Optical Airy beams and bullets

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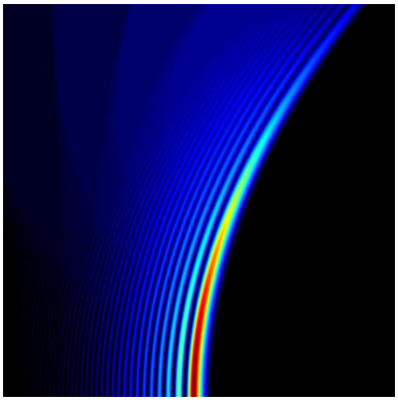
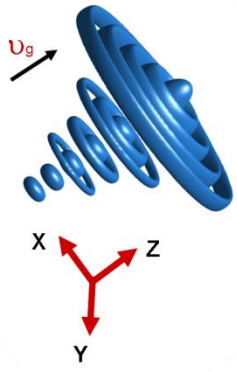
Abstract

In recent years, the quest for non-spreading or non-diffracting optical beam configurations has been motivated by possible applications in diverse fields ranging from biology to atom optics. Lately our group has explored the possibility of experimentally realizing non-spreading accelerating Airy beams in optics. This was done by exploiting the formal analogy between quantum wave mechanics and paraxial diffraction optics. We have demonstrated, that even though they are exponentially truncated (thus conveying finite energy), these Airy beams still exhibit a host of interesting characteristics. More specifically, they resist diffraction while their main intensity maxima or lobes tend to self-bend and accelerate in free space along parabolic trajectories. This ballistic behavior persists over long distances in spite of the fact that the center of gravity of these wavepackets remains constant (in agreement with Ehrenfest's theorem) and eventually diffraction takes over. Figure (a) depicts quasi-diffractionless propagation of a finite-energy Airy beam where its "acceleration" dynamics are apparent. These intriguing properties of the Airy wavepackets put them in a category by themselves. These beams, in contrast to the already known families of non-diffracting fields; are possible in one-dimension (excellent candidates for time applications), do not result from conical superposition, and are thus *highly asymmetric*. The peculiar features of Airy beams may find applications in near-field microscopy where their asymmetric intensity pattern could prove advantageous. Particle sorting (via optical gradient forces) along bent parabolic trajectories may be another fascinating direction.

Here we provide an overview of our recent work on optical Airy beams and bullets. Other aspects like their self-healing properties or the possibility of generating for the first time spatio-temporal optical Airy bullets (b) will be also discussed.



(a)



(b)