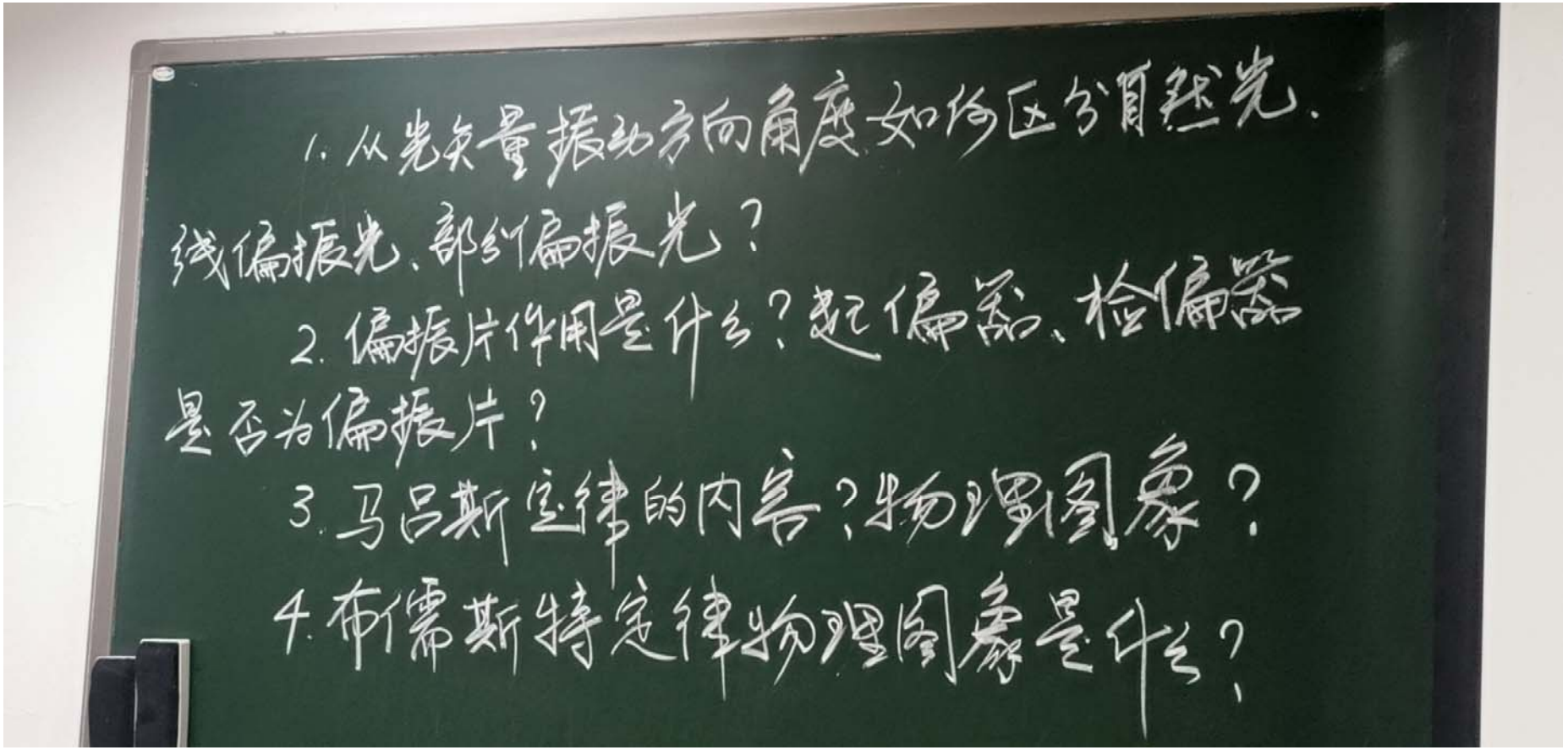
Chapter 22 Polarization of Light



Chapter 22 Polarization of Light

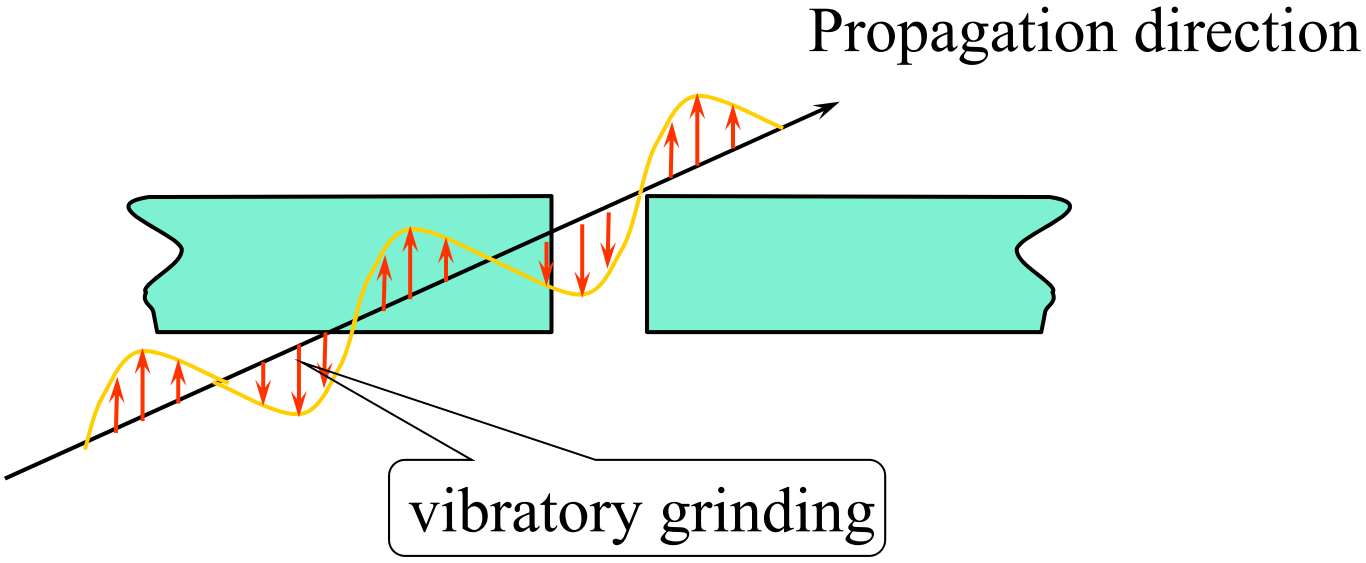
1. The concept of Polarization

- Dung beetles can discern moving direction by moonlight.
- The contrast of pictures

(a)

(b)

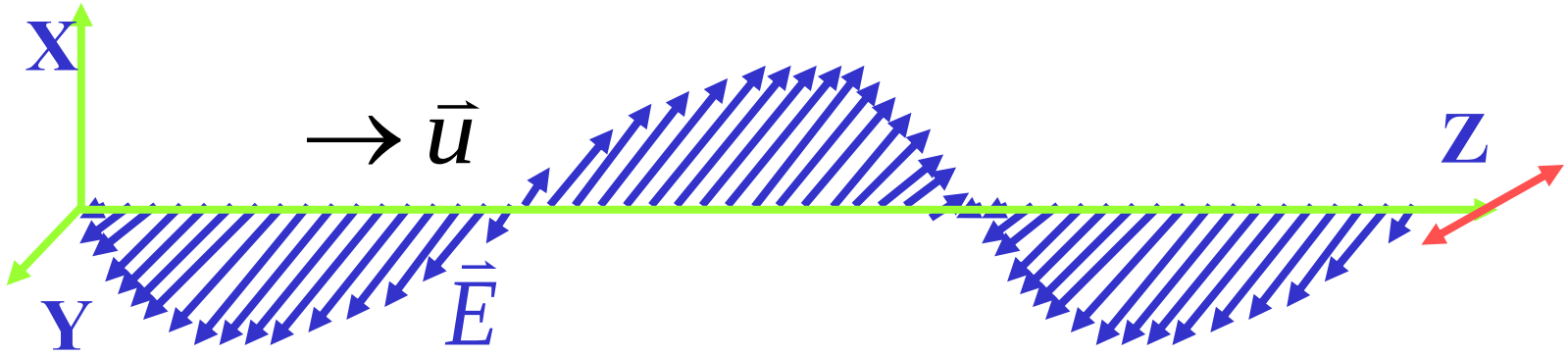
➢The double refraction experiment indicates that the light is transversal wave.



➢polarization

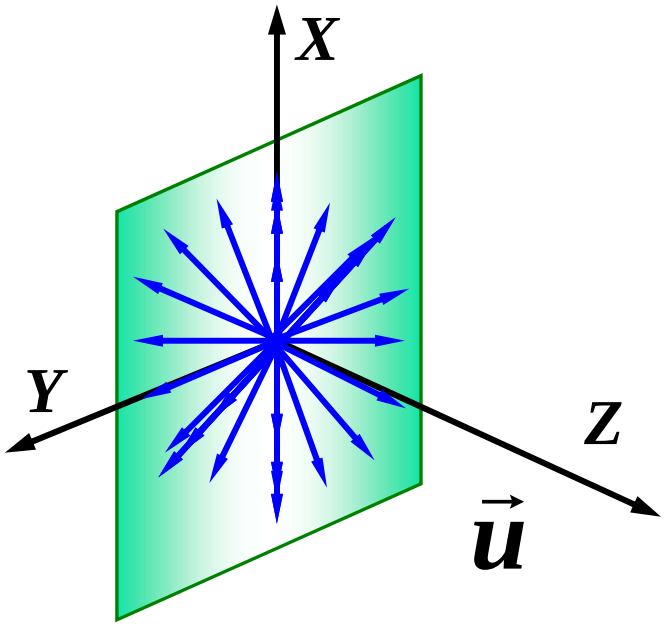
➢To longitudinal wave, the distribution of vibration directions are symmetrical to the propagation direction.

➢To transversal wave, the distribution of vibration directions are not symmetrical to the propagation direction. The asymmetry is called polarization.

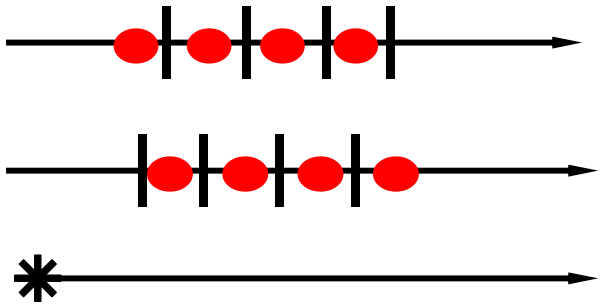


2. natural light , complete polarized light, partially polarized light

(1). natural light

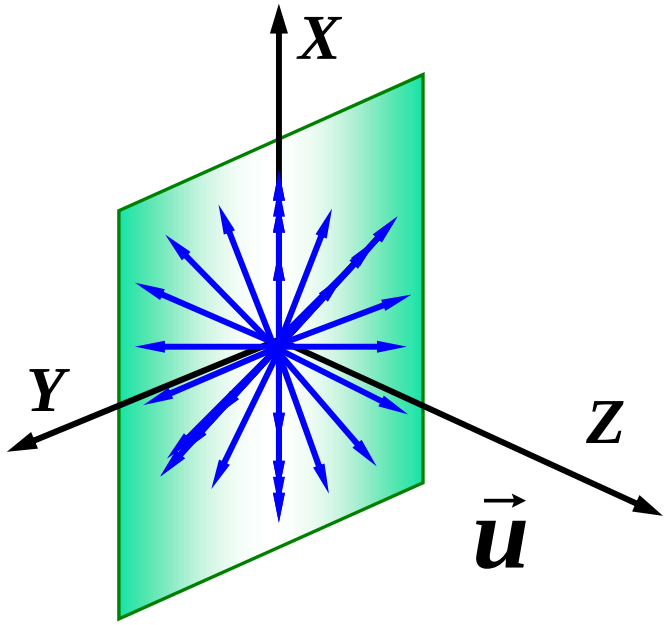


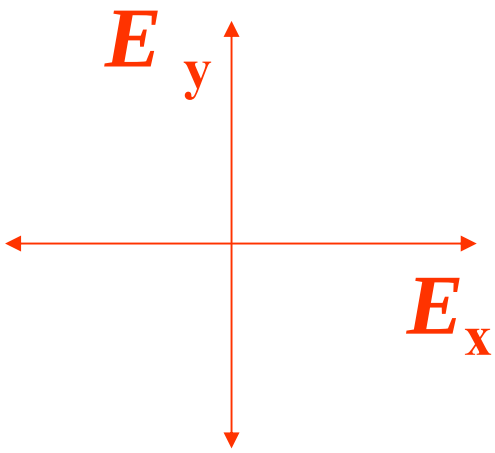
➢The geometric representation



The point in the figure indicates the vibration direction is perpendicular to the paper face, and the short line indicates the vibration direction is parallel to the paper face.

