Nature of Light
The Vectorial

CHAPTER 2


Second Edition

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TO MODERN OPTICS
INTRODUCTION

266 York
\[ \frac{\partial}{\partial t} \mathbf{E} = \nabla \times \mathbf{B} \]

In which the quantity \( \mathbf{B} \) is defined as:

\[ \mathbf{B} = \frac{\mathbf{E}}{c} \]

Where we have used the fact that the phase velocity is given by \( \mathbf{E} \).

Further:

\[ 2\pi f = \frac{c}{\lambda} \]

Equations like the following form for plane harmonic waves:

From the operator relations, Equation (21) and (22), the Maxwell equations are:

\[ \begin{align*}
0 &= \mathbf{E} \cdot \mathbf{E} \\
0 &= \mathbf{B} \cdot \mathbf{B} \\
0 &= \mathbf{E} \times \mathbf{B} \\
\end{align*} \]

For a plane harmonic wave, consider the complex exponential expression

\[ \phi(t, x, y, z) = A e^{i(kx - \omega t)} \]

We wish to examine this relationship in detail. It will be useful at this point to decompose into the two fields.

Solving these equations, we find that these equations are:

\[ \begin{align*}
\frac{\partial \phi}{\partial t} &= \nabla \cdot \mathbf{E} \\
\frac{\partial \phi}{\partial x} &= \nabla \cdot \mathbf{B} \\
\end{align*} \]

The Maxwell equations require that for fields that vary in time, the electric field is

\[ \begin{align*}
\nabla \cdot \mathbf{E} &= \frac{\partial \mathbf{B}}{\partial t} \\
\nabla \cdot \mathbf{B} &= \frac{\partial \mathbf{E}}{\partial t} \\
\end{align*} \]

The various Cartesian components of the fields in an electromagnetic wave are shown in the previous chapter, indicated by the arrows.

21. General Remarks
Chapter 3

Sometimes the word intensity is used for I, but this is not technically correct (see...

\[ I = \frac{c}{4\pi} \text{exp}(i(k \cdot r - \omega t)) \]

Consider a plane harmonic electromagnetic wave for which the fields are given by the expressions...

\[ E = F \text{exp}(i(k \cdot r - \omega t)) \]

Consider now the case of plane harmonic waves in which the vector of the wave and the electric field are always at right angles to each other. This vector is called the

The unit vectors P, A, and B are not always in the same direction. This will be the case for

\[ \mathbf{H} = \mathbf{I} \times \mathbf{E} \]

The last follows from the relation between the magnitudes of the electric and magnetic flux density vectors developed in the previous section.

By the factor 1/2, the factor of 1/2 in the formula of plane harmonic waves and the

\[ \mathbf{E} = \mathbf{A} \times \mathbf{H} \]

The intensity of the wave is then given by the vector product

\[ I = \frac{c}{4\pi} \text{exp}(i(k \cdot r - \omega t)) \]

\[ = I \]

\[ \mathbf{H} \times \mathbf{E} \]

We then have

\[ E = I \times F \]

2.3 • Linear Polarization

2.3.1. From the Polarization

The electric field vector is perpendicular to the wave vector and the wave vector in an

\[ \mathbf{E} \times \mathbf{H} \]

2.3.2. Electromagnetic Wave

\[ \mathbf{E} \times \mathbf{H} \]

2.4. Polarization

By the factor 1/2, the factor of 1/2 in the formula of plane harmonic waves and the

\[ \mathbf{H} \times \mathbf{E} \]

The intensity of the wave is then given by the vector product

\[ I = \frac{c}{4\pi} \text{exp}(i(k \cdot r - \omega t)) \]

\[ = I \]

\[ \mathbf{H} \times \mathbf{E} \]

We then have

\[ E = I \times F \]

2.3.1. From the Polarization

The electric field vector is perpendicular to the wave vector and the wave vector in an

\[ \mathbf{E} \times \mathbf{H} \]

2.3.2. Electromagnetic Wave

\[ \mathbf{E} \times \mathbf{H} \]
It is left as an exercise to show that for partial linear polarization,

\[
\frac{I_{\perpendicular}}{I_{\parallel}} = \sin^2 \theta
\]

\[
\theta = \arcsin \left( \frac{I_{\perpendicular}}{I_{\parallel}} \right)
\]

The degree of polarization of a light beam is defined as the fraction of the total light intensity, which is linearly polarized. Partial linear polarization can be considered to be a mixture of linearly polarized and unpolarized light, where the intensity of the linear beam is given by the transmission of the incident beam, and the intensity of the unpolarized light is given by the difference between the total intensity and the linear beam intensity.

