Lens Coplanar System Application based on Lateral Refraction and Reflection of Polarized Light

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Abstract

Demonstration that a polarized light over a lens will be reflected and refracted following the interception of the plane of polarization with the spherical lens surface, maintaining the orientation of refraction-reflection within the plane of polarization and it can be used for measurement of a polarized plane rotation.A polarized light over a lens will be reflected and refracted following the interception of the plane of polarization with the spherical lens surface, maintaining the orientation refractionreflection within the plane of polarization.A linearly polarized light beam over a lens will be reflected and refracted following the lines curves resulting from the interception of a plane of polarization with the sphere lens surface, keeping the orientation of refraction and reflection inside the plane of polarization.

Index terms— polarization, rotation, plane, lens, reflection, reflection, polarized light

1 Lens Coplanar System Application based on Lateral Refraction and Reflection of Polarized Light

Lázaro J., Miranda Díaz

Abstract-Demonstration that a polarized light over a lens will be reflected and refracted following the interception of the plane of polarization with the spherical lens surface, maintaining the orientation of refraction-reflection within the plane of polarization and it can be used for measurement of a polarized plane rotation.

A polarized light over a lens will be reflected and refracted following the interception of the plane of polarization with the spherical lens surface, maintaining the orientation refraction-reflection within the plane of polarization.

A linearly polarized light beam over a lens will be reflected and refracted following the lines curves resulting from the interception of a plane of polarization with the sphere lens surface, keeping the orientation of refraction and reflection inside the plane of polarization. Only looking at the lens laterally this effect is significant, and a lens behavor is like lateral analyzers if the polarization plane of the polarized light incident over the lens is rotated, and two pairs of fans on opposite edges to diameter are forming, get out to both sides of the lens. The resulting beams will take place at opposite ends to the diameter of the lens and it has the higher intensity, so that this phenomenon is noticeable only by observing the lens laterally and placing parallel to the optical axis Based in the principle that in the spherical surface of a lens fit n circles of radius r, and n is inversely proportional to r, then each circle is a lens itself. If a beam of light is projected in one of these areas, the phenomenon is expressed lateral side and the light get out diametrically opposite to the incident linearly polarized light get in, the lens acting as a waveguide for the light beam polarized. Demonstration that a polarized light over a lens will be reflected and refracted following the interception of the plane of polarization with the spherical lens surface, maintaining the orientation of refraction and reflection within the plane of polarization and it can be used for measurement of a polarized plane rotation. 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.

2 I.

Background lgebra properties of geometrical shapes are made to manifest when a linearly polarized light beam incident on a lens, such as the intersection between a plane and a spherical surface, a polarized light beam is electromagnetic waves and oscillate in planes parallel to each other in the same direction. When this planes affect orthogonally on the spherical surface of a convex lens, the light is reflected and refracted without leaving the plane which belongs at, in Figure 1 shown only the central portion of the lens for a better understanding. By rotated the polarization plane of polarized light beam, changes the direction of the rays reflected and refracted because they most remain within the plane of light polarization. Now, we will put the lens over horizontal surface and a beam of polarized light incident in its geometrical centre, with the polarized plane oriented vertically to us, we can see a brightness circle inside the lens (Fig. 1a), and what is that circle? It is light; light get out laterally from the lens. And why it is so brightness, because we are front of the polarized plane of the beam. With the polarized plane oriented parallel to us, the circle disappears, why, because there are two beam of light get out of the lens 90 0 from us to booths lens sides and parallel to our position, then we can not see the light. Let's consider that these two positions are extremes positions and between those positions, the circle change in intensity, decreasing while the polarized plane of beam is rotated up to be parallel to us.

3 Figure 1a: Inside the lens we can see a brightness circle

This is in fact our phenomena, and it that can be used in many applications, principally in determined the polarized light positions. Using photo sensors placed to 90 0 from each other, for example, when its value been the same, the polarized light will be at 45 0 between the extremes positions.

4 a) Concept

Return to the photo sensors, which are showing in Fig. 1a, the difference between the light intensity of each one, will be equivalent to the position of the beam polarized plane Ahead will see another concept, coplanar lenses and these equations will be not the same in that case, this is when only one lens has been used.

There is a way in which no matter if the light intensity has variation or not. These are an optical trigonometric system and follow trigonometric rules. The angle ? can go between 0 0 and 90 0 how we can see in Fig. 1b, if we divided 90 0 between 3.1416, the value result is 28.64 when ?a is CERO, them Ia is equal to 3.1416, but Io in this conditions will be equal to Ia divided between Sin (90 0 /180 0) is equal to 2(3.1416), which value is 6.28. Now can make the substitution of Io by 6.28 in the equations 1 and 2 and no matter if Io has variation or not, the result will be constant, because of the values ?a and ?b have variations, how they are subtracted, the variation will be annulated. In this way the effect of the absorption can be controlled.

Lets go used the EXCEL software, but first we will see the equations that we will use in it: When the perturbation Q is lowest than CERO, the line ?1 is over the line ?, that is not have perturbation. This is due to negative values are equivalent to increase the light intensity.

When the perturbation Q is upper than CERO, is equivalent to an absorption of light and pendent of ?1 decrease respect pendent of ?.

With these properties is possible avoid that perturbations could affect the measurements, only using an additional source or light (Q<0) nearest the lens, or the lenses in the case of coplanar lenses. The lector one can probe all this himself if build the excel table (Fig. 1.1) and change the values in columns A, B y C; but the values ? and ?1 remain approaches to each other.

If we desire construct an instrument to determine the value of the rotation of the plane of polarization of light using this phenomenon, it is necessary use two light sensors placed parallel to the optical axis and 90 0 spaced from each other and on the sides of the lens This has been possible because of the physical properties when linearly polarized light impinging on a lens, the light beam is reflected and refracted following the lines curves resulting from the interception of a plane of polarization with a lens spherical surface maintaining the orientation of refraction and reflection inner the plane of polarization. This is the physical concept obtained with our research and it permitted us understand better the phenomena and the procedure to follow in order give it a correct application.

The extension in the application of the phenomena gives us the possibility to find out the concept of coplanar lenses that do better than the precision of the measurements, with out loss the simplicity of the optical system used, and understood the difference between use one or two lenses and when we must use one lens or use two lenses.

If we used only one lens, when the polarized plane is rotated, there is a space between the photo sensors where the light not insides over the photo sensors areas, whereas in the system with two lenses always the light is over the photo sensors surfaces.

In conclusion we have given hear important concepts that abstract the more important things that most be remembered for a better understanding of the following matter.

5 II.

Researching I in Figure 1 let go place two observers, one on the right and another one on the left of the diametric line of the lens, the observer at the right sees the left side of the light source image, the rays that reach him are the result of the refraction and reflection within of the lens from the left side of the light source. The left observer sees from his position the right side of the light source image.

When the plane of polarization is orthogonal to the plane of the paper, that means it is parallel to the two observers, both observers observed that the light intensity of the image decry completely.

In that way the lens gives information about the orientation of the plane of polarization and the lens behaviour is like an analyzer of polarized light, which, shows this effect in Figure 2. A sequence of rotation of plane polarized light beam is showing in Figure **??** A light spot is observed in the centre of the lens, and the light intensity varies according on the plane of polarization spatial position, in relation to the observer position. An observer, who turns around the lens at the same speed that the plane of polarization is rotated, always will see the same intensity. Over the lens spherical surface can be placed perfectly n circles of radius r, the number n is inversely proportional to the radius r, whereas, while the radius will be shortest, the numbers of insert lens will be biggest. Each circle is an independent lens.

When the linearly polarized light incident chining on the lens edge, will occurred all explained before, but in the incidence region. The light travel along the lens diametric line and will exit the edge of the lens diametrically opposed to the incident beam and only at that point the image can be seen and not in any other region of the lens.

What has been explained here can be seen in Figure 4, where is including an equation in order to determine the number of reflections and selecting the appropriate lens according the lens geometry. Where: ?: light incident angle h: arc lens wide S: lens wide Let's do the beam of polarized light shinning in the lens edge, and after that the plane of polarization is rotated, when the lens diametrical line coinciding with the orientation of the polarization plane, the image of the light source, in the lens diametric opposite side, will be very bright. That bright will decrease when the polarization plane will be moved from that point.

We can be seen how change the outgoing light when the polarizing plane is rotated in the sequence shower in Figure 5.

