

# Atomism through the ages

Is it true that the atomic theory dates back to the Greeks? S.Ananthanarayanan takes a look.

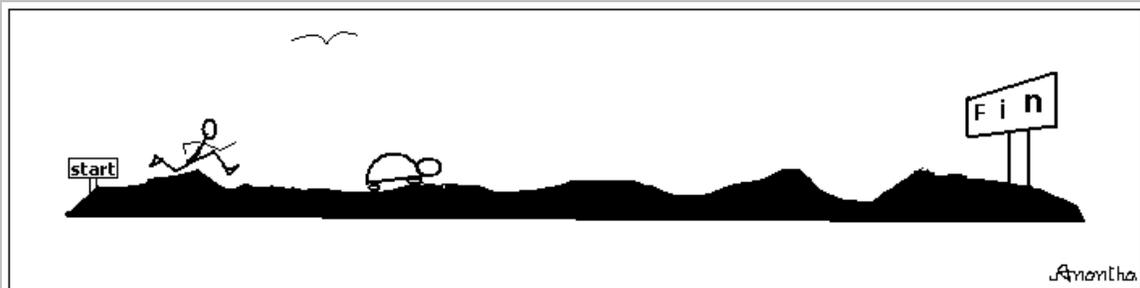
If the most important part of our knowledge of the physical world were to be expressed in a single sentence, that sentence, scientists believe, would be: “ All things are built from different kinds of tiny, identical and indivisible units, which we call atoms.” From this basic assertion of science all other material knowledge and technology inevitably follow.

## Greek origin

Democritus of Abdera, in ancient Greece, is attributed with having first suggested this idea of ‘atomism’. But that early idea was just a conjecture, of the mystic kind, not based on measurement and experiment and was not capable of being verified. The idea was also of no utility for the next 20 centuries. This is not surprising, because what led to the idea was a deficiency in Greek mathematics rather than insight into the nature of the physical world.

## Achilles and tortoises

A riddle current in Athens in the 5<sup>th</sup> century BC was of Achilles racing a tortoise that started with a lead of 100 metres. As Achilles is the legendary *fleet-foot*, he covers the 100 metres in 10 seconds flat. But in those 10 seconds, the tortoise has also moved forward by 1 metre. The tortoise is thus still 1 metre ahead.



Now, it takes Achilles only 1/10 of a second to cover that last metre. Except that in that fleeting instant, the tortoise goes forward by 1 centimetre. And in this way, how so ever short a time it takes Achilles to cover the distance to reach the tortoise, the tortoise goes a little forward and always stays ahead. How then can Achilles overtake the tortoise?

## Converging series

The answer, easy for many high school students of today, is that the series of  $100 + 1 + 1/100 + 1/10000 + \dots$  to infinite terms, is a *converging* series, or one where succeeding terms grow smaller so rapidly that the total never goes beyond a fixed value. In this case,

the total of the series is about 101.010101 metres, which Achilles covers in about 10.1010101 seconds. But Greek mathematicians did not have this sophistication in numbers and there was a problem indeed!

Philosophers then mulled over the mystery in vain, till they devised an answer in atomism. There was a limit, they said, to how small the tortoise' lead could get. You could divide a metre by 10, by 1000, by 10,000 or even by  $10^{5000}$ , but a stage would come when the lead would be the size of the smallest components of nature and further division was not be possible (the word *atom* comes from *atomos* Greek for *indivisible*). And at that point Achilles would forge ahead.

### **Modern atomic theory**

The atomic theory that we know today has nothing to do with these ancient Greek musings. It arose when scientists noticed that the elements always combined with other elements in fixed, simple ratios, by weight. A first rigorous study was of copper carbonate, which is made up of copper, carbon and oxygen. Joseph Louis Proust, a French chemist (1754-1826), found that when the substance was decomposed, it always yielded 4 parts (by weight) of oxygen to one part of carbon – regardless of the source of the original carbonate.

Proust found this idea of simple, fixed proportions was also true of other compounds and elements. The result was Proust's law, also known as the law of fixed proportions or the law of definite proportions. And from this law, the notion of atomism, or that matter must consist of kinds of indivisible particles, which are the units that participate in reactions, is a logical extension.

John Dalton (1766-1844), an English chemist, took these ideas forward and formalized the nature of the invisible, indivisible particles to be in keeping with the known facts of chemistry and behavior of materials. But to do honour to Democritus who first suggested the idea, Dalton retained the ancient Greek name for the elemental particles of his theory.

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