In the case of a light beam, the angle \( \theta \) is related to the intensity of the linear beam and the intensity of the unpolarized light by the following relation:

\[
\cos \theta = \frac{I_{\parallel}}{I}
\]

where \( I \) is the total intensity of the light beam.

**Figure 2.2** illustrates the relationship between the incident and the transmitted fields for a linearly polarized beam of light. The transmitted field is perpendicular to the incident field, and the intensity of the transmitted light is given by the cosine squared of the angle between the two fields.

**Figure 2.3** shows the direction of polarization of linearly polarized light, where the electric field is aligned along the transmission axis of the polarizer. The transmitted light is linearly polarized, and the intensity of the transmitted light is given by the cosine squared of the angle between the incident light and the transmission axis.
Also, as in a given image, in time, the red vectors describe right-way flows in space, where the direction of propagation is the right-way flow of the red vector at a given point. The sign of the vectors in Equation (2.7) are such that the vectors are shown in Figure 2.7.

The signs of the terms in Equation (2.7) are shown in Figure 2.7.

Note the above expression is a perfect solution of the wave equation.

Hence, \( E \) holds.

The total electric field \( E \) is the vector sum of the two components:

\[
E = (m - k \sin x + (m + k \sin y - k \cos y)
\]

2.4. Circular and Elliptical Polarization

In general, polarization can be described by two components, the direction of the spins, and the electric field. The spins of the electrons are oriented perpendicularly to the electric field of the incident wave.

Consider the special case of two linearly polarized waves:

Let us return temporarily to the real representation for electromagnetic waves.

Reference to the figure and note that the electric field of the incident wave is forward directed along the incident normal to the plane of the incidence. Two linearly polarized waves of equal magnitude are hindering the energy flux of the incident wave. The energy flux is reduced to zero.
real and imaginary parts of $E$ are equal, the expression can represent any type of polarization. Thus if $E$ is complex, we have

$$E(x, y, z) = A \text{ exp}(i(kx - \omega t))$$

The corresponding wave function is

$$\mathbf{E} = A \hat{\mathbf{E}}$$

By employing the identity $\hat{j} = i$, we can write

$$\mathbf{E} = A \hat{\mathbf{E}} = A \mathbf{E}$$

Circularly polarized wave can be written in complex form as

$$\mathbf{E} = A \mathbf{E} = A \mathbf{E} = A \mathbf{E}$$

Let us now return to the complex notation. The electric field for a linearly polarized wave is then called linearly polarized.

Circularly polarized wave is a wave that is not change in direction.

If the sign of the second term is changed, then the sense of rotation is reversed. This is called left-handed circularly polarized. Such a wave is said to be left-handed.

The reader is reminded here that if one uses the wave function $\mathbf{E} = A \mathbf{E}$ up to the complex conjugate, then the opposite sign convention applies. In this case the wave changes in magnitude in such a manner that the end of the vector rotates in magnitude. In magnitude, the vector rotates in magnitude. In magnitude, the vector rotates in magnitude. In magnitude, the vector rotates in magnitude. In magnitude, the vector rotates in magnitude.
The Jones vector is a powerful tool for describing the polarization of electromagnetic waves. It represents a vector in a complex plane, with the real and imaginary parts corresponding to the horizontal and vertical components of the field, respectively.

The Jones matrix is used to calculate the transformation of the Jones vector under various optical elements, such as lenses and mirrors. The elements of the matrix are related to the optical rotation and retardation of the wavefront.

The Jones calculus, named after J. J. Thomson, allows for the manipulation of Jones matrices to describe the propagation of polarized light through optical systems. This is particularly useful in the design of polarization-sensitive devices and systems, such as those used in telecommunications and optical communications.
so that its vector, after rotating an amount (p/p) w.r.t. the horizontal, lies in the 1, 0 plane. This means that the horizontal is the positive direction of the vector.

\[
\begin{bmatrix}
1 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 1 \\
\end{bmatrix}
\]

This matrix represents a quartet wave plate with its axis vertical. The Jones matrix of the optical element is given by

\[
\begin{bmatrix}
\rho & \phi \\
\eta & \alpha \\
\end{bmatrix}
\]

where \( \rho \) is the Jones matrix of the optical element. If \( \eta \) is a rotation of the Jones matrix, then we have

\[
\begin{bmatrix}
\rho & \phi \\
\eta & \alpha \\
\end{bmatrix}
\]

through a linear array of optical elements. Then the result is given by

\[
\begin{bmatrix}
1 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 1 \\
\end{bmatrix}
\]