➢The vibration of natural light can be projected on two perpendicular directions.





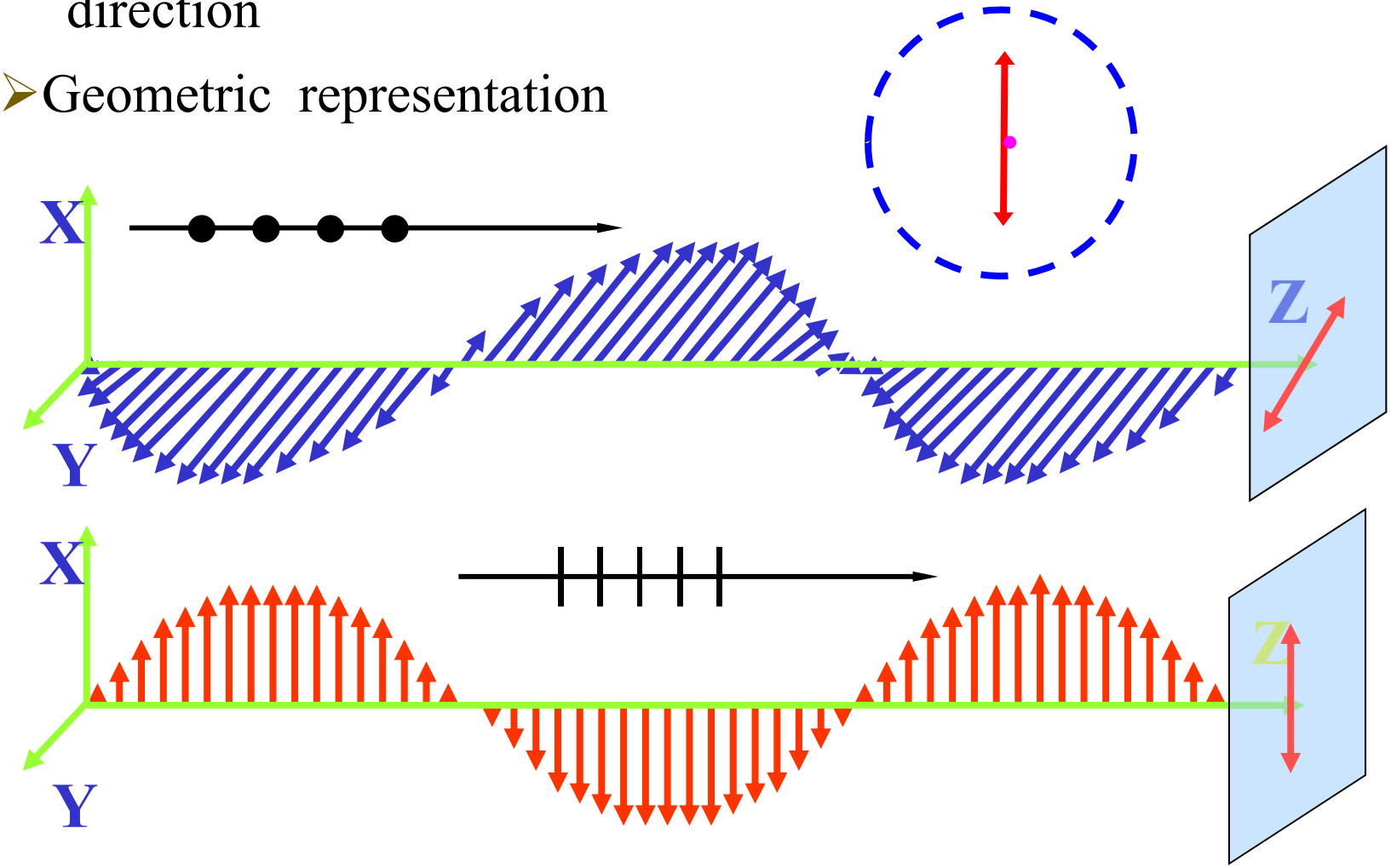
$$I = I_x + I_y = 2I_x = 2I_y$$

$$I_x = I_y = \frac{1}{2} I$$

(2). complete polarized light or polarized light

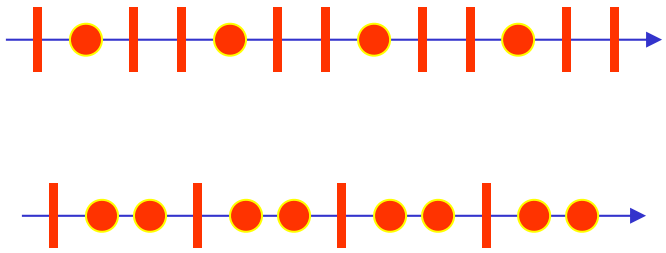
Complete polarized light is the light vibrating in only one direction

- Geometric representation



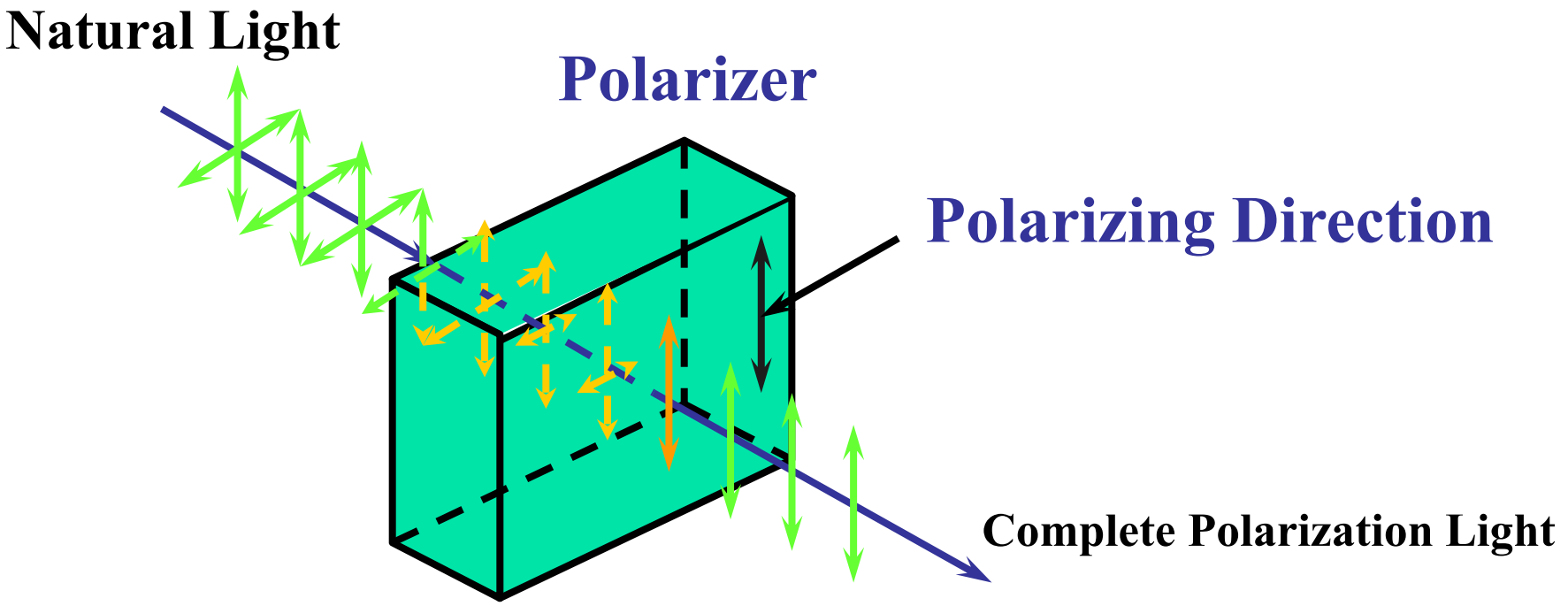
(3). partially polarized light

➢If the amplitude in one vibration direction is greater than one in another vibration direction, the light is called the partially polarized light.



