibn Sina viewed it as a persistent, requiring external forces such as air resistance to dissipate it. Ibn Sina made distinction between 'force' and 'inclination' (mayl), and argued that an object gained mayl when the object is in opposition to its natural motion. He concluded that continuation of motion is attributed to the inclination that is transferred to the object, and that object will be in motion until the mayl is spent.

Another 11th-century Persian polymath, Al-Biruni, proposed that heavenly bodies have mass, weight, and gravity, just like the Earth. He criticized both Aristotle and Ibn Sina for holding the view that only the Earth has these properties. The 12th-century scholar Al-Khazini suggested that the gravity an object contains varies depending on its distance from the centre of the universe referring to the centre of the Earth. Al-Biruni and Al-Khazini studied the theory of the centre of gravity, and generalized and applied it to three-dimensional bodies. They also founded the theory of ponderable lever, and created the science of gravity. Fine experimental methods were also developed for determining the specific gravity or specific weight of objects, based the theory of balances and weighing.

In the 12th century, Abu'l-Barakāt al-Baghdādī adopted and modified Ibn Sina's theory on projectile motion. In his Kitab al-Mu'tabar, Abu'l-Barakat stated that the mover imparts a violent inclination on the moved and that this

diminishes as the moving object distances itself from the mover. According to Shlomo Pines, al-Baghdādī's theory of motion was "the oldest negation of Aristotle's fundamental dynamic law anticipation in a vague fashion of the fundamental law of classical mechanics.

In the 14th century, both the French philosopher Jean Buridan and the Merton College of Oxford rejected the Aristotelian concept of gravity. They attributed the motion of objects to an impetus (akin to momentum), which varies according to velocity and mass; Buridan was influenced in this by Ibn Sina's Book of Healing. Buridan and the philosopher Albert of Saxony (c. 1320–1390) adopted Abu'l-Barakat's theory that the acceleration of a falling body is a result of its increasing impetus. Influenced by Buridan, Albert developed a law of proportion regarding the relationship between the speed of an object in free fall and the time elapsed. He also theorized that mountains and valleys are caused by erosion[d]—displacing the Earth's centre of gravity. Also in that century, the Merton College developed the mean speed theorem, which was proved by Nicole Oresme (c. 1323–1382) and would be influential in later gravitational equations.

Leonardo da Vinci (1452–1519) made drawings recording the acceleration of falling objects. He wrote that the "mother and origin of gravity" is energy. He describes two pairs of physical powers which stem from a metaphysical origin and have an effect on everything: abundance of force and motion, and gravity and resistance. He associates gravity with the 'cold' classical elements, water and earth, and calls its energy infinite. In Codex Arundel, Leonardo recorded that if a water-pouring vase moves transversally (sideways), simulating the trajectory of a vertically falling object, it produces a right triangle with equal leg length, composed of falling material that forms the hypotenuse and the vase trajectory forming one of the legs. On the hypotenuse, Leonardo noted the equivalence of the two orthogonal motions, one effected by gravity and the other proposed by the experimenter. By 1514, Nicolaus Copernicus had written an outline of his heliocentric model, in which he stated that Earth's centre is the centre of both its rotation and the orbit of the Moon. In 1533, German humanist Petrus Apianus described the exertion of gravity. Since it is apparent that in the descent [along the arc] there is more impediment acquired, it is clear that gravity is diminished on this account. But because this comes about by reason of the position of heavy bodies, let it be called a positional gravity.