Peculiarities of light diffraction at a screen with a straight edge at small values of screen thickness and density

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It was found experimentally that the relative light intensity considerably reduces in maxima and increases in minima of the diffraction pattern from an almost opaque screen with simultaneously growing illumination in the shadow region in the case of a decrease in the edge thickness or density of the screen substance down to small values.

As known, Fresnel, independently of Young, first explained the appearance of a diffraction pattern from a screen by interference of light rays reflected by the screen edge with direct rays. But, having failed to find the effect of the edge shape, thickness, and screen material and absorptance on the diffraction fringes, he arrived at an explanation of light diffraction based on the idea of secondary waves and the principle of interference discovered by Young.[1]

However, with publication of papers by Sommerfeld,[2] Rabinovich,[3] Malyuzhents,[4] and other investigators, the explanation of light diffraction by the joint effect of the edge and incident waves turned out to be more consistent with the physics of the phenomenon as compared to the explanation based on interference of secondary waves from Huygens–Fresnel imaginary sources.[3]

Appearance of light diffraction as a result of interference of the edge (boundary) wave with the incident wave is also confirmed by the results of my experimental investigations that have demonstrated the wrong of the Fresnel statements mentioned above. In particular, in Ref. 5 the light intensity was increased by 1.3 times and more in max and decreased in min of the diffraction pattern from a screen with unchanged parameters of the diffraction scheme, width and shape of the wave front, and the light flux of the incident wave, which is impossible according to the Fresnel–Kirchhoff theory. This is in obvious contradiction with the Fresnel idea of secondary waves.

In Refs. 6–8 it was found that a deflection or edge zone[8] exists in air above the screen surface, as well as on either side of an interface between media with different optical density. The width of this zone is about 60–80 μm, and the incident rays in it are deflected in the directions out from the screen and toward its shadow, thus becoming the edge rays.

According to Ref. 9, deflection of rays with $\lambda = 0.53$ μm in the zone near a straight edge of a thin screen (razor blade) is characterized by the equation

$$\varepsilon = 259.5/(h_z + 0.786), \qquad (1)$$

where ε is the deflection angle, in min; h_z is the separation between the initial trajectory of the ray and the screen edge, $h_z \geq 0.9$ μm.

According to Refs. 10 and 11, at the time of deflection the phases of the edge light components deflected from the screen toward the shadow area experience a shift equal to 0.5π (Ref. 12), rather than 0 and π as was stated in Refs. 2 and 3, in the direction of wave propagation (+) and opposite to it (–).

According to Ref. 7, the edge light propagating from the screen consists of the rays deflected in the zone toward the screen and from it (these rays form the main component) and the rays reflected from the edge on either sides from the initial direction, partly also after their prior deflection in the zone. After the phase shift by -0.5π in the case of deflection toward the screen and π in the process of reflection, the reflected component of the edge light propagating on the illuminated side turns out to be in phase with the main component. The component of the edge light reflected toward the shadow area after the loss of half-wave at reflection, to the contrary, turns out to be in antiphase with the main component of the same direction. Under the conditions of joint amplification of the main and reflected components on the illuminated side and their attenuation in the shadow area, the fluxes of the edge light propagating from the screen and toward its shadow are roughly equal.

Appearance of the main part of the boundary wave above the screen rather than on its edge[3] shows that the surface Poincare currents[13] that are the sources of secondary waves in the Sommerfeld theory either are not induced by the wave incident on the screen or waves emitted by them contribute insignificantly to the resulting flux of the edge light. This conclusion is consistent with the Malyuzhents statement[13] that the idea of surface currents as a primary cause of the diffraction field is wrong.

