In the third of a series of articles celebrating Einstein’s Miraculous Year, Cormac O’Raifeartaigh describes Einstein’s groundbreaking contribution to atomic theory.

In the year 1905, a young Albert Einstein published a number of scientific works that changed physics forever. The best known of these, now known as the Special Theory of Relativity, established Einstein as a scientist of note and led to his General Theory of Relativity, one of the pillars of modern physics. In a second 1905 paper, the young Einstein published a highly controversial proposal concerning the nature of light, a proposal that later formed a cornerstone of quantum theory, the revolutionary theory that underpins much of modern science and technology. Incredibly, the young Einstein made a third groundbreaking advance in 1905. He published an analysis that pointed the way towards a crucial test of the reality of atoms, and of the validity of the laws of thermodynamics. The outcome of that test underpins much of modern science, from our view of the atomic nature of matter to our understanding of meteorology and other complex systems.

Atoms and chemistry
The idea that all matter is made up of minute, indivisible entities called ‘atoms’ was first put forward by the philosophers of ancient Greece. The concept gained much credibility in the 19th century when scientists such as John Dalton used it to establish laws of chemistry that successfully described how the chemical elements combine to form molecules. A listing of the known elements in order of increasing atomic weight led to the development of The Periodic Table by Mendeleyev, a development that revolutionized the study of chemistry. It was widely assumed that the properties of a given element were determined by the properties of its constituent atoms. However, there was no direct evidence of the existence of atoms, and some eminent scientists simply did not believe in the ‘atomic hypothesis’.

Enter Einstein
Greatly interested in the atomic view of matter, the young Einstein devised a mathematical method of calculating the size of atoms and molecules in early 1905. From an analysis of sugar molecules dissolved in water, he calculated both the diameter of the...