3. Polarizer and Analyzer

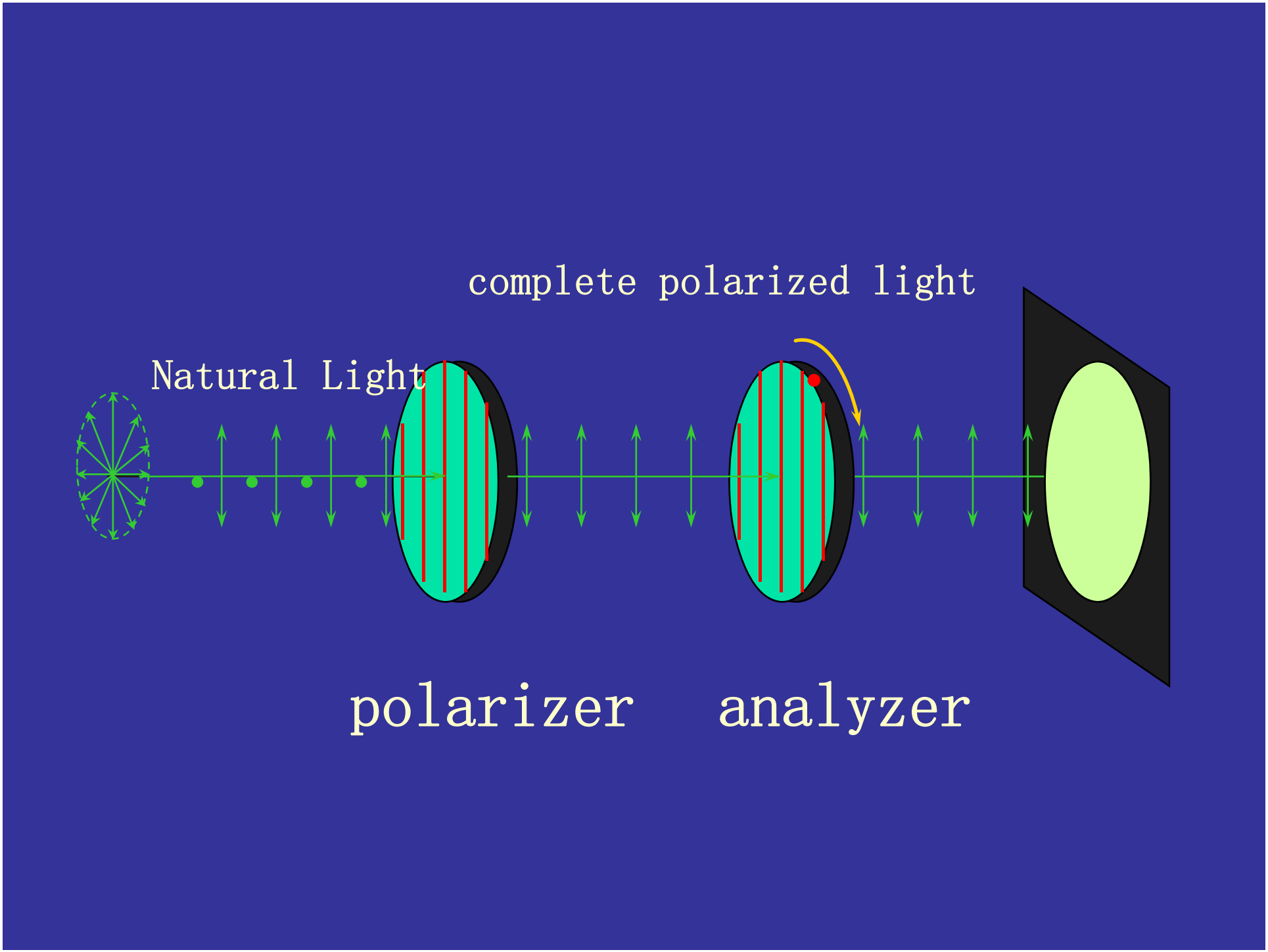
(1) polarizer

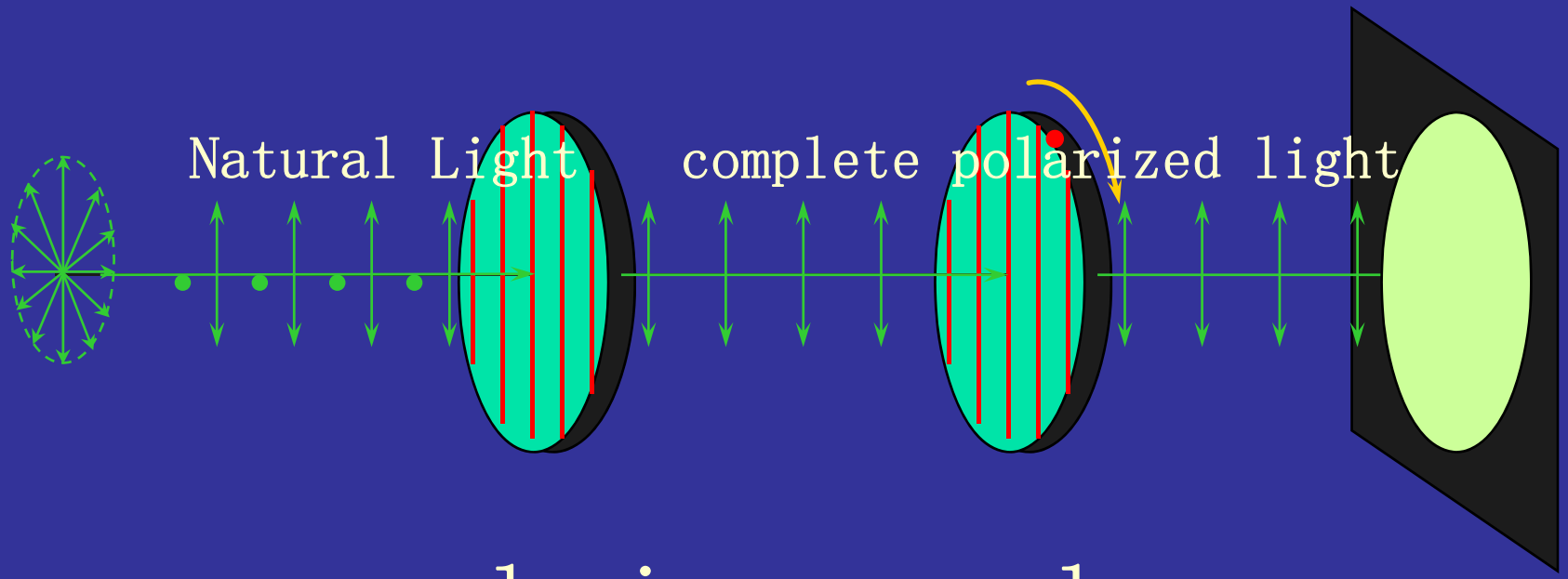


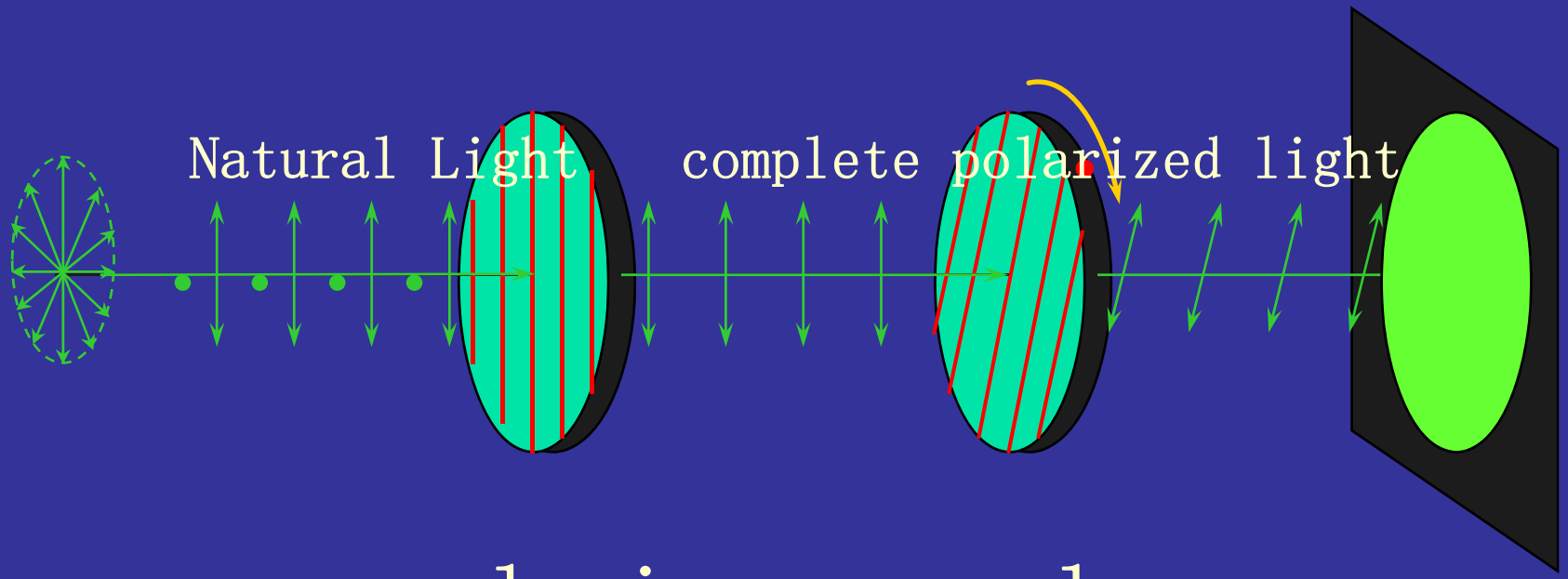
➢The action of a polarizer is just to permit only the light vibration of certain direction pass through itself; the certain direction is called the polarizing direction of the polarizer.

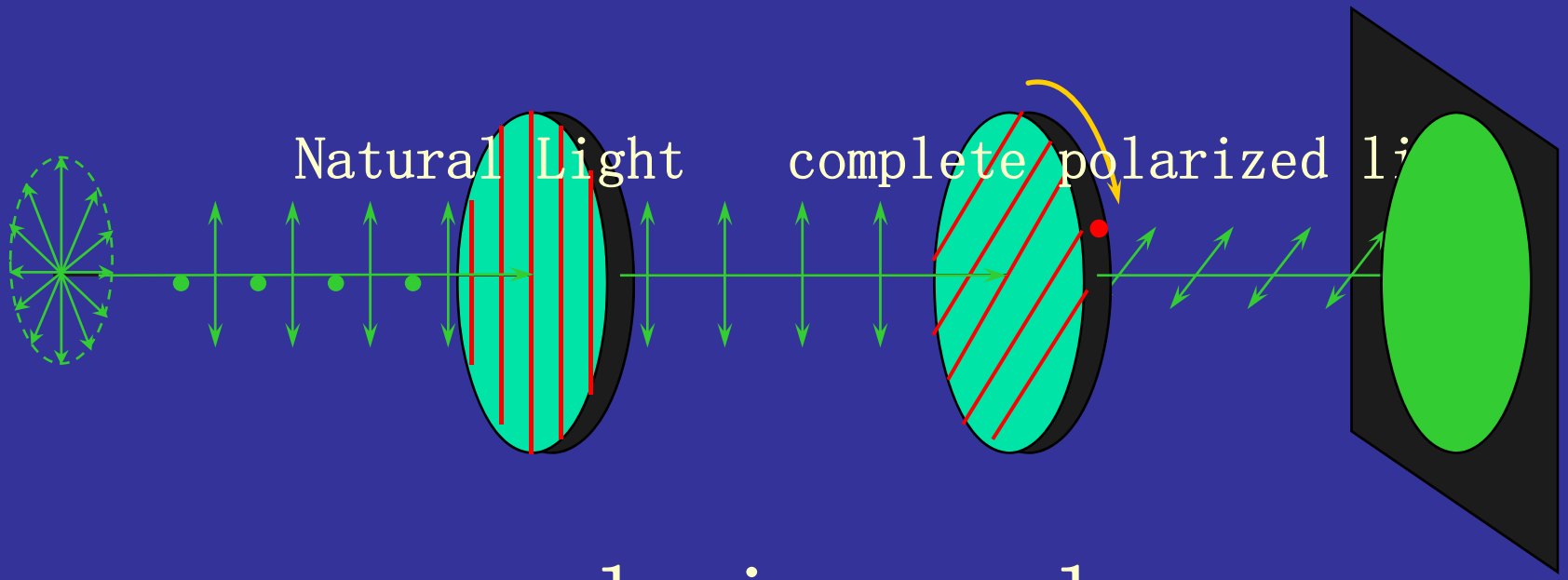
(2) Analyzer

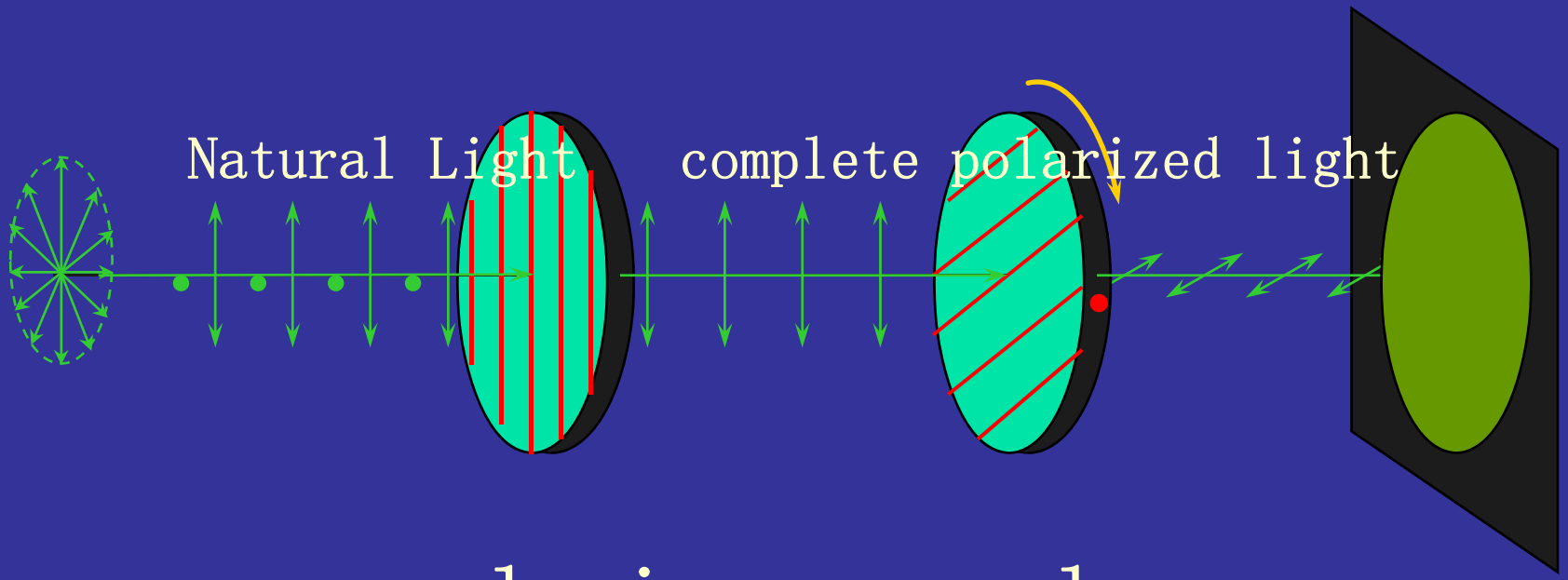
- A polarizer may be used to test whether a beam of light is polarized light. In order to know whether a beam of light is polarized light, you need only to turn the polariod in the section plane of the light beam and observe whether the brightness of transmission light is variable.

