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## Ancient Physics

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### History

The history of physics, whilst incorporating elements of the fine mathematics and astronomy practiced by the Babylonians, Indians, Egyptians and Zoroastrians, largely remained embedded in the supernatural realm of the gods.

It was not until the methodological and theoretical approach of the Ancient Greeks that physics in its modern form appeared, based upon mathematics and first principles rather than superstition.

Picking out the history of ancient physics can be difficult, mainly because it is extremely difficult to separate it from other fields such as astronomy, mathematics and alchemy. Science had yet to split into recognisable disciplines or even separate fully from theology and philosophy, so there was some overlap in the history of physics at this formative stage.



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## The History of Physics - The Child of Mathematics and Philosophy

Greek civilization, by historical standards, was exceptionally stable, despite the squabbles

between the city-states of Athens, Sparta and Thebes, amongst others. This stability and wealth allowed the arts and philosophy to prosper, with Homeric poets and talented playwrights sharing the intellectual sphere with some of the greatest philosophers that the world has ever known.

From theoretical mathematics, accurate astronomy and sophisticated philosophy sprang ancient physics, an attempt to explain the world and uncover the laws that governed the universe. The ancient Greeks believed that the universe was harmonious, perfect, and governed by elegant laws and equations, as laid down by mathematicians such as Pythagoras and Euclid.

## The History of Physics - Before Aristotle: Atomism and Natural Laws

Thales [1] was the first physicist and his theories actually gave the discipline its name. He believed that the world, although fashioned from many materials, was really built of only one element, water, called Physis in Ancient Greek. The interaction of water between the phases of solid, liquid and gas gave materials different properties. This was the first explanation to take natural phenomena out of the realm of divine providence and into the realm of natural laws and explanations.

Anaximander, more famous for his proto-evolutionary theory, disputed the ideas of Thales and proposed that rather than water, a substance called apeiron was the building block of all matter. With the aid of modern hindsight, we can say that this was another shrewd guess from Anaximander and very similar to the idea that hydrogen is the building block of all matter in our universe.

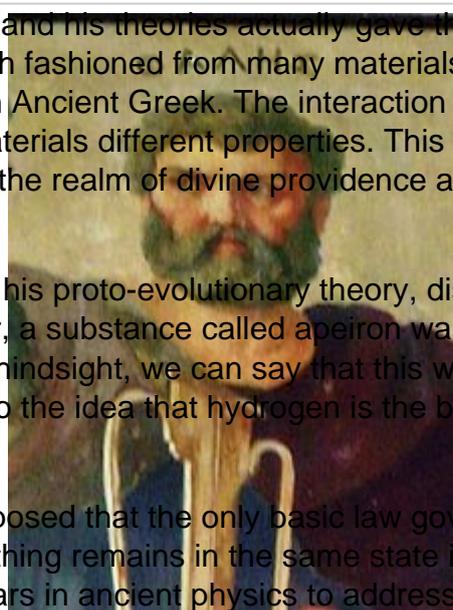
Heraclitus (around 500BC) proposed that the only basic law governing the universe was the principal of change and that nothing remains in the same state indefinitely. This observation made him one of the first scholars in ancient physics to address the role of time in the universe, one of the most important concepts even in the modern history of physics.

One of the first renowned ancient physicists was Leucippus (5th Century BC), who adamantly opposed the idea of direct divine intervention in the universe. This philosopher instead proposed that natural phenomena had a natural cause. Leucippus and his student, Democritus, developed the first atomic theory, arguing that matter could not be divided indefinitely and that you would eventually arrive at individual pieces that could not be cut.

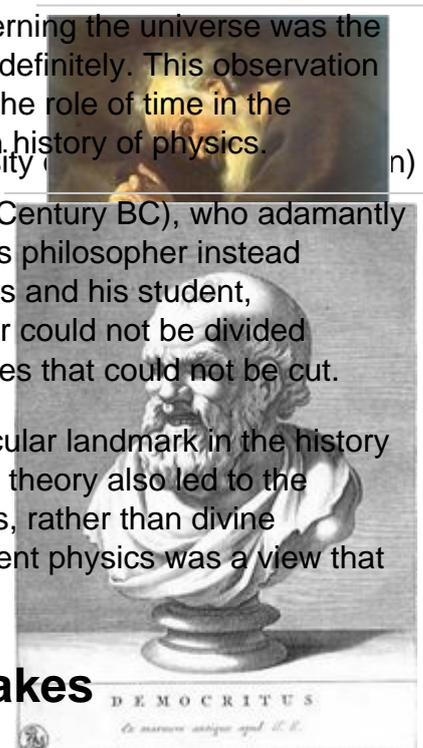
These are called atoms, from a-tom (not cut). However this particular landmark in the history of physics would lie forgotten until nearly two millennia later. This theory also led to the atomists proposing that these atoms were governed by strict laws, rather than divine providence. This removal of free will and even the soul from ancient physics was a view that made these philosophers detested by Plato.

