History of physics

A Newton's cradle, named after physicist Isaac Newton

Physics is a branch of science whose primary objects of study are matter and energy. Discoveries of physics find applications throughout the natural sciences and in technology. Historically, physics emerged from the scientific revolution of the 17th century, grew rapidly in the 19th century, then was transformed by a series of discoveries in the 20th century. Physics today may be divided loosely into classical physics and modern physics.

Ancient history

Further information: History of astronomy

Elements of what became physics were drawn primarily from the fields of astronomy, optics, and mechanics, which were methodologically united through the study of geometry. These mathematical disciplines began in antiquity with the Babylonians and with Hellenistic writers such as Archimedes and Ptolemy. Ancient philosophy, meanwhile, included what was called "Physics".

Greek concept

The move towards a rational understanding of nature began at least since the Archaic period in Greece (650–480 BCE) with the Pre-Socratic philosophers. The philosopher Thales of Miletus (7th and 6th centuries BCE), dubbed "the Father of Science" for refusing to accept various supernatural, religious or mythological explanations for natural phenomena, proclaimed that every event had a natural cause.[1] Thales also made advancements in 580 BCE by suggesting that water is the basic element, experimenting with the attraction between magnets and rubbed amber and formulating the first recorded cosmologies. Anaximander, famous for his proto-evolutionary theory, disputed Thales' ideas and proposed that rather than water, a substance called apeiron was the building block of all matter. Around 500 BCE, Heraclitus proposed that the only basic law governing the Universe was the principle of change and that nothing remains in the same state indefinitely. Along with his contemporary Parmenides were among the first scholars in ancient physics to contemplate on the role of time in the universe, a key concept that is still an issue in modern physics.

Aristotle
(384–322 BCE)

During the classical period in Greece (6th, 5th and 4th centuries BCE) and in Hellenistic times, natural philosophy slowly developed into an exciting and contentious field of study. Aristotle (Greek: Ἀριστοτέλης, Aristotélēs) (384 – 322 BCE), a student of Plato, promoted the concept that observation of physical phenomena could ultimately lead to the discovery of the natural laws governing them.[citation needed] Aristotle's writings cover physics, metaphysics, poetry, theater, music, logic, rhetoric, linguistics, politics, government, ethics, biology and zoology. He wrote the first work which refers to that line of study as "Physics" – in the 4th century BCE, Aristotle founded the system known as Aristotelian physics. He attempted to explain ideas such as motion (and gravity) with the theory of four elements. Aristotle believed that all matter was made up of aether, or some combination of four elements: earth, water, air, and fire. According to Aristotle, these four terrestrial elements are capable of inter-transformation and move toward their natural place, so a stone falls downward toward the center of the cosmos, but flames rise upward toward the circumference. Eventually, Aristotelian physics became enormously popular for many centuries in Europe, informing the scientific and scholastic developments of the Middle Ages. It remained the mainstream scientific paradigm in Europe until the time of Galileo Galilei and Isaac Newton.

Early in Classical Greece, knowledge that the Earth is spherical ("round") was common. Around 240 BCE, as the result of a seminal experiment, Eratosthenes (276–194 BCE) accurately estimated its circumference. In contrast to Aristotle's geocentric views, Aristarchus of Samos (Greek: Ἀρίσταρχος; c. 310 – c. 230 BCE) presented an explicit argument for a heliocentric model of the Solar System, i.e. for placing the Sun, not the Earth, at its centre. Seleucus of Seleucia, a follower of Aristarchus' heliocentric theory, stated that the Earth rotated around its own axis, which, in turn, revolved around the Sun. Though the arguments he used were lost, Plutarch stated that Seleucus was the first to prove the heliocentric system through reasoning.

The ancient Greek mathematician Archimedes, famous for his ideas regarding fluid mechanics and buoyancy.
In the 3rd century BCE, the Greek mathematician Archimedes of Syracuse (Greek: Ἀρχιμήδης (287–212 BCE) – generally considered to be the greatest mathematician of antiquity and one of the greatest of all time – laid the foundations of hydrostatics, statics and calculated the underlying mathematics of the lever. A leading scientist of classical antiquity, Archimedes also developed elaborate systems of pulleys to move large objects with a minimum of effort. The Archimedes' screw underpins modern hydroengineering, and his machines of war helped to hold back the armies of Rome in the First Punic War. Archimedes even tore apart the arguments of Aristotle and his metaphysics, pointing out that it was impossible to separate mathematics and nature and proved it by converting mathematical theories into practical inventions. Furthermore, in his work On Floating Bodies, around 250 BCE, Archimedes developed the law of buoyancy, also known as Archimedes' principle. In mathematics, Archimedes used the method of exhaustion to calculate the area under the arc of a parabola with the summation

of an infinite series, and gave a remarkably accurate approximation of pi. He also defined the spiral bearing his name, formulae for the volumes of surfaces of revolution and an ingenious system for expressing very large numbers. He also developed the principles of equilibrium states and centers of gravity, ideas that would influence the well known scholars, Galileo, and Newton.

