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RESEARCH ARTICLE

NEWTON'S RINGS FORMATION BY FLUID LAYER

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Abstract:

Demonstration of interference pattern in the Newton's Rings experiment is due to 'fluid layer' [1] present on the surface of the plano convex lens and the glass plate. These fluid layers combine to form plano convex complex fluid that gives rise to circular density ripples of compressions and rarefactions that taper off from the centre. The diameter of these ripples called Newton's Rings vary with the application of pressure by placing weights in the form of silver rings on the surface of the lens. The wavelength of Sodium light thus varies with pressure negating the standardization of the wavelength and thus disputes the wave theory of light.

Keywords: Fringes, rings, central spot, radius of curvature, wavelength, air film, and fluid layer.

1. Introduction:

Newton's rings are attributed to the interference between the rays reflected from the curved surface and the plane surface of the air film between the curved surface of the lens and the plane surface of the glass plate below in the Newton's Rings experiment [2].When a plano-convex lens of large radius of curvature is placed with its convex surface on a plane glass plate, a thin air film of gradually increasing thickness is supposed to be formed between them. At the point of contact, the thickness of the air film is supposed to be zero.

When a monochromatic light i.e., Sodium light is incident normally on the lens alternate bright and dark circular fringes can be seen. These fringes are assumed to be circular since the film has circular symmetry. But this principle is now disputed leading to disputing the validity of the wave theory of light, with the experimental evidence given below.

1.Methods:

Newton's Rings experiment is performed using the following apparatus: Sodium vapor

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lamp, Plano-convex lens of large radius of curvature, plane glass plate, traveling microscope of 10 x magnification, silver rings each weighing 1g and a magnifying reading lens. Weights are in the form of silver rings; silver metal is chosen because of its malleability. All the weights are standardized using a digital sensitive balance with utmost accuracy at the Indian Institute of Chemical Technology (IICT), Hyderabad.

The experiment is conducted several times using different options of weights. Starting from the smallest weight of 0.1g went up to a highest weight of 15g by adding weights of 1.0g each. Smallest single weight of 0.1g and the heaviest single weight of 2.0g are also used. For this purpose silver rings of different diameters and different weights are made. These rings are placed one above the other gently without disturbing the pattern in the set-up. Plano-convex lens with its convex surface is placed on a glass plate. The experimental set up is illuminated by a monochromatic source of light i.e., Sodium Vapour Lamp. The light is made to incident normally with the help of a condenser glass arranged at an angle of 45^o. Interference pattern consisting of a large number of concentric rings of gradually increasing diameter from the centre of the lens (point of contact) is obtained. The entire pattern is viewed through a traveling microscope and the readings are noted. The selected ring numbers are 2, 4, 6 & 8 and their diameters are computed. Wavelength of the monochromatic source of light in Å is determined using the formula,

$$\lambda = \frac{D_m^2 - D_n^2}{4R(m-n)}$$

Where R = radius of curvature of the lens

D_m = Diameter of the mth ring

D_n = Diameter of the nth ring

3. Results:

The following observations are made and the readings are tabulated.

The readings of the left and right edge readings of the rings in centimeters are noted and their difference gives the diameter of the respective rings. Finally the wavelength values with various combinations of rings are determined using the formula mentioned above. Weight of the plano-convex lens is 0.016485 kg, Radius of curvature of the plano-convex lens (determined using Spherometer) is 1.02 m and Least count of the microscope is 0.00001 m.

