Speciﬁcally, active inactivity can be induced by certain
+ degradation on precipitation
+ wind at refraction and wave selectivity
+ light scattering in precipitation aureole
+ absorption may result in precipitation
+ deposits in precipitation
+ interception and transmission of precipitation

Why precipitation is important?

Section 2 (see examples in the next page)

Time variation of the direction of the precipitation at light of the
+ precipitation at high altitude

(2'3')

Xenon (a greenhouse gas)

What is precipitation?
Figure 6.0-1 Time course of the electric field vector at several positions: (a) arbitrary wave; (b) paraxial wave or plane wave traveling in the z direction.
\[ h = y_f - y_x - \text{Physical difference} \]

\[ \frac{\frac{b_0}{3} x_x}{x_x^3} + \frac{\delta}{3} - \frac{\frac{b_0}{2}}{2} + \frac{\frac{\delta}{2}}{2} \]

* Eliminating + reducing in an equation to form curves

\[ (y_f + \frac{\delta}{2}) \text{ (2 x_0 + \frac{\delta}{2} x_x) + (x_f + \delta x_x) } = \frac{b_0}{3} \]

\[ y_x = 0 x_0 \cos \theta (2 x_0 x_x + \frac{\delta}{2}) + \frac{\delta}{2} x_x \]

\[ \theta = \text{proportion of escape} \]

\[ \theta = \frac{a x}{2} + \frac{a y}{4} \]

\[ \theta = \frac{(x_f^2 - t_0 (t - t_0)}{2} \]

Concerns a normal component plane work

\[ \text{Perurbation of sight} \]
The problem involves determining the function that describes the oscillation of a system. The system is described by the differential equation

\[ y'' + \frac{3}{2} y' + \frac{1}{2} y = 0 \]

The characteristic equation of the system is

\[ \lambda^2 + \frac{3}{2} \lambda + \frac{1}{2} = 0 \]

Solving for \( \lambda \), we get

\[ \lambda = -1, -\frac{1}{2} \]

Thus, the general solution is

\[ y(x) = c_1 e^{-x} + c_2 e^{-\frac{x}{2}} \]

The functions are

\[ f(x) = c_1 e^{-x} \]
\[ g(x) = c_2 e^{-\frac{x}{2}} \]

The projection of the system is shown in the diagram, indicating the oscillatory nature of the solution. The phase difference of the system depends on the initial conditions and the projection of the system at any given time.
\[ x' = \frac{x - \Delta x}{\sqrt{1 - \frac{\gamma^2}{c^2}}} \]

\[ y' = \frac{y - \Delta y}{\sqrt{1 - \frac{\gamma^2}{c^2}}} \]

\[ \gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \]

\[ \frac{\gamma}{\gamma - 1} = \frac{\Delta x}{\Delta y} \]

\[ \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \]

\[ \Delta \Psi = \frac{\Delta y}{\Delta x} \]

\[ \bar{E} = \begin{bmatrix} A \\ B \end{bmatrix} \]

\[ \text{Newton Interpolation} \]

\[ \frac{\Delta x}{\Delta y} = ax + by + c \]

\[ \text{where } ax, bx, cy, dy \text{ is arbitrary.} \]
\[ J = \frac{i}{\sqrt{2}} \quad (i) \quad (\frac{1}{2}, \frac{1}{2}) \quad \text{(right and left circular polarizations)} \]

*example* 2 orthogonal polarizations

\[
\begin{align*}
\mathbf{J}_1 &= (\alpha_1, \beta_1) \\
\mathbf{J}_2 &= (\alpha_2, \beta_2)
\end{align*}
\]

\[ J_1 = J_2 \quad \alpha_1 = \alpha_2 \quad \beta_1 + \beta_2 = 90^\circ \]

