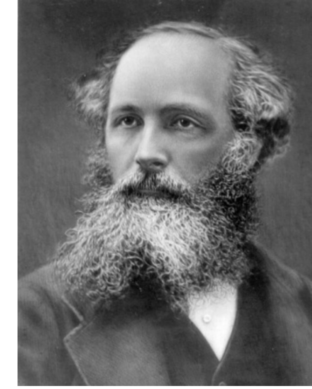


And God said

$$\oint \overline{E} \bullet \overline{dl} = -\int \frac{\partial \overline{B}}{\partial \tau} \bullet \overline{ds}$$

$$\oint \overline{H} \bullet \overline{dl} = \int \left(\overline{J}_C + \frac{\partial \overline{D}}{\partial \tau} \right) \bullet \overline{ds}$$

$$\oint \overline{D} \bullet \overline{ds} = \int \nabla \bullet \overline{D}\, dv$$

$$\oint \overline{B} \bullet \overline{ds} = 0$$

OR

$$\nabla \times \overline{E} = -\mu \frac{\partial \overline{H}}{\partial \tau}$$

$$\nabla \times \overline{H} = \overline{J}_C + \varepsilon \frac{\partial \overline{E}}{\partial \tau}$$

$$\nabla \bullet \overline{D} = \rho_v$$

$$\nabla \bullet \overline{B} = 0$$

OR

$$\nabla \times \overline{E} = -\mu \frac{\partial \overline{H}}{\partial \tau}$$

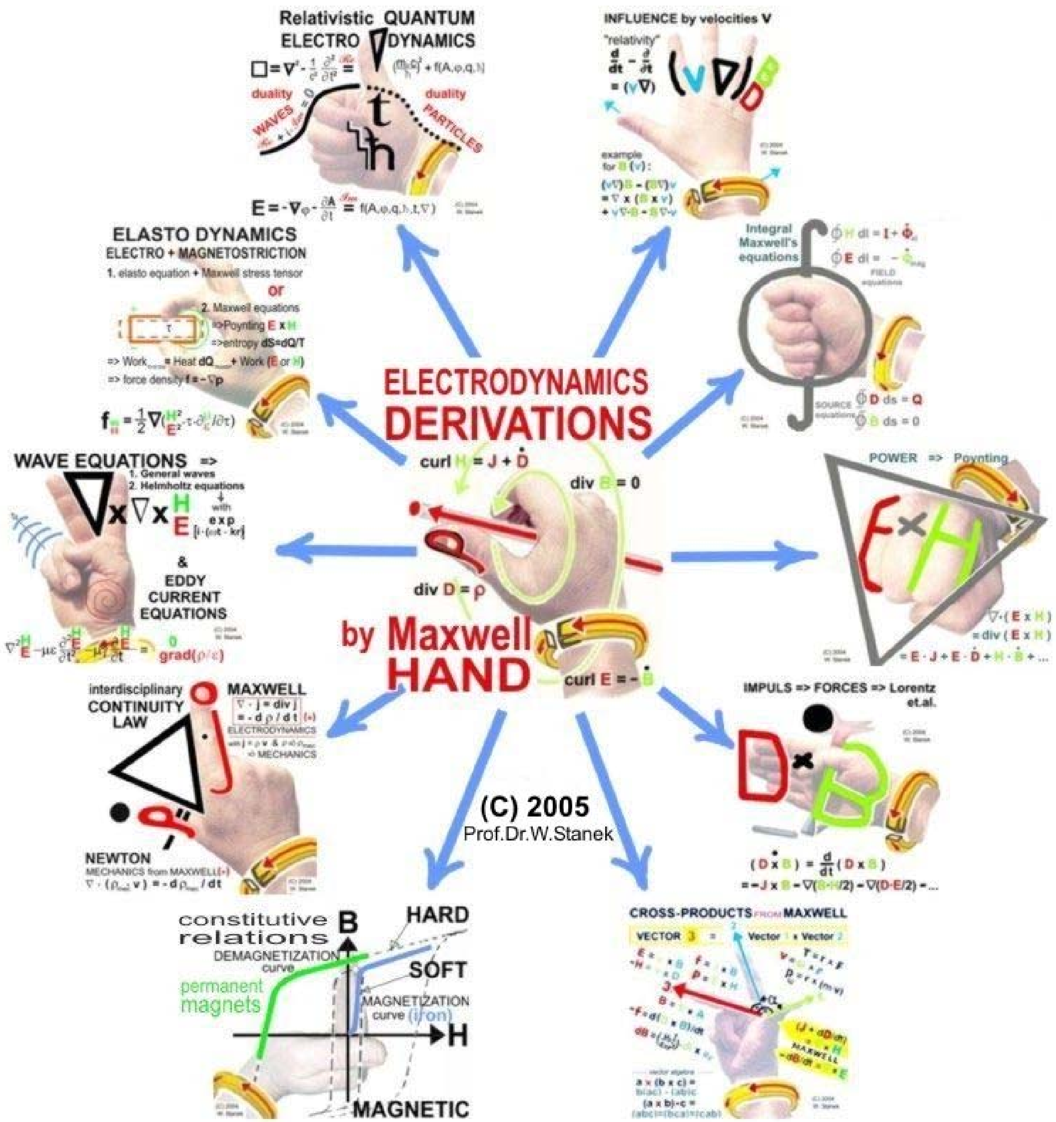
$$\nabla \times \overline{H} = J_c + \epsilon \frac{\partial \overline{E}}{\partial \tau}$$

$$\nabla \bullet \overline{D} = \rho_v$$

$$\nabla \bullet \overline{B} = 0$$

and there was light

Maxwell HAND



Tacoma Narrows Bridge

The animation shows the Tacoma Narrows Bridge (see Online Destinations) shortly before its collapse. What is its frequency?

- .1 Hz
- .25 Hz
- .50 Hz
- 1 Hz

The animation shows the Tacoma Narrows Bridge (see Online Destinations) shortly before its collapse. The distance between the bridge towers (nodes) was about 860 meters and there was also a midway node. What was the wavelength of the standing torsional wave?

- 1720 m
- 860 m
- 420 m
- There is no way to tell.

The animation shows the Tacoma Narrows Bridge (see Online Destinations) shortly before its collapse. What is the amplitude?

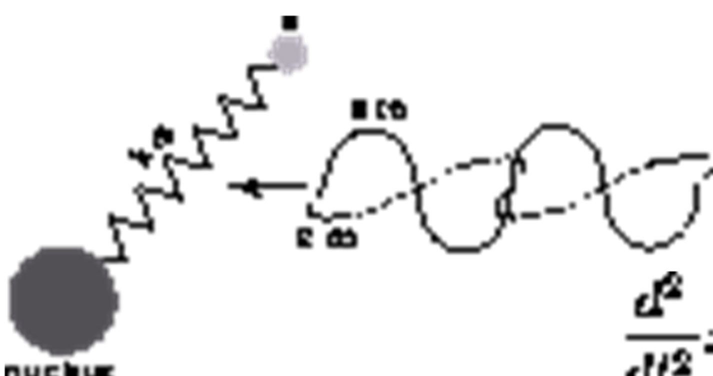
- .4 m
- 4 m
- 8 m
- 14 m

Lorentz Model vs. Positive Feedback

That it is the natural modes that are important can be seen by looking at the equation of motion for the oscillator.

$$M\frac{d^2x}{dt^2} + Kx + 2M\gamma\frac{dx}{dt} = 0. \qquad (1)$$

If γ is negative, the solutions are oscillatory with a frequency very near the natural frequency $\sqrt{K/M}$, but with an exponentially growing amplitude. There is nothing about γ that needs to have anything to do with that natural period. That is, the only role that the external conditions (pressure on the clarinet reed, motion of the bow, air stream blowing across the beer bottle) need play is to set up the conditions needed to make γ negative.



$$\frac{d^2}{dt^2}x(t) + 2\gamma\frac{d}{dt}x(t) + \omega^2 x(t) = \frac{e}{m}E(t).$$

Polarization and Propagation

In isotropic media (e.g. free space, amorphous glass, etc.)

