Top Lateral Refraction and Reflection of Polarized Light in Lenses, Coplanar Lens Systems, and Applications

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***Abstract*-When linearly polarized light impinging on a lens, it will reflect and refract along the lines curves resulting from the interception of a plane (plane of polarization) with a sphere (lens surface) maintaining the orientation of refraction and reflection in the plane of polarization. This effect is significant only looking at the lens laterally. Therefore, a lens acts as a lateral analyzer when we rotate the polarization plane of polarized light incident on the lens. Following this principle that in the spherical surface of a lens fit n circles of radius r, where n is inversely proportional to r, and each circle is a lens itself. Then if we shine a beam of light in one of these areas, the polarization phenomenon is expressed lateral side and diametrically opposite to where the incident linearly polarized light, the lens acting as a waveguide for the light beam polarized.**

Keywords-Polarization; Optic; Lens

I. INTRODUCTION

When a linearly polarized light beam incident on a lens are made to manifest the algebraic properties of geometric shapes, such as the intersection between a plane and a spherical surface, a polarized light beam is composed of electromagnetic waves to oscillate in planes parallel to each other and in the same direction. Taking one of these planes to affect orthogonally on the spherical surface of a convex lens, the light is reflected and refracted without leaving the plane to which it belongs, as shown in Figure 1 that the central portion of the lens for a better understanding. Now if we rotate the polarization plane of polarized light beam, not the lens, then also changes the direction of the rays reflected and refracted as they remain within the plane of polarization of light.

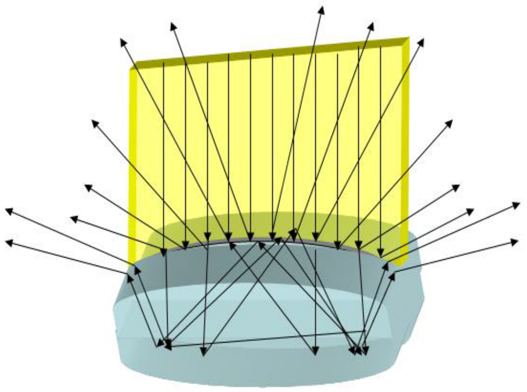


Figure 1 Representation of refraction and reflection to affect polarized light in a convex lens

A linearly polarized beam incident on a lens will reflect and refract following the interception between a plane (plane of polarization) and a sphere (lens surface), maintaining the orientation of the beams refracted and reflected within the plane of polarization that originated them, forming two pairs of fans on opposite edges to the diameter on both sides of the lens. The higher intensity of the resulting beams will take place at opposite ends to the diameter of the lens, so that this phenomenon is noticeable only by observing the lens laterally, i.e., placing parallel to the optical axis.

II. EXPERIMENT

If we put two observers, one on the right and one on the left as seen in Figure 1, the observer sees the right side of the image of the light source, because the rays that reach it are refracted and reflected within of the lens from the side opposite the light source, while the left observer sees the right side of the image of the light source.

Turning to the position as seen in Figure 1, both are observed to reduce the light intensity of the image completely when the plane of polarization is orthogonal to the plane of the paper, or it is parallel to the two observers.

Therefore, a lens can be used as an analyzer of polarized light, which gives information about the orientation of the plane of polarization, shows this effect, as shown in Figure 2.

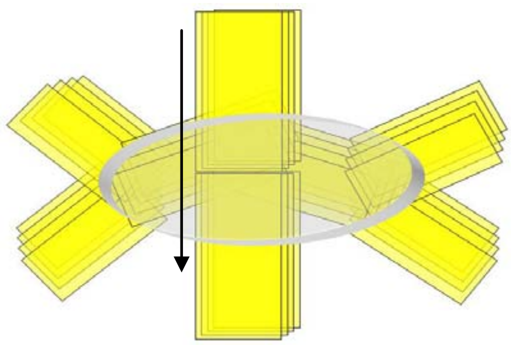


Figure 2 The reflection and refraction at a convex lens representation

Figure 2 represents the entire lens and the beam of polarized light. With this figure can be seen together as discussed earlier and conclude that the greatest refraction and reflection takes place in that zone in which the geometric central plane of the beam impinges on the diametric line of the circumference defined by the beam on the surface of the lens.