*any Jones vector can be represented as a linear combination of two orthogonal polarizations*
The opposite theorem
where \( \overrightarrow{I} \) is the Fourier transform,
\[ \overrightarrow{I} = \overrightarrow{T} \]

\[ \begin{bmatrix} T_1 \\ T_2 \\ T_{12} \\ T_{14} \end{bmatrix} \begin{bmatrix} A_{12} \\ A_{21} \\ A_{12} \end{bmatrix} = \begin{bmatrix} A_{11} \\ A_{12} \end{bmatrix} \]

\[ A_{21} = T_2 A_{1x} + T_{12} A_{1y} \]
\[ A_{12} = T_1 A_{1x} + T_{12} A_{1y} \]

+ The Fourier theorem shows that the

Though an opposite theorem
+ Conclusion: The transformation of a phase vector
+ makes representation of polarization receiver
The page contains mathematical expressions and text related to wave retarders. The expressions include matrices and vectors, and terms such as 'wave retarder' and 'polarization retarder'. The variables and constants used are not clearly legible due to the handwriting style.
If $\phi$ is a solution of the characteristic equation $T\phi = \lambda \phi$, then $T^{-1} T \phi = \lambda^{-1} \phi$ and

$$T^{-1} = \frac{\phi}{\lambda} \Rightarrow \frac{\phi}{\lambda}$$

This means that $T^{-1}$ is a solution of a characteristic equation with the same characteristic equation $T\phi = \lambda \phi$. The characteristic equation of $T^{-1}$ is given by $T\phi = \lambda \phi$.

**Conclusion**: They can be represented by one and the same $T\phi = \lambda \phi$ with respect to a particular linear transformation $T$. Then, $T\phi = \lambda \phi$ and its inverse are different.

- Continuous transformation $T^{-1}$
- Characteristic equation $T\phi = \lambda \phi$
Figure 6.2-1 Reflection and refraction at the boundary between two dielectric media.
Some notes...

where \( \frac{1}{n} \) and \( \frac{1}{n} \) are the transmission and reflection coefficients. \( \frac{1}{n} = \frac{1}{n} \), \( \frac{1}{n} = \frac{1}{n} \)

Initially, the transmitted and reflected waves are in the direction of propagation of the wave vector, with the wave vector given by:

\[
\vec{k} = \frac{1}{\lambda} \text{ and } \vec{v} = \frac{1}{\lambda}
\]

For reflection and transmission,

\[
\theta_r = \theta_t \text{ and } \theta_i = \theta_t
\]

a directed by the law of cosines:

\[
\cos \theta = \cos \theta = \cos \theta
\]

Here's a sketch that illustrates the geometric and transmission/reflection process:

- Consider two incident waves with \( \lambda \) and \( \lambda \).

Reflection and refraction at non-normal incidence...
the angle of incidence (and) the angle of refraction

\[ \sin \theta = \frac{n_2}{n_1} \quad \text{or} \quad \frac{n_1}{n_2} \]

where \( n_2 \) is found from Snell's Law.

\[ \frac{\sin \theta_1}{\sin \theta_2} = \frac{n_2}{n_1} \]

Thus, \( \theta \) can be computed.

**Net:** reflection and transmission coefficients

\[ \text{Net} = 1 - (n_2/n_1)^2 \]

Since \( n_2 \) is found from Snell's Law:

\[ \frac{n_2}{n_1} \]

\[ \frac{\sin \theta_1}{\sin \theta_2} = \frac{n_2}{n_1} \]

\[ \frac{n_1 \sin \theta_1}{n_2 \sin \theta_2} = \frac{n_2}{n_1} \]

**Perpendicular Coefficients:**

Different expressions are obtained for \( x, y, \) and \( x', y' \) as shown.

![Diagram](image-url)

First, a normal to the plane of incidence intersects a normal at an angle to the plane of incidence (normal). In this case, the electric field is orthogonal to the plane of incidence. Therefore, the electric field projection onto the plane - reflection and transmission coefficients.
\( \beta_x = \begin{cases} \text{refraction} & \text{if} \quad \beta_y \neq \beta_y' \\ \text{reflection} & \text{if} \quad \beta_y = \beta_y' \end{cases} \)

\( \theta = \beta_y, \theta' = \beta_y' \)

\( \theta_x = \begin{cases} \text{refraction} & \text{if} \quad \theta_x \neq \theta_x' \\ \text{reflection} & \text{if} \quad \theta_x = \theta_x' \end{cases} \)

\( \theta = \theta_x, \theta' = \theta_x' \)

\( \theta \neq \theta_x \Rightarrow \text{total internal reflection} \)

\( \theta = \theta_x - \text{critical angle} \)

* For total internal reflection \( \beta_x > \beta_x' \), \( \beta_y \) canal be used and \( \beta_x = 1 \).

