PHYSIKALISCHES KOLLOQUIUM

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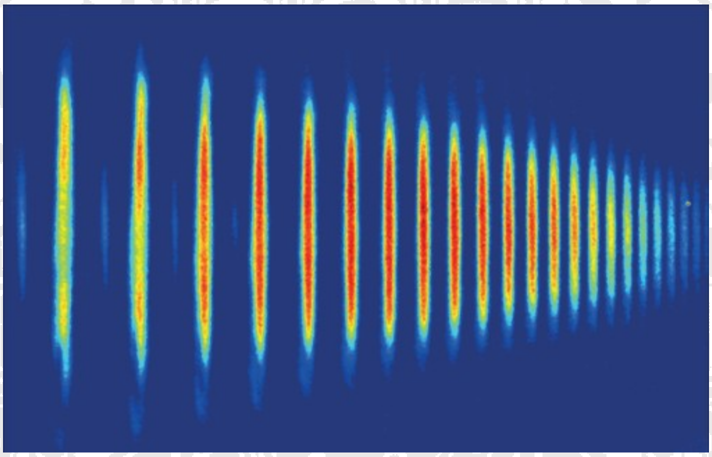
IM GROßEN HÖRSAAL



FROM OPTICAL BREAKDOWN TO RELATIVISTIC PLASMA MIRRORS: THE STORY OF A PIECE OF GLASS IN AN INTENSE LASER FIELD

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Dielectric materials such as silica are widely used in a wealth of applications, largely because they are transparent to visible light thanks to their large electronic bandgap. Yet, when such a material is exposed to a laser field of high enough intensity, electrons do get excited, for instance by the simultaneous absorption of multiple photons. This is what leads to optical breakdown, a major present technical issue in laser technology. Surprisingly, the exact mechanisms leading to this energy absorption by transparent materials are still not precisely understood.
If laser intensity goes even higher, the material surface gets very strongly ionized, and is thus turned into a dense plasma. Due to its high density, this plasma is reflective for the laser light, with a surface that remains as flat as the one of the initial target for several hundreds of femtoseconds (1 fs=10^{-15} s). Such a plasma can specularly reflect femtosecond laser pulses of almost arbitrarily high intensities, just like usual mirrors do for ‘low’ intensity light: these are called plasma mirrors.
At ‘moderate’ laser intensities (10^{15}-10^{17} W/cm^2), plasma mirrors can be used as high-dynamic ultrafast optical switches to ‘clean’ high power laser pulses in time, and have therefore become a crucial tool for laser-plasma physics experiments. At more ‘extreme’ intensities (>10^{18} W/cm^2), the incident laser field induces an oscillation of the plasma surface involving velocities of the order of the speed of light: such ‘relativistic plasma mirrors’ generate tens of harmonics of the laser frequency (see image) associated to intense attosecond (1 as=10^{-18} s) pulses, and emit beams of relativistic electrons. Hopefully in the near future, when exposed to the most powerful lasers existing to date, they will focus light to intensities approaching 10^{29}W/cm^2, such that its propagation into vacuum becomes non-linear and new regimes of quantum electrodynamics can be investigated experimentally.
In this presentation, I will present a simple overview of these very different physical aspects of the interaction of a piece of glass with laser fields of increasing intensities.