Non-linear optics

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February 26, 2014

Contents

1 Introduction

During the better part of the course we have studied linear phenomena, that is the interaction between matter and light described by the wave equation

$$\nabla^2 \mathbf{E} - \frac{1}{c^2}\frac{\partial^2 \mathbf{E}}{\partial t^2} = \frac{1}{\epsilon_0 c^2}\frac{\partial^2 \mathbf{P}}{\partial t^2}, \tag{1}$$

where the polarization $\mathbf{P}$ is linear wrt. the electric field of the light $\mathbf{E}$, as described by $\mathbf{P} = \epsilon_0 \chi \mathbf{E}$, where χ is electric suscpetibility of the medium. The course has touched upon non-linear phenomena, where the polarization can be expanded as $\mathbf{P} = \epsilon_0(\chi^{(1)}\mathbf{E} + \chi^{(2)}\mathbf{E}^2 + \dots)$.

In this project we describe and discuss two such effects, namely beam self-focusing using the Kerr effect, and wave mixing.

2 The Kerr effect

3 Wave mixing

References

[1] P.W. Milonni and J.H. Eberly. *Laser Physics*. Wiley, 2010. ISBN: 978-0-470-38771-9.