Self-accelerating beams through spectrum-engineering

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Abstract: We introduce the concept of spatial spectral phase gradient, and demonstrate, both theoretically and experimentally, how this concept could be employed for generating single- and multi-path self-accelerating beams. In particular, we show that the trajectories of the accelerating beams are determined *a priori* by different key spatial frequencies through direct spectrum-to-distance mapping. In the non-paraxial regime, our results clearly illustrate the breakup of Airy beams from a different perspective, and demonstrate how circular, elliptic or hyperbolic accelerating beams can be created by judiciously engineering the spectral phase. Furthermore, we found that the accelerating beams still follow the predicted trajectory also for vectorial wavefronts. Our approach not only generalizes the idea of Fourier-space beam engineering along arbitrary convex trajectories, but also offers new possibilities for beam/pulse manipulation not achievable through standard direct real-space approaches or by way of time-domain phase modulation. In addition, by introducing the spectral amplitude modulations in our methods, zigzag beams along convex trajectories are realized in both paraxial and non-paraxial conditions.