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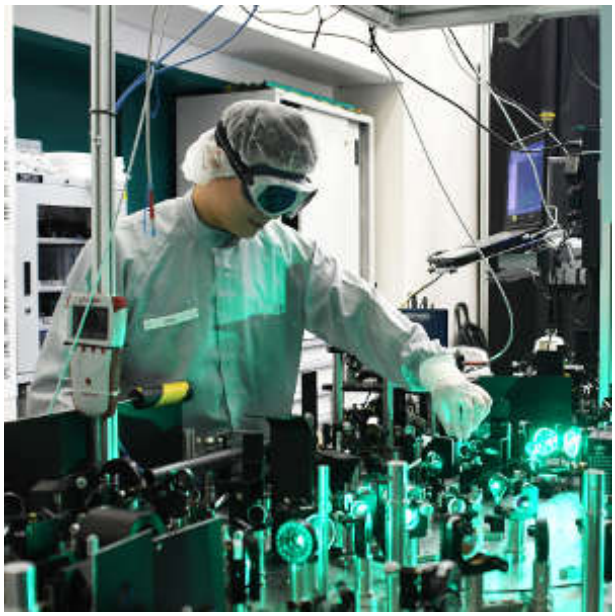
Monitoring molecules in a flash

Brief pulses of powerful laser light could unlock new insights into molecular dynamics.

A light source capable of generating powerful, ultra-short laser bursts could help scientists detect and monitor the behaviour of molecules with unprecedented temporal resolution.



A new laser source generates the ultra-brief laser pulses required for molecular analysis with high temporal resolution.
Thorsten Naeser, Max Planck Institute of Quantum Optics

Physicist Hanieh Fattahi of the Ludwig Maximilian University of Munich says such short pulses of laser light – known as 'transients' – are a powerful tool for spectroscopy. "In this regime, one can efficiently engineer the shape of the electric field of light," she says. A sufficiently strong and appropriately shaped field can enable detection of sub-atomic molecular dynamics at one-quadrillionth of a second (femtosecond) timescales.

Despite considerable progress, researchers have struggled to generate transients with sufficient energy. Fattahi's group, in collaboration with researchers at King Saud University in Saudi Arabia, has developed a powerful source that can overcome these limitations.

Their system employed lasers based on the element ytterbium, which can achieve high power but typically produce relatively long pulses. Fattahi and colleagues coupled the laser to a system known as an 'optical parameter chirped-pulse amplifier', which can efficiently convert these into brief transients that still retain sufficient power to achieve high resolution molecular detection.

As an initial demonstration, the researchers used their source to analyse individual water molecules. “We could detect the complex electrical field of the absorbed light by water molecules in the near-infrared spectral range for the first time,” says Fattahi. Based on these results, she anticipates it should be possible to perform spectroscopic analysis of molecular vibrations at femtosecond timescales, and her group is now exploring the potential to apply this technique to biological specimens.