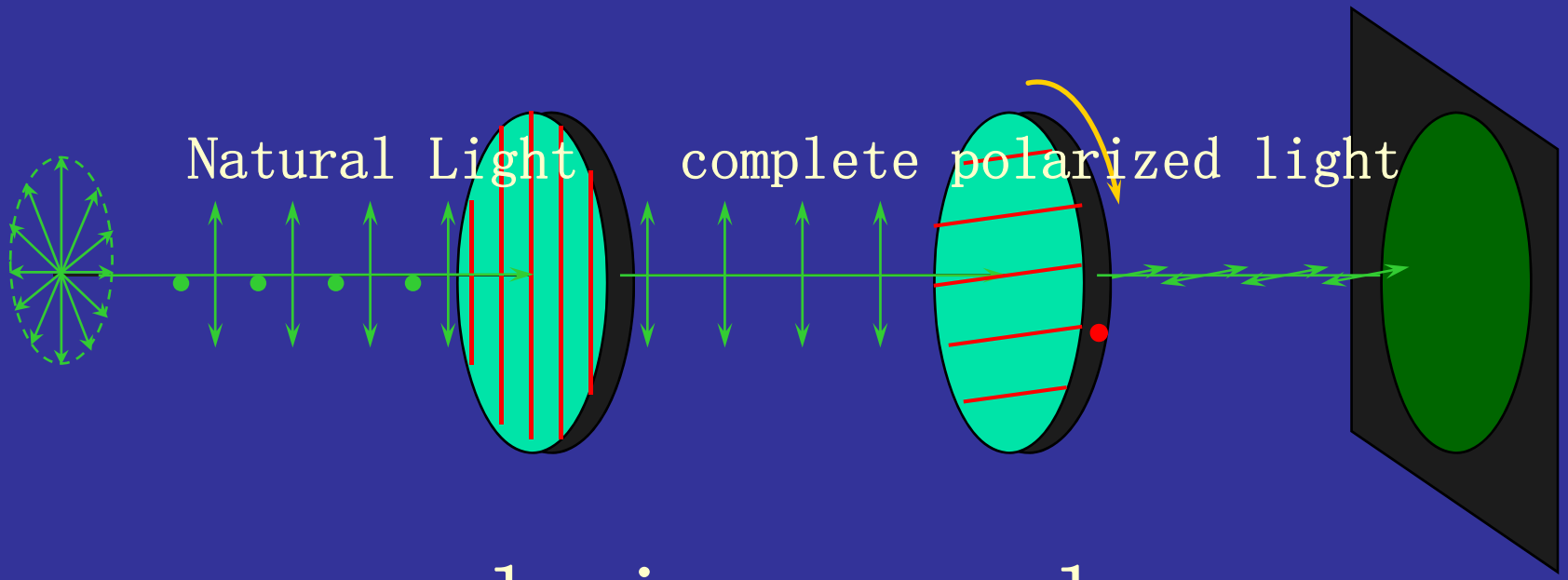

complete polarized light
Natural Light
polarizer
analyzer

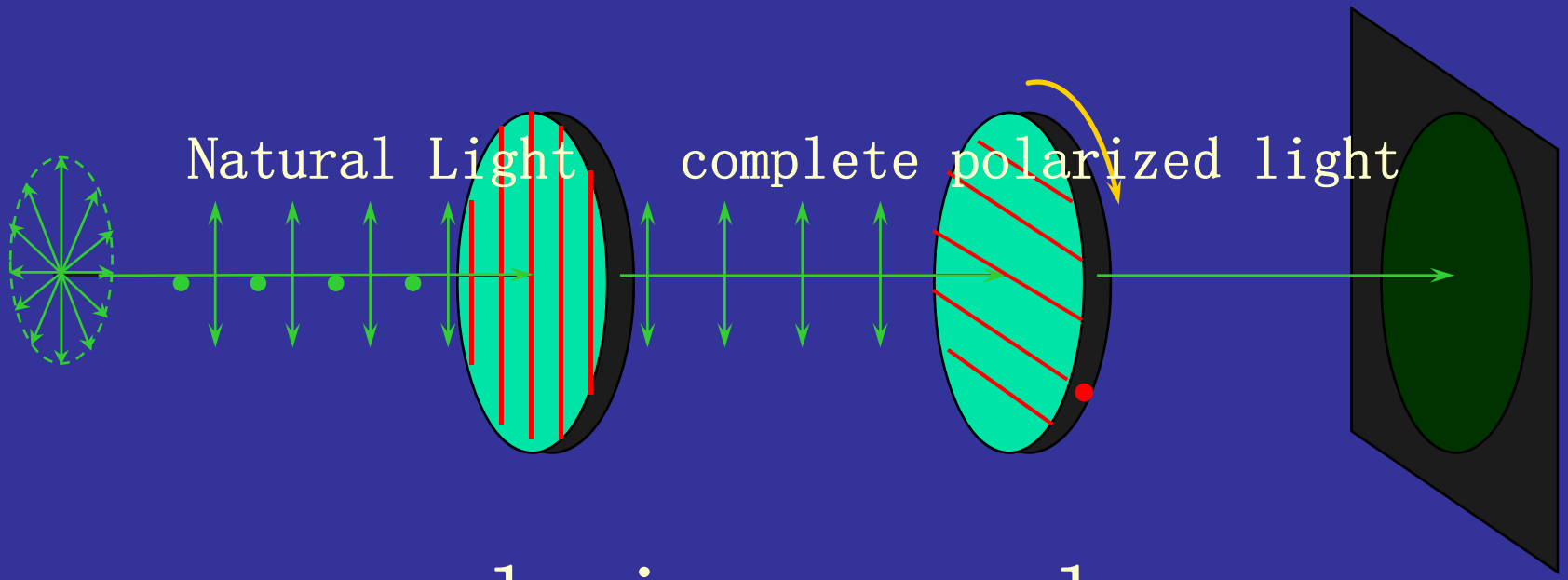

Natural Light
complete polarized light
polarizer
analyzer

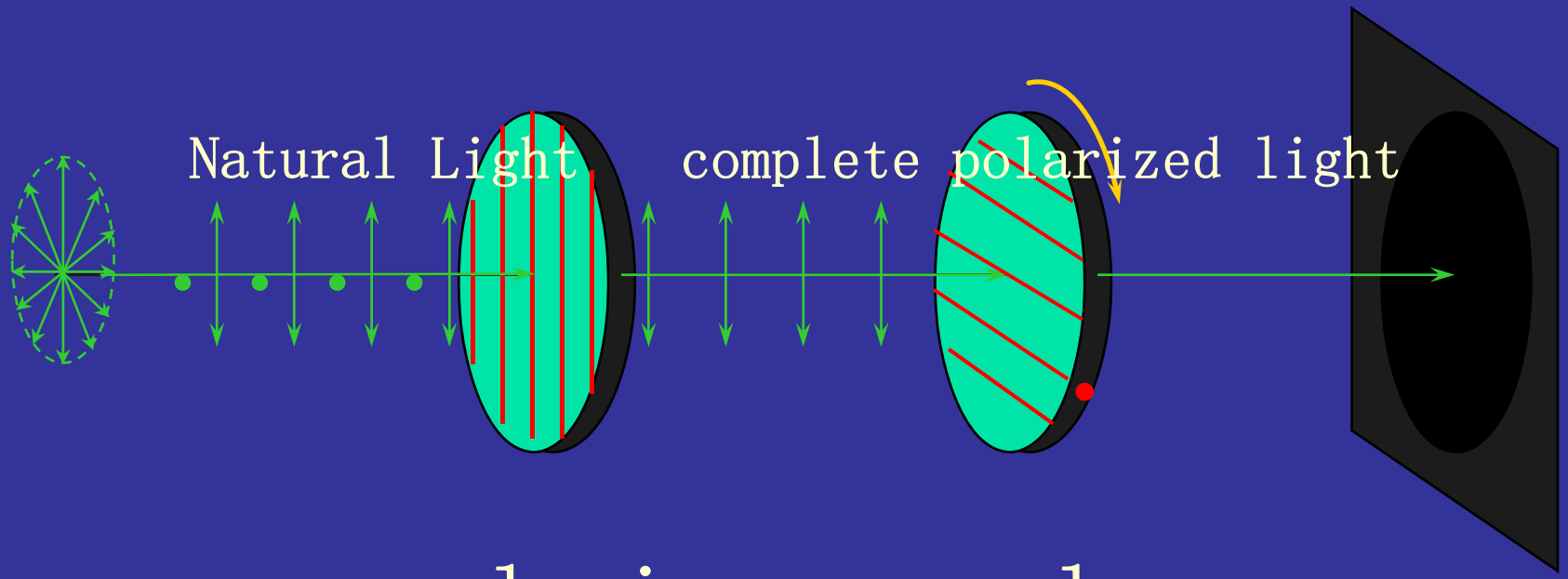

Natural Light
complete polarized light
polarizer
analyzer


Natural Light
complete polarized li
polarizer
