Tunable Mid-Infrared Pulse Sources Driven by Relativistic Laser-Plasma Interactions

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Optical rotators based on the Faraday effect have been widely used in optical systems, such as optical isolation and circulators. However, due to the limitation of crystals, the application of such optical rotators in high-power lasers has been severely hindered. Here, we propose a novel plasma rotator based on the frequency-variable Faraday rotation (FVFR), achieved by driving the magnetized underdense plasma with a relativistic linearly polarized laser. In the magnetized plasma, the drive laser undergoes photon deceleration and relativistic Faraday rotation, leading to the generation of relativistic polarization-tunable mid-infrared (mid-IR) pulse with intensity of 10^{16} W/cm^2 and a spectral width of 5-25 μm. With different magnetic elds, the polarization angle of the generated mid-IR pulse can be well controlled. Especially, one can obtain a circularly polarized mid-IR pulse with the average polarization degree of 0.94 at a suitable external magnetic eld. Such a rotator *via* FVFR is valid from mid to far-infrared and even THz waveband, offering new opportunities for strong-field physics, attosecond science, *etc.*, and paving the way for relativistic plasma magneto-optics and future relativistic plasma optical devices.

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