Table 2.1. Jones Matrices for Some Linear Optical Elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Jones Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circulator</td>
<td>[1 0]</td>
</tr>
<tr>
<td>Right</td>
<td>[0 1]</td>
</tr>
<tr>
<td>Left</td>
<td>[1 0]</td>
</tr>
<tr>
<td>Half-wave plate</td>
<td>[1 0]</td>
</tr>
<tr>
<td>Q quarter-wave</td>
<td>[1 0]</td>
</tr>
<tr>
<td>Half-wave plate</td>
<td>[1 0]</td>
</tr>
<tr>
<td>Quarter-wave</td>
<td>[1 0]</td>
</tr>
<tr>
<td>Half-wave plate</td>
<td>[1 0]</td>
</tr>
<tr>
<td>Quarter-wave</td>
<td>[1 0]</td>
</tr>
<tr>
<td>Half-wave plate</td>
<td>[1 0]</td>
</tr>
<tr>
<td>Quarter-wave</td>
<td>[1 0]</td>
</tr>
</tbody>
</table>

The vectorial nature of light
The problem of finding the eigenvalues and the corresponding eigenvectors of a 2x2 matrix is quite simple. The matrix equation

\[
\begin{bmatrix}
\lambda_1 & 0 \\
0 & \lambda_2
\end{bmatrix}
\begin{bmatrix}
x_1 \\
x_2
\end{bmatrix} = 
\begin{bmatrix}
x_1 \\
x_2
\end{bmatrix}
\]

corresponds, and is the phase change. The phase change may also be written as $\varphi = \phi$, which is the amplitude of the phase. However, depending on the value of $\lambda$, the amplitude and phase change may depend on the value of $\lambda$, the magnitude and phase change of the eigenvalue. Moreover, the way we use the same notation as when we pass through the angle, the particular eigenvectors of a wave which originates at the origin are represented by the two rows of the matrix.

Physically, an eigenvector of a given Jones matrix represents a basis vector on which the Jones matrix acts. This can be written as:

\[
\begin{bmatrix}
x_1 \\
x_2
\end{bmatrix} = 
\begin{bmatrix}
\lambda_1 & 0 \\
0 & \lambda_2
\end{bmatrix}
\begin{bmatrix}
x \\
x
\end{bmatrix}
\]

where $\lambda_1$ and $\lambda_2$ are the eigenvalues of the matrix. When the determinant of any matrix is zero, the matrix is singular, and no eigenvector can be defined.

The content of this section is illustrated in Figure 2.8 of some Jones vectors.

\[
\begin{bmatrix}
1 & 1 \\
0 & 1
\end{bmatrix}
\begin{bmatrix}
x_1 \\
x_2
\end{bmatrix} = 
\begin{bmatrix}
x_1 \\
x_2
\end{bmatrix}
\]

and the circular components is written

\[
\begin{bmatrix}
1 \\
0
\end{bmatrix}
\begin{bmatrix}
\lambda_1 \\
\lambda_2
\end{bmatrix} = 
\begin{bmatrix}
\lambda_1 \\
\lambda_2
\end{bmatrix}
\]

The left circular components is written

\[
\begin{bmatrix}
1 \\
0
\end{bmatrix}
\begin{bmatrix}
\lambda_1 \\
\lambda_2
\end{bmatrix} = 
\begin{bmatrix}
\lambda_1 \\
\lambda_2
\end{bmatrix}
\]

into linear components is written

\[
\begin{bmatrix}
1 \\
0
\end{bmatrix}
\begin{bmatrix}
\lambda_1 \\
\lambda_2
\end{bmatrix} = 
\begin{bmatrix}
\lambda_1 \\
\lambda_2
\end{bmatrix}
\]

2.8. Orthogonal Series of Circular Polaization. These are shown in Figure

\[
\begin{bmatrix}
\frac{1}{2} \gamma, -\frac{1}{2} \gamma \\
\frac{1}{2} \gamma, \frac{1}{2} \gamma
\end{bmatrix}
\]

Thus, for example, a particular pair of orthogonal to each other.

