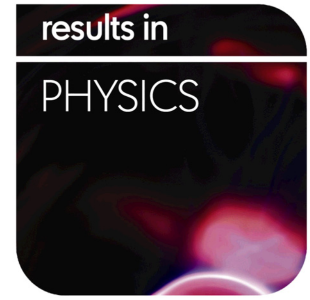

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Anomalous transverse transformation of astigmatic four-petal Gaussian beams in isotropic nonlocal nonlinear media

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ABSTRACT

In this paper, the evolution dynamics of astigmatic four-petal Gaussian beams in isotropic nonlocal nonlinear media is investigated. A series of analytical expressions are derived to describe the beam evolution, the beam width, and the critical power. The anomalous transverse transformation is presented, i.e., an astigmatic four-petal Gaussian beam is compressed in one transverse direction and it is broadened in the other transverse direction. These evolution characteristics of astigmatic four-petal Gaussian beams are illustrated through some numerical simulations.

Nonlinearity exists in nature widely, and optical solitons are typical nonlinear phenomena in optics [1, 2, 3, 4, 5]. Recently, nonlocal nonlinear media [6, 7] have attracted much attention, because of the discovery of many new novel nonlocal solitons [8, 9, 10, 11, 12, 13]. The evolution of optical beams in nonlocal nonlinear media also indicates many novel properties [14, 15, 16]. In this paper, the evolution dynamics of astigmatic four-petal Gaussian beams (AFPGBs) in strongly isotropic nonlocal nonlinear (SINN) media is investigated. The anomalous transverse transformation of AFPGBs is illustrated.

The evolution dynamics of AFPGBs in nonlinear media is governed by the nonlinear Schrödinger equation (NLSE). For the beam evolution in SINN media, the NLSE is reduced into a simplified form [7, 8, 13]

$$2ik\frac{\partial\Psi}{\partial z} + \left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2}\right)\Psi - k^2\gamma^2 P_0(x^2+y^2)\Psi = 0, \quad (1)$$

where k represents the wave number, γ is a material constant, z indicates the direction of beam propagation, and $P_0 = \iint |\Psi|^2 dxdy$ denotes the input power of AFPGBs.

The electric field of an AFPGBs in rectangular coordinates at the input plane ($z = 0$) is expressed as [17, 18]

$$\Psi(x,y,0) = C_0\left(\frac{x}{w_{0x}}\cdot\frac{y}{w_{0y}}\right)^{2n}\exp\left(-\frac{x^2}{w_{0x}^2} - \frac{y^2}{w_{0y}^2}\right), \quad (2)$$

where $C_0 = 4^n\sqrt{(2P_0)/(w_{0x}w_{0y})}/\Gamma(2n+1/2)$, $\Gamma(\cdot)$ denotes the Euler gamma function, $n = 0, 1, 2, 3\cdots$ denotes the order of the beam, w_{0x} and w_{0y} denote the size of the beam spot in x and y directions, respectively. In this paper, we take $\eta_0 = w_{0y}/w_{0x}$ to describe the asymmetric degree of AFPGBs at the input plane.

Resorting to the similar method in our previous work [13, 18], one can obtain the evolution expression of AFPGBs,

$$\Psi(x,y,z) = \frac{iC_0k}{2\pi\mathscr{L}_P\sin\xi}\psi(x)\psi(y), \quad (3)$$

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