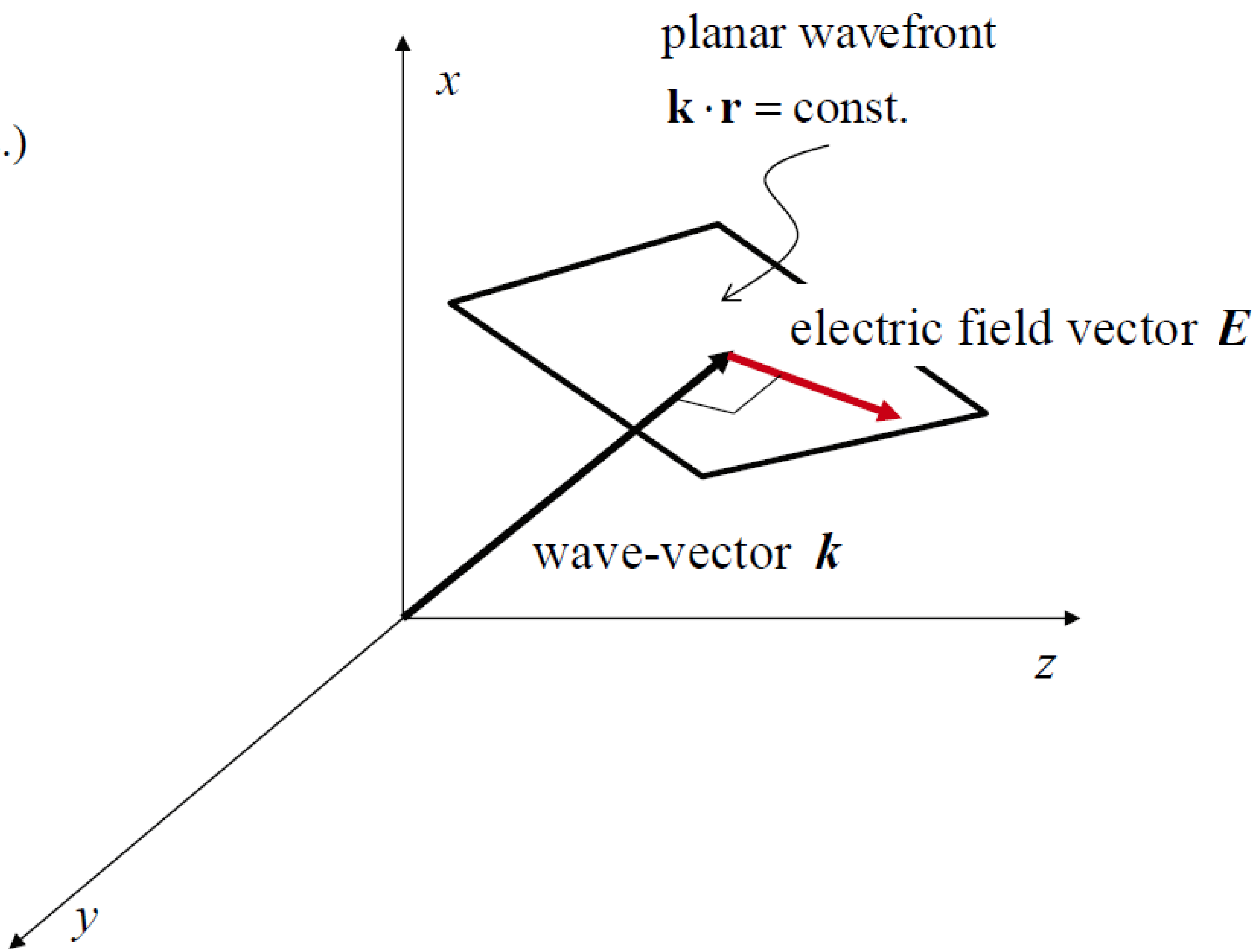
$\mathbf{k} \cdot \mathbf{E} = 0$

i.e. $\mathbf{k} \perp \mathbf{E}$

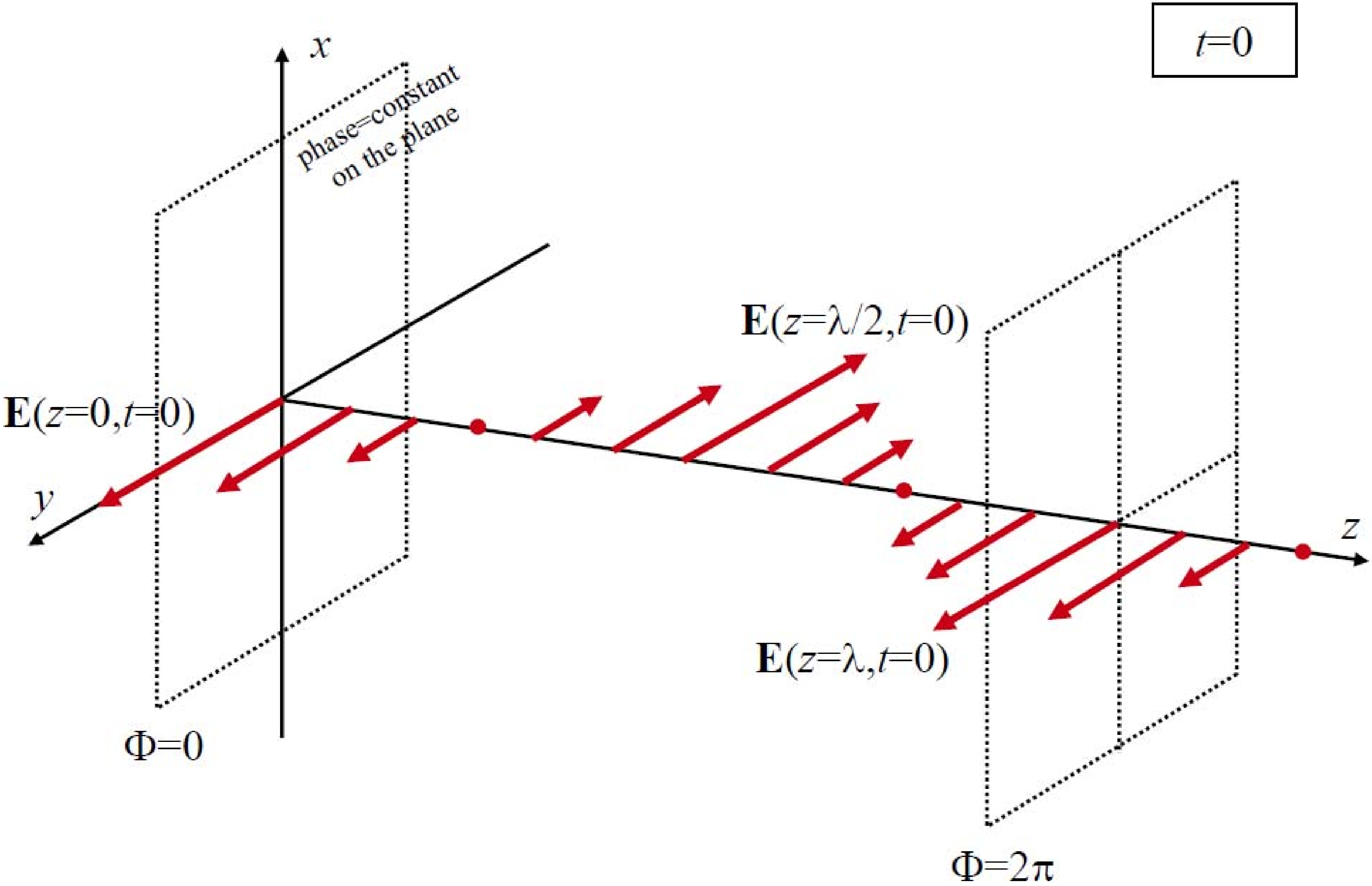
More generally,

$\mathbf{k} \cdot \mathbf{D} = 0$

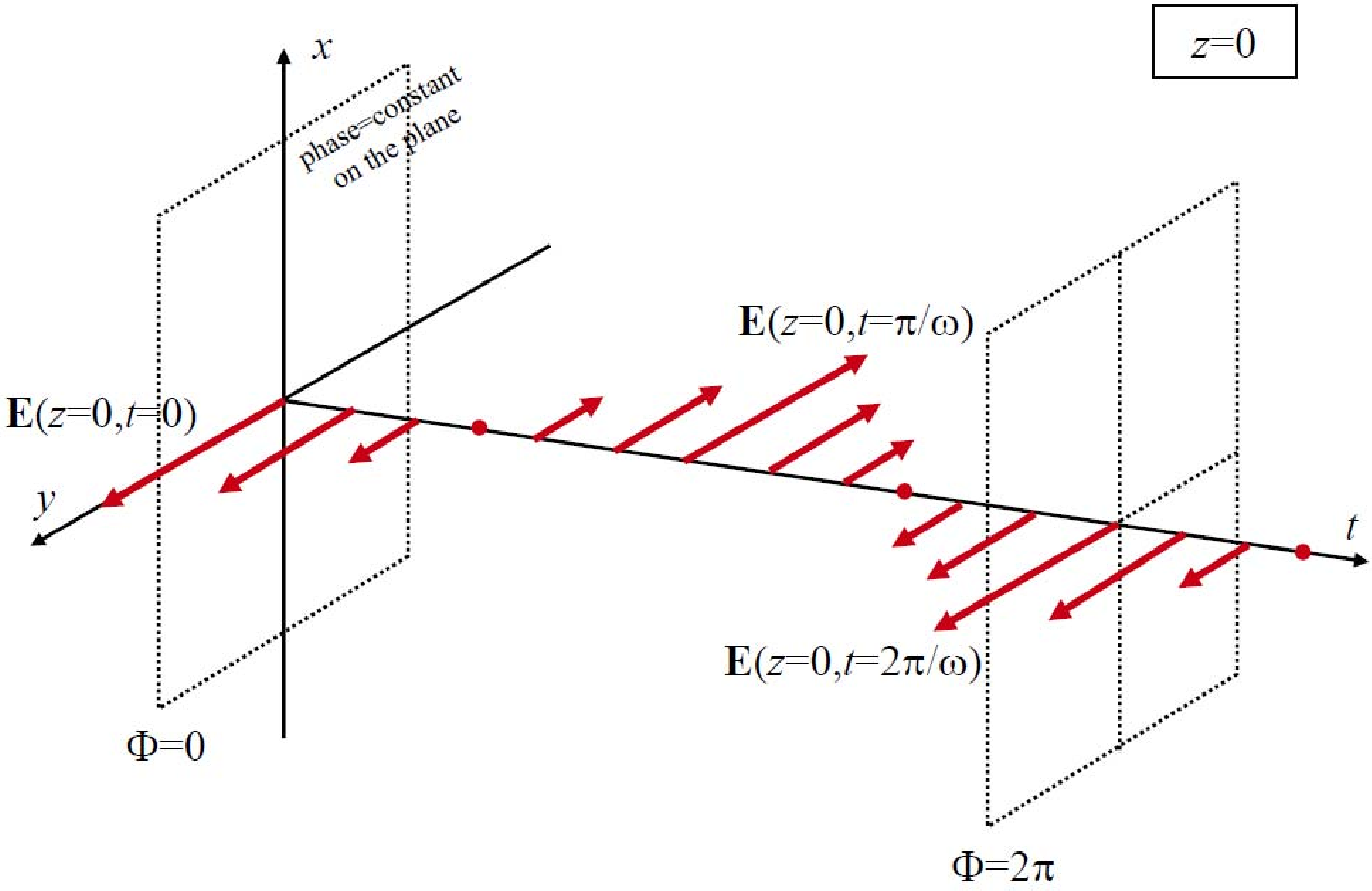
