基于气体激光成丝的 kHz 重频、21 μJ 太赫兹源

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在基于双色场飞秒激光成丝产生 THz 辐射中，成丝辐射 THz 的强度、带宽、偏振等特性会受到包括双色场的时间延迟、色散、偏振、波长、空间走离以及气体环境等在内的众多参数的影响。只有实现对上述参数的有效调控，才能获得高效的 THz 辐射源。

南开大学刘伟伟教授团队使用单脉冲能量为 6 mJ 的飞秒激光脉冲通过 β-BBO 倍频产生双色光场，通过倾斜 α-硼酸钡 (α-BBO) 晶体实现了双色激光脉冲在空间和时间上的精确重叠，并利用双色波片保证了双色激光具有相同偏振，在氩气中成丝辐射的太赫兹脉冲最大能量达到 21 μJ，THz 转换效率达到创纪录的 0.35%。

实验测量了气体种类对双色场辐射 THz 效率的影响实验结果表明氩气中 THz 辐射的转换效率最高。在此基础上进一步测量了氩气中不同 α-BBO 倾斜角度与辐射 THz 功率的关系，倾斜 α-BBO 能更好地实现时间和空间走离的补偿，进而提高 THz 波的产生效率。该项研究工作实现了双色场成丝辐射 THz 能量转换效率的突破，对于高强度 THz 源的研究以及探索强太赫兹辐射与材料的相互作用具有重要意义。

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Over 20 J THz laser pulse generated at 1 kHz in gas media

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The THz generation scheme based on dual-color femtosecond laser filamentation has higher energy conversion efficiency than that using single-color femtosecond laser. In this scheme, the intensity, bandwidth, polarization and other characteristics of the THz radiation can be affected by many laser parameters including the temporal delay, dispersion, polarization, wavelength, spatial departure of the dual-color fields.

The research group led by Prof. Weiwei Liu from Nankai university used femtosecond laser with single pulse energy of 6 mJ to generate the dual-color laser filamentation by frequency doubling the fundamental laser via a β-BBO crystal. The dual-color laser beams achieve the perfect spatial-temporal overlap through a tilted α-BBO crystal. Meanwhile, a dual-wavelength plate was used to make the dual-color laser beams have the identical polarization. The energy of the THz pulse generated from the laser filament in argon can be up to 21 μJ and the corresponding THz conversion efficiency reaches 0.35%. The ambient gas species' influence on the THz generation efficiency by the dual-color laser filamentation was investigated experimentally. Experimental results show that the highest conversion efficiency of THz radiation is achieved in argon gas. The relationship between the tilting angle of α-BBO and the generated THz power in argon was also investigated. α-BBO with optimal tilting angle and pre-designed thickness can simultaneously compensate the time delay and spatial walk-off of the two-color laser beams, playing the critical role in improving the generation efficiency of THz wave.

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