6 III. Coplanar Lens Systems

Placing two identical lenses in a same plane, where they join the edges lets traced between touching edges an extending line, so the intercept between this line, with another line tangent to the upper edges of the two lenses and perpendicular to the first line, will have the centre of the polarized light beam, and the light emerging in each of the lenses will be 90 o to each other in two points diametrically opposite in each lens. The geometric representation of this phenomenon is represented in Figure 6. If the light beam linearly polarized is rotated, when the diametrical path of one of the lens coincides with the polarization plane orientation, an image so bright of light source will be obtained in the opposite diametric position in that lens, while there be not light in the diametrically opposite position in the other lens. Rotating the plane of polarization in towards the lens with a less than intensity of light, the intensity of light in this point will grow in intensity, whereas in the other lend will decrease. The difference between the booths points is 90 o . The scream shoot of two still pictures taken from a media conducted in the laboratory is showing in Figure 7. In the lower part (the floor) there is a hole through which passes the polarized light beam, two lenses are positioned downwards for the back and sides of this orifice, and the bottom are projects the light emerging from the lens which are the white-bluish halos over two black screens. In the left picture the projected halo over the left black screen is brightness than the halo over the right black screen. In the left picture the spot of light of greater intensity is over the right black screen as a consequence of the polarization plane rotation.

IV.

7 Applications

There are various applications in which this phenomenon can be used. 1. Data transmission using polarized light in which, for example 0 0 represent zeros and 90 0 represent ones in function of the variation of the polarization plane position and can be detected using a polarizer electric effect, This have the advantage in avoid the loss of information because we are only interested in the angles of the plane of polarization and it does not matter the levels of light intensity does not remain constant, and only take the information corresponding to ones and zeros and them depends of the light plane polarized position, not of the intensity. 2. Sea and air signalling guidance. 3. 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).

8 a) One application

Stimulating a light emitter diode (LED) or a semiconductor laser with electric pulses and make passing the pulsing beam of polarize light obtained thru an optical system and the end of this system place two photodiodes spatially arranged at 90 0 to each other and their detection surfaces parallel to the transmission axis of polarized light, and its polarization plane axis oriented at 45 0 of the vertices of the edges where the photodiodes join, at output of two operational amplifiers, there will be two pulse train signals one in each one with the same shape in time, but when the polarization plane will be rotated, the radiance of the light projected onto the photodiodes change, and signals being out of phase to the outputs of the amplifiers, the difference between the fronts of the pulses in booths signals is proportional to the rotation of the plane of polarization light angle.

With a phase discriminator digital circuit, is obtained a pulse equal to the difference in time between two sides of the rise time in the output of booths amplifiers.

The value of rotation of the plane of polarization of light is directly proportional to the width of this deference, that is, the greater the rotation, the greater the pulse width.

The composition that will be used is: 1) A very simple optic system.

2) Luminous source to light emitting diode (LED).

3) Two Optic-Electronic Amplifiers sensor associated to front wave differentiating digital circuits. This system will can be possible determined the polarized light plane rotation in form very comfortable and precise, without the necessity to use analyzers, rotational modulators, neither magnetic coil that are those more commonly employees for the polarized light plane measure. Give there that the outlined method has the advantage the mobile mechanical parts total lack and not having to use big currents densities in induction coils, its precision depending of the pulses modulation electric sign stability and the optic system alignment precision, including the photodiodes spaced to 90 0 degrees among them incidence faces.

If linearly polarized light affect in a lens, the polarized light will be reflected and refracted along the curves lines between the interceptions of a plane with a sphere, i.e. the polarized light plane on the surface of the lens, and following the orientation of the of polarization plane. Only looking at the lens side this effect is significant. Then the lens behavior is like a side analyzer when the polarization plane of polarized light that falls on it is rotated. If we desire construct an instrument to determine the value of the rotation of the plane of polarization of light using this phenomenon, it is necessary use two light sensors placed parallel to the optical axis and 90 0 spaced from each other and on the sides of the lens. In Figure **??**, the green color circles are the photodiodes and when the plane of polarization of light rotated, the light over photodiodes detection surface change. But this has two disadvantages, one is the light intensity is low and the other is the absorption effect of distorting information because there is a lighted space between the sensors would not touch the surface of both. The Eq. (**??**) is the same to Eq. (**??**) when used only one lens is; the difference is between Eq. (1) and Eq. (**??**) and between Eq. (2) and Eq. (**??**). . The problems of low light intensity and the absorption effect of distorting information because there is a lighted space between the sensors would not touch the surface of both, was fixed with a geometric study of the lenses where were find out the solution. Over the lens spherical surface can be placed perfectly n circles of radius r, the number n is inversely proportional to the radius r, whereas, while the radius will be shortest, the numbers of insert lens will be biggest. Each circle is an independent lens.

9 System with only two lens

When the linearly polarized light incident chining on the lens edge, will occurred all explained before, but in the incidence region. The light travel along the lens diametric line and will exit the edge of the lens diametrically opposed to the incident beam and only at that point the image can be seen and not in any other region of the lens. In this way we will not have a coneshaped beam on the side of the lens, but a point where we will get the whole picture and therefore with greater intensity.

In Figure 5 the sequence is showing, where the intensity of out coming light is a function of position of the polarize plane incident over the border lens surface.

But we still have a problem and we have to use two sensors to polarized light to come on as a light source. When the polarized plane is rotated, there is a space between the photo sensors where the light not insides over the photo sensors areas. The solution to this problem is to use a system of two identical lenses placed in the same plane and positioned so that they cross a line where you play two of its edges with another drawn from the edges that touch the two lenses and orthogonal to the first, is the center of the beam. This ensures that the two points of light coming out diametrically opposed in each of the lenses are at 90 0 from each other. Figure 6 is the geometric representation By rotating the linearly polarized light beam, the lens diameter path coincides with the orientation of the polarization plane will have a very bright image of the light source, while the diametrically opposite position of the other lens will have not light. If we continue to rotate the plane of polarization in the direction of the lens with less intensity than light, it will grow in intensity and decreasing the other, when both intensities are equal will be in the place where the instrument has its zero. There will be a gap of 90 0 between the points. Year 2019J Gl b) c)

electric current is generated in them will be directly proportional to the amount of light reaching them, there is a gap between rising fronts amplified signal pulses obtained in photodiodes if they do not receive the same amount of light and that is the value of rotation of the polarization plane. In this case is necessary the use of two coil (3 and 5) in order compensated and modulate with a ramp electric signal the laser beam and detect the moment in which the compensation occur, and that time interval is the value of the polarized plane rotation, in our case only need a little electronic amplifier, without compensation coil nether modulation coil, ramp electric signal or scale extension mechanics because only can measurement little amount of rotation angles with this equipment.

The coils 3 and 5 are so big and its electric energy consumption is so big too and introduces errors in the measurement value.

Our method no has these problems and beside is simpler than this. See the Fig. 13 and made The fundamental advantage with other methods is that the method that we are defendant hear is optic fully and uses the lens like ayes, no need process extra in order obtain the desire objective, this property reduce the errors in the measurement values, is more precision and simple than any other. It works like Laurent polarimetry [5] Malus's Low Behavior. [1,2] If between a pulsating light source and a radiometer we place two polarizing sheets, with their polarization axes at 90 0 , the radiometer will measure zero or minimal candle power, then as broken the polarizing sheet, will go increasing the light intensity reading in the measuring instrument, until a maximum that will correspond when we have rotated it 90 0 (Malus's low).

If now the polarizing sheet utilized as analyzer is retired and used instead of the radiometer and our amplifier is placed, its exit, view in an oscilloscope, a pulse will appear which width will go increasing until a maximum valor when going rotating the polarizing sheet in the same sense, and starting from there it will begin to diminish until a minimum and a phase shift will take place, increasing the width until a maximum, but now in opposed sense (Figure 10). Comparing both methods has obtained more information with our amplifier than with the radiometer. When in the oscilloscope appear a minimum, the polarized light plane will be exactly at 45 0 or -45 0 regarding the horizontal one give the paper plane and like the line with double arrow represent, that is to say that already know in the fact that the sense the polarization plane is oriented of and to identify this in the polarizing sheet. Now then, if we place an active optic substance in that trajectory, being the plane of polarization placed at 45 0 , superior image gives the drawing in Figure 10, we will have a pulse that will increase its width toward the right if the substance is levorotary, and counterclockwise if it is not levorotary, being its magnitude in agreement with the angular quantity that the substance has rotated the plane of polarization.

If initially the plane of polarization is to -45 0 , inferior image gives the drawing in Figure **??**, a pulse will increase its width counter-clockwise if the substance is levorotary, and toward the right if it is not levorotary. FD1 and FD2 in the Figure 10 When an optical substance is put in inner measurement chamber, the polarized plane will be rotated and in one of the lents the light will be increasing and in the other the light will be decreasing, them the pulse wide in witch lents where the light increased will less than the wide where the light decreased. This deference between booths pulses will be the polarized plane rotation. If the difference is more than CERO, it means that the substance is LEVOGIRA and the wild of the pulse in FD1 will be greater than the wild pulse in FD2. Whereas, is the deference is less than CERO, it means that the substance is DEXTROGIRA and the wild of the pulse in FD1 will be less than the wild pulse in FD2.