(reminder: in anisotropic media, e.g. crystals, one could have **E** not parallel to **D**)



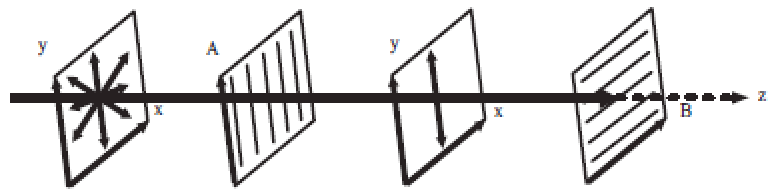
Linear polarization (frozen time)

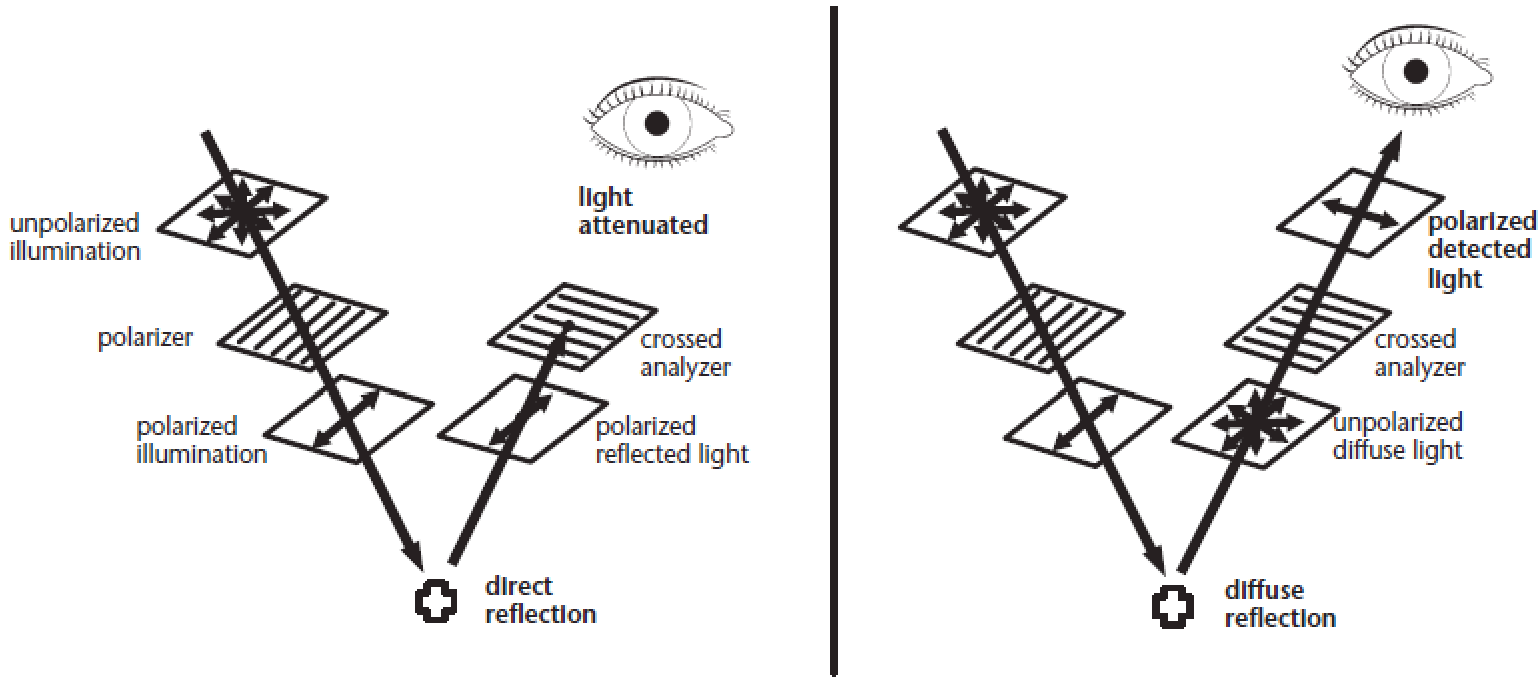


Linear polarization (fixed space)