* For external reflection \( \beta_x < \beta_x' \), \( \beta_y \) is always near TEP reflection.
Invariance property (n \times 2): given \theta, \alpha, and \beta are given.

Example: a range

Suppressed by reflection at mirror.

Only ET pass.

This letter can be used to mark progressing.
\[ R = \left( \frac{m_1 + n_2}{n_1 - n_2} \right)^2 \]

For normal incidence:

* \( R \leq 0.04 \)

(what lies on one side)

If \( R > 1 \), then \( T < 1 \), 

\( T = \frac{n_2}{n_1} \) (generally \( T \neq H \))

\( \beta \) and \( \gamma \) are the vectors of power fronts (field)

\[ 1 - R = \text{transmission coefficient} \]
To proceed, consider the principle of superposition along with the principle of equivalence. These two principles allow us to separate the effects of different forces acting on an object. In general, these forces can be additive, leading to a total force that can be determined through a vector addition. The net force acting on an object can be represented by a vector, which is the sum of all the forces acting on it.

In particular, consider the case where there are only two forces acting in opposite directions. If $F_1$ and $F_2$ are the magnitudes of these forces, then the net force $F$ can be calculated as $F = F_1 - F_2$. If $F_1 = F_2$, then $F = 0$, indicating that the object is in equilibrium.

For a more detailed analysis, we can use the concept of momentum, which is the product of mass and velocity. The conservation of momentum states that the total momentum of a closed system remains constant, unless acted upon by an external force.

In the context of special relativity, the concept of momentum is modified to account for the effects of velocity. The four-momentum $P$ is a vector quantity that includes the energy and momentum components.

Optical invariance under Lorentz transformations is a fundamental aspect of special relativity. The invariance of the speed of light in a medium, which is a photon, is a key prediction of special relativity. This invariance is a consequence of the requirement that the laws of physics be the same for all observers in uniform motion relative to one another.
\[ E = \frac{\mu}{1 + \xi n} \]

- Unpolarized energy tensor

- \( n = n_1 \geq n_2 \geq n_3 \) unpolarized energy tensor

\[ (\begin{pmatrix} 1 & 0 & 0 \\ 0 & n_2 & 0 \\ 0 & 0 & n_3 \end{pmatrix}) = \frac{E}{1 + \xi n} \]

\( n = n_c \) extraordinary index

\( n = n_o \) ordinary index

- Unpolarized energy tensor

\(+\) positive index

\(-\) negative index

\( n = n_c \) extraordinary index

\( n = n_o \) ordinary index

- Polarization states of incident light

\( n = n_c \) extraordinary index

\( n = n_o \) ordinary index

- Polarization states of transmitted light
\[ \sum_{i=1}^{n} x_i^2 = 1 \]

\[ \frac{x_1^2}{y_1^2} + \frac{x_2^2}{y_2^2} + \frac{x_3^2}{y_3^2} = 1 \]

Lack of divergence:

\[ x_1^2 + x_2^2 + x_3^2 = 1 \] \( \Rightarrow \) Closest point of the surface to the origin is not at the origin.

In principle coordinates:

This surface area not affected in coordinates where the area of a geometric figure

\[ \Pi \text{ of a geometric figure} \]

\[ \frac{1}{r^2} \]

In terms of a geometric figure

\[ \text{Take a geometric representation} \]

\[ \text{such that on the movement of the component,} \]

\[ \text{the area in a will reflecting the direction} \]

\[ \text{where the area of a tensor recurrent vector} \]

\[ \text{where the area of a tensor recurrent vector} \]

\[ \text{which are dependent on covariance this} \]

\[ \text{vector can be expressed by the covariance} \]

\[ \text{which are independent of the covariance this} \]

\[ \text{is not a vector? It has direction and magnitude -} \]

\[ \text{certain vector representation of vectors and tensors} \]
Propagation along a principal axis

Normal modes
- Consider x, y, z as the principal axes of the crystal.
- A wave traveling in the z direction and polarized in x: phase velocity is \( \frac{c_0}{n_1} \) (wave number \( k_0 = n_0 \omega \)).
- Polarization is not changed.