With these is demonstrated that the system has optical behavior, no need uses others applications in order obtained the results of measurement of the polarized plane rotation.

10 VI. Wave Form at the Output Electronic Amplifier

In the Figure 11 the signs time letters, where we only use the rise time between the pulse signals in each output of both operational amplifiers. That difference is equivalent to the rotation of the polarize axis, this value is equal to signal pulse in the last one line.

11 Conclusions

The optical system and the phenomenon which occurs therein can be used as a new polary metric detection method, in which the accuracy of alignment of the optical system is essential for accuracy of detection. It's a new polari metric detection method, based, first, the new principle of refraction and reflection of light polarized in lenses and the first time use of coplanar optical lens systems that significantly improve the use of the analyzed.

When a bean of polarized light incident in the lens geometrical centre, with the polarized plane oriented vertically to us, we can see a brightness circle inside the lens, which is light; light get out laterally from the lens. And it is so brightness if we are front of the polarized plane of the bean. With the polarized plane oriented parallel to us, the circle disappears, because there are two bean of light get out of the lens 90 0 from us to booths lens sides and parallel to our position, then we cannot see the light. Let's consider that these two positions are extremes positions and between those positions, the circle change in intensity, decreasing while the polarized plane of bean is rotated up to be parallel to us.

All this has be possible because when linearly polarized light impinging on a lens, it will reflect an d refract al on g 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 within the plane of polarization. This is the physical concept obtained with our research and it permitted us understand better the phenomena and the procedure to follow in order give it a correct application.

12 Concept:

The reflection and refraction when linearly polarized light impinging on a lens, it will be maintaining within the plane of polarization.

The extension in the application of the phenomena gives us the possibility to find out the concept of coplanar lenses that do better than the precision of the measurements, without loss the simplicity of the optical system used, and understood the difference between use one or two lenses and when we must use one lens or used two lenses.

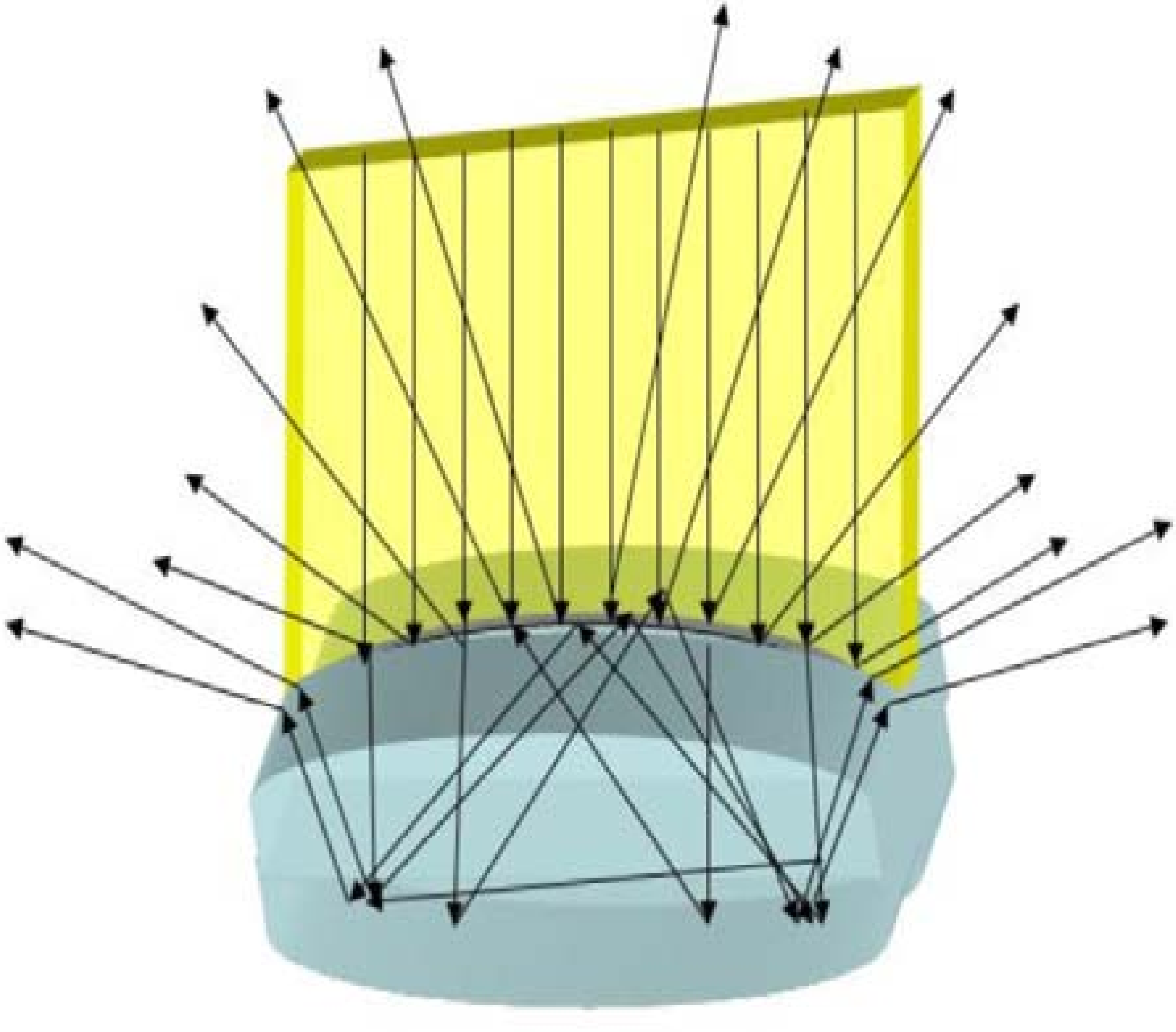
By first time have been used a parallel lens systems and this is a new optical method for polarymetric measurement, with this, extremely simple, sure and precise measurements equipments can be built.

If we used only one lens, when the polarized plane is rotated, there is a space between the photo sensors where the light not insides over the photo sensors areas, whereas in the system with two lenses always the light is over the photo sensors surfaces.

The Constant Height and Variable Phase Electro-Optic Amplifier allow determine the beam of light polarization plane orientation.

It also allows to determine the magnitude that has been rotated when introducing an active optic substance and to also know if the same one is levorotary or not.

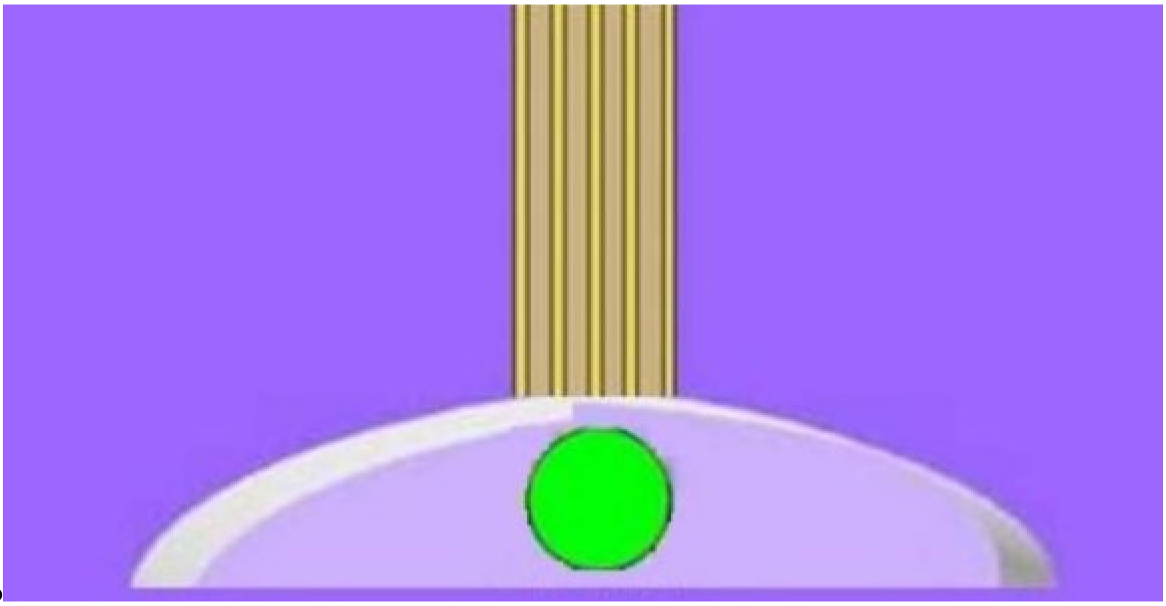
The fundamental advantage with other methods is that the method that we are defendant hear is optic fully and uses the lens like ayes, no need process extra in order obtain the desire objective, this property reduce the errors in the measurement values, is more precision and simple than any other. [1] [2]