Working with linear polarized light





absorption of direct reflection

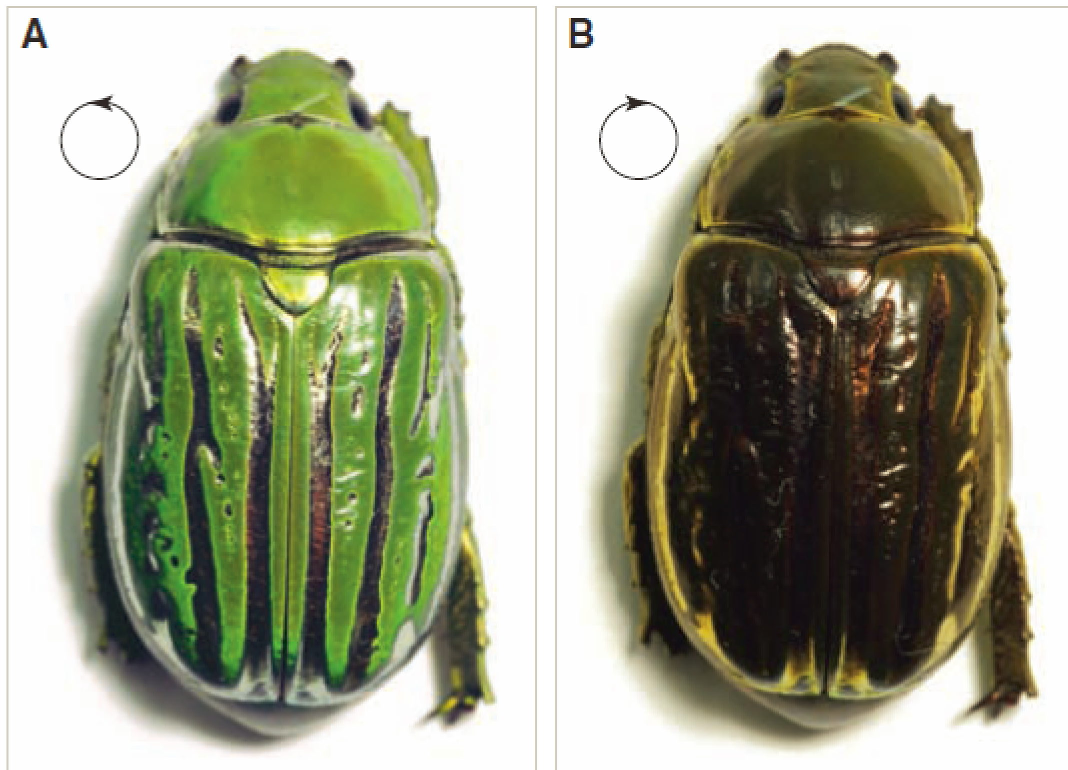
diffuse reflections passing

Where is the turtle?

Homework problem: polarized sunglasses

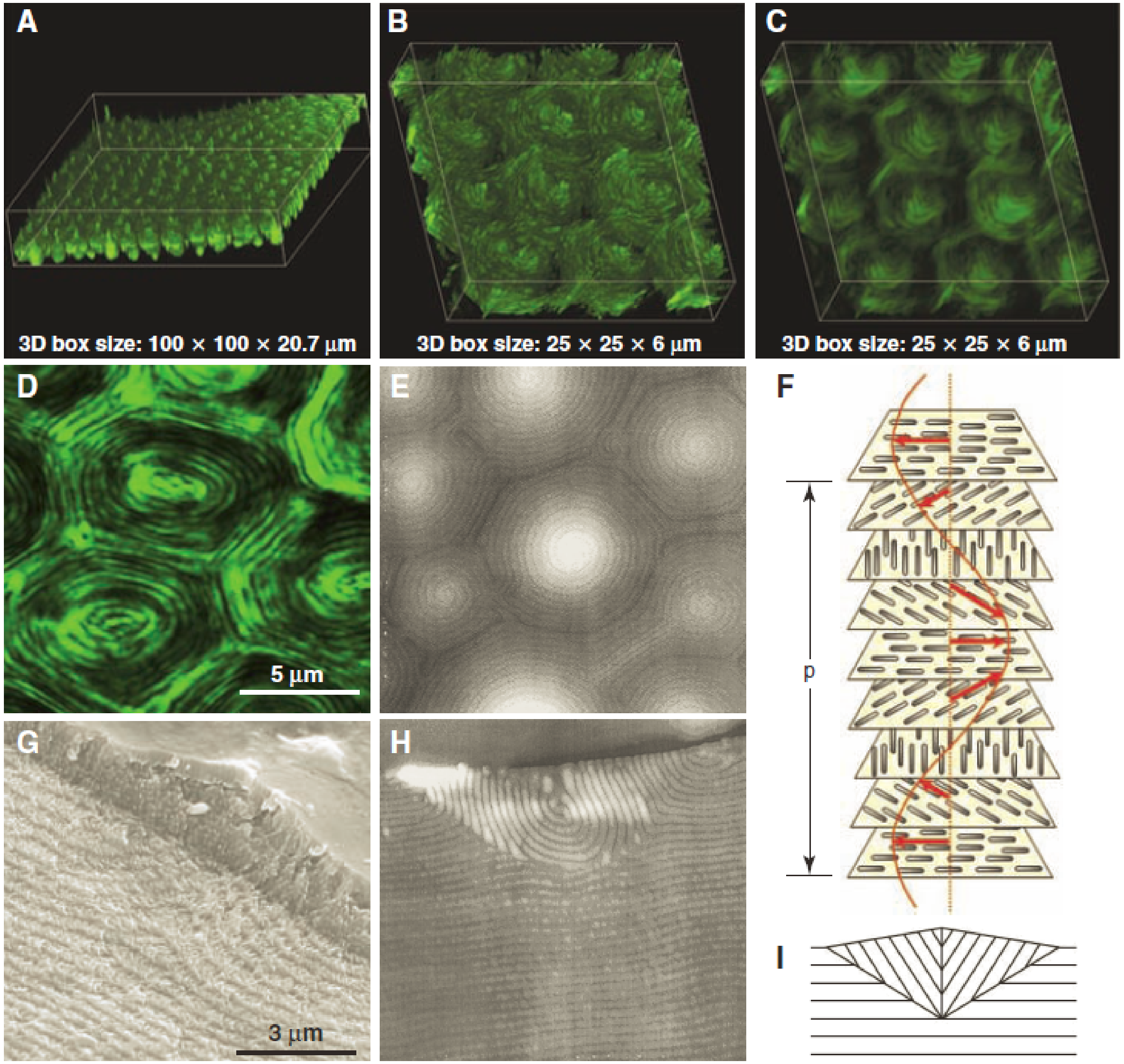
Circularly polarized light in nature

Fig. 1. Photographs of the beetle *C. gloriosa.* (**A**) The bright green color, with silver stripes as seen in unpolarized light or with a left circular polarizer. (**B**) The green color is mostly lost when seen with a right circular polarizer.