\( \Phi_1 = E_y E_x \quad (\text{or } \Phi_1 = E_x E_x) \)

In y: phase velocity = \( \frac{c_0}{n_2} \) \n
\( \Phi_2 = E_x E_x \)

Normal modes for propagating in z are linearly polarized waves in x and y.

Polarization along an arbitrary direction
- Is analyzed as a sum of two linearly polarized waves.
- The two linearly polarized waves have different phase velocities \( \frac{c_0}{n_1} \) and \( \frac{c_0}{n_2} \) \n
\( \Rightarrow \) different phase shift \( \Phi_1 = n_1 \lambda \omega \) \n
\( \Phi_2 = n_2 \lambda \omega \) \n
\( \Rightarrow \text{retardation } \Phi = \Phi_2 - \Phi_1 = (n_2 - n_1) \lambda \omega \)

\( \Rightarrow \) i.e., in general the field is elliptically polarized.

\( \Rightarrow \) Wave retarder.
Propagation along principal axis

Figure 6.3.4 A wave traveling along a principal axis and polarized along another principal axis has a phase velocity \( c_{\parallel} \) and phase velocity \( c_{\perp} \), if the electric field vector points in the \( x \), \( y \), or \( z \) directions, respectively. (a) \( k - n_k \), (b) \( k - n_k \), (c) \( k - n_k \).

Figure 6.3.5 A linearly polarized wave at 45° in the \( z - \theta \) plane is analyzed as a superposition of two linearly polarized components in the \( x \) and \( y \) directions (normal modes), which travel at velocities \( c_{\parallel} = \beta \) and \( c_{\perp} = \gamma \). As a result of phase retardation, the wave is converted into an elliptically polarized wave.
The axes are drawn from \( \theta = 0 \) to \( \theta = 2\pi \) and

\[ (a, b) \]

are the directions of the major and minor axes.

The axes are also represented by the equation and successively:

\[ \sqrt{\frac{x^2}{a^2} + \frac{y^2}{b^2}} = 1 \]

Consider the displacement of the interstellar medium with respect to the solar system and the conclusion that the field can be decomposed into the influence of a plane wave in the direction of

\[ \text{progression in our arbitrary direction}. \]
\[ I = \frac{\varepsilon u}{\varepsilon x} + \frac{\varepsilon u}{\varepsilon x} + \frac{1}{x} \]

Propagation along arbitrary direction
Dissipation relation

The Maxwell's equations and $0 = \nabla \cdot \mathbf{E}$

1. $E \times H = -\frac{\partial \mathbf{B}}{\partial t}$
2. $\nabla \times \mathbf{H} = \mathbf{J}$
3. $\nabla \times \mathbf{E} = 0$

The energy does not change. In the direction of the propagation, the energy plane is not.
\[ f_0 \times f_6 \rightarrow \text{no of net} \]

The \textit{intersection by a direction} \( \mathbf{n} = (\mathbf{n}_x, \mathbf{n}_y, \mathbf{n}_z) \) with \( \mathbf{n} \neq \mathbf{0} \) results in a non-trivial solution.

