Fastest-ever flashgun captures image of light wave

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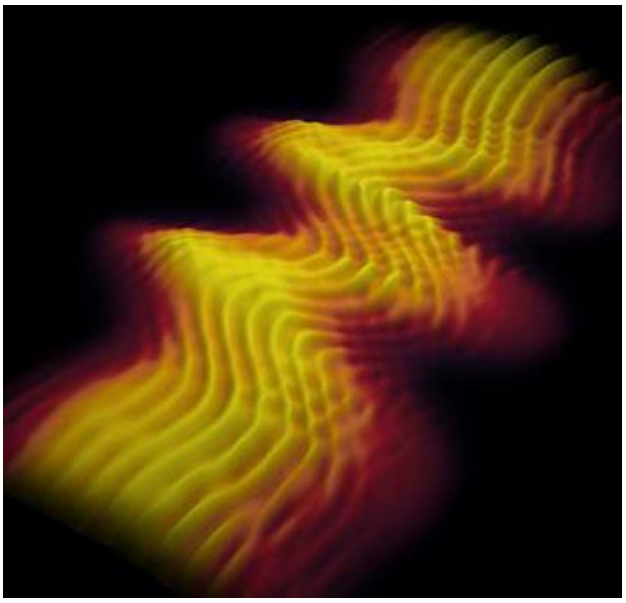
- Colin Barras



Enlarge image

Image of a pulse of light that is 2.5 billionths of a millionth of a second long (Image: Science)

However hard you stare, you would still miss it. Researchers have found a way to generate the shortest-ever flash of light – 80 attoseconds (billionths of a billionth of a second) long.

Such flashes have already been used to capture an image of a laser pulse too short to be "photographed" before (see right).

The light pulses are produced by firing longer, but still very short laser pulses into a cloud of neon gas. The laser gives a kick of energy to the neon atoms, which then release this energy in the form of brief pulses of extreme ultraviolet light.

The trigger pulses fired at the neon cloud are themselves only 2.5 femtoseconds, billionths of a millionth of a second, long, says team member Eleftherios Goulielmakis at the Max Planck Institute for Quantum Optics in Garching, Germany.

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Light punch

The trigger pulses contained only one or two oscillations of a light wave so that they packed a compact energy punch when they reached the neon cloud.

To do this, the researchers had to corral the trigger-pulse photons into a tightly packed bunch using a device called a chirped mirror.

These multilayered mirrors make the photons at the front of a pulse travel further than the slower photons at the rear do. That gives the back markers time to catch up, in this case producing a tight pack of photons that hit the neon atoms at roughly the same time.

Photon finish

To find out how short the light flashes from the neon atoms were, Goulielmakis and colleagues directed them onto a second neon gas cloud.

As each flash is intense enough to completely ionise a neon atom and release an electron, the researchers could use those electrons like a flashgun, to illuminate some of the original 2.5 femtosecond trigger pulses of laser light.

"Only sampling them with a "sampler" way shorter than that can render them visible," explains Goulielmakis.

Recording the energy of the electrons that passed through the pulse generates a crisp side-profile of the short laser beam, not unlike a sporting photo-finish image (see right). The image of the laser clearly shows the single oscillation of the trigger pulse.

Computer analysis of the image reveals that the flashes of light used to make the electrons lasted just 80 attoseconds – the shortest ever made.

Electron 'camera'?

Jonathan Marangos at Imperial College London, UK, says the super-short flashes could let researchers image the movement of electrons around large atoms.

"Any better understanding of the microscopic world is going to have an impact across all of science," he says.

The previous record for the shortest light pulse was 130 attoseconds, set in 2007. "To go from 130 to 80 attoseconds is a major step," says Marangos.

In the future, Goulielmakis hopes to produce light pulses of 24 attoseconds, the atomic unit of time, defined as how long it takes an electron to travel from one side of a hydrogen atom to the other.

But Marangos thinks even shorter pulses are possible. "There's nothing magical about the atomic unit of time," he says, saying zeptosecond pulses of trillionths of a billionth of a second might be possible. These would be capable of imaging the movement of nuclear particles like protons, says Marangos.

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- Eleftherios Goulielmakis, Max Planck Institute for Quantum Optics
- http://www.attoworld.de/people/Goulielmakis/EGoulielmakis.html
- Jonathan Marangos, Imperial College London
- http://www3.imperial.ac.uk/people/j.marangos

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