1

Figure 1: Figure 1 :

1b



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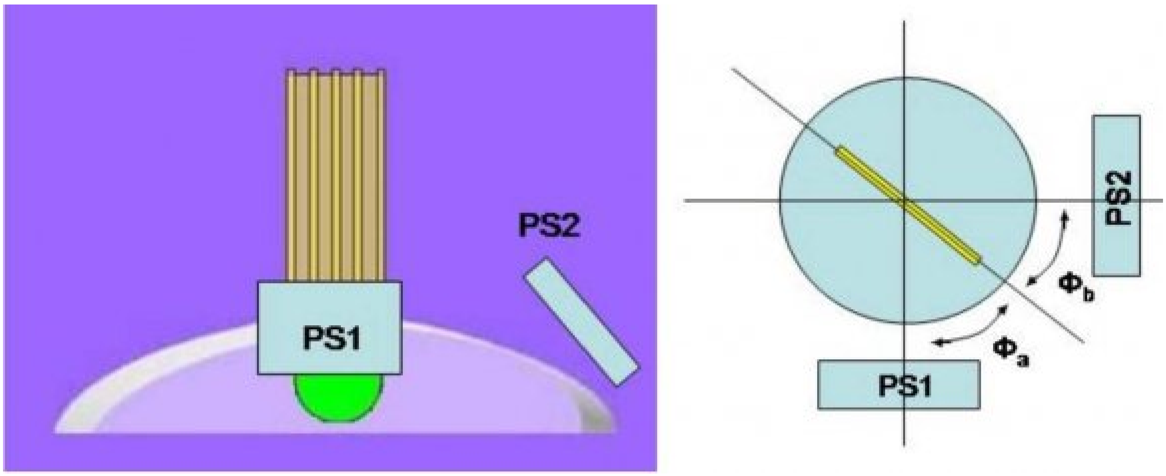

Figure 3:

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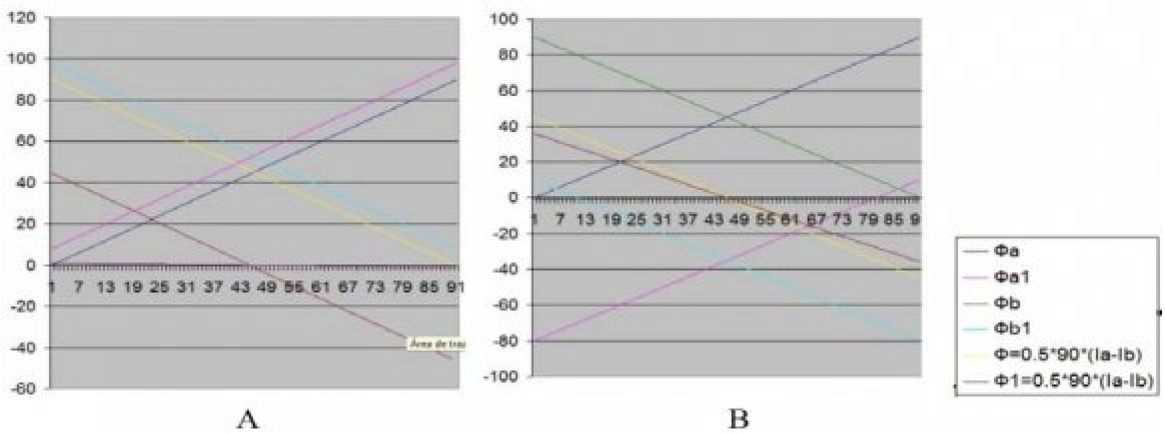

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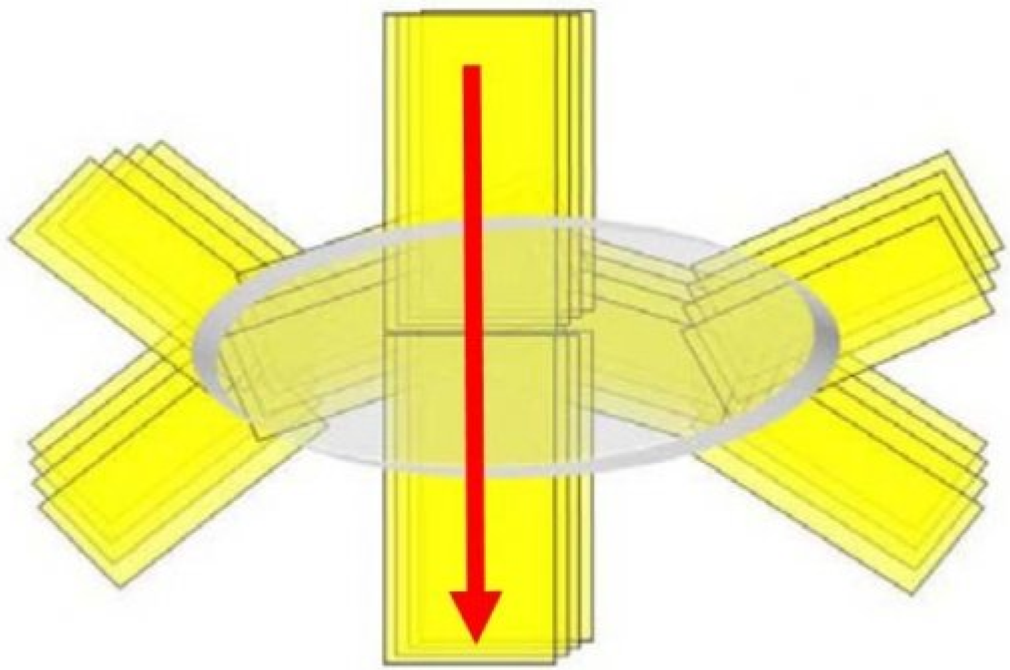

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Figure 5: Figure 2 :

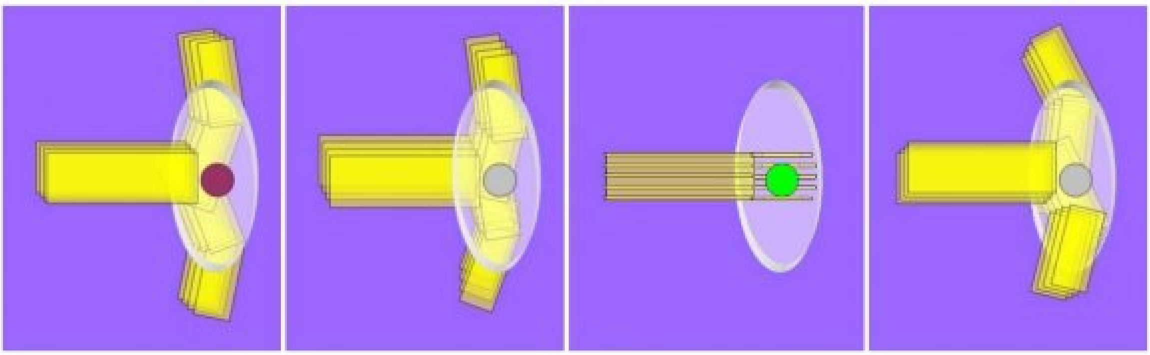

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Figure 6: Figure 3 :