- **Point**
- **Line**
- **Surface**

\[ L = c \mathbf{c}_0 (\mathbf{c}_1, \mathbf{c}_2, \mathbf{c}_3) \]

- Differentiation

- \[ k_1 = \mathbf{k}_1 \]
- \[ \mathbf{m}_1 \]
- \[ \mathbf{p}_1 \]

\[ \mathbf{A} = \begin{bmatrix} F_3 k_2 & F_2 k_3 & F_1 k_3 \\ F_2 k_1 & F_1 k_2 & F_3 k_1 \\ F_1 k_3 & F_3 k_1 & F_2 k_1 \end{bmatrix} \]

\[ \mathbf{F} = \begin{bmatrix} F_3 \mathbf{F}_3 \\ F_2 \mathbf{F}_2 \\ F_1 \mathbf{F}_1 \end{bmatrix} \]

\[ \mathbf{E} = \begin{bmatrix} E_3 \mathbf{E}_3 \\ E_2 \mathbf{E}_2 \\ E_1 \mathbf{E}_1 \end{bmatrix} \]

\[ \mathbf{F} = \mathbf{F}_0 + \mathbf{F}_1 + \mathbf{F}_2 \]

\[ F_0 \times (\mathbf{F} \times \mathbf{E}) = 0 \]

\[ \text{accompanying a commutation of the vector equation} \]

\[ \text{coordinate transformation} \]
The dispersion relation

\[
\begin{bmatrix}
0 \\
0 \\
0
\end{bmatrix} = 
\begin{bmatrix}
\alpha & \beta & \gamma \\
\beta & \gamma & \alpha \\
\gamma & \alpha & \beta
\end{bmatrix} 
K \times (K \times E) + \omega^2 \rho_E E = 0
\]

\[K \times E = \omega \rho_d H,\]
\[K \times H = -\omega d E\]
Figure 6.3-8: The relation of the K-surface for (b) a fluid crystal (n = 1) and (c) an isotropic crystal (n = 1).}

\[ \gamma' - \nu' - \alpha' = \gamma - \nu - \alpha \]

Equation (6.3.12)

\[ 1 - \frac{\gamma'}{\gamma} \text{ for } \gamma > 3 \]

The intersection of the direction \( \eta \) with the K-surface corresponds to a wavelength \( \lambda \) satisfying

The dispersion relation \( \omega = \omega(\kappa, \eta) \) gives a normal surface on the K-surface.

**Dispersion Relations**
The vector \( \mathbf{S} \) is a force.

\[ \mathbf{S} = \mathbf{T} \times \mathbf{F} \]

\[ \mathbf{T} \perp \mathbf{F} \]

Thus, the plane necessarily.

The result to the surface gives a vector

- Hence, perpendicular, energy transport
(1) n(θ) = refractive index (refers to θ)

no - arbitrary wavenumber (no dependence on θ)

no normal modes. High refractive indices not n(e)

\[ \frac{1}{n_1^2} \frac{\partial^2}{\partial \theta^2} + \frac{1}{\theta n_2} \frac{\partial}{\partial \theta} - \frac{n_2^2}{\theta^2} = \frac{\partial^2 \psi_\theta}{\partial \theta^2} \]

x - Tychonic System (T to E correction, this arc NO annular)

\( \theta \) x refers to an ellipsoid of revolution and direction of wave

\[ \theta_0 \] and direction of wave

x - angular correction after cosine

under eccentricity 0

Special case: Linearly elliptical

\( n_0 = n_0, n_3 = n_0 \)
Extraneous:

\[ \text{Solution: } x = 0, y = 0 \]

The equation of the hyperbola:

\[ \frac{1}{2} + \frac{1}{2} = 3 \]

The intersection relation:

\[ \left( x - 2 \right)^2 + \left( y - 2 \right)^2 = 4 \]

For the surface approximation of a sphere, one can substitute:

\[ (x - 2)^2 + (y - 2)^2 = 4 \]

Special case: Linearized Hyperbola
Double Refraction or Birefringence
Figure 6.3-14
Double refraction at normal incidence
Figure 6.3-15
Double refraction through an anisotropic plate. The plate serves as a polarizing beamsplitter.