Figure 3 is a sequence of rotation of plane polarized light beam. In the center of the lens side, a light spot is observed that its light intensity varies depending on the spatial position of the plane of polarization relative to the position of the observer, which in this case is that of the reader. Hence, an observer who turns laterally around the lens with the same speed the plane of polarization will always see the same intensity.

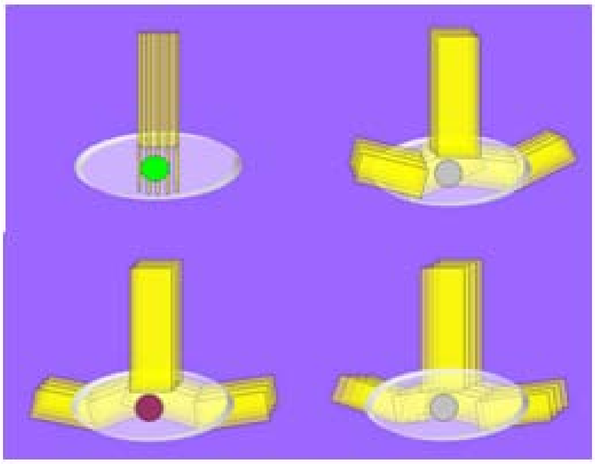
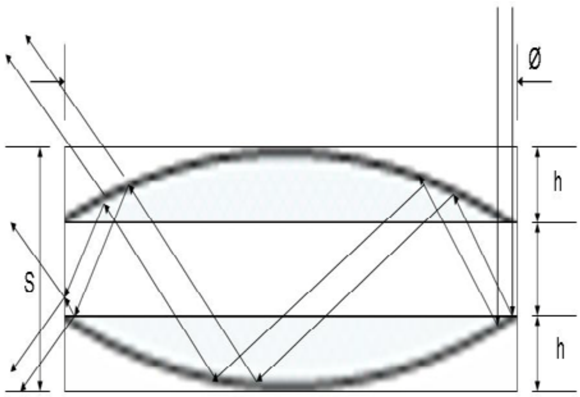


Figure 3 Polarize plane rotation sequence

The lens being a spherical surface, over it can be placed perfectly **n** circles of radius **r**, the number **n** is inversely proportional to the radius **r**. Each circle can be seen as a lens.

Taking this into account, if the linearly polarized light incident is on the lens edge, it will pass all that is explained above, but in the region of incidence, the light will exit the edge of the lens diametrically opposed to the incident beam and it just shows the image at that point and not in any other region of the lens.

Figure 4 shows what has been explained here, including an equation to determine the number of reflections that occur within the geometry of the lens and selecting the appropriate lens.



$$Reflections = \frac{\phi(1/S + 1/2h_{arc})}{2}$$

Figure 4 Reflections on the lens to make an impact on its edge beam perimeter

If we shine the beam of polarized light in the lens edge, rotate the plane of polarization of light along the diametrical opposite of the lens coinciding with the orientation of the polarization plane, it will have a very bright image of the light source. To rotate the plane, that intensity will decrease.

Figure 5 shows a sequence in which we can see how to change the outgoing light when the polarizing plane is rotated.

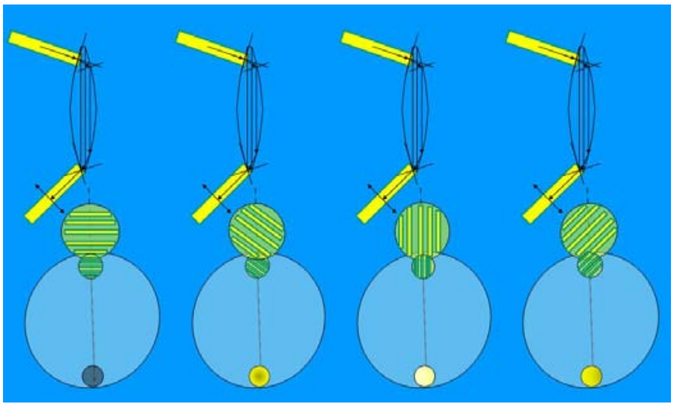


Figure 5 Sequences that shows how changes the out coming light lens in a lens side view

III. COPLANAR LENS SYSTEMS

Taking two identical lenses and placing them in the same plane so that the intercept between the line extending perpendicular where they join the edges of the lens, with another line tangent to the upper edges of the two lenses and orthogonal to the first, is the center of the light beam we ensure that the two points diametrically opposite light emerging in each of the lenses 90^0 are out of phase to each other. Figure 6 is the geometric representation of what we are saying.