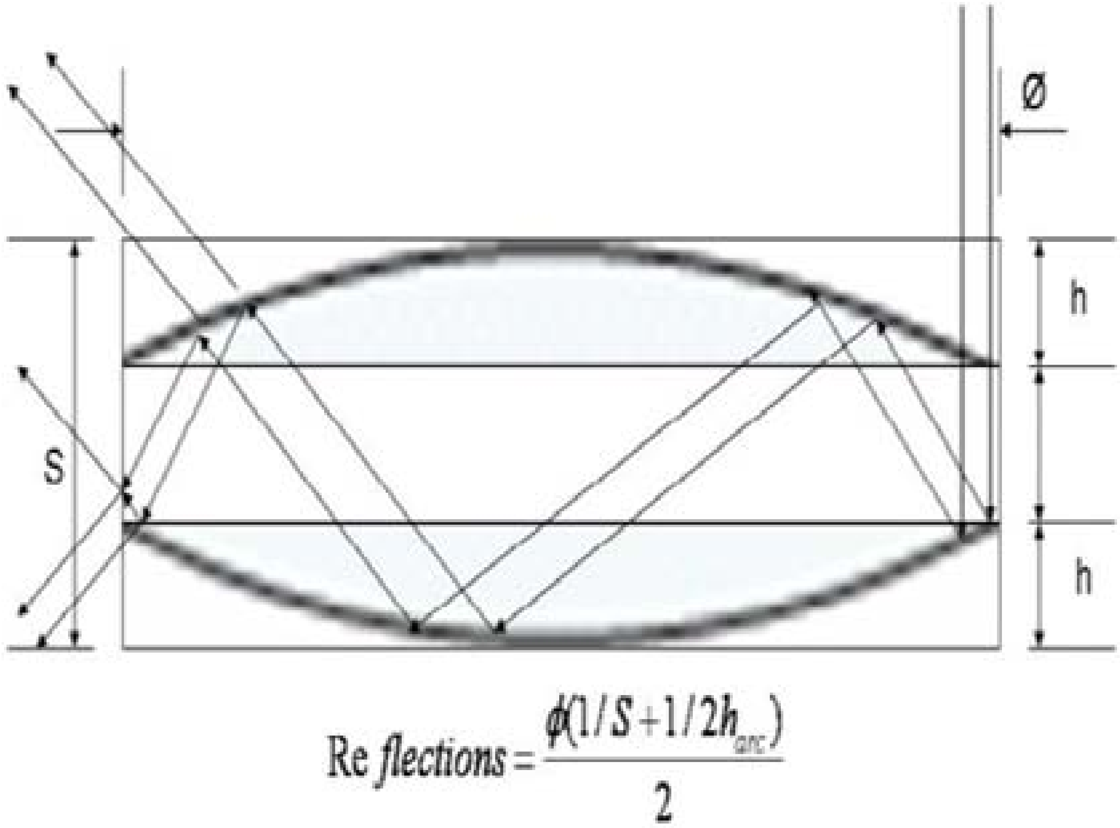

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Figure 7: LensFigure 4 :

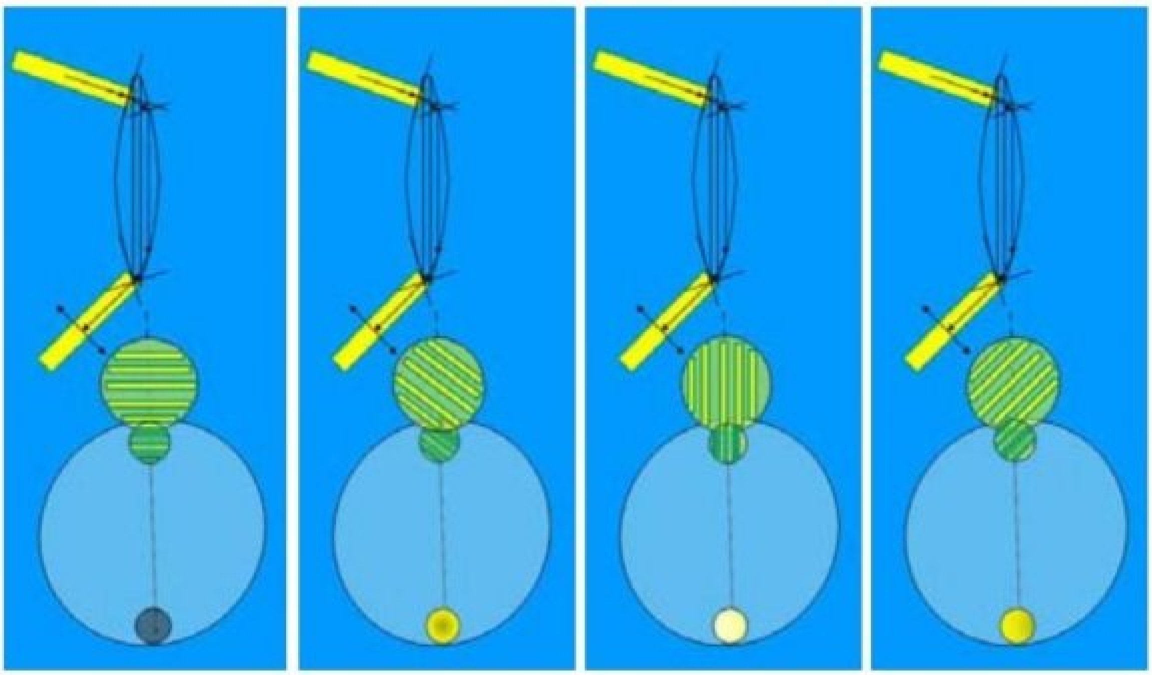

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Figure 8: Figure 5 :

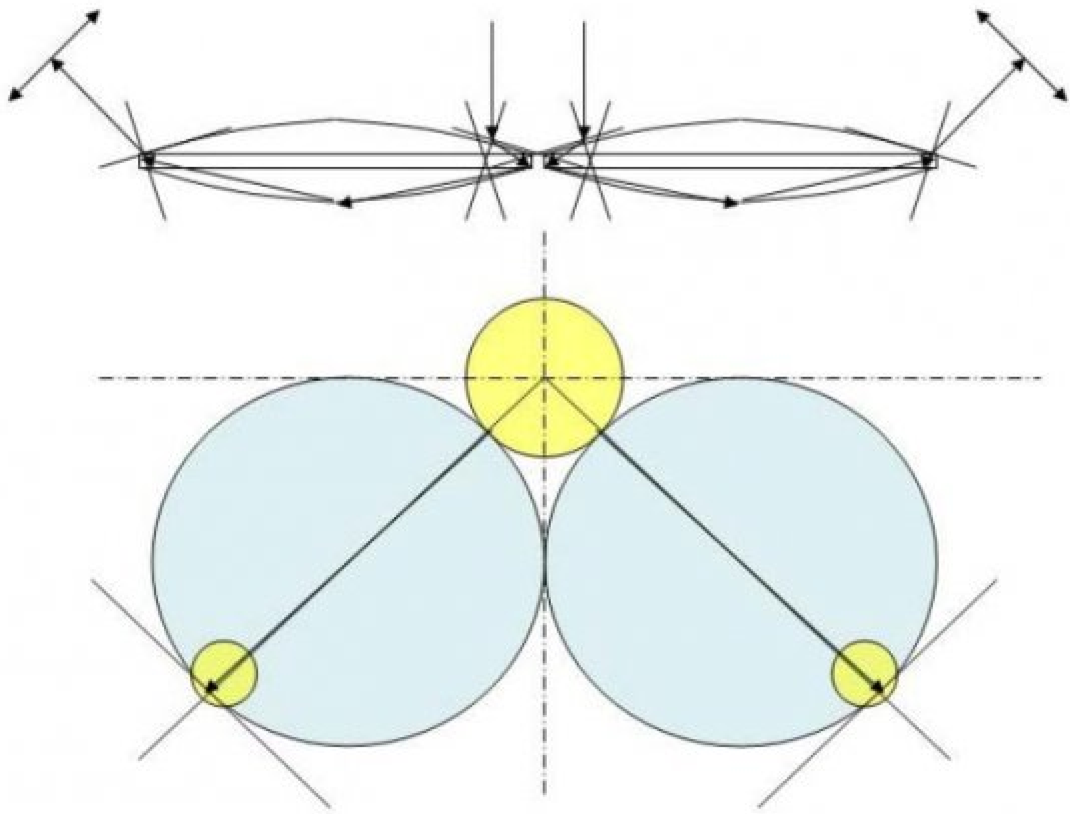

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Figure 9: Figure 6 :

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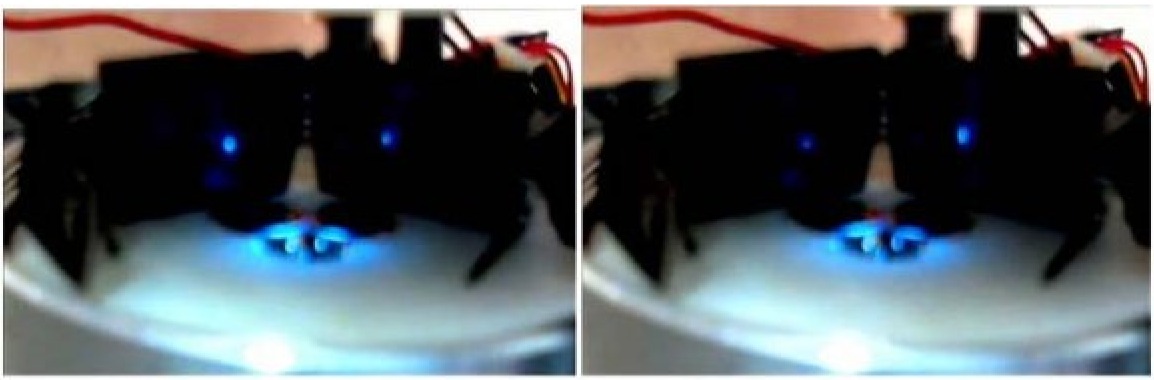

Figure 10: Figure 7 :