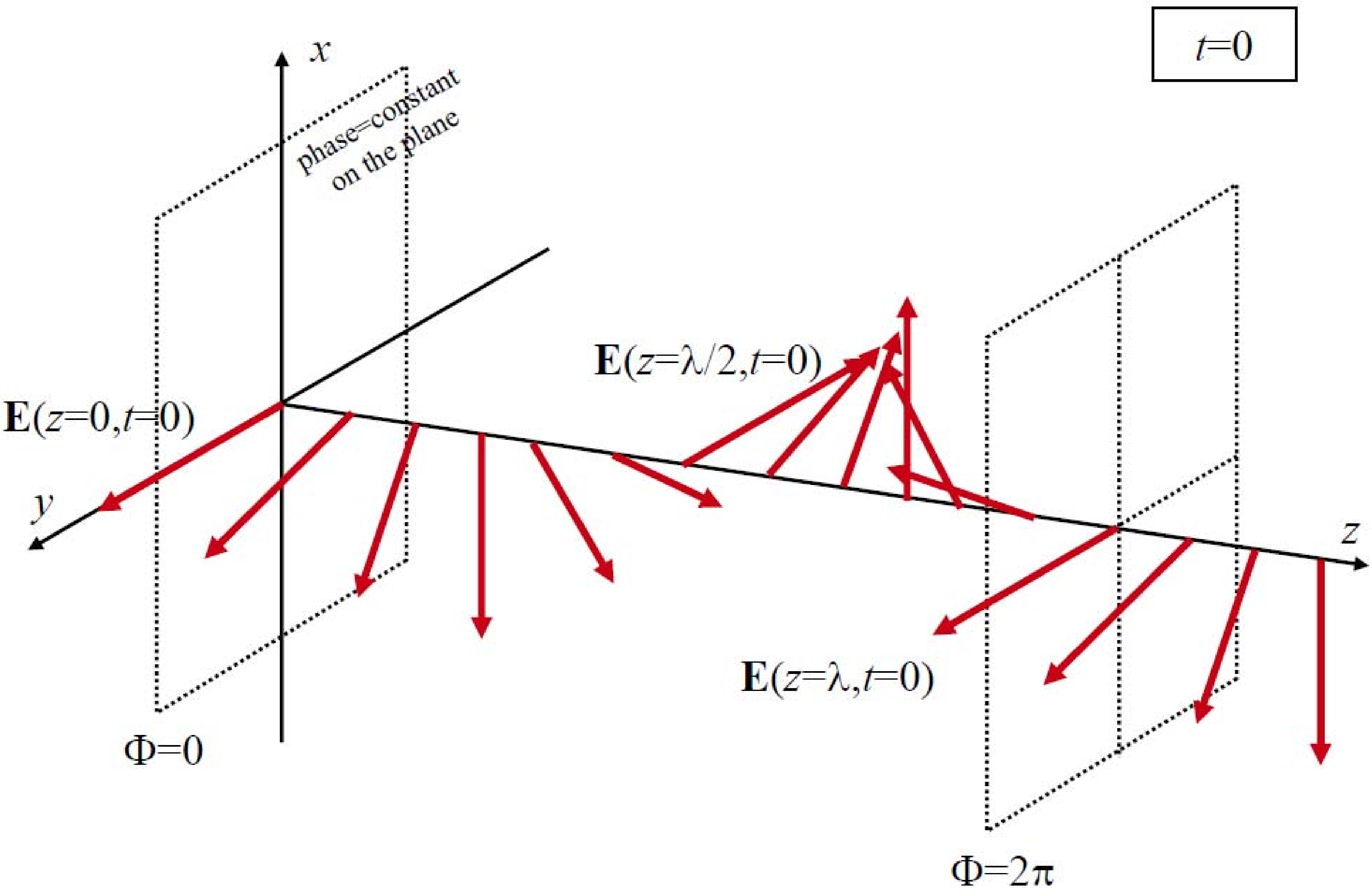


SCIENCE VOL 325 24 JULY 2009 **449**

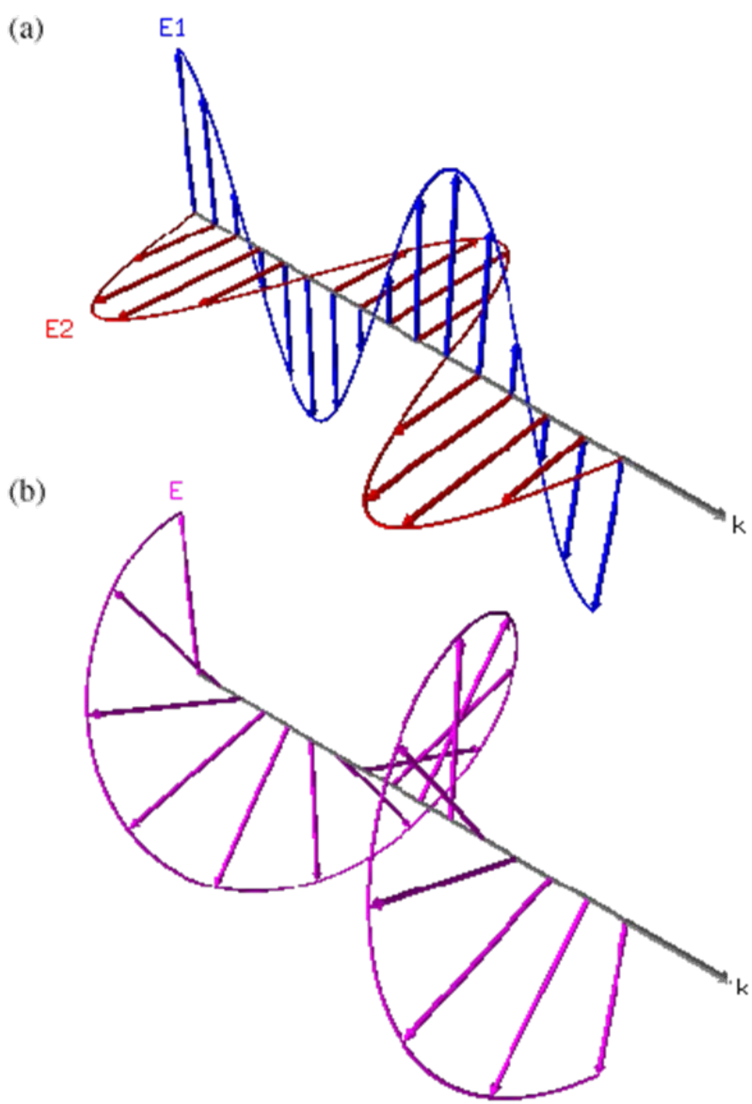
Morphology and microstructure of cellular pattern of C. gloriosa

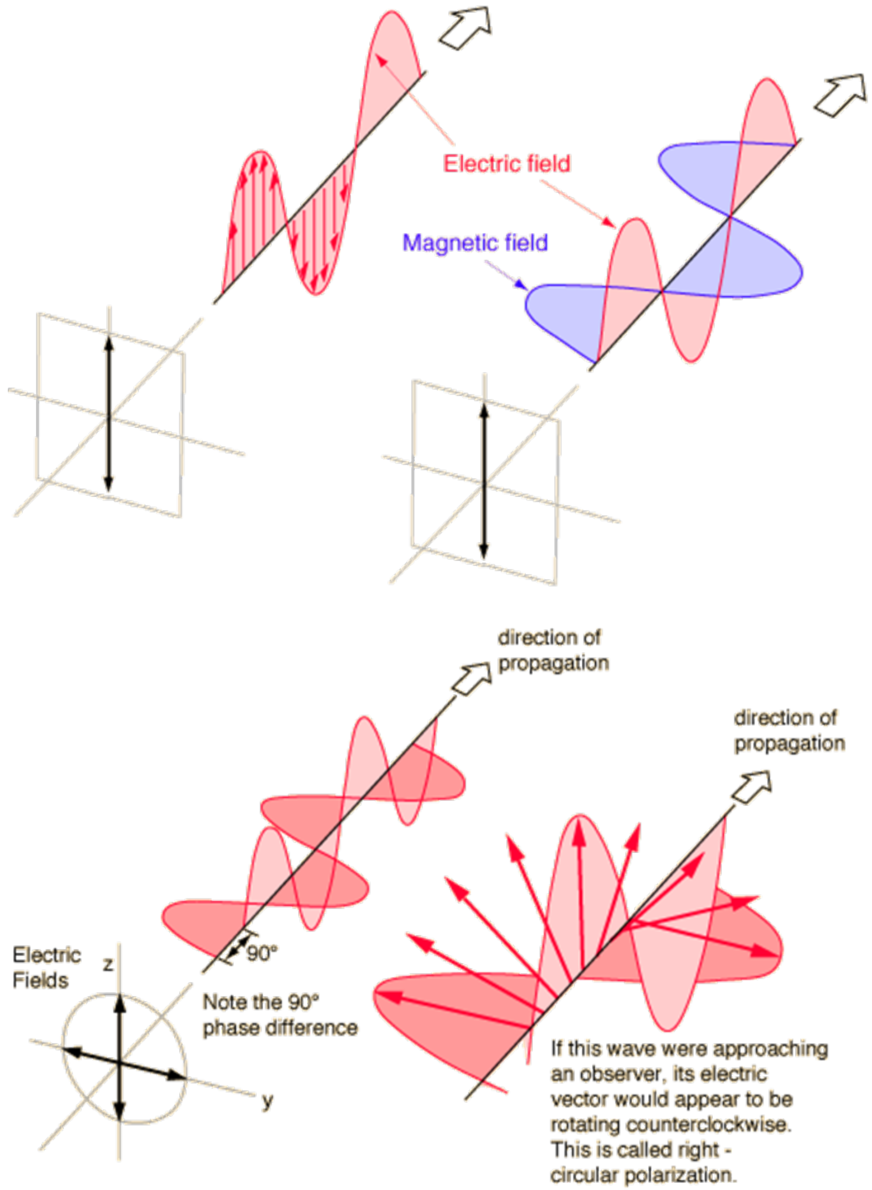


Circular polarization (frozen time)

