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Generation of Long-Range Quasi-Non-Diffracting Bessel-Gaussian Beams in Few-Cycle Femtosecond Laser Fields

In this talk we will describe a new, simple and robust method for generating long-range Bessel-Gaussian beams with divergences on the microradian scale. The approach is entirely based on singular and Fourier optics. Initially, an optical vortex (OV) with a high topological charge (~20 and higher; [1]) is formed on the input Gaussian laser beam with a flat wavefront. Due to the modulation instability (which plays a positive role here), the vortices decay into single-charged ones. Repulsing, they transform the Gaussian beam into a ring-shaped beam with a large radius-to-width-ratio. Once the vortices are annihilated (erased), the ring-shaped beam is focused with a thin lens and a Bessel-Gaussian beam is sculpted behind the lens'focus [2,3]. We will present experimental and numerical evidences supporting the claims that: (i) these beams are long-range and quasi-non-diffracting, (ii) can be generated in both - continuous-wave beams and in the fields of ultrashort (femtosecond) laser pulses [4], (iii) the approach is non-wavelength-selective, independently of the used approach for generation highly-charged OVs - spiral phase or spatial light modulators, and (iv) can be created in femtosecond laser fields by generating the second harmonic of ring-shaped, strongly azimuthally modulated necklace beams Fourier-transforming them in space [5]. We believe that these results are of interest for e.g. free-space optical communications.

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References:

[1] L. Stoyanov et al., European Physical Journal Plus 138, 702 (2023).
[2] L. Stoyanov et al., Scientific Reports 10, 21981 (2020).
[3] L. Stoyanov et al., Optics Communications 480, 126510 (2021).
[4] L. Stoyanov et al., Optics Express 29, 10997 (2021).
[5] N. Dimitrov et al., Photonics 12, 119 (2025).

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