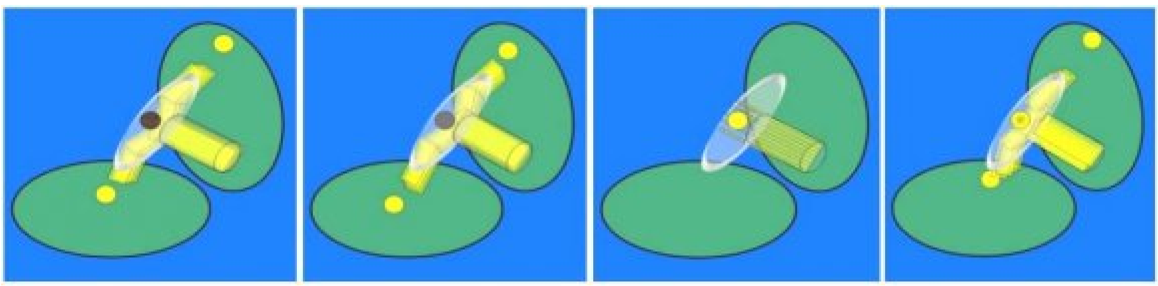

Figure 11:

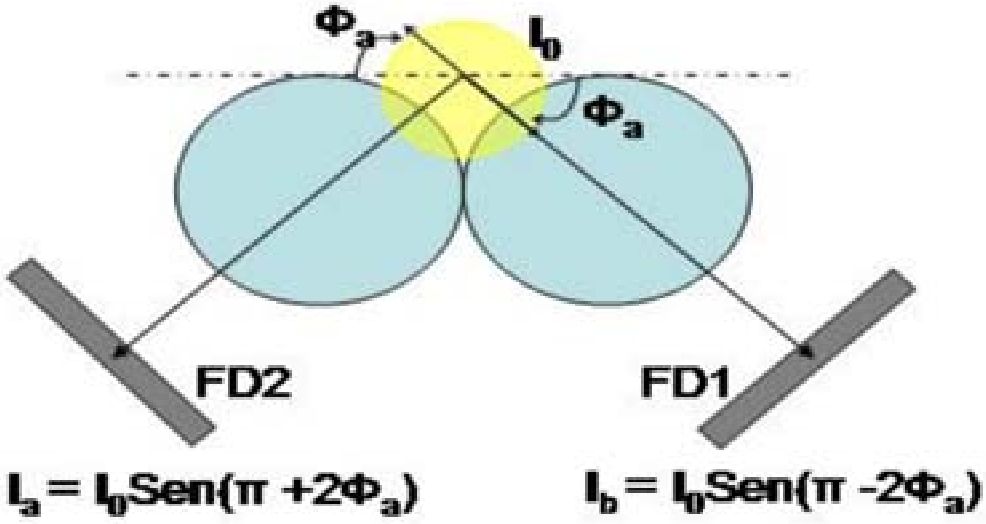

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Figure 12: Figure 8 . 1 :

9

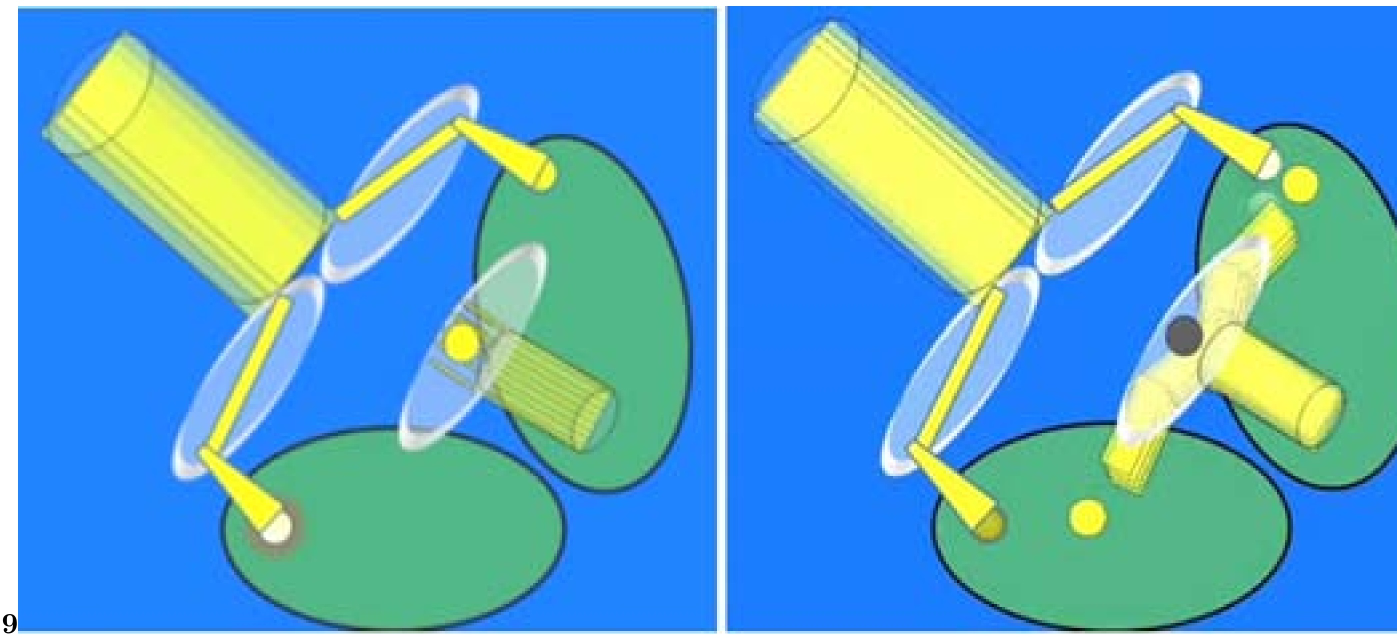
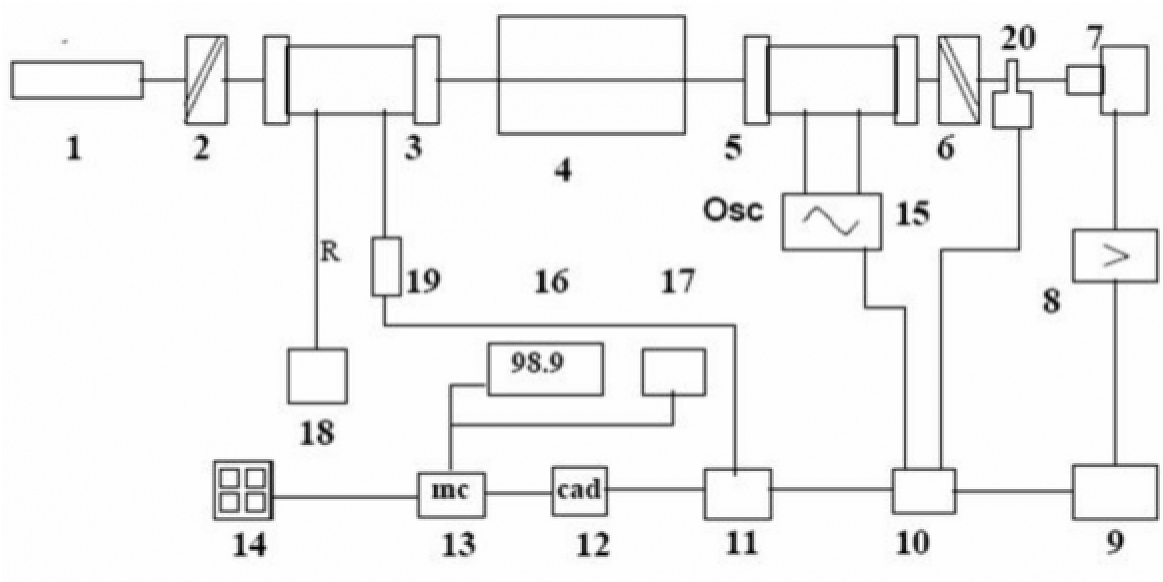


Figure 13: Figure 9 :



