NANOSCIENCE COLLOQUIUM

New approaches to light control: From nonlinear quasi-waveguides to gas-phase sono-photonics

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ABSTRACT: Ultrafast optical laser pulses play a crucial role in many fields: they allow for precise measurements at nanometer length and femto- to attosecond time scales and are essential for many industrial applications such as semiconductor manufacturing and healthcare. Although ultrafast lasers have been available for over half a century, our ability to create and control ultrashort pulses, is rapidly advancing until today. This talk will focus on two new laser pulse control schemes.
The first scheme relies on optical multi-pass cells (MPCs), a new tool for nonlinear optics with quasi-waveguiding properties hybridizing free-space and guided-wave nonlinear optics [1,2]. MPCs have recently enabled large-factor post-compression and shaping of ultrashort pulses approaching the few-cycle regime [3] and open the door to new ultrafast laser platforms.
The second scheme employes intense ultrasound (sono) waves for contactless laser pulse (photon) control directly in ambient air, opening a new research field: gas-phase sono-photonics [4].

[1] A.-L. Viotti, M. Seidel, E. Escoto, [...], C.M. Heyl, “Multi-pass cells for post-compression of ultrashort laser pulses”, Optica 9, 197-216 (2022).
[2] P. Balla, H. Tünnermann, S.H. Salman, [...], C.M. Heyl, “Ultrafast serrodyne optical frequency translator”, Nature Photonics 17, 187–192 (2023).
[3] S. Rajhans [...], C.M.Heyl, “Post-compression of multi-millijoule picosecond pulses to few-cycles approaching the terawatt regime”, Opt. Lett. 48, 18 (2023).
[4] Y. Schrödel, C. Hartmann, C. Zheng, [...], Heyl, C.M., “Acousto-optic modulation of gigawatt-scale laser pulses in ambient air”, Nature Photonics 18, 54–59 (2024).

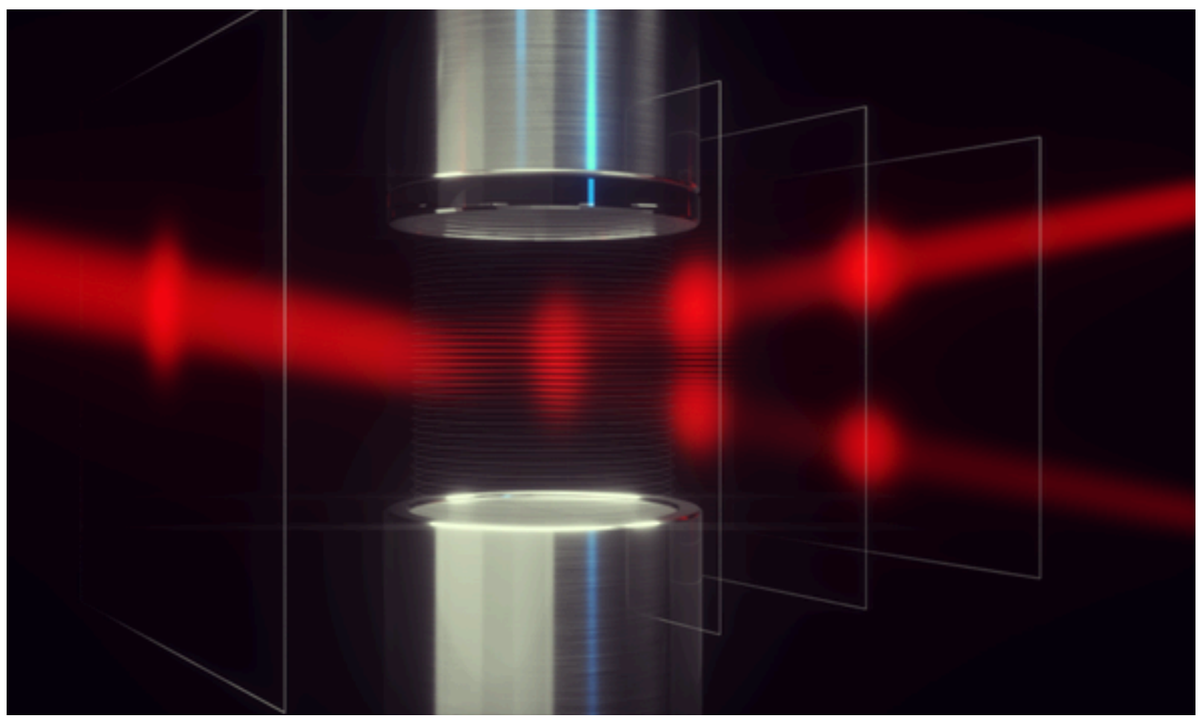

Figure: Laser pulse deflection at an invisible grating made of air

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