The absence of real Fresnel secondary waves and induced currents in the zone of appearance of the edge wave and unrealistic existence, because of the low air density, of the refractive index gradient in it capable of deflecting rays by the angles sufficient for formation of diffraction patterns, as well as the fact that the Young–Malyuzhents diffusion theory contradicts the experimental observations[6] and deflection of edge rays at a large, as compared with λ, distance from the screen are likely indicative of the truth in the Newton

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hypothesis about remote interaction of light particles with bodies.[14] If we accept that this interaction is real, then the cause for ray deflection in the considered cases becomes clear, if the light ray is understood as a trajectory of propagation of a light quantum along with the elementary light wave connected with it.[15]

In this paper we consider the results of experimental investigation of light diffraction on the screen having the thickness 64 times smaller than the thickness of a razor blade. Along with Ref. 5, these results point to the wrong of the idea that the light diffraction is independent of the screen thickness that exists since the Fresnel time.

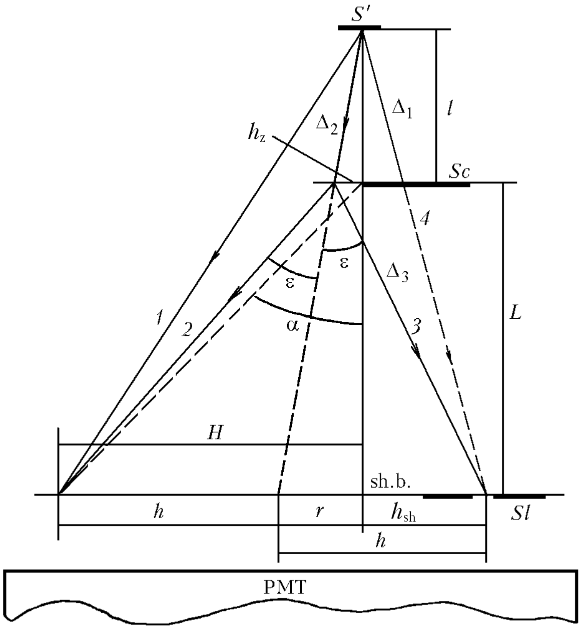

Fig. 1. Geometry of diffraction of light from a linear source on a thin screen with a straight edge.

The experiments were conducted using the optical arrangement shown in Fig. 1, where S' is the image of the slit S being a linear light source; Sc is a thin screen with a straight edge separated by $l = 12$ mm and $L = 99.5$ mm, respectively, from S' and the plane of observation of the diffraction pattern; Sl is the 20-μm thick scanning slit; PMT is a photomultiplier tube; *1* and *2* are the direct and edge rays interfering in the fringes of the diffraction pattern; *3* is the edge ray propagating toward the screen shadow; h is the distance from the points of incidence of the edge rays to the projections of their initial trajectories; H are the distances from the centers of the diffraction fringes to the shadow boundary (sh.b.); h_{sh} is the distance from sh.b. to the point of incidence of the edge ray *3*. The slit S that is not depicted in Fig. 1 is illuminated by a parallel beam of green light ($\lambda = 0.53$ μm) generated by a filament lamp. The image S' is formed by the Yupiter-8 objective. The width of S, S' is equal to 36 μm. The light beam is bounded by a 3.4-mm wide aperture slit that is installed in front of the objective by $\min_1$ of the diffraction pattern from S. As a results, the intensity distribution on the screen located beyond the beam over its width in the plane of the slit Sl is similar to the distribution in the central maximum from S. To obtain the highest intensity of edge rays, the screen edge is set at the beam axis so that the light flux propagating from S' is halved.

The screen is an Al film evaporated on a lavsan film 13 μm thick that attenuates the incident light by 8700 times. The thickness of the Al film calculated from its weight and area is $t = 5.4 \cdot 10^{-2}$ μm. The film weight was measured with VLM-20g-M scales.

To reveal peculiarities of light diffraction on this screen, diffraction patterns from a blade (Ladas) and a 70-μm thick screen of an opaque soot layer deposited onto a 0.5-mm thick K8-glass plate in kerosene flame were studied with the same parameters of the experimental scheme and the light source.