analyzer


Natural Light
complete polarized light
polarizer
analyzer


Natural Light
complete polarized light
polarizer
analyzer

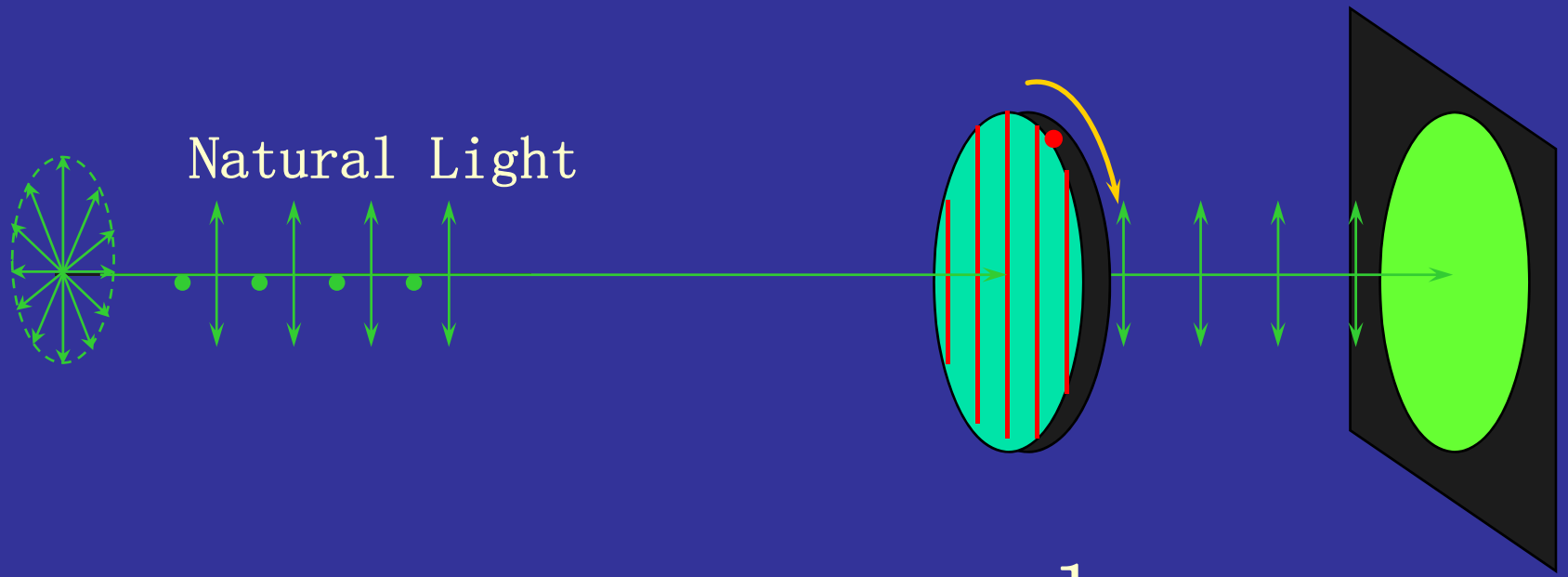

Natural Light
complete polarized light
polarizer
analyzer

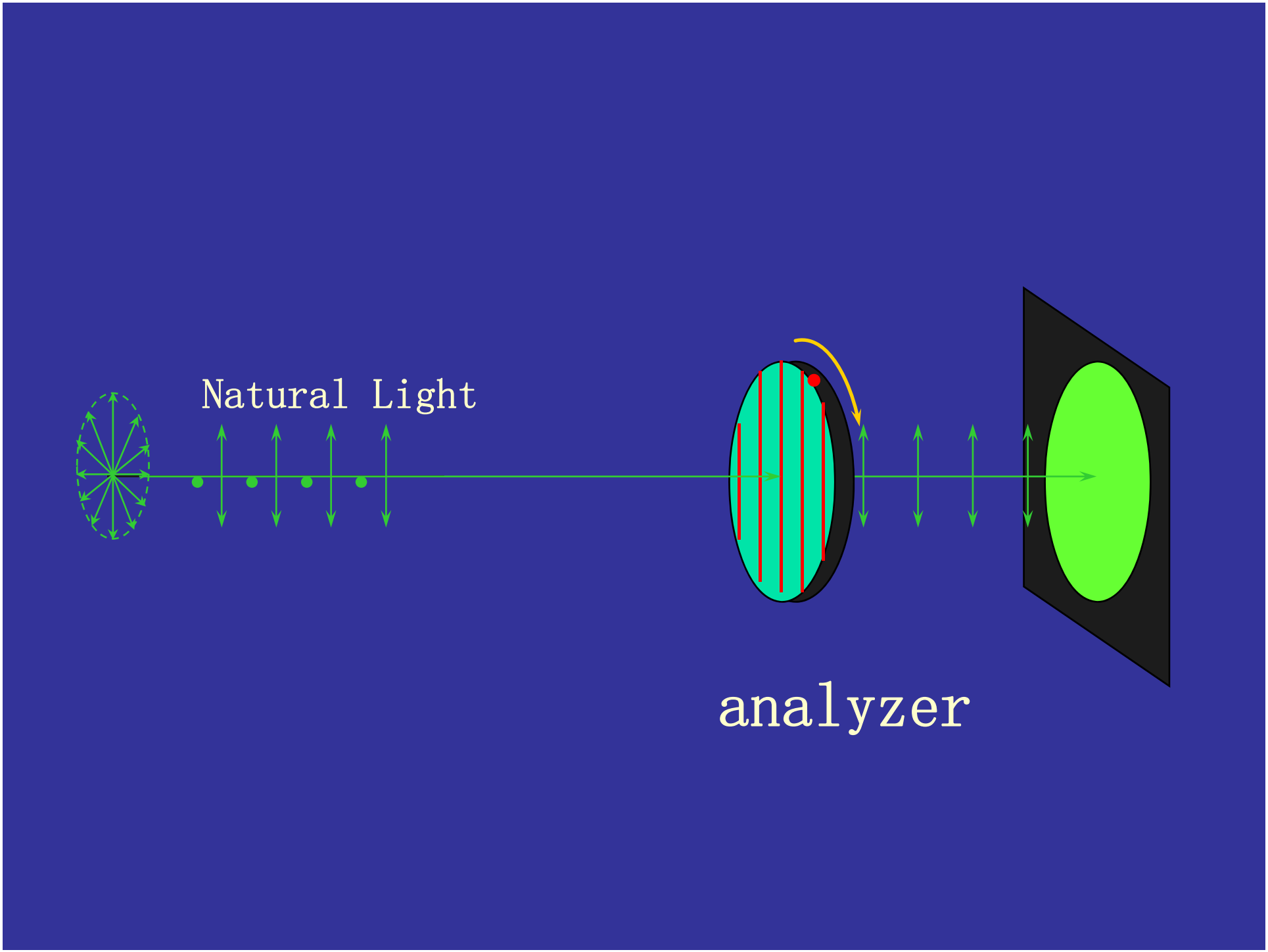


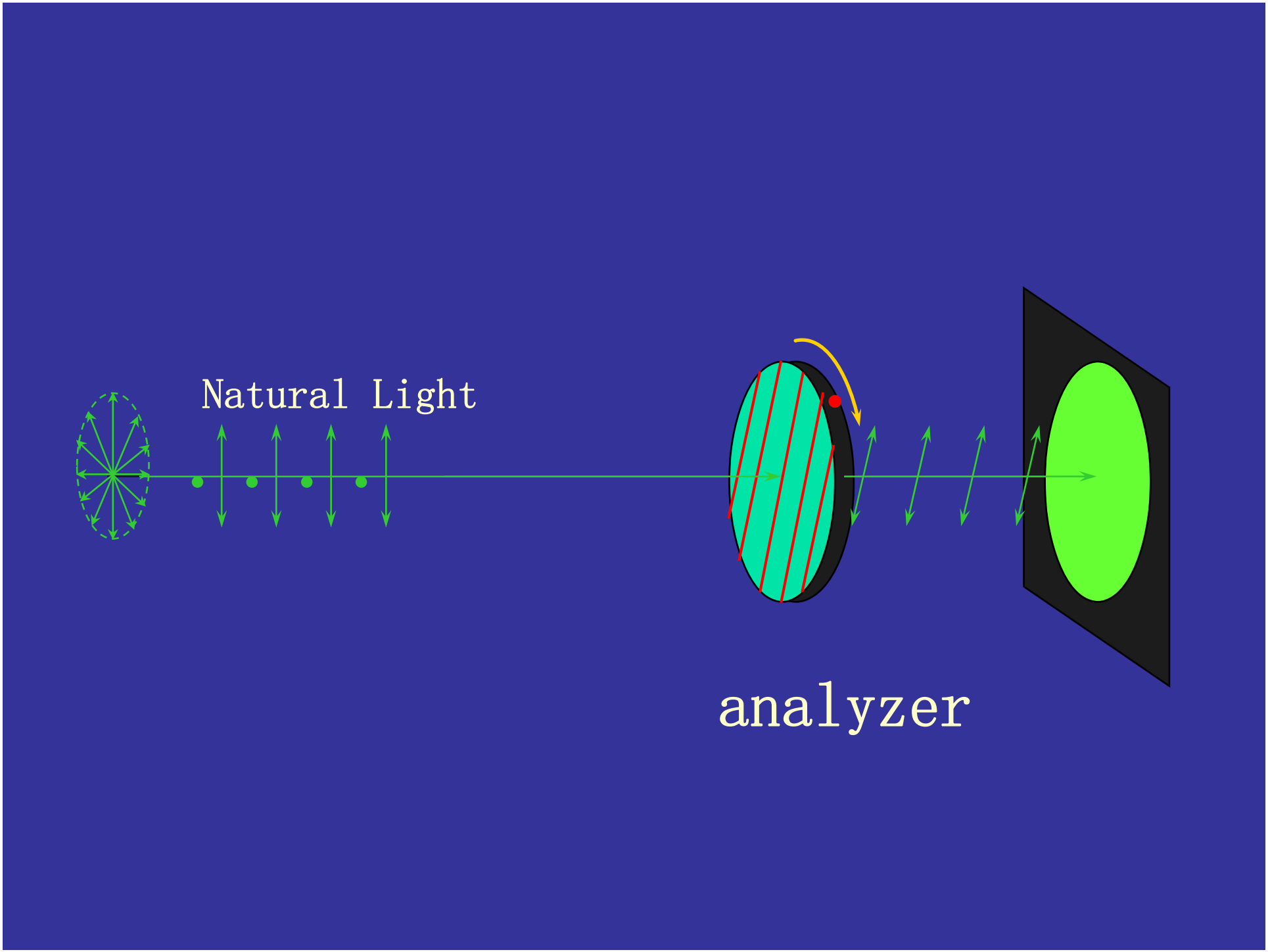
polarizer analyzer

