

Thanks, Albert!

2005 is the centenary of what physicists have called “Einstein’s Miraculous Year”. In 1905, Einstein published five extraordinary papers; scientists are still exploring the ramifications of some of them today. What do century-old ideas have to do with computers? More than you might think.

Einstein’s first article suggested that light acts like both a wave and a particle, explaining how light striking metal creates an electric current. This led to quantum physics and eventually to light-sensitive devices of many kinds. This work earned Einstein a Nobel prize in 1922. (More work by Einstein in 1916-25 eventually led to lasers - CD and DVD players, fiber-optic communications and bar-code scanners).

The second paper showed a new method of estimating the sizes of molecules. While not often cited today, this paper secured Einstein’s long-delayed doctorate.

In the third paper Einstein showed that the random motion of microscopic particles (the Brownian motion we learned about in high school) is caused by the motions of atoms. In 1905 quite a few older scientists didn’t believe atoms were real, so this was important. (Even Einstein made mistakes: experiments a few years later gave results different from his predictions; unable to find errors in his equations, he sought help from a colleague. Corrected, the equations agreed well with experimental results.) The methods Einstein developed can be used to model the diffusion of pollutants in the air and stock prices.

The fourth and fifth papers, dealing with the relationships of time, energy, motion and mass (“special relativity”), joined the concepts of matter and energy. (In 1907, Einstein added the famous equation  $E=mc^2$ .) One of the odder consequences of special relativity is that the clocks in GPS satellites have to compensate for the diminished gravity in orbit.

Scientists are still creating new technologies from Einstein’s ideas. Microscopic Brownian “ratchets” can separate viruses, analyze blood, and remove pollutants from water. Researchers in several labs are exploiting special relativity to speed up computer chips and reduce power consumption. Instead of using herds of electrons to represent 1 or 0, changing a single electron’s magnetic orientation (“spin”) can represent 0 or 1. In 20 years we’ll see ultra-miniature computers vastly more powerful than today’s.

Thanks again, Albert.

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