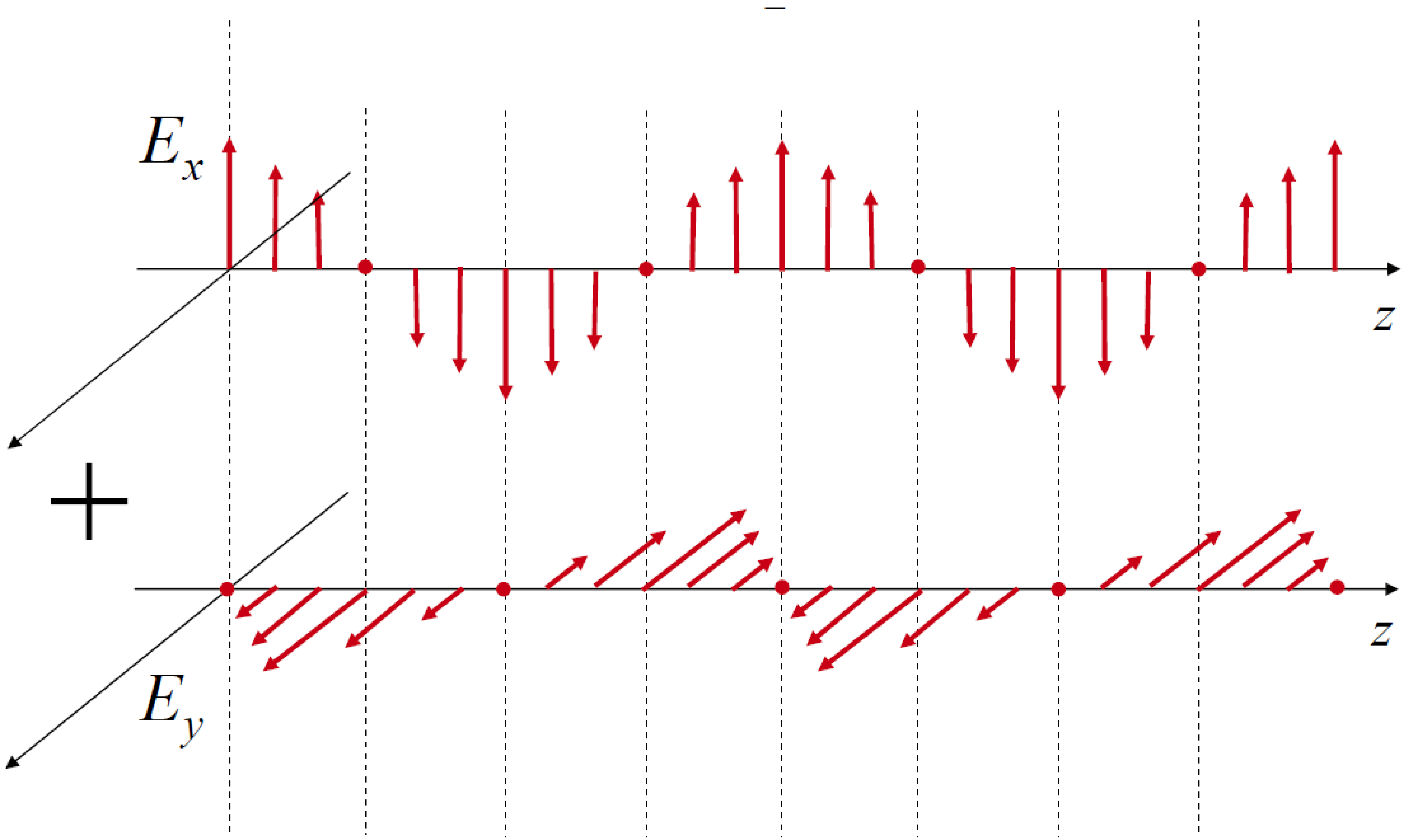


Linear versus Circular polarization

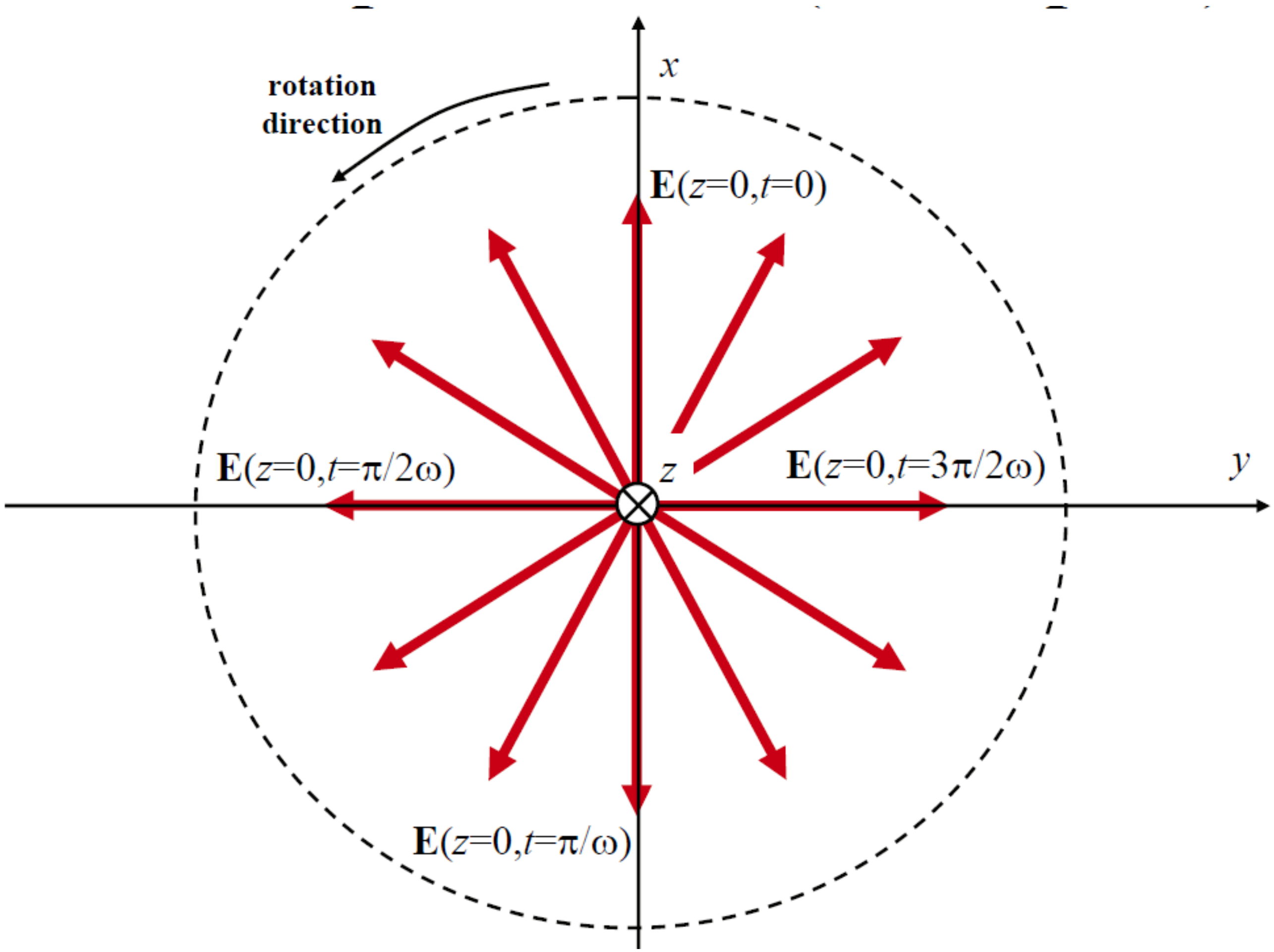




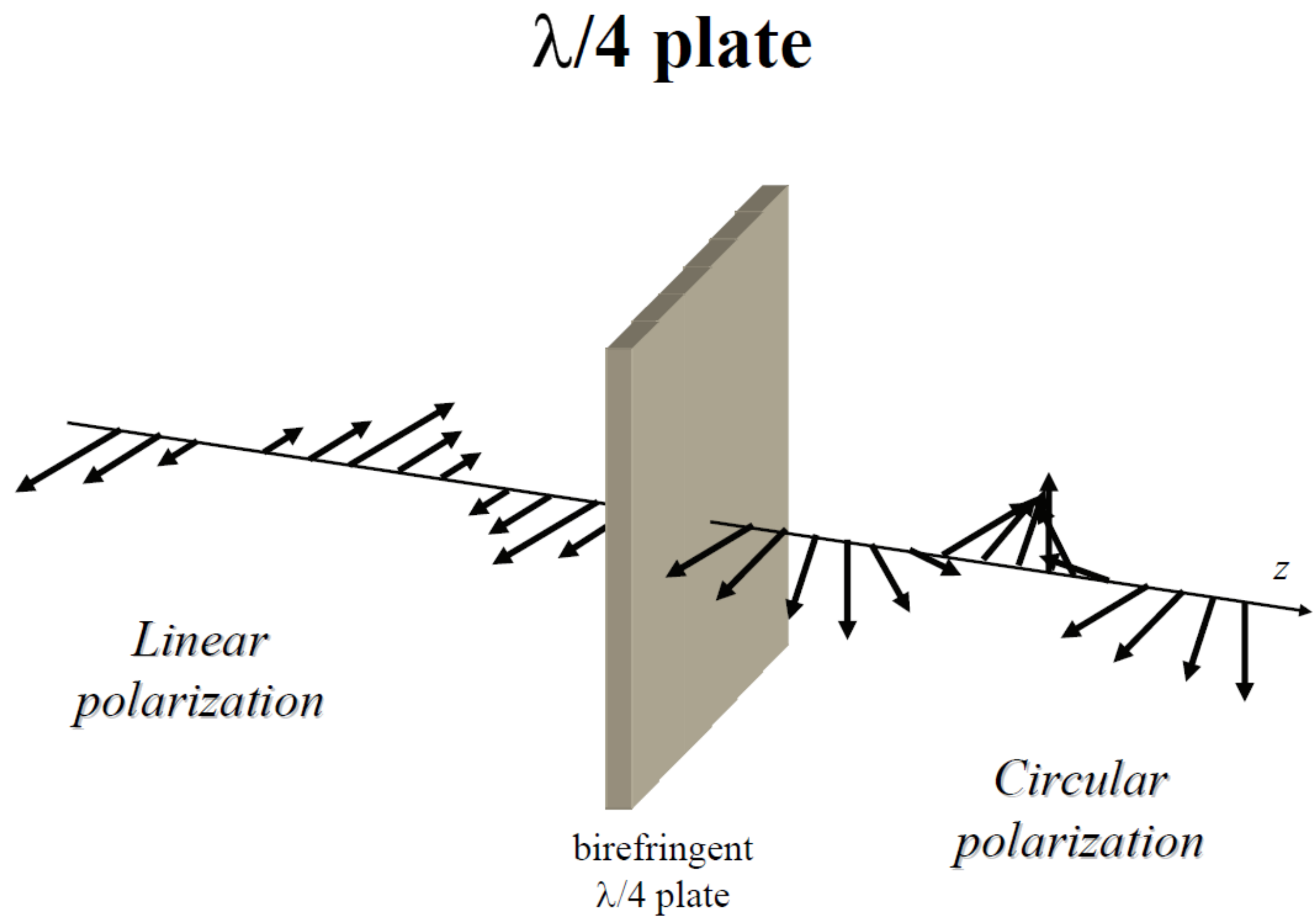
Circular polarization (linear components)



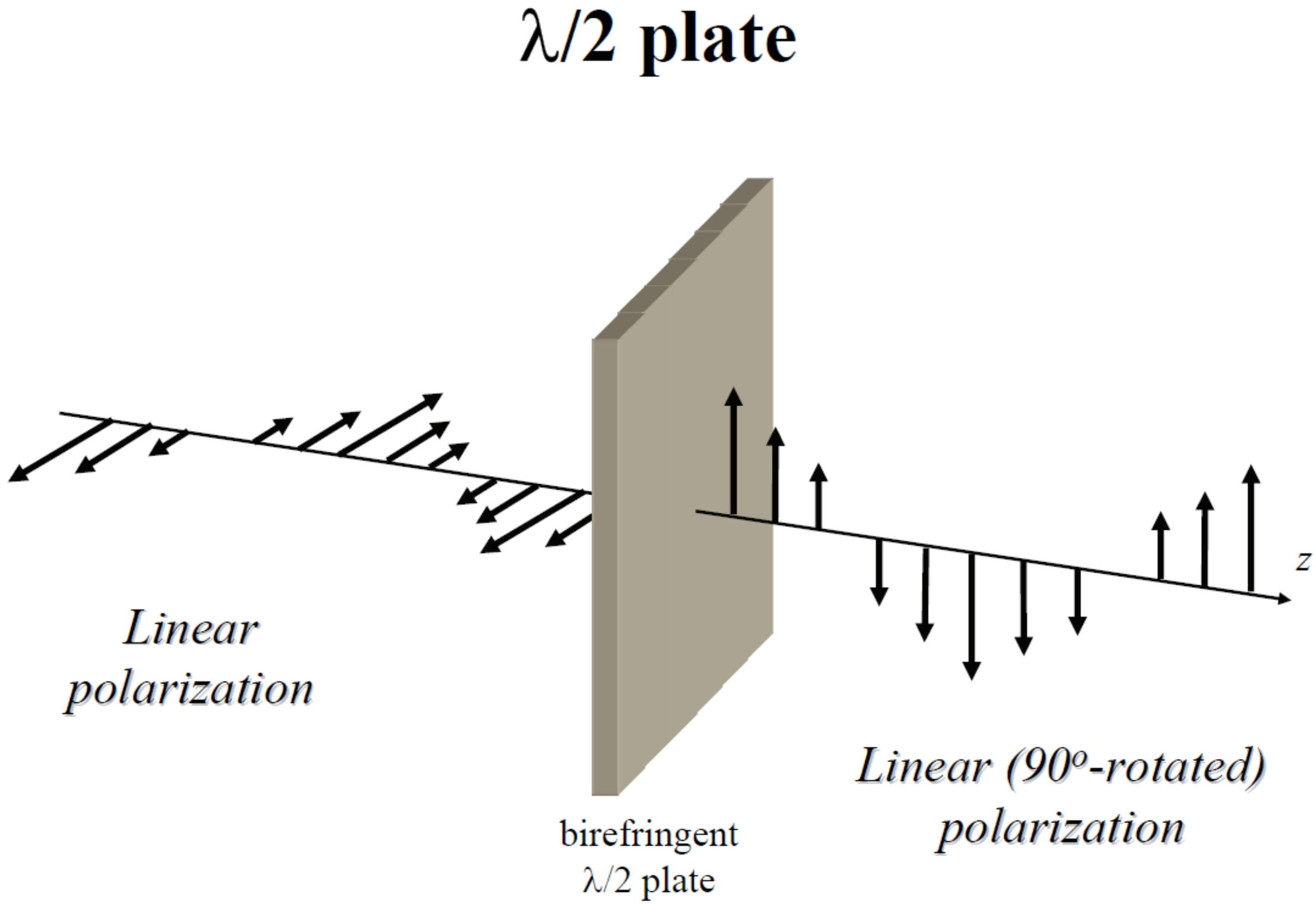
Circular polarization (fixed space)