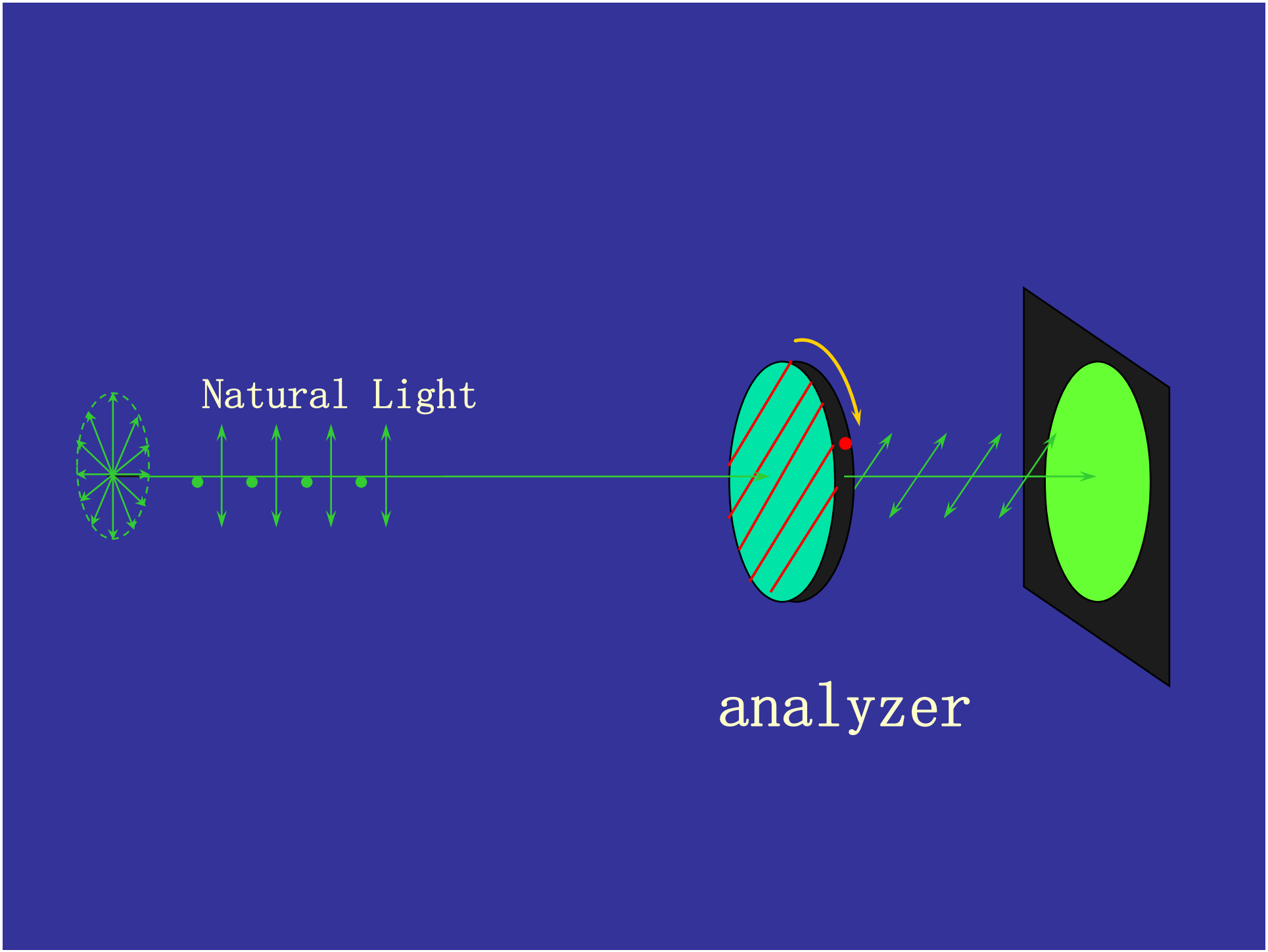
两偏振片的偏振化方向相互垂直 光强为零

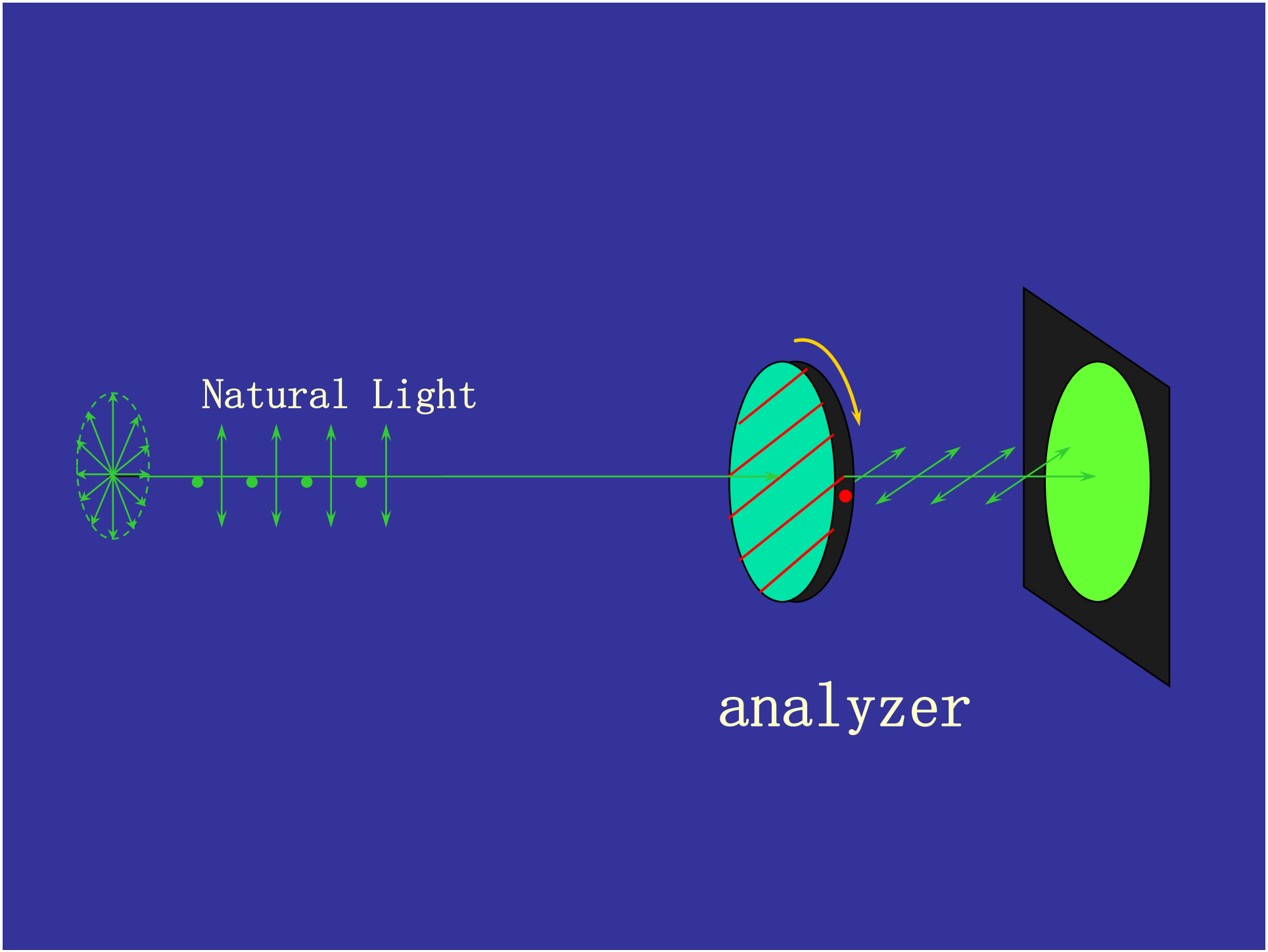
Natural Light通过旋转的**analyzer**，光强不变

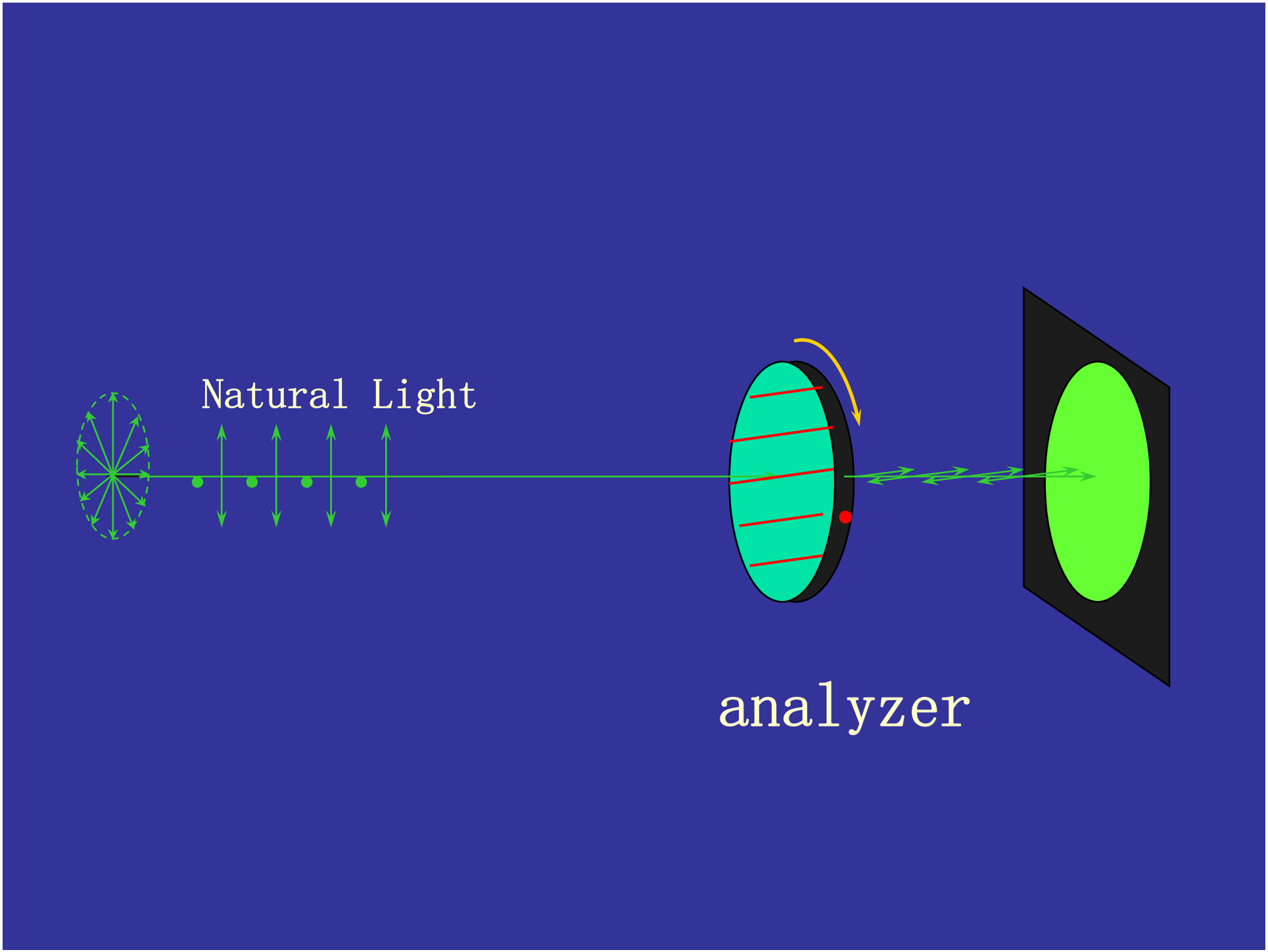


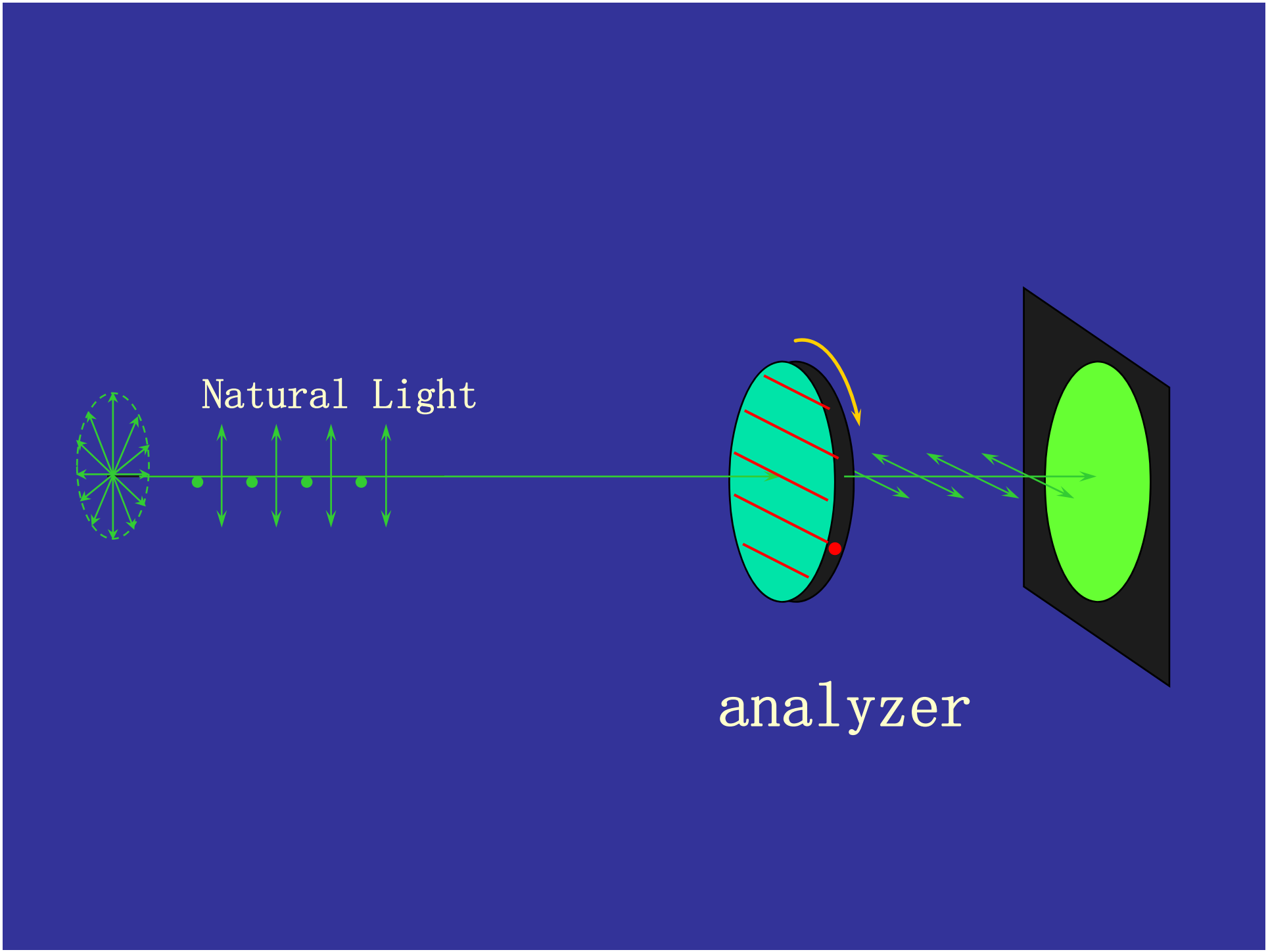

Natural Light
analyzer

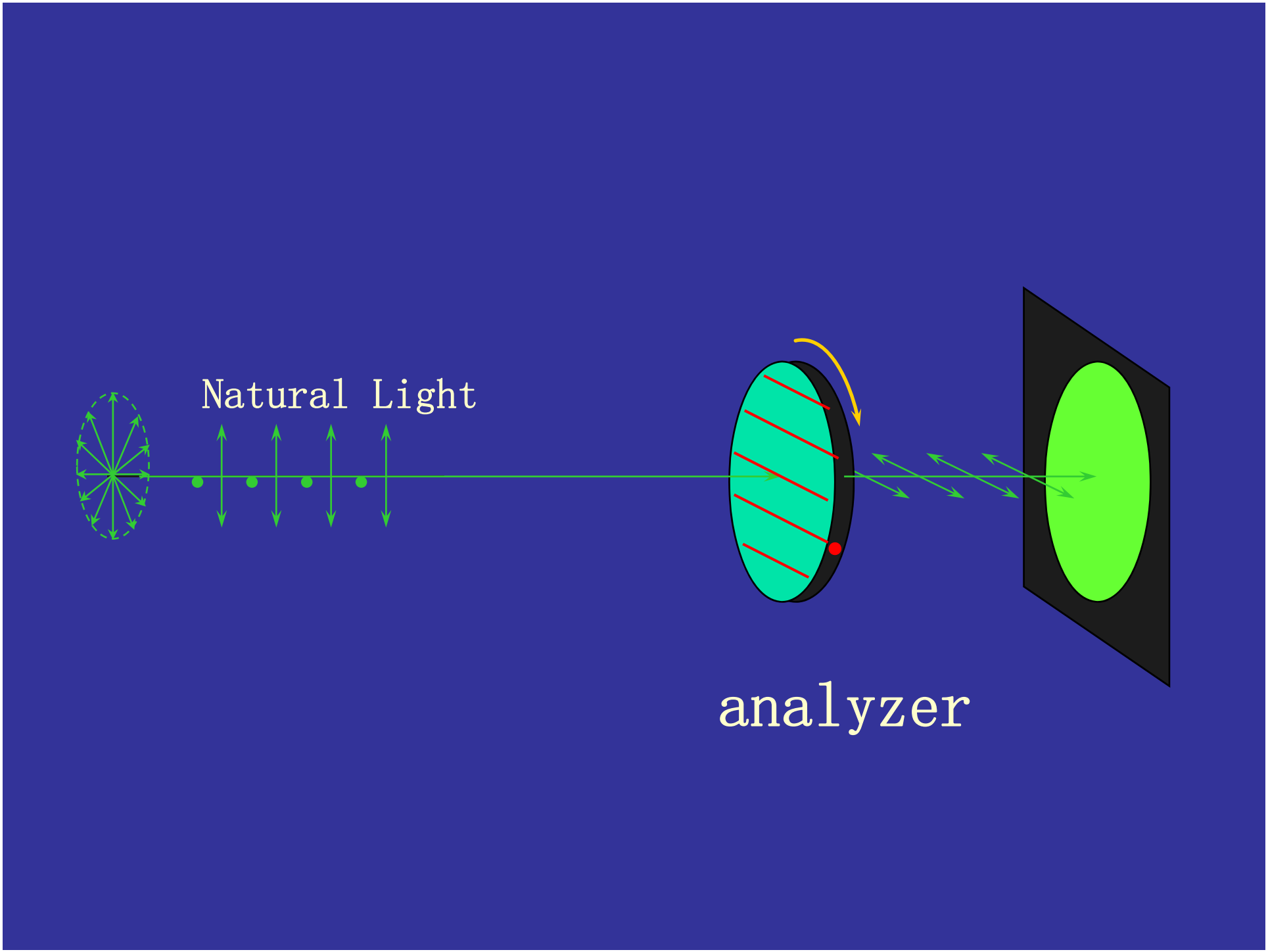

Natural Light
analyzer

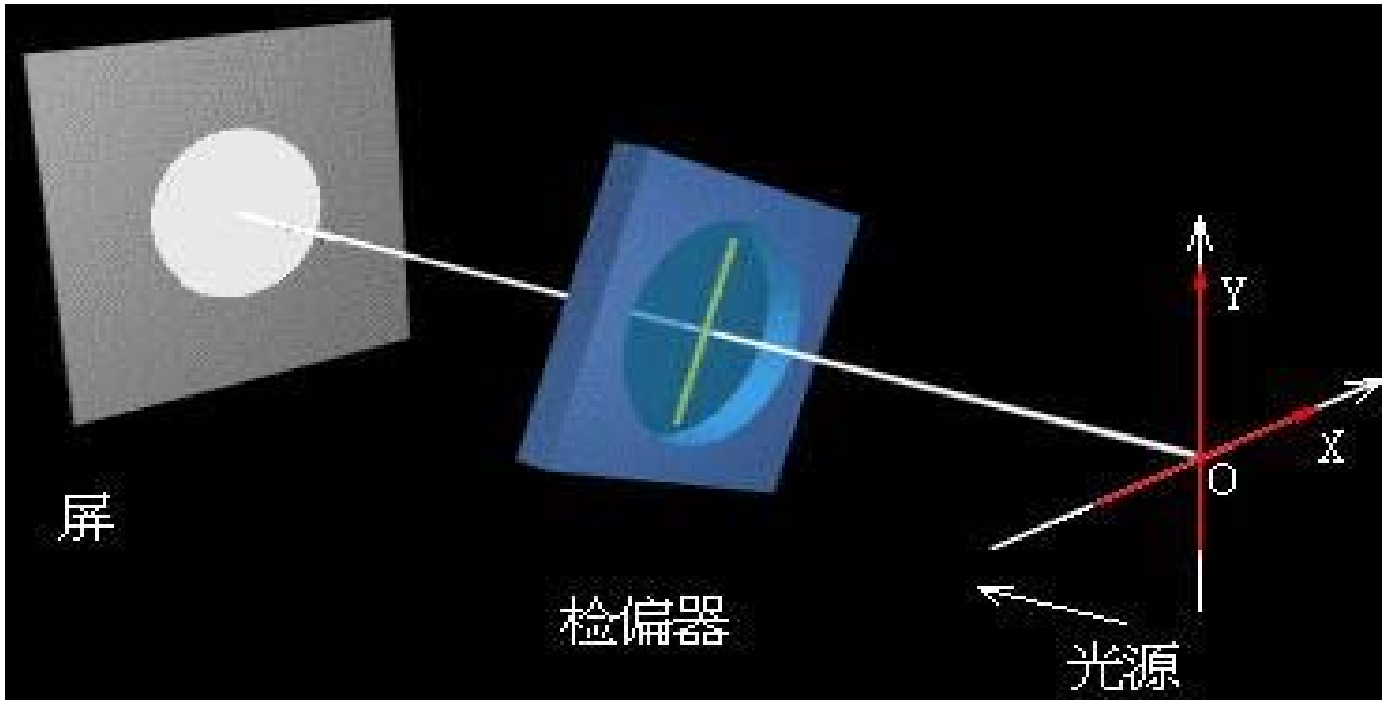

Natural Light
