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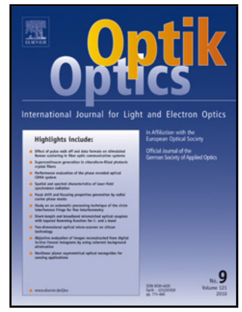

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Optical electrostriction pressure and its influence on the momentum of the light pulse in an optical medium

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Abstract

The momentum of a light pulse propagating in an optical medium consists of the electromagnetic and mechanical components propagating together. If the optical electrostriction pressure produced by the light pulse is taken into account, a distribution between these components is changed. We show that the mechanical component becomes negative with increasing the refractive index of the medium. As a result, the electromagnetic component can be greater than the total momentum of the light pulse in the medium.

Keywords: momentum of light; optical pressure; momentum density; momentum flux density; Abraham force, electrostriction pressure.

1. Introduction

It is known, a light pulse propagating in free space has momentum although its mass is equal to zero unlike the conventional momentum of a body having mass. The momentum of the photon is equal to Σ/c where Σ is the photon energy. The momentum of the conventional body since time of Newton is equal to mv where m and v are the mass and velocity of the body, respectively. A propagation of the same light pulse in an optical medium is accompanied by appearance the conventional momentum connected with moving particles of the medium, the mass of which is different from zero. In order to distinguish these two types of momentum, we will refer to the momentum of a photon in free space as an electromagnetic momentum, and the ordinary momentum of Newton as a mechanical momentum.

The arise of the mechanical momentum in the medium is caused by optically induced forces (OIF) arising in the regions where leading and trailing edges of the light pulse are propagating. We have shown that the OIFs are equal to the Abraham forces and their action results in splitting the total momentum of the light pulse by two components [1,2]. The total

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