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Experimental and Simulation Study on Direct Acceleration of Electron Beams Driven by Vortex Lasers

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Recent developments in relativistic Laguerre–Gaussian (LG) lasers have sparked physical research into petawatt (PW) laser facilities. It has been observed that LG lasers not only produce hollow laser intensity but also generate novel structured electric fields for different LG modes. In the case of left circularly polarized LG lasers, the longitudinal electric field, combined with the hollow intensity around the axis, enables stable direct acceleration of electrons. Compared to traditional Gaussian lasers, this configuration allows for stable concentration of electrons at the center, resulting in the generation of high-flux beams. Recently, the longitudinal vortex laser (LG) has been further extended to the transverse vortex laser (STOV), introducing time dimension modulation for the electron beam. This advancement has achieved isolated attosecond electron acceleration and corresponding attosecond γ-ray generation. This report discusses the recent development of PW vortex lasers at the SULF laser facility, along with considerations for electron acceleration driven by LG and STOV lasers and their applications in γ-ray generation.

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