The oscillation of the electric field in a laser pulse has been measured for the first time by physicists in Austria and Germany. The technique could be used to study ultrafast dynamics in atoms and molecules (E Goulielmakis et al. 2004 Science 305 1267).

The electromagnetic field of visible light performs about $10^{15}$ oscillations per second. Although it is possible to measure the amplitude of these oscillations, and also their frequency or wavelength, the variation of the electric field itself has not been measured directly until now.

Ferenc Krausz and co-workers at the University of Vienna, the University of Bielefeld and the Max Planck Institute for Quantum Optics sent an extreme-ultraviolet laser pulse with a duration of just 250 attoseconds ($250 \times 10^{-18}$ s) into a gas of neon atoms, along with the longer femtosecond ($10^{-15}$ s) pulse that they wanted to measure. This second pulse contains only a few cycles of the electromagnetic field. The attosecond pulse ionises the neon atoms, and the electrons that are released are then accelerated by the electric field of the longer pulse. The duration of the electron bunch is much shorter that the timescale over which the electric field of the femtosecond pulse changes.

The energy of the accelerated electrons - which can be measured with a spectrometer - depends on the strength of the electric field in the femtosecond pulse. By varying the relative timing of the two pulses and measuring how the electron energy changes, it is possible to build up a picture of the electric field in the longer pulse (see figure). The method reveals that the light pulse has a duration of 4.3 femtoseconds.

"Our technique can measure the dynamic evolution and the exact value of the electric field for few-cycle light waves that extend from the infrared to the ultraviolet," Krausz told PhysicsWeb. "It paves the way for using these waves for accurate studies in ultrafast atomic and molecular physics."