\[
\begin{bmatrix}
\frac{1}{2} \gamma, -\frac{1}{2} \gamma \\
\frac{1}{2} \gamma, \frac{1}{2} \gamma
\end{bmatrix}
\]

are orthogonal if

\[
\begin{bmatrix}
\gamma \\
\gamma
\end{bmatrix}
\]

and

\[
\begin{bmatrix}
\gamma \\
\gamma
\end{bmatrix}
\]

In terms of Jones vectors, it is easy to verify that the corresponding orthogonal polarization for any type of polarization. Orthogonal Polaization is mutually orthogonal series. In one orthogonal, the right circular and left circular polarizations are mutually orthogonal. When the right circular is circularly polarized, the left circular is circularly polarized. For example, circularly polarized light has the Jones matrix

\[
\begin{bmatrix}
1 \\
0
\end{bmatrix}
\begin{bmatrix}
1 \\
0
\end{bmatrix}
\]

Where the matrix entries are complex numbers.
Waves are traveling in the same medium, hence the wave vectors have the same phase space. In the phase space of the incident and reflected waves (\( \theta < \phi \))

\[
\phi \sin \theta = \gamma = \cos \theta, \quad \sin \beta = \sin \gamma \gamma
\]

\[
\sin \beta \cos \gamma = \sin \gamma \gamma
\]

Therefore, Equation (2.4) from Section 2.6 shows that the reflected wave is the second harmonic of the transmitted wave. This relationship is illustrated in Figure 2.10, the angles between the boundary incidence angle \( \theta \) and the reflected wave is also shown. The angle \( \gamma \) is the phase of the reflected wave, and the angle \( \beta \) is the phase of the transmitted wave.

These conditions imply that all three wave vectors \( \beta, \gamma, \) and \( \delta \) are related by the boundary condition. Since the three conditions are already satisfied, we must have

\[
\begin{bmatrix}
\beta \\
\gamma \\
\delta
\end{bmatrix} = \begin{bmatrix}
\alpha \\
\beta_0 \\
\gamma_0
\end{bmatrix}
\]

Now in order to satisfy the boundary condition for electromagnetic waves, we can use the following expression:

\[
(\alpha - \beta)_0 = (\beta - \gamma)_0 = (\gamma - \delta)_0
\]

The electric field \( E \) and magnetic field \( B \) are related by the boundary condition.

By the following expressions:

\[
\begin{bmatrix}
\alpha \\
\beta_0 \\
\gamma_0
\end{bmatrix} = \begin{bmatrix}
0 \\
1 \\
0
\end{bmatrix}
\]

The field of \( \alpha \) is a function of its own function. The electric field can be found by solving the matrix equation above.

\[
0 = \alpha - (\beta - \gamma)(\gamma - \delta)
\]

This is a quadratic equation in \( \gamma \), known as the secular equation.

\[
0 = \begin{bmatrix}
\gamma - \beta & \gamma - \delta \\
\beta - \gamma & \delta - \gamma
\end{bmatrix}
\]

The secular equation is the determinant of the matrix. To find the roots, there is a condition that \( \gamma \) and \( \delta \) are not both zero, the determinant of the matrix must vanish.

\[
0 = \det \begin{bmatrix}
\beta_0 \\
\gamma_0
\end{bmatrix}
\]

Now in order that a nontrivial solution exists, namely one in which \( \gamma \) and \( \delta \) are not both zero, the determinant of the matrix must vanish.
The transmission and reflection coefficients of plane polarized light are defined as the amplitudes of the electric field vectors of the transmitted and reflected light, respectively. The coefficients are given by

\[ \phi = \cos \theta \ \text{and} \ \cos \alpha - \sin \theta \ \text{for the transmitted light.} \]

\[ \phi = \cos \theta \ \text{and} \ \cos \alpha + \sin \theta \ \text{for the reflected light.} \]

For plane polarized light, the electric field vector \( E \) is parallel to the plane of incidence. Therefore, the transmission coefficient is

\[ T = \frac{E_{\text{transmitted}}}{E_{\text{incident}}} = \frac{\cos \theta}{\cos \alpha} \]

and the reflection coefficient is

\[ R = \frac{E_{\text{reflected}}}{E_{\text{incident}}} = \frac{\sin \theta}{\cos \alpha} \]

where \( \theta \) is the angle of incidence, \( \phi \) is the angle of transmission, and \( \alpha \) is the angle of reflection.

The phase difference between the transmitted and reflected light is given by

\[ \phi = \cos \theta \text{ and } \phi = \cos \alpha + \sin \theta \]

for plane polarized light.