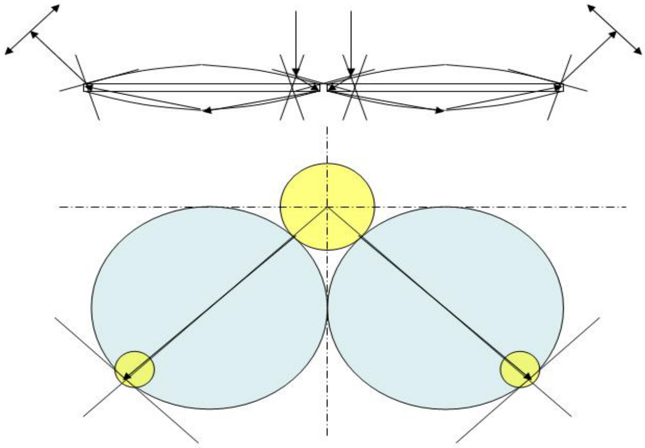


Figure 6 Parallel lens system

By rotating the light beam linearly polarized in the diametrical path of the lens coincides with the orientation of the polarization plane have a bright image of light source in the side position, while the position diametrically opposite the other lens not light. If we rotate the plane of polarization in the direction of the lens with a lower intensity of light, this will grow in intensity and the other will decrease. There will be a difference between the points 90^0.

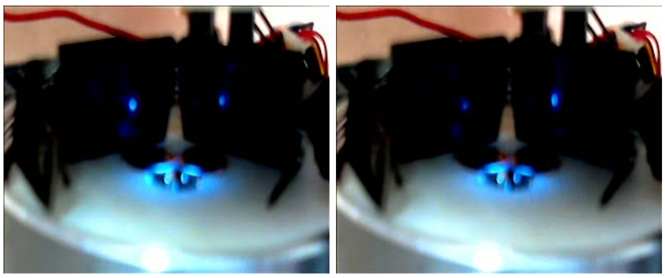


Figure 7 Vista fixed to an experiment made media

Figure 7 is the capture of two still pictures taken from a media that was conducted in the laboratory. At the bottom is a hole through which passes the polarized light beam, downwards for the back and sides of the orifice are positioned two lenses, and the bottom two black screens on which projects the light emerging from the lens which are the white-bluish halos. On the left of the spot of light of greater intensity on the screen is dark in the left and the right is in the right display as a consequence of the rotation of the polarization plane.

IV. APPLICATIONS

The optical system and the phenomenon that it is used can be used in various applications.

1) It can be used in data transmission using polarized light in which the variation of the polarization plane position can represent ones and zeros by the use of polarizer electric effect, which would be very advantageous because it would avoid the loss of information because it does not matter that the levels of light intensity does not remain constant because we are only interested in the angles of the plane of polarization that is who would take the information corresponding to one and zero.

2) Use in sea and air signaling the effect of polarization.

3) In weighing systems in which rotation of the polarization plane would be proportional to body weight.

4) In polarimetry instruments.

5) In determining if a beam of light is polarized or not (astronomic).

V. CONCLUSIONS

The optical system and the phenomenon which occurs therein can be used as a new polarimetric detection method, in which the accuracy of alignment of the optical system is essential for accuracy of detection .

It's a new polarimetric detection method, based, first, the new principle of refraction and reflection of light polarized lenses and the first use of optical lens systems that significantly improve coplanar the use of the phenomenon analyzed

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NOTE: References have been mentioned rather to indicate the field belonging the subject matter hereof, as the phenomenon is not reflected in the literature.

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Research iterests

Automatic Control Theory

The development of new mathematical equations in order to make process regulator electronic design for automatic control process and new arithmetical method in order to grow up a new automatic control theory. This project has been developed in collaboration with the Mathematical Cathedra of Havana University, UNIVERSITY CITY JOSE A. HECHEVERRIA (CUJAE) and Oil Refinery Ñico López.

Optic polarmetry

The development of new methode in order to make a new equipment for polarymetric measurement.

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