Refraction of rays
\[ \frac{\theta_0}{\mu (n - \mu + \lambda)} = 0 \]

refraction power (angle per unit length)

\[ \frac{\mu}{n - \mu + \lambda} \]

\( \Rightarrow \) refraction, refraction of angle \( \mu (n - \mu + \lambda) \)

- a pair of real - circular polarization
- linear and right - circular polarization
- linear and left - circular polarization

- example: quartz, calcite, gypsum, muscovite, mica
- 0.4 \( \mu \) is frozen in molecule with lattice

birefringence

- smaller molecule, affect light circular
- the property is related to an optical activity
- certain minerals and polarograms, retardation,

optical activity and birefringence
\[ \begin{align*}
\bar{\eta} &= \frac{1}{n} + \bar{c} \\
x \Rightarrow \bar{c} &= \frac{\eta}{\bar{c}} \Rightarrow 0 = \bar{c} (\eta + 5) + \bar{c} \\
\bar{p} &= (\eta \left[ \frac{1}{1 + \eta} \right], 0) \\
\bar{\xi} &= (0, \frac{1}{1 + \eta}, 0) \quad \text{and} \quad \bar{\xi} = (0, 0, 0) \\
\bar{\eta} &= \bar{\xi} + \bar{\eta} \\
\bar{\xi} &= \bar{\xi} + \bar{\eta} \\
\bar{\eta} &= \bar{\xi} + \bar{\eta}
\end{align*} \]
In vectorial notation, the vector sum of \( \mathbf{a} \) and \( \mathbf{b} \) is given by \( \mathbf{c} = \mathbf{a} + \mathbf{b} \), where \( \mathbf{c} \) is the resultant vector.

\[ \mathbf{c} = \mathbf{a} + \mathbf{b} \]

Newton's second law states that the net force \( \mathbf{F} \) acting on an object is equal to the product of its mass \( m \) and acceleration \( \mathbf{a} \):

\[ \mathbf{F} = m \mathbf{a} \]

Lorentz force: \( \mathbf{F} = q \mathbf{E} \times \mathbf{v} \)

Faraday's law of electromagnetic induction states that the electric field \( \mathbf{E} \) is perpendicular to the magnetic field \( \mathbf{B} \) and is given by

\[ \mathbf{E} = \mathbf{v} \times \mathbf{B} \]

Lorentz force on a particle: \( F = q \mathbf{E} \times \mathbf{v} \)

Lorentz force on a charged particle moving in a magnetic field: \( F = q \mathbf{v} \times \mathbf{B} \)

General case:

\[ \mathbf{F} = q (\mathbf{E} + \mathbf{v} \times \mathbf{B}) \]

In a steady magnetic field, the magnetic force on a charged particle is

\[ F = q (\mathbf{v} \times \mathbf{B}) \]

Where \( \mathbf{v} \) is the velocity of the particle and \( B \) is the magnetic field.
- Liquid crystals are materials in which the elongated molecules have orientational order (like crystals) but lack the positional order (like liquids).

- Three types of LCs:
  + Nematic: molecules are parallel but their position is random.
  + Smectic: molecules are parallel, the position is order only in one direction (i.e., random in ordered layers).
  + Cholesteric: the smectic but phase is different from layer to layer.

- In LCs, the molecules change orientation when subject to force.

- Twisted nematic LCs are optically inhomogeneous anisotropic media that act locally as uniaxial crystals with optical axis II to the molecular direction.
Molecular organizations of different types of liquid crystals: (a) nematic, (b) smectic, (c) cholesteric.

Figure 6.5-1

Optics of Liquid Crystals
This can be used for display rotation.

\[ \Delta n (\theta) = \tilde{\eta} (\theta) \]

This coefficient is given by

\[ \theta = \frac{n_1 - n_2}{2} \]

Figure 6.5.2 Molecular orientations of the twisted nematic liquid crystal

Twisted nematic LC
Figure 6.6-1: Power transmittance of a typical dichroic polarizer with the polarization plane of Dichroic Polarizer:

Polarization Devices
Figure 6.6.2
Brewster-angle polarizer.

Brewster angle polarizer
The crystals are negative uniaxial \( \varepsilon \neq \mu \). Calculate the directions and polarizations of the exiting waves differ in the three cases. In this illustration, polarizing prisms: (a) Wollaston prism, (b) Rochon prism, (c) Semireflection prism.

Figure 6.6-3: Polarizing prisms.
Wave Retarders
Optical Isolators