Quarter wave plate

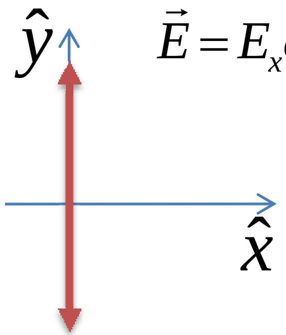


Half wave plate

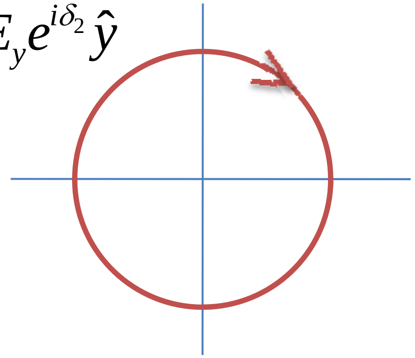


Polarization: Summary and Quiz

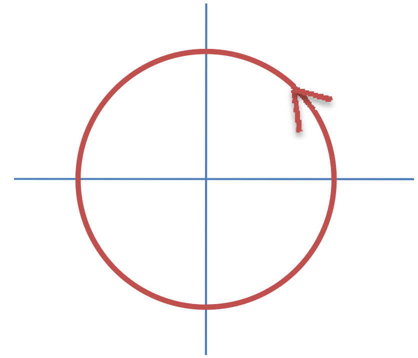
$$\vec{E} = E_x e^{i\delta_1}\hat{x} + E_y e^{i\delta_2}\hat{y}$$