The results of investigation of the diffraction pattern from the blade are given in Table 1, while those for the screen of the Al film and the soot screen are tabulated, respectively, in Tables 2 and 3. In Tables 1–3: I_{fr} and I_{inc} are light intensities in the diffraction fringes and in the incident wave; $I_{rel} = I_{fr}/I_{inc}$; a_{ed} is the amplitude of the edge wave equal to $(\sqrt{I_{fr}} - \sqrt{I_{inc}})$; $I_{ed.b}$, I_{ed}, $I_{ed.l}$ are the intensities of the edge light equal to a_{ed}^2; $A = a_{ed}H$; $I'_{rel} = (\sqrt{I_{b.l}} \pm a_{ed})^2/I_{b.l}$ is the relative intensity of diffraction fringes at the constant light intensity over the wave front width equal to its value $I_{b.l}$ at the shadow boundary, that is, the intensity characterized by the Fresnel integrals. In experiments with the blade, sh.b. was determined from H between it and $\max_1$ characterized by the equation[12]

$$H = (r + h) = [h_z(L + l)/l + \sqrt{(k_0 + k)\lambda L(L + l)/l}], \quad (2)$$

where $(k_0 + k)$ is the number of $\lambda/2$ in the geometrical propagation difference between the rays *1* and *2*; $k = 0, 2, 4, ...,$ correspond to max, while $k = 1, 3, 5, ...,$ correspond to min; $k_0 = 0.5$ is the mentioned initial shift between the incident and edge light by $0.5\lambda/2$ in the direction of propagation of the edge rays (this shift occurs at ray deflection from the screen in the zone). As the blade was replaced by the Al film or the soot screen, sh.b. was determined from the distance from it to the light beam axis, since the parameters of the scheme and the screen position were kept unchanged.

As can be seen from comparison of values of I_{rel} in Tables 1 and 2, replacement of the blade by the Al film worsened the contrast of the diffraction pattern that worsens further with the increasing fringe order. This phenomenon manifests itself as the decreasing intensity of max and the increasing intensity of min. As can be judged from the values of $I_{ed.b}/I_{ed}$, it is caused by the decrease in the intensity of the edge light that grows with the growing fringe order and, consequently, the diffraction angle $\alpha = (H/L)\,57.3° \cdot 60' = 3438H/L$, in min, and the angle $\varepsilon = 3438h/L$, in min.

Table 1. Characteristics of diffraction pattern from a blade

Fringe	H, mm	I_{fr}, rel. units	I_{inc}, rel. units	I_{rel}	a_{ed}	$I_{\text{ed.b}}$, rel. units	A	I'_{rel}	ε, min	h_z, μm
max_1	0.629	99.62	70.4	1.415	1.5903	2.53	1	1.361	17.1	14.4
min_1	0.959	32.46	45.4	0.715	1.0406	1.083	0.998	0.794	29.61	8
max_2	1.211	38.81	29.2	1.329	0.8258	0.682	1	1.18	38.24	6
min_2	1.407	12.64	17.7	0.714	0.6521	0.425	0.918	0.868	45.25	4.95
max_3	1.594	15.6	11.1	1.4054	0.618	0.382	0.985	1.334	51.31	4.27
sh.b.	0	22.8	91.3	0.2494	–	–	–	–	–	–

Table 2. Characteristics of diffraction pattern from a $5.4 \cdot 10^{-2}$ μm thick screen

Fringe	H, mm	I_{fr}, rel. units	I_{inc}, rel. units	I_{rel}	a_{ed}	I_{ed}, rel. units	$I_{\text{ed.b}}/I_{\text{ed}}$	A
max_1	0.645	90.11	68.87	1.3085	1.194	1.4256	1.774	0.77
min_1	0.946	42.26	49.73	0.8498	0.5511	0.3037	3.566	0.52
max_2	1.193	36.65	31.52	1.163	0.4403	0.194	3.517	0.52
min_2	1.399	17.86	19.34	0.9217	0.1713	0.0294	14.49	0.24
max_3	1.595	12.37	11.09	1.1158	0.1875	0.0352	10.86	0.3
sh.b.	0	28.48	91.3	0.312	–	–	–	–

