Published online 13 September 2005 | Nature | doi:10.1038/news050912-5

Column

The last Renaissance scientist

Einstein should be remembered for more than relativity and wacky hair, says Philip Ball

Philip Ball

Genius, sage, clown, peace campaigner, Zionist: this Year of Physics has reinforced the idea that everyone can have the Einstein they want. He wrote letters to children but neglected his own. He championed Marie Curie but suppressed his first wife's scientific contributions. He was responsible for the atom bomb and campaigned against it. All of these things have been claimed of Einstein, although some are distorted and some plain wrong. It seems that we can project whatever we will onto that familiar, tousled image.

But scientifically, his contribution is clear - isn't it? The Einstein celebrations this year, the centenary of his annus mirabilis, have focused largely on the most famous of his five landmark papers in 1905: "On the electrodynamics of moving bodies", which introduced the theory of special relativity. People still struggle with the notion of time running slower and space getting shorter, but this theory clearly deals with what we popularly suppose physics to be about - space and time and the strangeness of the cosmos.

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And so the rest of Einstein's 1905 output has been sidelined, with the possible exception of his Nobel-winning paper on the photoelectric effect, which guides us into the weird world of quantum theory. But that is to misunderstand Einstein's position as a scientist - something that even some scientists today are guilty of.

Physicist Manuel Cardona of the Max Planck Institute for Solid-State Research in Stuttgart has now helped to redress the balance by claiming him as "the father of solid-state physics" - or perhaps, Cardona says, of the even broader field of condensed-matter physics, which embraces both liquids and solids (see http://xxx.arxiv.org/abs/physics/0508237). In other words, Einstein was not some abstract theorist weaving mathematical webs from intangible concepts. He cared about stuff.

But one can go further than that. In 1905, you could have been forgiven for mistaking Einstein for a chemist. His first paper, appearing in Annalen der Physik in 1901 when he was 21, dealt with the relationship between the surface tension of liquids and their chemical composition. His doctoral thesis, submitted to the University of Zurich in 1905, followed up on this interest by showing how the size of a liquid's molecules could be calculated from its viscosity.

That encouraged him to think about diffusion - the meandering of molecules in a liquid - which led to one of his classic 1905 papers, an explanation of brownian motion, described by the botanist Robert Brown in 1828. Einstein showed that this dancing of microscopic particles can be accounted for by the collisions of much smaller, invisible molecules with the grains.

His theory allowed him to predict how fast, on average, a grain should travel. In 1908 the French physicist Jean Perrin verified these predictions experimentally, providing the first clear evidence that molecules - and thus atoms - exist. Most scientists already assumed that they did, but others thought such an assumption unwise without direct evidence. Perrin's work won him the Nobel prize in 1926.

Cardona points out that Einstein was interested in solids too. Einstein explained how crystal lattices take up heat as vibrations, and his ideas paved the way for an understanding of superconductivity.

It's understandable that these achievements have never been as widely celebrated as Einstein's work on relativity - mundane matter doesn't have the glamour of black holes, time travel and $E = mc^2$. But by neglecting Einstein's interest in condensed matter, we miss what was so striking about his science. To his mind, all of these things were parts of a unified view of nature. "It is a wonderful feeling," he wrote in 1901, "to realize the unity of a complex of phenomena which, to immediate sensory perception, appear to be totally separate things."

This belief in the unity of science was reflected by Einstein's fruitless quest in later life for a unified theory of the fundamental forces of nature - a quest still pursued today.

But even talk of the unification of physics risks missing the point. Einstein not only believed that such a picture exists, but also had the intellectual wherewithal to help construct it. Few contemporary scientists make important contributions to more than one area of science, let alone do so within a single year.

It is sometimes suggested that Plato and Aristotle were the last people to encompass their entire intellectual culture (and even they had little to say about the arts). Nineteenth-century scientists couldn't claim that breadth, but some, like Michael Faraday, Louis Pasteur, and Alexander von Humboldt, could still make significant contributions to several fields. By Einstein's time, science had become even more specialized, and he was perhaps the most famous member of the last generation to embrace all of physics. That's why to celebrate Einstein's 1905 achievements is also to lament the passing of an era, for science is too fragmented for us to see his like again.