Intense THz sources and applications

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ABSTRACT

Terahertz (THz) radiation, located in-between microwave and infrared frequencies, belongs to one of the most interesting and less explored regions of the electromagnetic spectrum. Currently, the interaction of powerful THz pulses with matter is a major frontier in strong field laser physics and nonlinear optics. A plethora of scientific challenges and applications are presently under study, like table-top electron acceleration, THz-enhanced attosecond pulse generation and strong electric and magnetic THz field interactions with matter. Nevertheless, despite the rapid development of THz science during the last two decades, most available table-top THz sources remain rather weak limiting the interactions of THz radiation with matter mostly in the realm of linear optics.

Here we discuss our advances towards the generation of intense, broadband THz fields. We focus on the generation scheme based on two-color filamentation in air, under which the fundamental and the second harmonic of an ultrashort pulsed laser are combined and focused into air forming a filament, which produces intense THz pulses in the far field. Novel approaches to enhance the THz emission and further upscale the efficiency of these sources will be presented. These, among others, include the use of mid-infrared two-color laser pulses to drive the filamentation in air, resulting in an unprecedented THz conversion efficiency of a few percent, exceeding by far any previously reported experimental values for plasma-based THz sources [1]. Moreover, due to the large bandwidth of the generated THz radiation (~ 20 THz) the peak THz electric and magnetic fields exceed the 100 MV/cm and 33 Tesla, respectively. Based on our experimental findings and theoretical estimates, it is projected that soon multi-millijoule THz pulses with peak electric and magnetic fields in the gigavolt per centimeter and kilotesla level, respectively, will become available. Quasi-static ultrashort electric and magnetic bursts at these intensities will enable extreme nonlinear and relativistic science.

REFERENCES

[1] Koulouklidis, A. D. et al., Nature Communications **11**, 292 (2020)