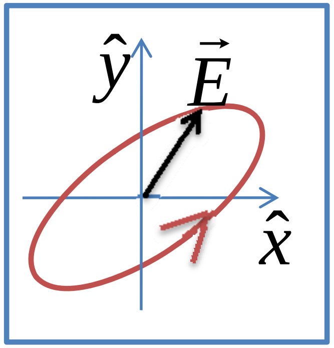
linear polarization
y-direction



right circular
polarization

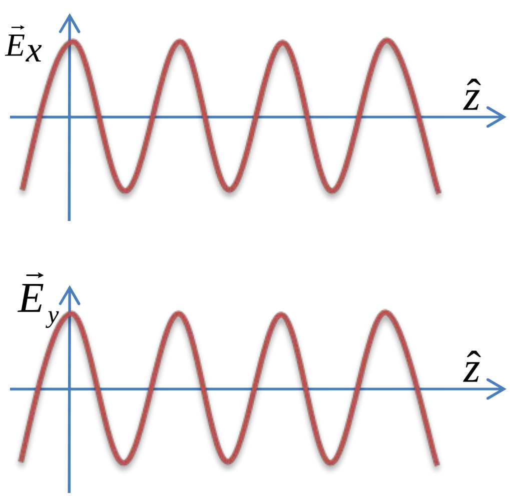


left circular
polarization

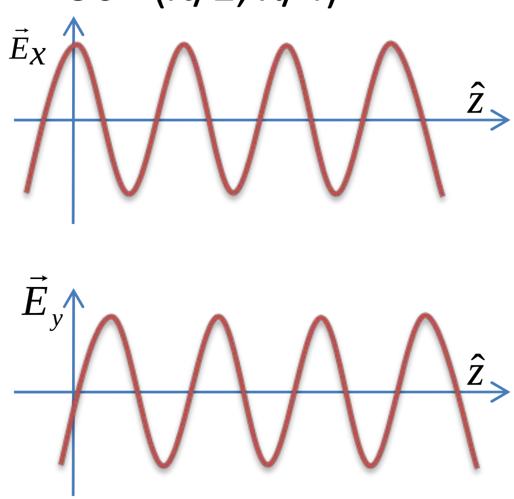


left elliptical
polarization

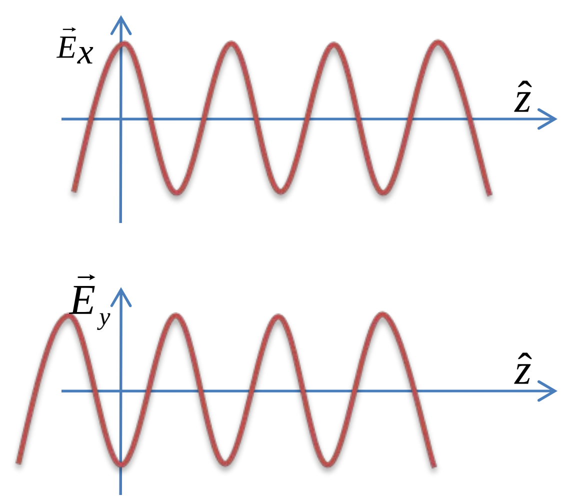
Phase difference = 0^0



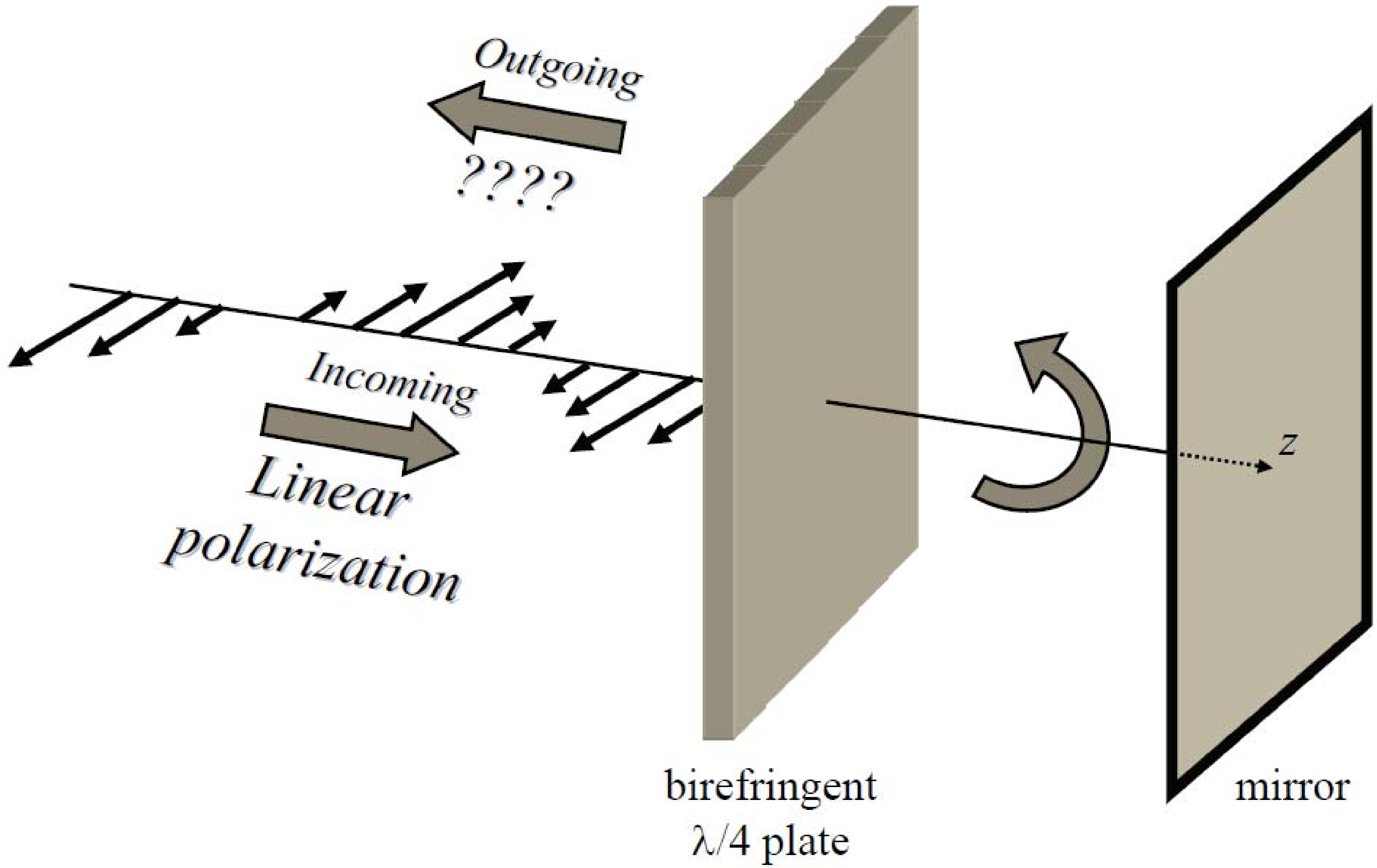
Phase difference ➔
90^0 ($\pi/2$, $\lambda/4$)



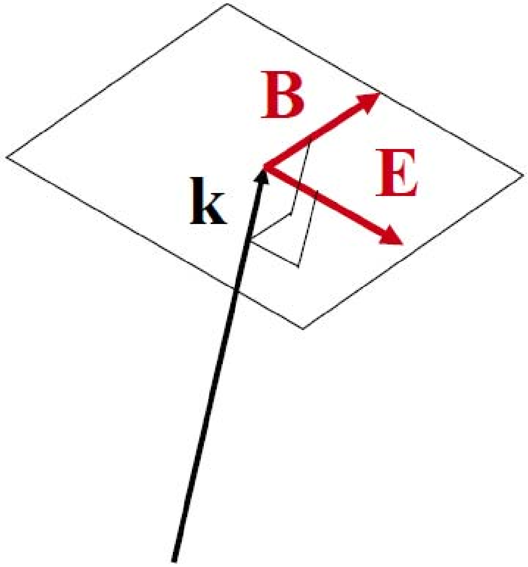
Phase difference ➔
180^0 (π, $\lambda/2$)



Quiz for the 1st Optics Lab



Hint



$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t} \quad \text{where} \quad \mathbf{E} = \hat{\mathbf{x}} E_0 \, e^{i(\mathbf{k}\cdot\mathbf{r} - \omega t)}$$

$$\Rightarrow \nabla \times \equiv i\mathbf{k} \times \quad \text{and} \quad \frac{\partial}{\partial t} \equiv -i\omega$$

$$\Rightarrow \mathbf{B} = \frac{1}{\omega} \mathbf{k} \times \mathbf{E}$$

Vectors **k**, **E**, **B** form a right-handed triad.

<u>Note:</u> free space or isotropic media only