analyzer


Natural Light
analyzer

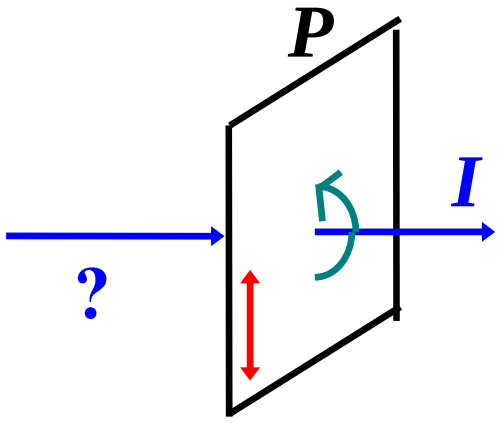

Natural Light
analyzer

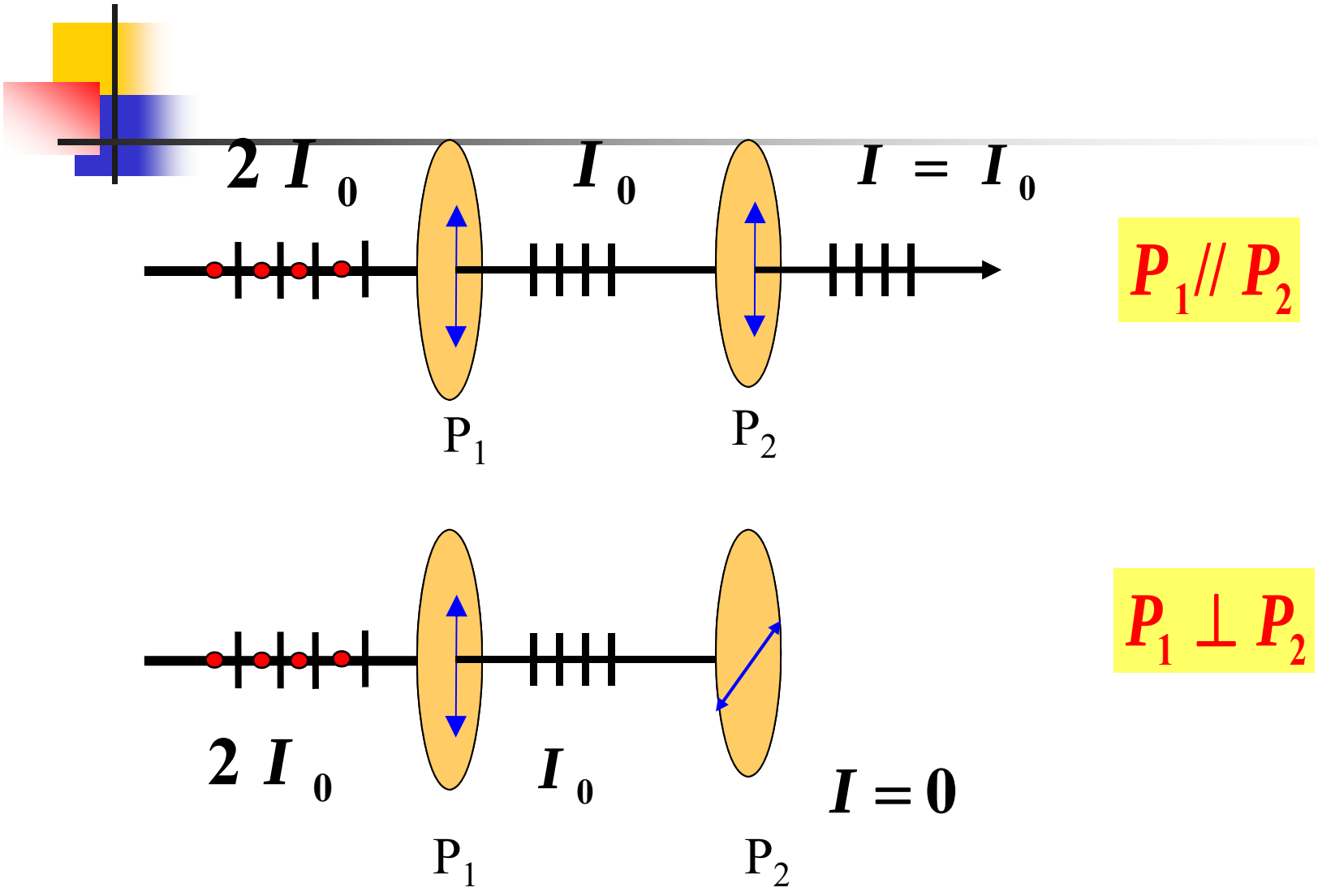

Natural Light
analyzer

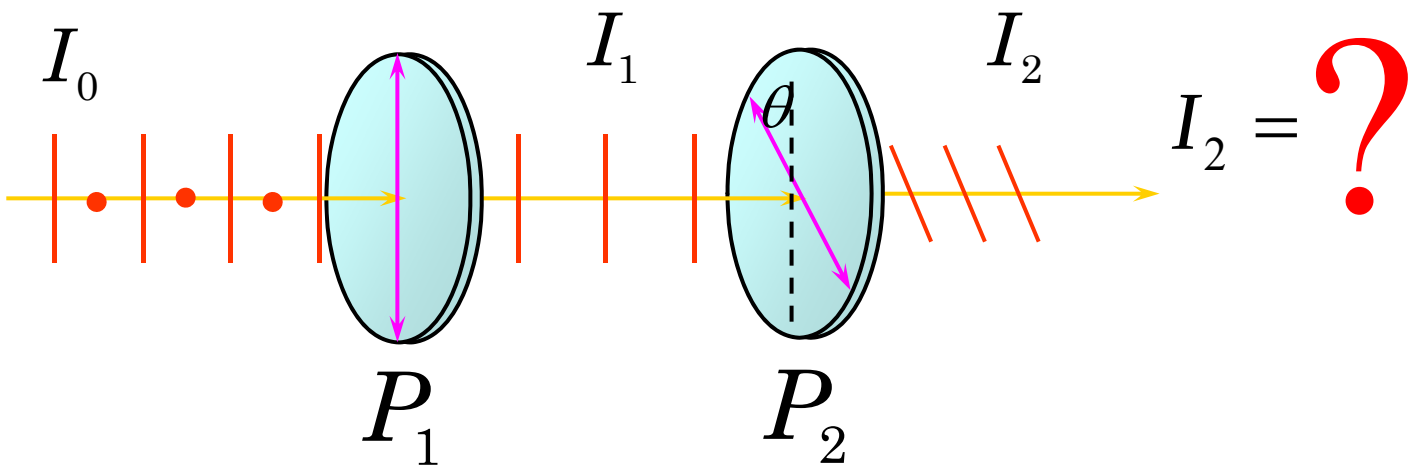

Natural Light
analyzer



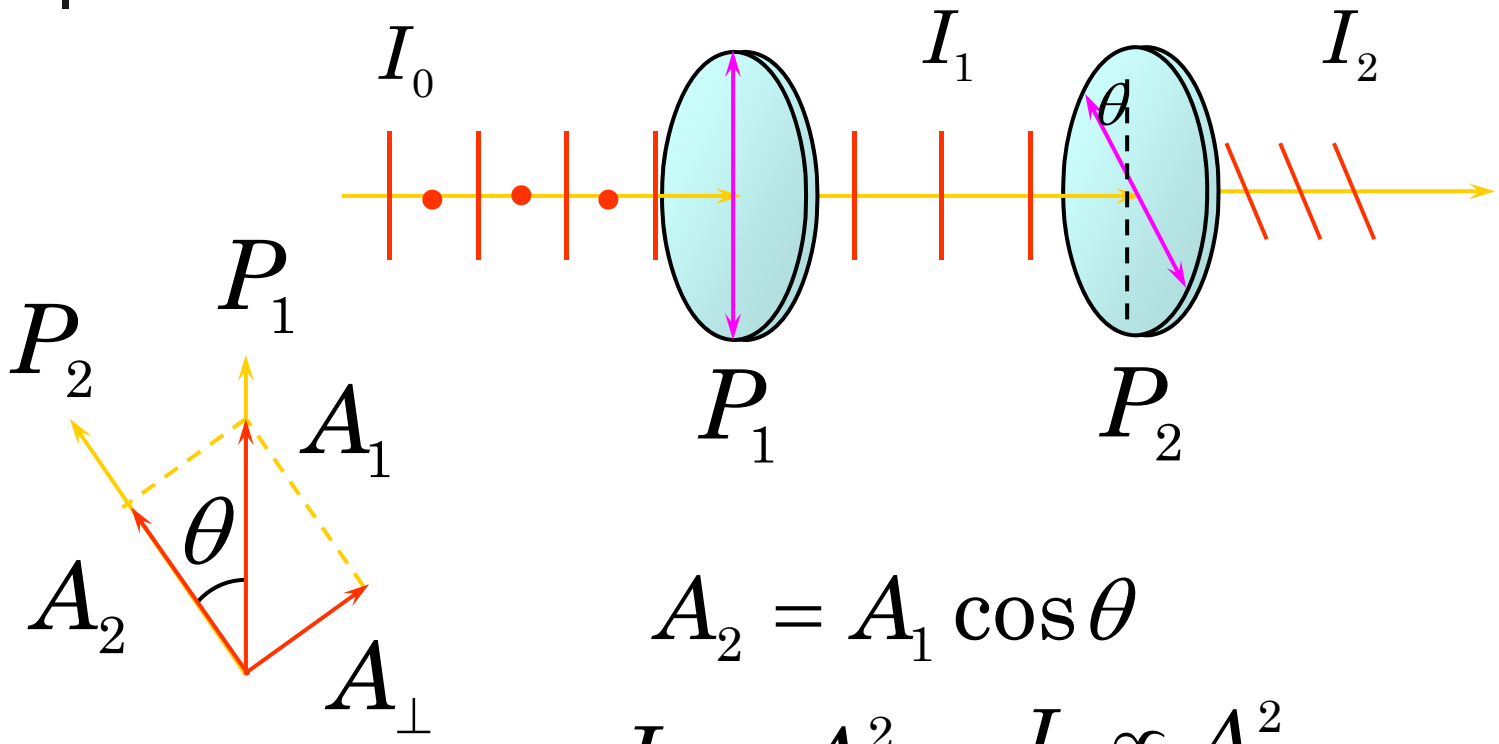
Natural Light
Complete Polarized Light
Partially Polarized Light




