For third order aberrations of the whole system one can obtain the following relations

$$S_1 = \sum \frac{h^4}{f^3} P + \sum 4 \frac{ah^3}{f^2} W + \sum \frac{ah^2}{f} (5.4a - a'),$$

$$S_2 = \sum \frac{yh^3}{f^3} P + \sum \frac{h^2}{f^2} (4ay - J)\, W +$$

$$+ \sum \frac{ah}{f} (2.7ay + 2.7\beta h - a'y),$$

$$S_3 = \sum \frac{y^2 h^2}{f^3} P + \sum \frac{2hy}{f^2} (ay - \beta h)\, W +$$

$$+ \frac{ay}{f} (5.4\beta h - ya') + J^2 \sum \frac{1}{f},$$

$$S_5 = \sum \frac{y^3 h}{f^3} P + \sum \frac{y^2}{f^2} (4ay - 3J)\, W +$$

$$+ \frac{y}{f} \left(3.7 h\beta^2 + 0.7 a\beta y - \frac{a y^2}{f} \right).$$

Similarly when using the reversed parameters we obtain

$$S_1 = \sum \frac{h^4}{f^3} \overleftarrow{P} - 4 \sum \frac{\alpha' h^3}{f^2} \overleftarrow{W} + \sum \frac{\alpha h^2}{f} (5.4\alpha - \alpha'),$$

$$S_2 = \sum \frac{yh^3}{f^3} \overleftarrow{P} + \sum \frac{h^2}{f^2} (-4\alpha' y - J)\, \overleftarrow{W} + \sum \frac{h\alpha'}{f} \times$$

$$\times (2.7\alpha' y + 2.7\beta' h - y\alpha),$$

$$S_3 = \sum \frac{y^2 h^2}{f^3} \overleftarrow{P} - \sum \frac{2yh}{f^2} (y\alpha' + h\beta') \overleftarrow{W} + \frac{\alpha' y}{f} \times$$

$$\times (5.4 h\beta' - y\alpha) + \sum \frac{J^2}{f},$$

$$S_5 = \sum \frac{y^3 h}{f^3} \overleftarrow{P} + \sum \frac{y^2}{f^2} (-4\alpha' y + 3J) \overleftarrow{W} + \sum \frac{y}{f} \times$$

$$\times \left(3.7 h\beta'^2 + 0.7 \alpha' \beta' y + \frac{y^2 \alpha'}{f} \right).$$

These formulae are convenient for automised computations and for the correction of pancratic systems. Finally taking into account some possible positions of lenses, we get a system of linear equations. For that purpose suitable programs were prepared, to calculate the coefficients of the equations and to solve the equations by the method of the least squares. The tables [1, 2] facilitate the choice of glasses and the calculations of curvatures if several components are double-cemented lenses.

Pancratic systems thus computed needed only small correction with ray tracing.

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Henryk Wojewoda *

A Single-Lens Stigmatic Condensor

1. Single-lens condensors are employed in the laser devices (see [1–3]). The purpose is to achieve a perfect focussing of the parallel monochromatic light beam. The condensor presented in the paper is of the convexo-concave type, the convex surface being aspherical. The condensor happens to fulfil all the conditions requested for such a system of the f-number equal to 1 and a perfect correction achieved for a parallel light beam of $\lambda = 1.06\ \mu$m.

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2. The problem of glass selection is reduced to the choice of any glass of well-known parameters. In particular the index of refraction for the chosen wavelength has to be known to a good accuracy. The glass selected was BK 516-64 (producer J. W. O. Poland, melt number 13083, Standard PN 57/6862-06, $n_d = 1.51670$, $n_C = 1.51423$, $n_F = 1.52225$, $v_d = 64.4$). The refraction index for the length $\lambda = 1.06$ μm was evaluated form the dispersion formula

$$n = n_0 + \frac{C}{\lambda - \lambda_0} \tag{1}$$

where n_0, λ_0 and C are some constants characterizing the glass. The calculations resulted in the following values $n_0 = 1.49883$, $\lambda_0 = 159.3$, $C = 7.6537$ and $n = 1.50732$.

3. In accordance with the accepted assumptions the f-number is equal to 1. Hence, assuming the acting diaphragm to be as high as 40 mm we obtain for the focal length $f' = 40$ mm. The other parameters characterizing the lens are determined by the paraxial optics formulae

$$\Delta_k(n\alpha) = \frac{h_k \Delta h}{r_k}, \quad h_{k+1} = h_k - d_k\, \alpha_{k+1},$$

$$s'_{F'} = \frac{h_p}{\alpha'_p}, \quad \sigma'_{H'} = s'_{F'} - f' \tag{2}$$

where α_k denotes the angles between the light ray and the optical axis of the system, h_k denotes the intersection height of the ray with the boundary surfaces of the media, d_k is a corresponding curvature radius, f' denotes the focal length, $s'_{F'}$ is the focal distance and $\sigma'_{H'}$ is the principal point distance.