Table 3. Characteristics of diffraction pattern from an opaque soot layer 70 μm thick

Fringe	H, mm	I_{fr}, rel. units	I_{inc}, rel. units	I_{rel}	a_{ed}	$I_{\text{ed.b}}$, rel. units	$I_{\text{ed.b}}/I_{\text{ed.l}}$	A	I'_{rel}
max_1	0.597	99.72	73.1	1.364	1.4357	2.061	1.227	0.857	1.323
min_1	0.943	39.71	52	0.764	0.9077	0.824	1.314	0.856	0.819
max_2	1.188	39.52	33	1.199	0.546	0.298	2.77	0.649	1.1166
min_2	1.389	16.49	19	0.867	0.3003	0.09	4.71	0.417	0.9372
max_3	1.568	13.1	11	1.192	0.1552	0.0926	4.12	0.243	1.032
sh.b.	0	24.23	91.3	0.2655	–	–	–	–	–

Simultaneously, the fringes displaced a little, and $H_{\max_1}$ increased, the separation between max_1 and min_1 decreased by 29 μm, while the separations between other fringes was almost unchanged. This is likely caused by a small increase of k_0 with respect to the value presented above, since according to Eq. (2) the growth of k_0 is accompanied by the decrease of the separation between the fringes that decrease fast with the increasing fringe order because of the decreasing fraction of k_0 in the sum $(k_0 + k)$. Displacement of max_1 from sh.b. led to the decrease of corresponding I_{inc}.

In the case of light diffraction at the screen of Al film, A decreases with the increasing fringe order, that is, a_{ed} is no longer inversely proportional to H and $\tan\alpha = H/L$ (Ref. 10).

Unlike the decrease in the intensity of the edge wave on the illuminated side, the decrease of the screen thickness caused an increase in the intensity I_{sh} of the edge wave propagating to the shadow area of the Al film that is characterized by the ratio of I_{sh} to $I_{\text{sh.bl}}$ in the blade shadow presented in Table 4.

Seemingly, the decrease in the edge wave intensity on the illuminated side and its increase in the shadow of a very thin screen can be completely explained by the decrease in the amount of light reflected from the screen edge, since attenuation of the reflected components of the edge light causes attenuation of the resulting edge wave propagating on the illuminated side and its intensification in the shadow area. However, according to the data of Ref. 16, the intensity of the reflected component on the illuminated side increases with increasing α, and at α corresponding to the position of max_1 in the diffraction pattern from the Al film it is close to 0. Consequently, max_1 in the considered patterns is formed as a result of interference of the main component of the edge wave with the incident light. The intensity of the edge light coming to max_1 of the diffraction pattern from the Al films turns out to be 1.774 times lower than its value at max_1 of the diffraction pattern from the blade. This attenuation of the main component is indicative of the decrease in the efficiency of ray deflection in the deflection zone of the Al film, since it causes narrowing of the zone, at which rays are deflected within the previous angle range, and the corresponding decrease in the flux of deflected rays.

Table 4. Light intensity *I* distribution in the screen (blade and Al film) shadow area

h_{sh}, μm	$I_{\text{sh.bl}}$, rel. units	I_{sh}, rel. units	$I_{\text{sh}}/I_{\text{sh.bl}}$	Fringe	I_{inc}, rel. units.	a_4	I_z	Δ_{sh}, λ/2
0	22.84	28.56	1.251					
58	18.4	23.3	1.266					
108	14.9	19.31	1.296					
158	12.7	16.7	1.315	max_1	89.76	0.1017	15.88	0.245
208	10.7	14.07	1.315					
258	8.8	11.53	1.31					
308	7.5	9.6	1.28					
358	6.3	7.8	1.235					
408	5.4	6.57	1.216	min_1	80.1	0.096	7.1	0.565
458	4.65	5.68	1.222					
508	4	5.02	1.255					
558	3.5	4.55	1.3					
608	3.1	4.17	1.345					
658	2.7	3.82	1.415					
708	2.35	3.47	1.475					
758	2.1	3.25	1.545					
808	1.85	3.00	1.619	max_2	56.4	0.0806	2.73	1.55
858	1.7	2.64	1.555					
908	1.53	2.3	1.50					
958	1.35	1.96	1.455					