2 I 0
I 0
I = I 0
P1
P2
P1// P2
2 I 0
I 0
I = 0
P1
P2
P1 ⊥ P2


I_0
I_1
I_2
θ
$I_2 = ?$
P_1
P_2

4. Malus' s Law

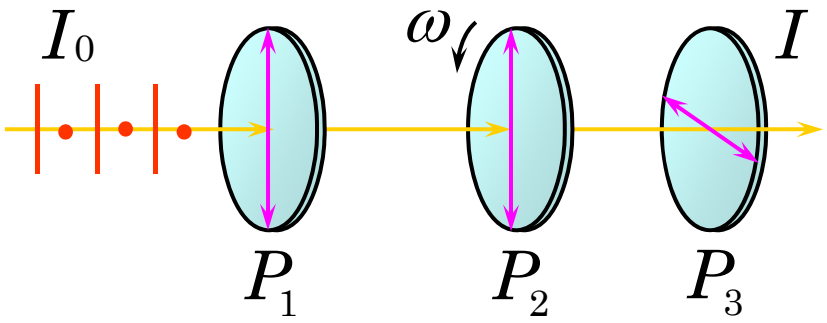


$$A_2 = A_1 \cos\theta$$

$$I_1 \propto A_1^2, \quad I_2 \propto A_2^2$$

$$I_2 = I_1 \cos^2\theta$$

➢Example

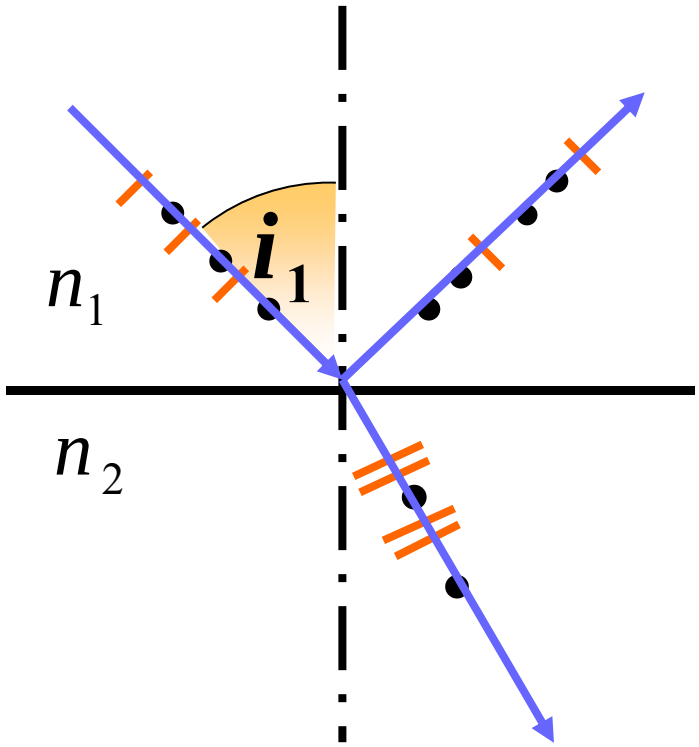


The polarizing directions of polarizer P_1 and P_3 keep vertical. polarizer P_2 does uniform circular motion with angular speed ω . The incident light is natural light.

Prove

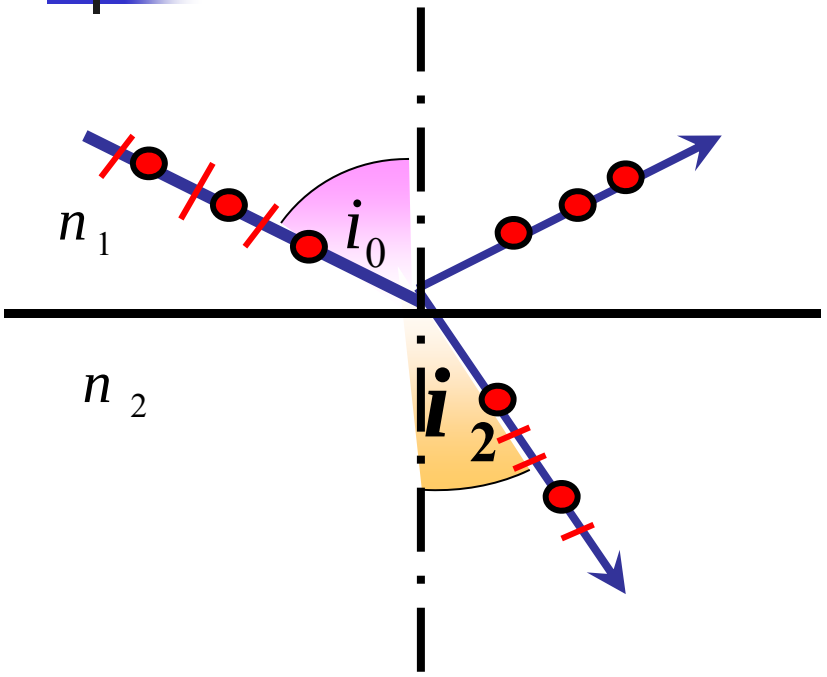
$$I = I_0(1-\cos 4\omega t)/16$$

5. Brewster ' s Law



- when the natural light is reflected or refracted, the reflection or refraction light is generally the partially polarized light, in addition, the main vibration direction of the reflection light is perpendicular to the reflection face as shown in figure .

➢If the incident angle i_0 satisfies the condition:



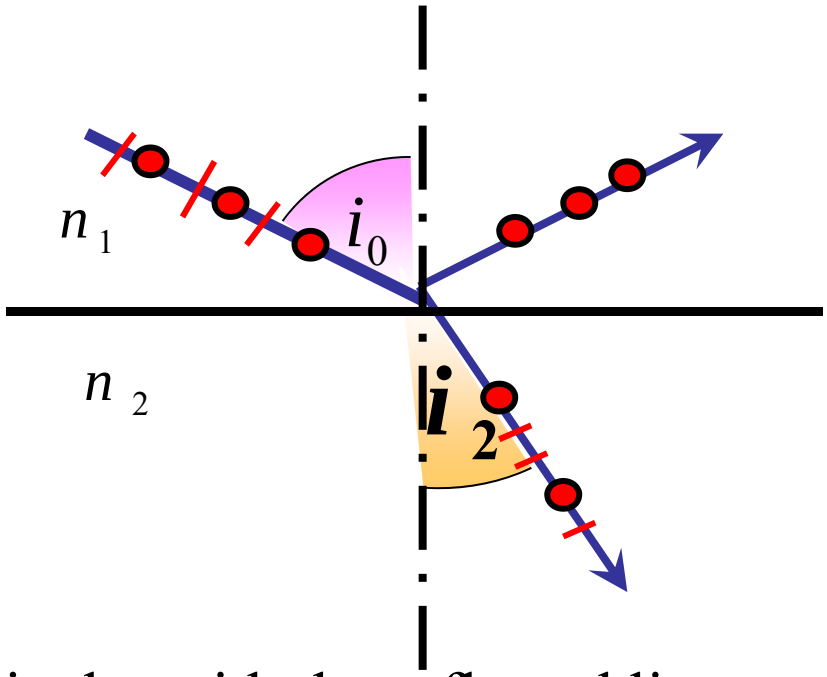
$$\operatorname{tg} i_0 = \frac{n_2}{n_1}$$

➢The reflected light is complete polarized, and its vibration direction is perpendicular to the reflected plane. This conclusion is called the Brewster (D.Brewster, 1781-1868) law, the angle i_0 is called Brewster angle .

$$tg\,i_0 = \frac{n_2}{n_1}$$

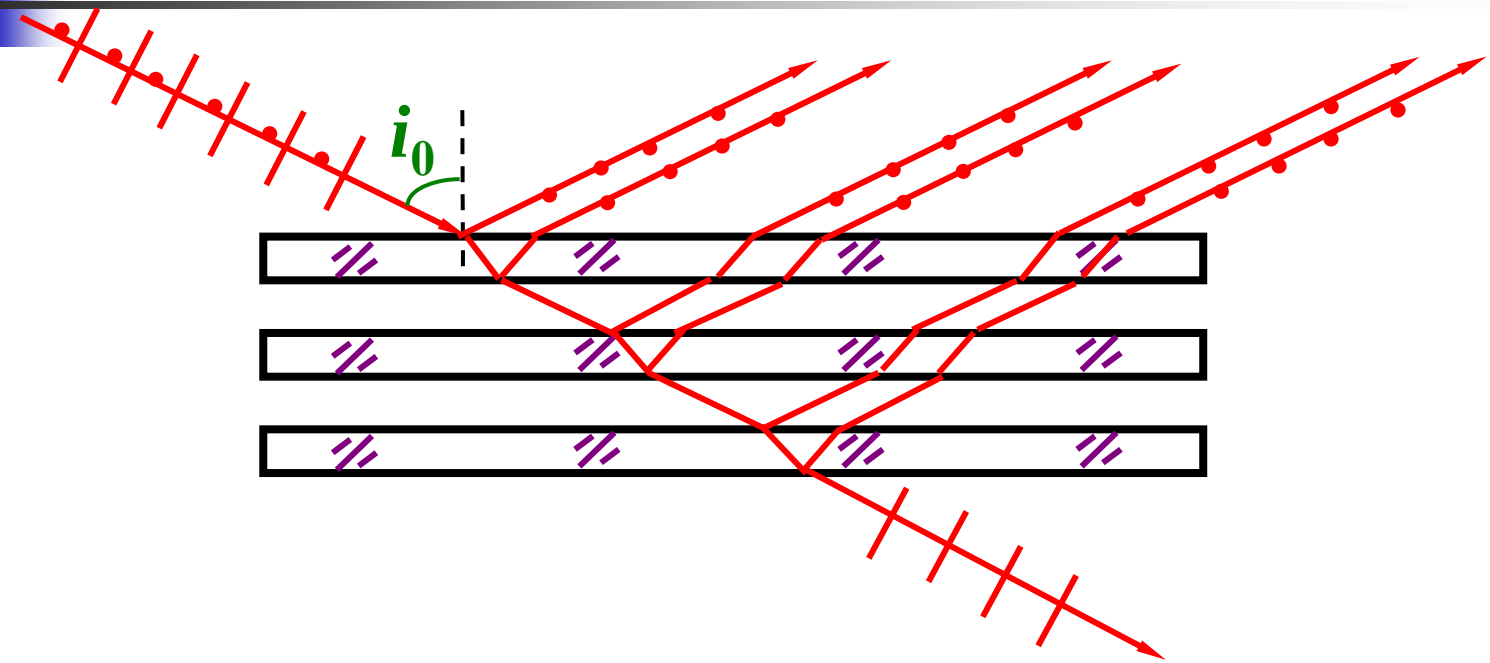
$$n_1 \sin i_0 = n_2 \sin i_2$$

$$i_0 + i_2 = 90^0$$



- The refraction line is perpendicular with the reflected line
- If even the entrance angle equals Brewster angle, the refraction light is partially polarized light, and its main vibration direction is in the refraction plane.

➢a pile of glass plates



➢The intensity of reflection light is only 7.5％ of the intensity of incoming nature light, Thereby, in order to obtain the stronger complete polarized light, apply often a pile of glass plates. So, we obtain a beam of approximate complete polarized light after many reflections.