Hipparchus (190–120 BCE), focusing on astronomy and mathematics, used sophisticated geometrical techniques to map the motion of the stars and planets, even predicting the times that Solar eclipses would happen. He added calculations of the distance of the Sun and Moon from the Earth, based upon his improvements to the observational instruments used at that time. Another of the most famous of the early physicists was Ptolemy (90–168 CE), one of the leading minds during the time of the Roman Empire. Ptolemy was the author of several scientific treatises, at least three of which were of continuing importance to later Islamic and European science. The first is the astronomical treatise now known as the Almagest (in Greek, Ἡ Μεγάλη Σύνταξις, "The Great Treatise", originally Μαθηματικὴ Σύνταξις, "Mathematical Treatise"). The second is the Geography, which is a thorough discussion of the geographic knowledge of the Greco-Roman world.

Much of the accumulated knowledge of the ancient world was lost. Even of the works of the better known thinkers, few fragments survived. Although he wrote at least fourteen books, almost nothing of Hipparchus' direct work survived. Of the 150 reputed Aristotelian works, only 30 exist, and some of those are "little more than lecture notes"[according to whom?].

India and China
Further information: History of science and technology in China and History of Indian science and technology

The Hindu-Arabic numeral system. The inscriptions on the edicts of Ashoka (3rd century BCE) display this number system being used by the Imperial Mauryas. Important physical and mathematical traditions also existed in ancient Chinese and Indian sciences.

Star maps by the 11th-century Chinese polymath Su Song are the oldest known woodblock-printed star maps to have survived to the present day. This example, dated 1092,[note 1] employs cylindrical projection.
In Indian philosophy, Maharishi Kanada was the first to systematically develop a theory of atomism around 200 BCE[2] though some authors have allotted him an earlier era in the 6th century BCE.[3][4] It was further elaborated by the Buddhist atomists Dharmakirti and Dignāga during the 1st millennium CE.[5] Pakudha Kaccayana, a 6th-century BCE Indian philosopher and contemporary of Gautama Buddha, had also propounded ideas about the atomic constitution of the material world. These philosophers believed that other elements (except ether) were physically palpable and hence comprised minuscule particles of matter. The last minuscule particle of matter that could not be subdivided further was

termed Parmanu. These philosophers considered the atom to be indestructible and hence eternal. The Buddhists thought atoms to be minute objects unable to be seen to the naked eye that come into being and vanish in an instant. The Vaisheshika school of philosophers believed that an atom was a mere point in space. It was also first to depict relations between motion and force applied. Indian theories about the atom are greatly abstract and enmeshed in philosophy as they were based on logic and not on personal experience or experimentation. In Indian astronomy, Aryabhata's Aryabhatiya (499 CE) proposed the Earth's rotation, while Nilakantha Somayaji (1444–1544) of the Kerala school of astronomy and mathematics proposed a semi-heliocentric model resembling the Tychonic system.

The study of magnetism in Ancient China dates back to the 4th century BCE. (in the Book of the Devil Valley Master),[6] A main contributor to this field was Shen Kuo (1031–1095), a polymath and statesman who was the first to describe the magnetic-needle compass used for navigation, as well as establishing the concept of true north. In optics, Shen Kuo independently developed a camera obscura.[7]

Islamic world
Main articles: Physics in the medieval Islamic world and Science in the medieval Islamic world
See also: List of scientists in medieval Islamic world

Ibn al-Haytham (c. 965–1040).
In the 7th to 15th centuries, scientific progress occurred in the Muslim world. Many classic works in Indian, Assyrian, Sassanian (Persian) and Greek, including the works of Aristotle, were translated into Arabic.[8] Important contributions were made by Ibn al-Haytham (965–1040), an Arab scientist, considered to be a founder of modern optics. Ptolemy and Aristotle theorised that light either shone from the eye to illuminate objects or that "forms" emanated from objects themselves, whereas al-Haytham (known by the Latin name "Alhazen") suggested that light travels to the eye in rays from different points on an object. The works of Ibn al-Haytham and al-Biruni (973–1050), a Persian scientist, eventually passed on to Western Europe where they were studied by scholars such as Roger Bacon and Vitello.[9]

Ibn al-Haytham used controlled experiments in his work on optics, although to what extent it differed from Ptolemy is up to debate .[10][11] Arabic mechanics like Bīrūnī and Al-Khazini developed sophisticated "science of weight", carrying out measurements of specific weights and volumes[12]

Ibn Sīnā (980–1037), known as "Avicenna", was a polymath from Bukhara (in present-day Uzbekistan) responsible for important contributions to physics, optics, philosophy and medicine. He published his theory of motion in Book of Healing (1020), where he argued that an impetus is imparted to a projectile by the thrower, and believed that it was a temporary virtue that would decline even in a vacuum. He viewed it as persistent, requiring external forces such as