The decrease in the efficiency of ray deflection in the zone located above the edge of the Al film, in its turn, is indicative of its dependence on the amount of screen substance in the region of interaction of light rays with the screen that manifests itself at its small values.

In spite of the increase in the intensity of reflected component propagating in the illuminated side with increasing α, its value at $\max_3$ is far less than the intensity of the main component. Therefore, even the complete removal of the reflected component of the edge wave cannot cause that strong decrease of $I_{\rm ed}$ with the increasing fringe order, which is characterized by $I_{\rm ed.b}/I_{\rm ed}$. Consequently, the decrease in the efficiency of ray deflection over the width of the zone of the Al films varies in such a way that the decrease in the intensity of deflected rays increases with the increasing deflection angle.

Denote the amplitudes of the resulting and main components of the edge light at $\max_1$ of the diffraction pattern from the blade and in its shadow at $h_{\rm sh} = h_{\max_1}$ as $a_{{\rm ed}_1}$, a_1, $a_{\rm sh}$, a_2 and the amplitude of the reflected component in the blade shadow at the given distance as $a_{\rm ref}$, $a_{\rm z}$ is the decrease in the amplitude of the edge wave due to the decrease in the efficiency of ray deflection in the zone of the Al film. Since the reflected component at $\max_1$ is close to 0, $a_{{\rm ed}_1} = a_1 = 1.59$. Since the intensity of the edge light is the same on the illuminated side and in the shadow area when the blade serves as a screen, $a_{\rm sh} = a_{{\rm ed}_1} = 1.59$. As the Al film has very small reflecting surface on the edge compared to that of the blade, assume the amplitude of the reflected component to be equal to 0 in the film shadow. In the case of the blade $a_{\rm sh} = (a_2 - a_{\rm ref})$. Since $a_1 = a_{\rm ed1} = a_{\rm sh}$, then $a_1 = (a_2 - a_{\rm ref})$. As $I_{\rm ed}$ at $\max_1$ decreases by 1.774 times and $I_{\rm sh}$ increases by 1.374 times (see Table 4), at $h_{\rm sh} = h_{\max_1}$ the amplitude of the resulting component at $\max_1$ from the Al film $a'_{{\rm ed}_1} = a_{{\rm ed}_1}/\sqrt{1.774} = 1.194 = (a_1 - a_{\rm z})$. The amplitude of the resulting component in the shadow of the Al film is

$$a'_{\rm sh} = (a_2 - a_{\rm z}) = (a_1 + a_{\rm ref} - a_{\rm z}) =$$

$$= [(a_1 - a_{\rm z}) + a_{\rm ref}] = a_{\rm sh}\sqrt{1.374} = 1.864.$$

Based on this

$$a_{\rm ref} = (1.864 - 1.194) = 0.67;\ I_{\rm ref} = 0.449;$$

$$a_2 = (a_1 + a_{\rm ref}) = (1.59 + 0.67) = 2.26;$$

$$I_2 = a_2^2 = 5.109;\ I_2/I_{{\rm ed.b}_1} = 5.109/2.529 = 2.02;$$

$$I_{\rm ref}/I_{{\rm ed.b}_1} = 0.449/2.529 = 0.177;$$

$$a_{\rm z} = (a_1 - 1.194) = (1.59 - 1.194) = 0.396 < a_{\rm ref}.$$

Therefore, the increase in the intensity of the edge wave in the film shadow because of the absence of the reflected component dominates over its decrease due to the decrease in the efficiency of ray deflection. As a result, the intensity of the edge wave in the film shadow has a higher value than in the blade shadow.