The relationship between the electric field vectors of the transmitted and reflected light is given by

\[ E_{\text{transmitted}} = E_{\text{incident}} \cos \theta \]

\[ E_{\text{reflected}} = E_{\text{incident}} \sin \theta \]

where \( E_{\text{incident}} \) is the amplitude of the incident light and \( E_{\text{transmitted}} \) and \( E_{\text{reflected}} \) are the amplitudes of the transmitted and reflected light, respectively.

The phase difference between the transmitted and reflected light is given by

\[ \phi = \cos \theta - \sin \theta \]

for plane polarized light.

The relationship between the electric field vectors of the transmitted and reflected light is given by

\[ E_{\text{transmitted}} = E_{\text{incident}} \cos \theta \]

\[ E_{\text{reflected}} = E_{\text{incident}} \sin \theta \]

where \( E_{\text{incident}} \) is the amplitude of the incident light and \( E_{\text{transmitted}} \) and \( E_{\text{reflected}} \) are the amplitudes of the transmitted and reflected light, respectively.
The equation for the amplitudes of the reflected and refracted waves can be expressed in the form

\[
\frac{\phi \cos \theta + \phi' \cos \theta'}{\phi' \cos \theta - \phi \cos \theta'} = \frac{u_1}{u_2} = n
\]

\[
\phi + \phi' = \phi' + \phi
\]

\[
\frac{\phi \cos \theta + \phi' \cos \theta'}{\phi' \cos \theta - \phi \cos \theta'} = \frac{n_1}{n_2}
\]

These equations allow for the calculation of the amplitudes of the reflected and refracted waves. The relationship between the amplitudes is given by the ratio of the indices of refraction of the two media.
Given by Equations (2.24) to (2.26) are real for all values of \( \theta \), and

in the case of external reflection, \( n < 1 \), the amplitude ratios as

mediated having the larger index of reflection.

In a medium having the larger index of reflection, internal reflection always occurs in the medium having the smaller index of refraction, whereas in external reflection, the reflection occurs at the boundary from the side with the smaller index of refraction. The boundary from the side with the smaller index of refraction is called the internal reflection, whereas in the medium having the larger index of refraction, the reflection occurs at the boundary from the side with the larger index of refraction. This is called the external reflection. The index of refraction \( n \) for glass is about 1.5, and for water, it is about 1.33. The same holds for the index of refraction for other materials.

Thus, for glass of index 1.5, the reflection at normal incidence is

\[
\frac{1 + n}{1 - n} Y = Y
\]

For glass of index 1.5, the reflection at normal incidence is

\[
\frac{1 + n}{1 - n} Y = Y
\]

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\]

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\[
\frac{1 + n}{1 - n} Y = Y
\]

For glass of index 1.5, the reflection at normal incidence is

\[
\frac{1 + n}{1 - n} Y = Y
\]
The Brewster angle is very small, however, because of dispersion. The equation over the visible spectrum is very

\[ \theta = \arcsin \left( \frac{1}{\sqrt{n^2 - 1}} \right) \text{ degrees} \]

and for internal reflection from glass to air

\[ \theta = \arcsin \left( \frac{1}{n} \right) \text{ degrees} \]

are valid expressions for the Brewster angle.

The angle of incidence is thus defined as the angle that the light ray makes with the surface of the glass.

The Brewster angle is defined as the angle of incidence at which the reflected light is completely polarized.

Example: For glass of index 1.5, we have for external reflection from air to glass:

\[ \theta = \arcsin \left( \frac{1}{\sqrt{1.5^2 - 1}} \right) \approx 52.25^\circ \]

This angle is called the polarizing angle of the Brewster angle.

In the TM case, we see that the reflection is zero for this particular angle of incidence such that the electric field of the reflected light is zero.

By multiplying the expressions, the Brewster angle can be easily verified.

\[ \frac{x}{x} = \cos \theta \sin \theta + \frac{y}{y} = \sin \theta \cos \theta \]

The Brewster angle is a property of the material and is independent of the angle of incidence.

When the internal angle of incidence is equal to or greater than the critical angle, total internal reflection occurs, and no light is transmitted through the glass. This is why we cannot see the other side of a glass window.
The vectorial nature of light

2.9 The Evanescent Wave in Total Reflection

The evanescent wave is when the electric field is exponentially damped over a small distance. To show this, let 

\[ \phi = \frac{\mu}{\theta \sin \gamma}, \]

\[ I = \frac{\mu}{\theta \sin \gamma} - 1 = \phi \cos \kappa \sin \theta, \]

\[ \kappa \sin \theta - \phi \sin x, \gamma = 1 \cdot \ell. \]

On choosing coordinate axes as shown in Figure 2.10, we have

\[ E_{\text{in}} = E_{\text{out}}. \]

The wave vector of the incident light in the medium.

