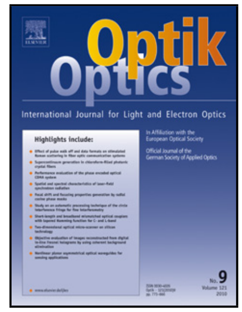
Accepted Manuscript



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PII: S0030-4026(17)31635-2
DOI: https://doi.org/10.1016/j.ijleo.2017.12.007
Reference: IJLEO 60129

To appear in:

Received date: 29-10-2017
Revised date: 5-12-2017
Accepted date: 5-12-2017

Chirped Airy beams in strongly nonlocal media with focusing and defocusing nonlinearity

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Abstract

In this paper, we derive an analytical solution of linearly chirped Airy beams (CAB) propagating in strongly nonlocal media with focusing and defocusing nonlinearity. Our analytical results show the periodic evolution pattern of CAB supported by strongly nonlocal focusing nonlinearity is made to be gradually reshaped each other between Airy distribution and conventional standard Gaussian distribution. Meanwhile, we further disclose how initial chirp affects the periodic evolution of optical beam. It is found that we can change ballistic trajectory gradually from conventional parabolic to trigonometric shapes through increasing initial chirp; however the corresponding period is only determined by the degree of nonlocality but independent on the former. Moreover, another interesting property is that initial chirp will lead to a positive or negative transverse displacement of the resulting Gaussian distribution depending on the direction of input beam, but does not affect its shape and longitudinal location. On the other hand, for defocusing nonlinearity, CAB is found to exhibit the conventional nonperiodic self-accelerating behavior, which direction is decided by the initial chirp. Our analytical results agree with the existing results and can be confirmed by numerical prediction.

1. Introduction

The nonspreading solutions also called Airy wave packet to the free-particle Schrödinger equation was first introduced in the context of quantum mechanics by Berry et al nearly 30 years ago [1] and later realized in optical field both theoretically and experimentally by Christodoulides et al in 2007 [2,3]. Over the past few years, the latter has attracted considerable attention in the area of the propagation and generation in dispersive linear/nonlinear media, due to some unusual properties such as self-accelerating without external force [2,3], approximately nondiffracting [2,3], and self-healing behaviors [4]. Accordingly, these unique properties give rise to great potential applications of novel Airy beam in many fields of optical micromanipulation [5,6], and high-resolution microscopy [7, 8] and all-optical routing [9].

Besides the linear propagation of Airy beams, the nonlinear control of Airy beams is recently demonstrated to be able to bring about many novel dynamics such as supercontinuum generation [10], optical filamentations [11,12] and optical solitons [13-17]. However, most of foregoing researches on Airy beam in the nonlinear regime have only been limited to the local case. As is well known, the nonlocal nonlinearity allowing the refractive index at a particular point depending on the optical intensity in a certain neighborhood of this location, have been found in many physical systems []. Different kinds of optcial beam/soliton propagation have theoretically been well understood in nonlocal nonlinear media up to now, such as conventional symmetric Gaussian profile with or without vortex [18-21], Ince-Gaussian profile [22], Laguerre-Gaussian and Hermite-Gaussian profile [23,24], Tripole-mode and