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Generation of high-power terahertz radiation and its interaction with matter[1]

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Sandwiched between the optical and microwave regimes, the far infrared or terahertz (THz) frequency range has recently drawn special attention due to its ubiquitous nature and broad applications. THz radiation (or T-rays) can easily pass through non-polar materials such as clothing, paper, plastics, wood and ceramics. This property allows many applications in molecular sensing, biomedical imaging and spectroscopy, security scanners, and plasma diagnostics. High-power THz generation is also vital for applications in nonlinear THz optics and spectroscopy, and so there is a growing demand for intense, compact THz sources. Here I will talk about our approach in using tabletop, ultrashort-pulsed lasers to produce intense THz radiation and study nonlinearities driven by THz pulses in matter. Recently, we have demonstrated strong THz field generation via cylindrical focusing of two-color laser pulses in air. In this experiment, a terawatt (TW) laser pulse at 800 nm passes through a nonlinear crystal (BBO) and generates its second harmonic pulse at 400 nm. Both pulses pass through a cylindrical lens and are focused together to generate a 2-dimensional plasma sheet in air. This plasma sheet can yield scalable THz radiation approaching gigawatt (GW) peak power. Such an intense THz pulse can be used to accelerate electrons at relativistic velocities and to study quasi-DC tunneling ionization of atoms and molecules at THz frequencies.

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