The evanescent wave is when the electric field is exponentially damped over a small distance. To show this, let

\[ \phi = \frac{\mu}{\theta \sin \gamma}, \]

\[ I = \frac{\mu}{\theta \sin \gamma} - 1 = \phi \cos \kappa \sin \theta, \]

\[ \kappa \sin \theta - \phi \sin x, \gamma = 1 \cdot \ell. \]

On choosing coordinate axes as shown in Figure 2.10, we have

\[ E_{\text{in}} = E_{\text{out}}. \]
Definite (with glass of index 1.5, as calculated from Equation (2.7))

f. The phase difference A is equal to 2π/3 for an angle θ = 15°.

The difference between the component J and JF reflections
and their electrical component is equal to 
the electrical component of the reflected wave.

The phase difference with respect to the reflected wave
in the direction of the normal is
μ = \cos \theta,

\frac{\mu}{\mu} = \cos \theta

In Figure 2.17, the cross-section shows the intensity pattern for light
in the direction of the normal.

**Figure 2.17: Phase Changes in Total Internal Reflection**

Phase change, \( \phi \), with the incidence angle, \( \theta \):

\frac{\theta}{\sin \theta} = \sin \frac{\pi}{2}

From the figure, the phase change can be found:

\frac{\theta}{\sin \theta} = \sin \frac{\pi}{2}

2.10 Phase Changes in Total Internal Reflection

This effect is used by G. G. H. and R. R. in 1947 and is known as the G.G. effect.

In Internal Reflection:

\[ \mu = \cos \theta \]

\[ \phi = \mu \theta \]

\[ \phi = \mu \theta \]

\[ \phi = \mu \theta \]

The essential element is the phase shift made in a wave.

The external element is the phase shift made in a wave.

The extraordinary light, transmitted by Fresnel's law, is shown in Figure 2.18.

**Figure 2.18: Transmission of Extraordinary Light**

A method of changing intensity pattern into intensity pattern.
The reflected light is, in general, differently polarized. See Section (2.1.2).

\[
\begin{bmatrix}
\theta \\
\nu \\
\end{bmatrix}
= \begin{bmatrix}
\theta_{\text{ref.}} \\
\nu_{\text{ref.}} \\
\end{bmatrix}
= \begin{bmatrix}
\dot{\theta} \\
\dot{\nu} \\
\end{bmatrix}
= \begin{bmatrix}
\theta \\
\nu \\
\end{bmatrix}
\]

where \( \theta \) and \( \nu \) are the angles of incidence and reflection, respectively.

\[\begin{bmatrix}
1 & 0 \\
0 & 1 \\
\end{bmatrix}
\]

is the direction of the incident light, and \( \begin{bmatrix}
0 & 1 \\
1 & 0 \\
\end{bmatrix}
\]

is the direction of the reflected light.

\[\begin{bmatrix}
\theta' \\
\nu' \\
\end{bmatrix}
= \begin{bmatrix}
\theta \\
\nu \\
\end{bmatrix}
\]


\[\begin{bmatrix}
1 & u \\
0 & 1 \\
\end{bmatrix}
\]

is the Jones vector of the reflected light.

\[\begin{bmatrix}
1 & u \\
0 & 1 \\
\end{bmatrix}
\]

is the Jones vector of the incident light.

\[\begin{bmatrix}
0 & 1 \\
1 & 0 \\
\end{bmatrix}
\]

is the Jones vector of the transmitted light.

\[\begin{bmatrix}
\theta' \\
\nu' \\
\end{bmatrix}
= \begin{bmatrix}
\theta \\
\nu \\
\end{bmatrix}
\]

\[\begin{bmatrix}
1 & u \\
0 & 1 \\
\end{bmatrix}
\]

is the Jones vector of the reflected light.

\[\begin{bmatrix}
1 & u \\
0 & 1 \\
\end{bmatrix}
\]

is the Jones vector of the incident light.

\[\begin{bmatrix}
0 & 1 \\
1 & 0 \\
\end{bmatrix}
\]

is the Jones vector of the transmitted light.