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Lensless formation and turbulence response of Airy-type beams generated by direct Fresnel propagation.

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We investigate a lensless Airy-type beam generated by direct Fresnel propagation of a Gaussian-apodized cubic phase. Unlike the conventional finite-energy Airy beam, which is formed by a Fourier-transforming lens system [1], the lensless field is not an Airy beam at the input plane. Starting from the Fresnel diffraction integral, we show analytically that an Airy-type structure forms during propagation, but with a different Airy argument and therefore different transverse dynamics.

The conventional beam follows the familiar parabolic main-lobe trajectory, while the lensless field undergoes a formation stage before developing an Airy-like profile. The two beams are compared using propagation maps, transverse profiles, and two-dimensional and three-dimensional intensity distributions. We then examine their behaviour in atmospheric turbulence [2] using a phase-screen model. The comparison is performed at a matched free-space plane where both beams have the same normalized transverse intensity distribution. The results show that, despite this free-space intensity matching, the two fields exhibit different scintillation behaviour, indicating that turbulence response depends not only on the receiver-plane intensity profile but also on the beam's complex-field evolution during propagation.

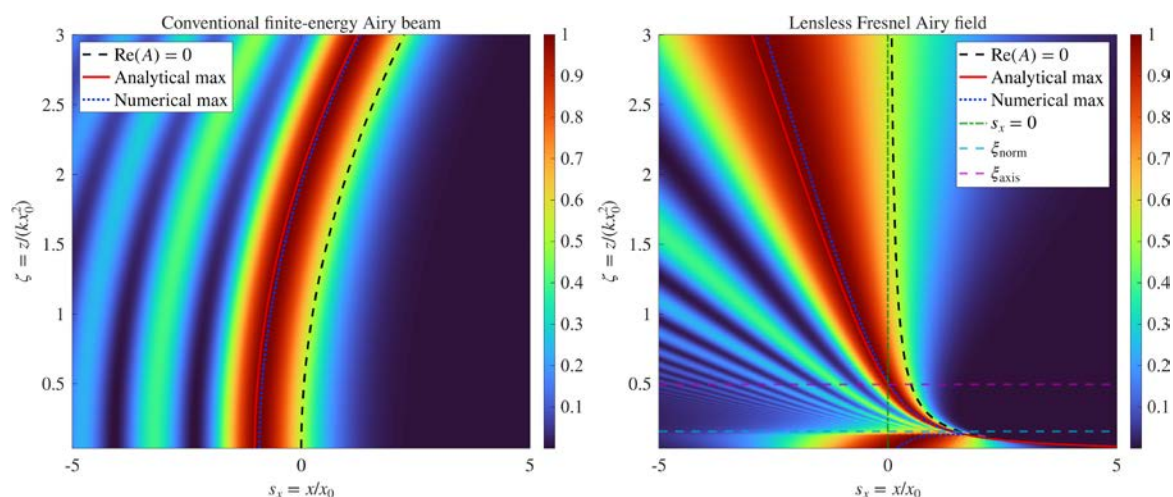


Fig. 1 Short and clear caption, revealing the message of the figure.

REFERENCES

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- [2] L. C. Andrews and R. L. Phillips; Laser Beam Propagation through Random Media, 2nd ed., Bellingham: SPIE Press (2005).