In our case $k = 1,2$, $p = 2$, $n_1 = n'_2 = 1$, $n_2 = n$ and $r_2 = \infty$. In particular for $d = 0$ (an infinitely thin lens) the curvature radius of the aspherical surface in the paraxial region has been calculated with the help of an arythmometer giving $r_1 = 20.293$ mm. For $d = 16$ mm (the thickness is relatively big to avoid possible deformations due to pressure difference in the object and image spaces) it has been obtained: $s'_{F'} = 29.385$ mm, $\sigma'_{H'} = -10.615$ mm, $s_F = -40.000$ mm and $\sigma_H = 0$.

4. A parametric equation of the aspheric surface profile is to be determined for the reversed pass of the light rays [4]. The requirements posed to the imaging quality (a perfect correction of the spherical aberration of a parallel monochromatic light beam) are equivalent to the condition of preserving the focal distance. Defining $a = \sin u'_2$ (u'_2 being an aperture angle in the image space) we obtain the aspheric surface profile equation in the form

$$\frac{dx}{dy} = \frac{a}{\sqrt{n^2 - a^2} - 1},$$

$$y = (d - x)\frac{a}{\sqrt{n^2 - a^2}} + s'_{F'}\frac{a}{\sqrt{1 - a^2}}. \tag{3}$$

5. Internal approximation. The numerical method of calculation consists in evaluating the profile of the aspherical surface of the lens point after point. When changing successively the parameter a we estimate the corresponding values of x and y. The programme of calculation is determined by the following formulae:

$$
\begin{aligned}
&1.\ a_k = \sin u'_{2k} \\
&2.\ A_k = \frac{a_k}{\sqrt{n^2 - a_k^2}}, \\
&3.\ B_k = A_k d + s'_{F'}\frac{a_k}{\sqrt{1 - a_k^2}}, \\
&4.\ C_k = \frac{1}{\frac{1}{A_k} - \frac{1}{a_k}}, \\
&5.\ D_k = C_k y_{k-1} - x_{k-1}, \\
&6.\ M_k = 1 + A_k C_k, \\
&7.\ x_k = \frac{C_k B_k - D_k}{M_k}, \\
&8.\ y_k = -A_k x_k + B_k
\end{aligned}
\tag{4}
$$

where $k = 1, 2, 3\ldots$

In accordance with the boundary conditions for the system of equations (3) it is assumed for the initial values of x and y the following: $x_0 = 0$, $y_0 = 0$ (for $a_0 = 0$).

6. The calculations have been made on an ODRA-1204 computer. The relation $y = F(x)$ may be determined (by tabelarising) with the arbitrary accuracy. For example, we give in the table the coordinates of several points of an aspheric surface profile for the lens and the deviation from the Abbe sine condition

$$\delta f' = \frac{y}{a} - f'.$$

7. For the control computing the corresponding values of x and y are used together with the respective $C = \frac{dx}{dy}$. The following formulae are to check the results obtained

x	0.0001	0.6274	2.5573	5.9640	11.2094
y	0.0400	5.0083	10.0225	15.0249	20.0064
C	0.0020	0.2503	0.5233	0.8488	1.2783
f'	-0.002	-0.147	-0.562	-1.235	-2.033

1. $\dfrac{x_k-x_{k-1}}{y_k-y_{k-1}} = C_k,$

2. $\operatorname{tg} u'_{1k} = C_k \dfrac{\sqrt{n^2(1+C_k^2)-C_k^2}-1}{\sqrt{n^2(1+C_k^2)-C_k^2}+C_k^2}$

3. $\sin u'_{2k} = n \sin u'_{1k}$, (5)

4. $s'_{F'} = [y_k-(d-x_k)\operatorname{tg} u'_{1k}]\operatorname{ctg} u'_{2k}$.

In accordance with the assumption the focus distance $s'_{F'}$ is constant for all the coordinates x, y which satisfy the equation (3). It has been obtained $s'_{F'} = 29.385$ mm.

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Lucjan Grochowski *

Magneto-Optic Modulator Using the Monocrystal YIG

The paper constains a description of a modulator giving large rotation angle of the polarization plane. Some results obtained when modulating laser beam of 1.15 μm wavelength are also given.

The magneto-optic modulation is based on the mutual interaction of optical radiation with an external magnetic field in materials, in which the optical properties depend on the applied magnetic field intensity. For modulators of the discussed type, the magneto-optic effects of Faraday and of Kerr are of practical application. The present paper deals with the first of these effects.

The Faraday effect known since 1845, has awaken new interests recently. It is due to the new materials giving large possibilities in measuring technique [2, 4, 5] and application of the effect to the investigations of semiconductors [10, 11]. Especially good properties for the design of modulators exhibits granate $Y_3Fe_5O_{12}$. Since the Faraday effect of this granate is rather large, this material was used for construction of the modulator described in the present paper.

As an optically active device a plane-parallel plate of 10 mm thickness, cut out from a single crystal of $Y_3Fe_5O_{12}$, free of impurities was used in the modulator. The crystal plate was placed in a solenoid producing magnetic field. The modulating wavelength was chosen to 1.15 μm, for two reasons. The first one is the pronouncement of magneto-optical properties at this wavelength, for there lies near by the absorption edge of radiation, the second reason is the easy use of the line when working with the He-Ne laser. The transmittance of the beam through the specimen is about 0.1; thus the light intensity can produce effects which are easily measured.

The dependence of the rotation angle α of the polarization plane on the magnetic field intensity produced by the electric current I flowing through

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