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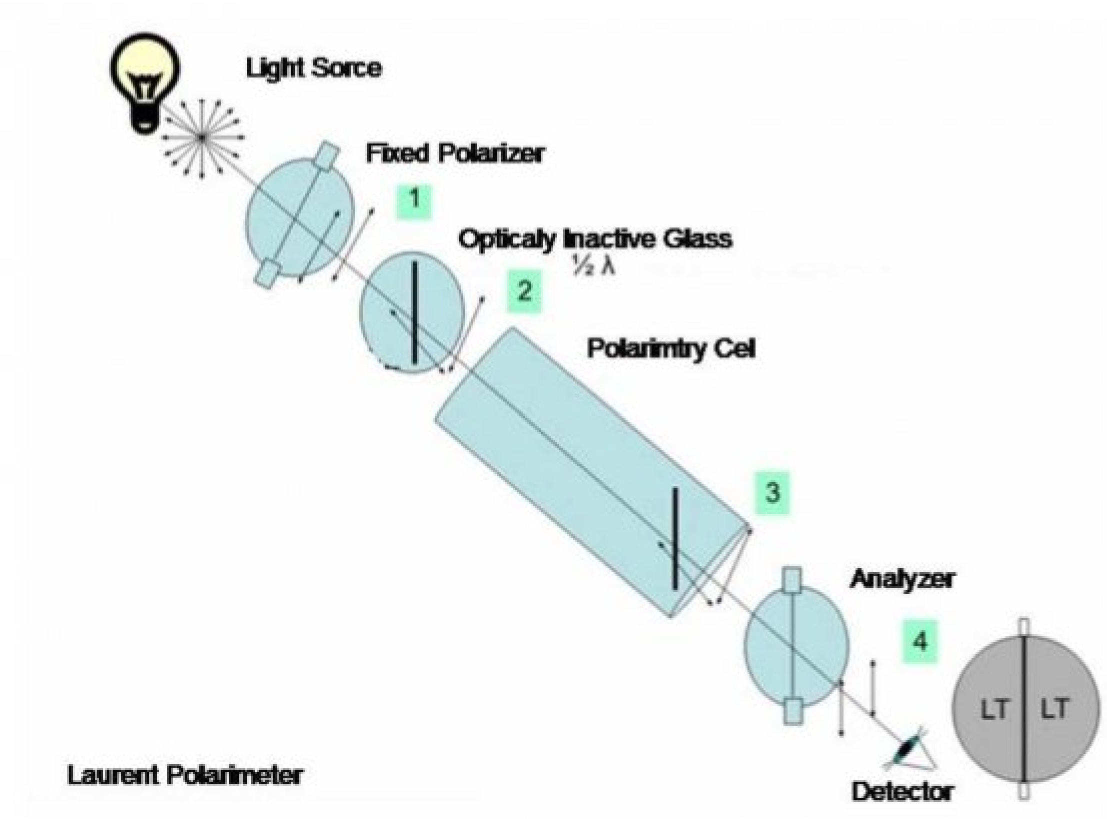

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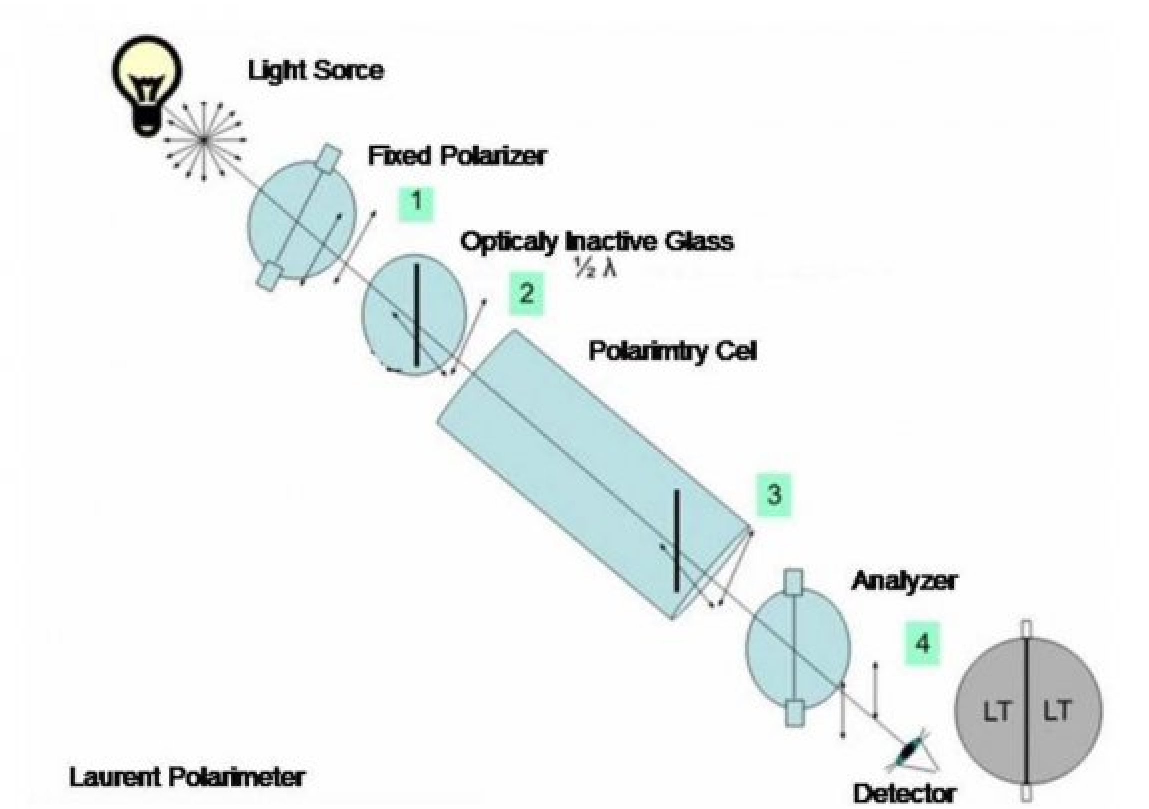

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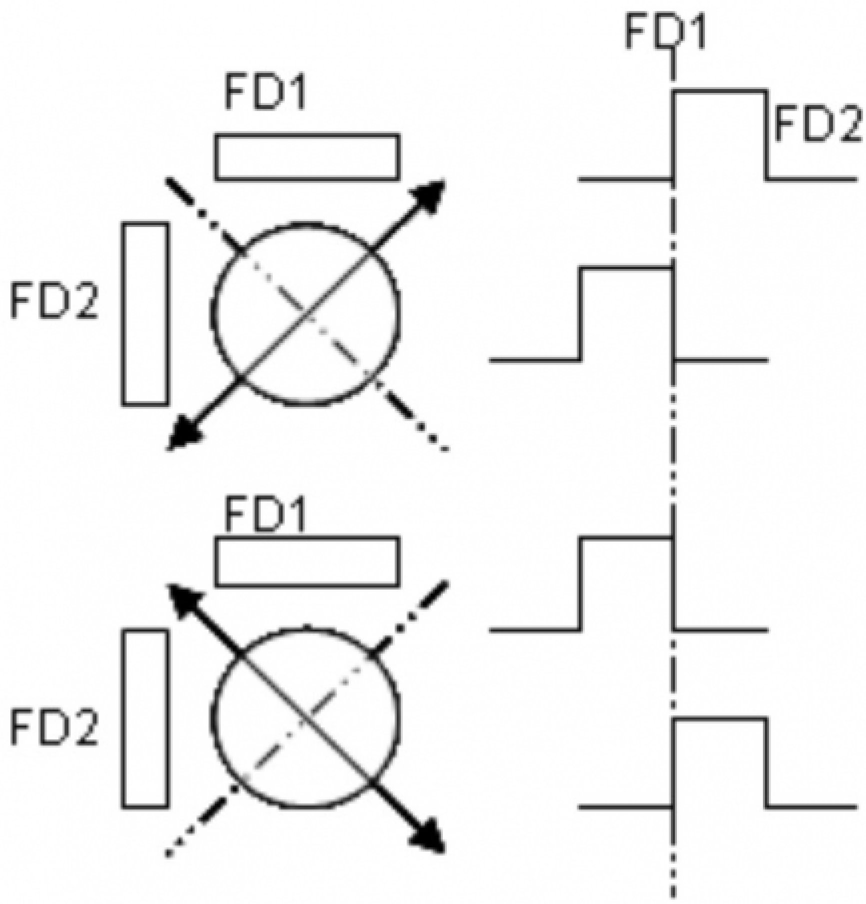
Figure 16: Figure 10 :