According to data from Tables 1 and 3, the diffraction pattern at light diffraction at the soot screen, similarly to the pattern from the Al film, is characterized by the lower fringe contrast as compared with the pattern from the blade that also decreases with the increasing fringe order. However, the decrease in the fringe contrast and in the intensity of the edge light on the illuminated side in this case is less pronounced than in the case with the Al film.

Simultaneously with the decrease in the intensity of edge rays on the illuminated side, it increases in the shadow area by 1.29 to 1.52 times with respect to the intensity in the blade shadow as $h_{\rm sh}$ varies from 0 to 1.170 mm and by 1.322 times at $h_{\rm sh} = h_{\max_1}$, that is, roughly the same as in the shadow of the Al film.

Although the decrease of $I_{\rm ed.l}$ at $\max_1$ is insignificant as compared with the corresponding change of $I_{\rm ed}$, it still takes place. Consequently, the decrease in the intensity of the edge wave on the illuminated side and its increase in the shadow area up to the given values are caused not only by the decrease in the reflected component because of the absorption of the reflected rays by soot, but also by the small decrease in the efficiency of the ray deflection in the zone near the soot edge.

This decrease with the soot layer roughly 20 times thicker than the blade and 1290 times thicker that the Al film can be explained by the low density of soot in the experiment, equal (based on the measured weight and volume) to 0.0173 g/cm^3 and 156 times smaller than that of Al. Therefore, the amount of soot in the zone of interaction of the deflected rays with it proves to be comparable with the amount of substance in the case of light diffraction on the Al film.

Since soot incompletely absorbs the rays incident on the screen edge and has lower reflectivity than the blade, the reflected component of the edge light does not decrease down to 0 in the case of light diffraction on the soot screen. Denote the difference between the amplitudes of the reflected components in the shadow of the blade and the soot screen at $h_{\rm sh} = H_{\max_1}$ as $a'_{\rm ref}$, the amplitudes of the resulting edge components at $\max_1$ and in the shadow at $h_{\rm sh} = h_{\max_1}$ in the case of diffraction on the soot screen as $a_{\rm ed.s}$ and $a_{\rm sh.s}$, and the decrease in the amplitude of the edge wave due to the decrease in the efficiency of ray deflection in the zone near the soot edge as $a_{\rm z.s}$.

From the above data:

$$a_{\rm ed.s} = a_{{\rm ed}_1}/\sqrt{1.227} = 1.4356 = (a_1 - a_{\rm z.s});$$

$$a_{\rm z.s} = (1.59 - 1.4356) = 0.1547;\ a_{\rm sh} = (a_2 - a_{\rm ref}) = a_1;$$

$$a_{\rm sh.s} = [a_2 - (a_{\rm ref} - a'_{\rm ref}) - a_{\rm z.s}] = [(a_2 - a_{\rm ref}) + a'_{\rm ref} - a_{\rm z.s}] =$$

$$= [(a_1 - a_{\rm z.s}) + a'_{\rm ref}] = (1.4356 + a'_{\rm ref}) = a_{\rm sh}\sqrt{1.322} = 1.8283;$$

$$a'_{\rm ref} = (1.8283 - 1.4356) = 0.3927 > a_{\rm z.s}.$$

As a result, the light intensity in the shadow of the soot screen turns out to be higher than that in the shadow from the razor blade. Due to absorption by soot, the intensity of reflected component decreased by $0.67^2/(0.67 - 0.3927)^2 = 5.85$ times as compared to its value in the shadow from the razor blade.

When the soot edge was formed as a 50 μm thick wedge with the edge thickness of about 4 μm in order to decrease the amount of soot in it, diffraction fringes almost disappeared, and the intensity of the edge wave on the illuminated side decreased, on the average, by 6.6 times with respect to its values presented in Table 3. This can be seen from the data presented in Table 5, where $I_{\text{ed.w}}$ is the intensity of the edge wave in the considered case.