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Weight-g	0.0				2.0				4.0				6.0				8.0				10.0				12.0 (Fringe Shift)			
Ring No.	L	R	D=L-R	D²	L	R	D=L-R	D²	L	R	D=L-R	D²	L	R	D=L-R	D²	L	R	D=L-R	D²	L	R	D=L-R	D²	L	R	D=L-R	D²
8	2.517	2.097	0.420	0.176400	2.516	2.091	0.425	0.180625	2.516	2.089	0.427	0.182329	2.516	2.089	0.427	0.182329	2.519	2.088	0.431	0.185761	2.519	2.087	0.432	0.186624	2.506	2.099	0.407	0.165649
6	2.490	2.123	0.367	0.134689	2.486	2.117	0.369	0.136161	2.488	2.117	0.371	0.137641	2.489	2.116	0.373	0.139129	2.489	2.115	0.374	0.139876	2.490	2.115	0.375	0.140625	2.475	2.128	0.347	0.120409
4	2.456	2.156	0.300	0.090000	2.453	2.150	0.303	0.091809	2.456	2.149	0.307	0.094249	2.457	2.148	0.309	0.095481	2.457	2.146	0.311	0.096721	2.457	2.146	0.311	0.096721	2.440	2.163	0.277	0.076729
2	2.415	2.196	0.219	0.047961	2.412	2.190	0.222	0.049284	2.415	2.190	0.225	0.050625	2.416	2.189	0.227	0.051529	2.415	2.188	0.227	0.051529	2.418	2.187	0.231	0.053361	2.392	2.212	0.180	0.032400
λ	λ1	λ2	λ3		λ1	λ2	λ3		λ1	λ2	λ3		λ1	λ2	λ3		λ1	λ2	λ3		λ1	λ2	λ3		λ1	λ2	λ3	
	5294	5247	5314		5442	5365	5323		5397	5380	5332		5322	5343	5368		5456	5483	5413		5509	5444	5347		5449	5443	5393	

Weight-g	12.0			
Ring No.	L	R	D=L-R	D²
9	2.520	2.086	0.434	0.188356
7	2.490	2.114	0.376	0.141376
5	2.458	2.145	0.313	0.097969
3	2.418	2.185	0.233	0.054289
λ	λ1	λ2	λ3	
	5538	5477	5336	

4. Discussion:

Effect of Pressure on the Newton's Rings by placing weights:

When plano-convex lens with its convex surface is placed on the glass plate, density ripples which are regarded as Newton's rings are produced. If the periphery of the lens is subjected to pressure by pressing with fingers, the fringes are disarrayed, distorted and disoriented as they move outward starting from the central point. And when the pressure is eased, the fringes move back to their original position. So this basic and simple experiment demonstrates the fact that pressure affects the interference fringes to the extent that their diameter varies. This phenomenon led to the experiment using weights in the form of rings to exert pressure.

Readings are noted starting with zero weight and for 2.0g, 4.0g, 6.0g, 8.0g, 10.0g & 12.0g. Fringe shift occurred at 12.0g.As the pressure increases the diameter increases and fringe shift occurs at a later stage resulting in the change of ring number, with the transformation of the central spot into a new ring. The selected ring numbers 2,4,6 & 8 now turn into 3,5,7 & 9 respectively and the central spot becomes ring number 1. These observations are tabulated and the change in diameter values can be clearly seen.

If the experiment is started with a bright central spot, it gradually turns into a faint dark spot then a full dark spot and eventually turns out into a new ring. Thus the central spot becomes ring number one and the first ring becomes second and so on. In the initial stages of experimentation, smaller weights such as 0.1g & 0.5g have been used but profound results were not obtained. But with the use of larger weights stark difference in terms of variation of diameter and transformation of central spot into a new ring observed clearly. Further the size and the position of the rings also changed. Finally the standard wavelength value 5893 Å is not obtained.

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Fluid Layer:

The presence of fluid layer on the surfaces of the lens and the glass plate due to ambient gases is evident in this experiment and it replaces the air film. Earlier experiments have revealed that the thin fluid layer covering the curved surface of the plano-convex lens and the glass below combine to form a plano-convex shaped complex fluid. In this complex fluid, density ripples in the form of compressions and rarefactions are formed and these ripples taper off from the centre. When the pattern is illuminated by Sodium vapour lamp, the compressed portions look dark and the rarefied portions look bright.

When the pressure is exerted on the lens, plano-convex complex fluid gets distorted due to density variations and fringes get broadened.

5. Conclusion:

The diameter of the rings increased gradually with the increase of weight in steps of 1g.The central spot transformed gradually into a ring and as the weight increased further it transformed into a clear ring. So this experiment reveals that the plano convex complex fluid present at the point of contact of lens and glass plate by combination of the fluid layers adhering on the curved surface of the lens and the plane surface of the glass plate, is playing role in the formation of ripples as interference fringes. Thus the concept of air film giving rise to interference fringes in Newton's Rings experiment is ruled out. This substantiates the particle nature of light.

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