

# Master Physique fondamentale et applications

## Nonlinear optics

### Informations

Composante : Faculté des Sciences

### Responsables

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### Langue(s) d'enseignement

Anglais

### Contenu

#### 1 Introduction

- 1.1 Explaining the name
- 1.2 The origin of the nonlinearity in P(E)
- 1.3 The polarization density and the susceptibility tensors
- 1.4 List and classification of NLO effects
- 1.5 The symmetries of higher order susceptibilities
- 1.6 Simplified photon picture

#### 2 Linear but anisotropic optics

- 2.1 Propagation in an anisotropic medium
- 2.2 The "types" of phase matching;

#### 3 The nonlinear wave equation

- 3.1 The exact version
- 3.2 The approximated version for three wave interaction
- 3.3 Energy conservation and Manley-Rowe rel.

#### 4 Practical aspects of three wave interaction

- 4.1 SHG
- 4.2 Phase matched OPA with non-depleted pump
- 4.3 Influence of the crystal anisotropy: effective nonlinearity

#### 5 Third order nonlinear optical response

- 5.1 Optical Kerr effect
- 5.2 Nonlinear optical parameters, ...

### Compétences à acquérir

At the end of this module, the student will be able to:

- Understand the formalism of the classical description of nonlinear optics
- Develop an understanding of the classical NLO wave equation for superpositions of monochromatic waves
- Find directions of phase matching in a nonlinear optical crystal
- Understand how the crystal symmetries influence the Chi tensor and the effective nonlinearity
- Establish the system of differential equations describing a chi2 effect.
- Be able to derive the set of differential equations for a given situation and solve it using approximations or numerical tools
- Understand the physics of frequently encountered nonlinear optical phenomena
- Know some basic applications of NLO

### Modalités d'organisation

This course is a classical lecture. Exercices are given during the lecture.

### Bibliographie, lectures recommandées

P. N. Butcher and D. Cotter "The Elements of Nonlinear Optics", Cambridge University Press (1991, or better 1998)

Robert W. Boyd, "Nonlinear Optics" 3rd edition (Academic Press)

### Pré-requis obligatoires

A solid mathematical background is needed: complex numbers, complex

vector analysis, differential equations, Fourier transforms.

### Prérequis recommandés

Scientific programming skills are helpful to evaluate the phase mismatch, solve the sets of differential equations, ...

### VOLUME HORAIRE

- Volume total: 20 heures
- Cours magistraux: 20 heures

### Codes Apogée

- SPFBU30J [ELP]

### Pour plus d'informations

[Aller sur le site de l'offre de formation...](#)



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