Table 5. Characteristic of diffraction pattern from the soot screen with the edge thickness of 4 μm

Fringe	H, mm	I_{fr}, rel. units	I_{inc}, rel. units	I_{rel}	a_{ed}	$I_{\text{ed.w}}$, rel. units	$I_{\text{ed.l}}/I_{\text{ed.w}}$
$\max_1$	0.577	81.46	72.35	1.126	0.52	0.2704	7.622
$\min_1$	0.914	46.1	51.14	0.901	0.3632	0.132	6.246
$\max_2$	1.176	31.19	28.66	1.088	0.2309	0.0533	5.59
$\min_2$	1.346	18.94	19.95	0.9493	0.1146	0.0131	6.88
$\max_3$	1.546	11.87	11.06	1.073	0.1192	0.0142	6.52
sh.b.	0	48.72	91.54	0.532	–	–	–

The values of $I_{\text{sh}}/I_{\text{sh.l}}$ presented in Table 4 are indicative of the existence of max and min of illumination in the shadow area of the Al film that arise due to interference of the edge rays *3* with the intensity I_3 with the rays *4* of the incident wave characterized by the amplitude a_4 after passage through the film. The geometrical propagation difference arising between them $\Delta_{\text{g}} = (\Delta_2 + \Delta_3 - \Delta_1) = k_{\text{g}}\,\lambda/2$ with the allowance for Eq. (1) is determined by the equation

$$k_{\text{g}} = \left\{\frac{h_{\text{sh}} - 7.86\cdot 10^{-4}(L + l)/l}{2} + \right.$$

$$\left. + \sqrt{\frac{[h_{\text{sh}} - 7.86\cdot 10^{-4}(L+l)/l]^2}{4} + \frac{75.48\cdot 10^{-6}L(L+l)^2}{l}}\right\}^2 \Big/$$

$$\Big/ \frac{\lambda L(L+l)}{l}.$$

At $\min_1$ separated from sh.b. by $h_{\text{sh}} = 0.408$ mm, $\Delta_{\text{g}} = 0.565\lambda/2$. Taking into account the initial shift by $\Delta_{\text{init}} = 0.5\lambda/2$ in the rays deflected to the screen shadow, the total propagation difference $\Delta_{\text{tot}} = 1.065\cdot\lambda/2$ is larger by $0.065\lambda/2$ than the propagation difference needed for formation of $\min_1$.

If this Δ is caused by the increase of the optical path of the rays *4* in the Al film, then the Al refractive index $n = (\Delta\lambda/2t + 1) = 1.322$. This value is close to n of Al for the yellow line of Na, equal, according to Ref. 17, to 1.44.

As can be seen, light diffraction at screens with very low transmittance of the incident wave (at which the interfering edge light from the deflection zone located in the screen near its edge is almost equal to 0) allows n of metals and strongly absorbing substance to be determined in a simple way. According to Table 4, $\Delta_{\text{g}} = 1.55\lambda/2$ at $\max_2$. Then $\Delta_{\text{tot}} = (1.55\lambda/2 + \Delta_{\text{init}}) = 2.05\lambda/2$ with the needed propagation difference equal to λ.

Formation of the fringes considered at Δ_{g} differing by $0.5\lambda/2$ from the needed one is an additional confirmation of appearance of the initial delay in rays propagating after deflection in the zone to the shadow area that is denied by the existing theory.

The described attenuation of the edge light with the decreasing screen thickness and density of the screen substance down to small values should lead to the decrease of the diffraction component in the light scattered by aerosol particles under similar conditions.

Besides, the experimentally found[10,12] initial shift by $\pm 0.5\lambda/2$ in the edge rays at their appearance in the process of light diffraction that is confirmed in this paper should be one of the causes for distortion of the wave front of radiation propagating through aerosol.

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