Generation of Divergence-Free Bessel-Gauss Beam From an Axicon Doublet for Km-Long Collimated Laser

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Abstract

A well-collimated intensity profile at long distance has long been a desired laser property crucial for many potential applications. Extending a non-diverging range for ordinary laser beyond kilometers scale would permit superior performance for optical technologies, including LIDAR, or free-space communication. In this paper, we propose a facile but powerful technique to generate a long-range non-diverging beam from a cemented axicon doublet structure. The system is all solid-state with optical design parameters based on current technological availability. A compound axicon here is expected to provide sufficiently low beam converging beyond the limit of a single axicon. The resulting beam profile is regarded as Bessel-Gauss with inward radial wave component that compensates diffraction of a normal Gaussian mode profile. A numerical simulation was performed to verify for km-long laser propagation domain, accomplished by using Electromagnetic Waves, Beam Envelopes interface in the COMSOL Multiphysics® software, which allows finite element simulation for optics wave in an ultra large domain without spending excessive resources. It was found that, with an input beam waist of only 25 mm, an axicon doublet at optimal parameters can generate a Bessel-Gauss beam with divergent-free range of at least 2 km.