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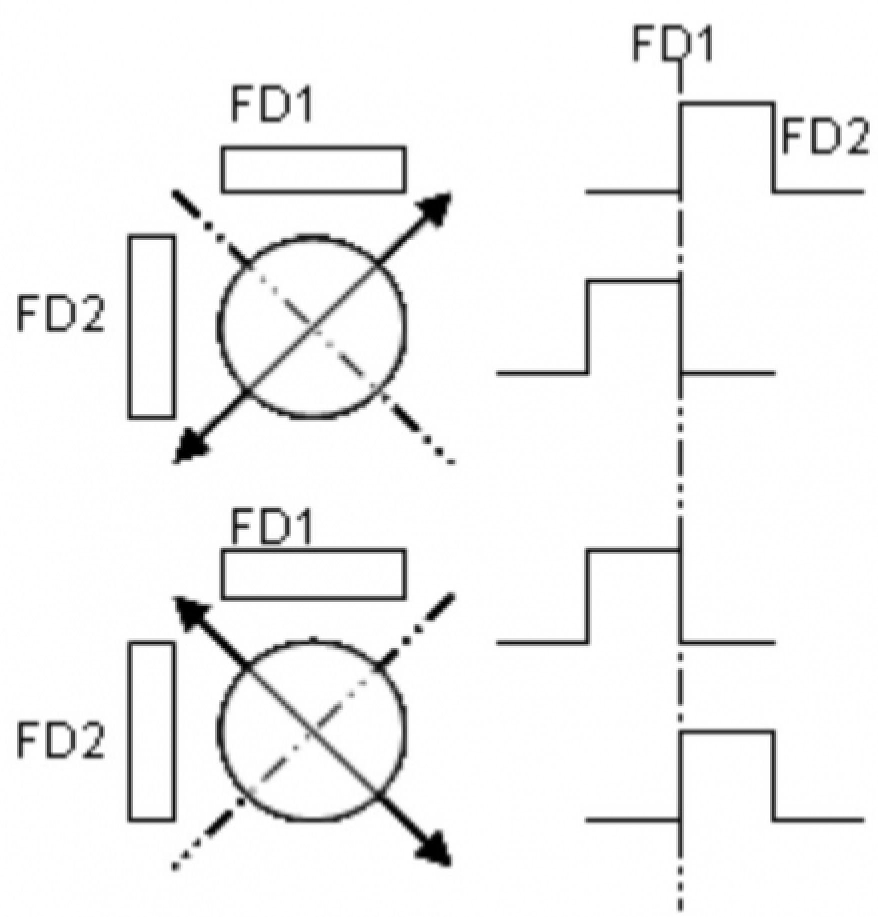

1

Figure 18: Figure 10. 1 :

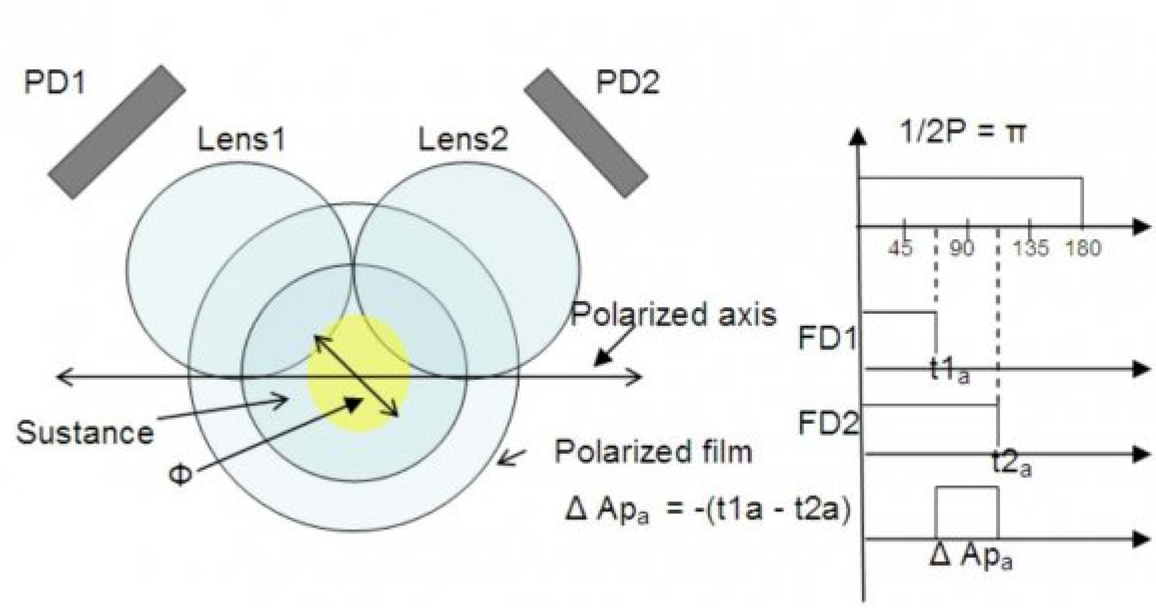

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Figure 19: Figure 11 :Figure 12 :

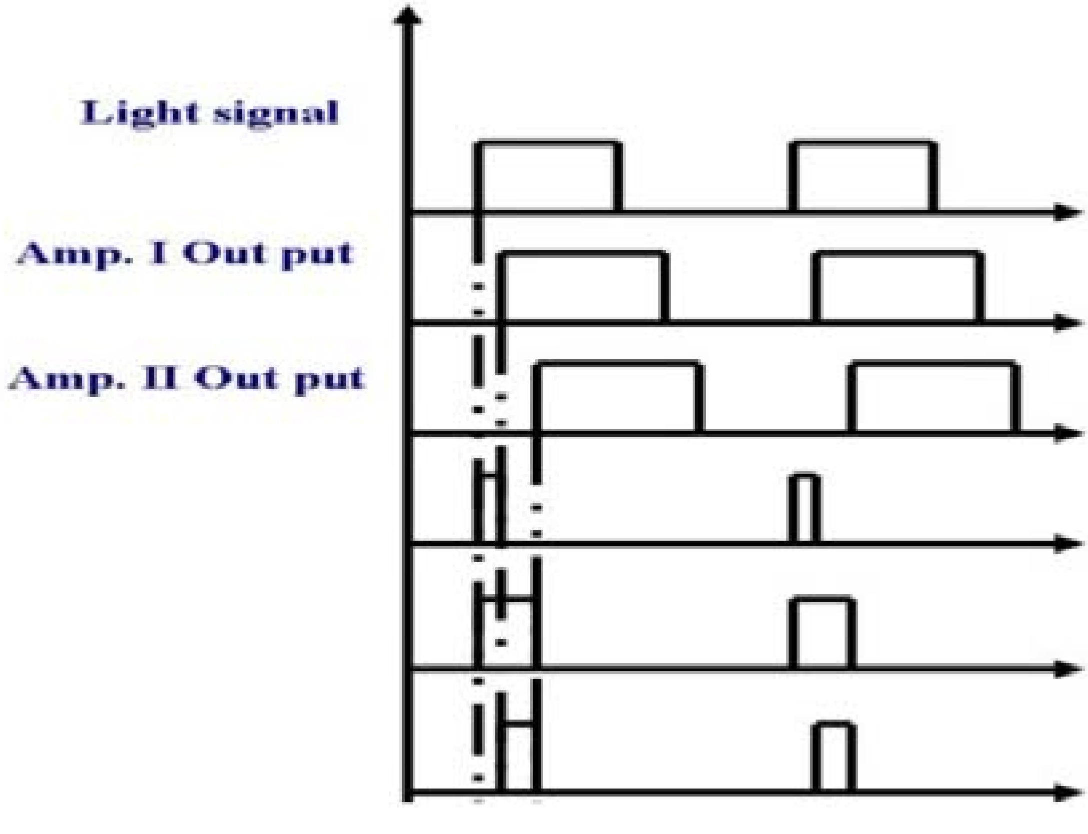

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Figure 20: Figure 13 :

	82	1
	6,28	
32	6,28	1 8
	1	
	83	
	6,28	
33	6,28	8
	1	
34	6,28	1 8
	1	
	84	
	6,28	
35	6,28	1 8
	1	
	85	
	6,28	
36	6,28	1 8
	1	
	86	
	6,28	
37	6,28	8
	1	
38	6,28	1 8
	1	
	87	
	6,28	
39	6,28	1 8
	1	
	88	
	6,28	
40	6,28	1 8
	1	
	89	
	6,28	
41	6,28	8
	1	
42	6,28	1 8
	1	
	90	
	6,28	

12 CONCEPT:

.1 Appendix

Lens Coplanar System Application based on Lateral Refraction and Reflection of Polarized Light

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[Landsberg et al. ()] , G S Landsberg , First Optic , Book , Mir . LIGHT POLARIZATION 395-414. 1976.

[Díaz ()] *Invention Author Certificate*, Miranda Díaz , LJ . 2008. 12 p. 24. CU 23333 A1, Equipo De Polarimetría Y Medición De Absorción

[Note References have been mentioned rather to indicate the field belonging the subject matter thereof, as the phenomenon is not *Note References have been mentioned rather to indicate the field belonging the subject matter thereof, as the phenomenon is not reflected in the literature*,

[Hecht] *Optics, Fourth Edition, 6 Geometrical Optics, 5.1Lens, 150-170, 8 Polarization*, E Hecht . p. .

[Recorrido: Polarimetría: Polarímetro de Laurent -CampusVirtualFFyBvirtual.ffyb.uba.ar/mod/book/vie w] *Recorrido: Polarimetría: Polarímetro de Laurent -CampusVirtualFFyBvirtual.ffyb.uba.ar/mod/book/vie w*, http://virtual.ffyb.uba.ar/mod/book/view.php?id=88060&chapterid=1864 (Accessed: 2019-06-07)