### Podglądanie reakcji chemicznych: eksperymenty typu pump-probe

### The motions and locations of nuclei and electrons determine energy flow and charge transfer in molecules. Pump–probe spectroscopy is a stroboscopic method to record those motions. A pump pulse initiates the motions and a probe detects them. The collection of probe signals taken at multiple time delays between the two pulses captures the dynamics.

### The x-ray laser can serve as either the pump or probe when it is paired with a short pulse laser of the appropriate wavelength. Pump–probe methods were developed for conventional lasers that produce the pump and probe with a variable optical path difference to set the delay, which can be adjusted easily by small fractions of the pulse duration. The delay is much more challenging when one of the pulses is a local laser and the other is an x-ray laser produced by transporting relativistic electrons more than a kilometer. The delay can drift by pico seconds if the Sun goes behind a cloud and the temperature in the accelerator building changes.

O laserze na swobodnych elektronach opowie ktoś inny. Natomiast tu należy przedstawic 2 przykłady wykonania takich eksperymentow pump-probe, np. Te zawarte w pracy Resonant internal quantum transitions and femtosecond radiative decay of excitons in monolayer WSe2, C. Poellmann , et. al., NATURE MATERIALS | VOL 14 | SEPTEMBER 2015 (to jest w miare nowa, ale pierwsza z brzegu; mozna zaproponowac inna) i np. nowa prace (Liat Levin, Wojciech Skomorowski et. al., Coherent control of bond making: The performance of rationally phase-shaped femtosecond laser pulses, Arxive 2015, published in PRL) w której autorzy pokazują, ze można zmusić atomy do syntezy w cząstkę (a nie tylko do rozpadu), pracę, która zaanonsowana jest poniżej

**A femtosecond laser pulse makes molecular bonds (**<http://scitation.aip.org/search?value1=R.+Mark+Wilson&option1=author&option912=resultCategory&value912=ResearchPublicationContent>**,**  sierpień 2015, page 19)

Początek formularza

 [R. Mark Wilson](http://scitation.aip.org/search?value1=R.+Mark+Wilson&option1=author&option912=resultCategory&value912=ResearchPublicationContent)

The result of a chemical reaction is dictated by energy potentials and thermodynamics, but physicists have long hoped to steer reactions in new ways with coherent light from lasers. For the first time, researchers demonstrate the coherent control of the reaction by which two atoms form a molecule. The achievement—coupled with other photocatalyst tools—could potentially lead to a chemical assembly line, in which lasers slice and weld molecular pieces into a desired end product.

Coherent control of chemical reactions, which was first proposed thirty years ago, employs shaped laser pulses to place molecular reagents in states that promote a rare reaction process. Several groups have succeeded in controlling which bonds are cut in a target molecule (i.e., selective photodissociation). However, the coherent control of bond formation has proven more elusive.

A collaboration between experimentalists at Technion-Israel Institute of Technology in Haifa, Israel, and theorists at the University of Kassel in Germany has now controlled the photoassociation of a simple molecule. The team fired femtosecond laser pulses at a sample of magnesium atoms, which could absorb multiple infrared photons from the laser to form Mg2. This process is rare, but the researchers found they could alter the Mg2 yield by changing the pulse shape. In particular, a positive chirp (i.e., a pulse whose frequency steadily increases with time) boosted the yield by a factor of 5 over an unshaped pulse. To explain this chirp dependence, the team constructed a model that showed the pulse shape affects transitions between vibrational levels in an intermediate state. With this understanding, they optimized the pulse shape using a feedback system, gaining a further 35% in the reaction yield.

*This research is published in* [Physical Review Letters](http://journals.aps.org/prl). Coherent control of bond making: The performance of rationally phase-shaped femtosecond laser pulses

**Literatura**

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C. Poellmann , et. al., NATURE MATERIALS | VOL 14 | SEPTEMBER 2015

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4. Liat Levin, Wojciech Skomorowski et. al., Coherent control of bond making: The performance of rationally phase-shaped femtosecond laser pulses, arxive 2015, published in PRL