

Electrodynamics and Optics Notes

Xinyu Zhong
Wolfson College

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Abstract

Abstract of this course

1 Revision

2 Optics

2.1 Jones's Notation

2.2 Birefringent Material

For isotropic medium : $\mathbf{P} = \epsilon_0 \chi \mathbf{E}$ $\mathbf{D} = \epsilon \epsilon_0 \mathbf{E}$

2.2.1 Discussion 1

Q: How an uniaxial birefringent material can be used to make a quarter wave plate.?

Uniaxial birefringent material have principle refractive indices n_o , n_o and n_e . We can consider a plane-polarised EM wave $e^{i(kz - \omega t)}$ travels along O_z at a different speeds c/n_f or c/n_s depending on whether \mathbf{E} is parallel to O_x or O_y . As the wave transverse the plate, the phase will shift: $e^{ik(z=0)} \rightarrow e^{ik_f(z=d)}$, where $k_f = \frac{\omega n_f}{c}$.

So the phase shift will depend on the optical thickness, d and also the refractive index:

Along fast axis, the change is $e^{i\omega n_f d/c}$.

Along slow axis, the change is $e^{i\omega n_s d/c}$.

The Jones matrix for the plate can be written as

A quarter-wave plate is on with difference in phase shift corresponding to $\lambda/4$

3 Coherence

3.1 Coherence and Interference

Interference ideas provide a useful quantified description for the degree of correlation, or degree of coherence.

3.2 Temporal Coherence

3.2.1 Power Specturm of Temporal Coherence

Wiener Khinchine Theroem: The FT of the auto correlation function of a function is the quare modulus of the FT of the function itself

3.3 Spatial Coherence

4 Electrodynamics

4.1 Gauge in EM

4.2 A in simple cases

4.3 A in quantum mechanics

4.3.1 Hamiltonian

4.3.2 Aharanov-Bohm Effect

4.4 Maxwell Equation in terms of \mathbf{A} and ϕ

$$\frac{\epsilon\mu}{c^2}\ddot{\phi} - \nabla^2\phi = \frac{\rho}{\epsilon\epsilon_0}$$

$$\frac{\epsilon\mu}{c^2}\ddot{\mathbf{A}} - \nabla^2\mathbf{A} = \mu\mu_0\mathbf{J}$$

4.4.1 Lorenz condition

A suitable gauge that simplifies maxwell equation, by choosing the gauge: $\nabla \cdot \mathbf{A} + \epsilon\mu\frac{\dot{\phi}}{c^2} = 0$
 Note: for static filed the Lorenz condition is chosen to be Coulomb gauge.

4.5 Solution for \mathbf{A} and ϕ

Square bracket mean "evaluated at the *retarded time*" $t - \frac{|\mathbf{r}-\mathbf{r}'|}{c}$

5 Dipole Radiation

Accelerating charges are of the interest of radiating.

5.1 The Hertzian Dipole