## The History of Physics - Aristotle's Mistakes

Interestingly, whilst Aristotle [2] is regarded as the father of science, and certainly contributed to the history of science [3] with his methodology and empiricism, he actually hindered the



Thales - Fresco from the University of



Democritus. (Public Domain)

progress of physics for many millennia. He made the fatal error of assuming that mathematical theory and the natural world did not overlap, a sign of his overreliance upon empiricism. Aristotle attempted to explain ideas such as motion and gravity with his theory of elements, an addition to ancient physics that also spread into alchemy and medicine.

Aristotle firmly believed that all matter was made up of some combination of five elements, earth, air, fire, water and invisible aether. He took this further by suggesting that the realm of earth was surrounded by air, followed by the realms of fire and aether. Every element naturally attempted to return to its own realm, so a stone fell to the earth because it was trying to return to its own element. Flames rose because they wanted to return to the realm of all-enveloping fire whilst smoke, a combination of air and fire, also rose towards the heavens. Water flowed downwards because the realm of water lay below the realm of earth.

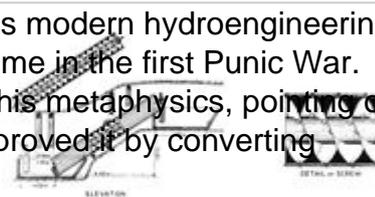
This idea, of the realms existing in neatly defined concentric circles, with aether surrounding all, held sway for centuries, shaping European science until the coming of such minds as Galileo and Newton. Until then, Aristotle's contribution to ancient physics continued to misdirect later scholars.

## The History of Physics - Eureka and the Stars

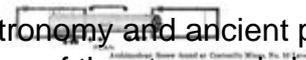
Archimedes [4] is best known for his eureka moment, discovering the principles of density and buoyancy whilst enjoying a bath, but his contributions to the history of physics were much more profound. His ancient physics was closely tied to his gift of invention as he used mathematical and theoretical principles to create devices that are still common today.

Archimedes calculated the underlying mathematics of the lever and also developed elaborate systems of pulleys to move large objects with a minimum of effort. Whilst he did not invent these ancient devices, he improved upon them and laid down principles that allowed the construction of sophisticated machines. He also developed the principles of equilibrium states and centres of gravity, ideas that would influence the Islamic scholars, Galileo, and Newton.

Finally, his Archimedes screw [5] for moving liquids underpins modern hydroengineering, and his machines of war [6] 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.



Hipparchus (190 - 120 BC) straddled the divide between astronomy and ancient physics, using sophisticated geometrical techniques to map the motion of the stars and planets, even predicting the times that solar eclipses would happen. To this, 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.

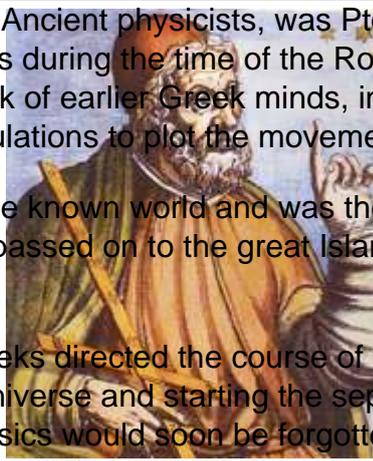


The sophistication of Hipparchus was probably built upon the detailed mathematics and observations of the Babylonians and he wrote many books elucidating his ideas. Sadly, all but a few scattered fragments are lost to the ravages of time.

## The History of Physics - Ptolemy and the Rise of the East

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The last, and one of the most famous, of the Ancient physicists, was Ptolemy. This physicist and astronomer was one of the leading minds during the time of the Roman Empire. He wrote many treatises and books containing the work of earlier Greek minds, including Hipparchus, and also calculated some sophisticated calculations to plot the movement of the heavens.



His work in ancient physics spread around the known world and was the major conduit through which the knowledge of the Greeks passed on to the great Islamic scholars of the medieval period.

Certainly, the contribution of the Ancient Greeks directed the course of the history of physics, refining the mathematics underpinning the universe and starting the separation of theology and science. Their knowledge of ancient physics would soon be forgotten in Europe as the study of physics passed into the Islamic Houses of Wisdom and the great minds of China and India.

Medieval ideal portrait of Ptolemy (Public Domain)

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### Links

- [1] <https://explorable.com/thales>
- [2] <https://explorable.com/aristotles-psychology>
- [3] <https://explorable.com/history-of-the-scientific-method>
- [4] <https://explorable.com/archimedes>
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