Ukrainian Journal of Physical Optics
ISSUE 4
2025

INCREASE IN THE ACOUSTO-OPTIC FIGURE OF MERIT IN SiO_2 CRYSTALS DUE TO OPTICAL ACTIVITY. ANISOTROPIC ACOUSTO-OPTIC INTERACTIONS. ERRATA

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Received: 03.10.2025

Abstract. In this work, we have corrected the errors that appeared in our recent publication [Mys O., et al., 2023. Ukr.J.Phys.Opt. 24(3) 262], and which are related to the accounting for in the relations for the effective elasto-optic coefficients of the ellipticity of the diffracted wave.

Keywords: acousto-optic diffraction, anisotropic diffraction, diffraction efficiency, quartz crystals, optical activity, ellipticity of optical eigenwaves
UDC: 535.43, 535.551, 535.562, 534-16
DOI: 10.3116/16091833/Ukr.J.Phys.Opt.2025.04109

Our recent paper [1] contains errors in deriving the relationships for the effective elasto-optic (EO) coefficients related to the VII, VIII, and IX types of anisotropic acousto-optic (AO) interactions in quartz crystals. These errors have been related to the accounting of these relations for the ellipticity not only of the incident optical wave but also of the diffracted wave. However, as shown in our later work [2], accounting for the ellipticity of the diffracted optical wave in the relations for the effective EO coefficient is erroneous. Therefore, the following corrections must be made to the paper:

Abstract. It has been shown that for the incident circularly polarized optical wave propagating along the optical axis, the value of the AO figure of merit is nearly twice as high as for the linearly polarized wave. When the incident optical wave deviates from the optical axis, the contours of the dependencies of the effective EO coefficient and AO figure of merit on the diffraction angle become the same for both circular and linearly polarized waves, which is caused by the decreasing ellipticity of optical eigenwaves.

Eqs. (3) and (5) should be disregarded. Eq. (12) should be written as:

$$p_{eff} = \sqrt{0.5(E_1^2 + E_2^2 + E_3^2)}\,. \tag{10}$$

Eqs. (17-21) should be replaced by:

$$\begin{aligned} p_{eff}^{2(\mathrm{VII})} &= 0.5\{p_{12}\cos\Theta\cos\xi + p_{13}\sin\Theta\sin\xi + p_{14}\sin(\Theta+\xi)\}^2 \\ &+0.5\chi^2 \left\{ \begin{array}{l} (p_{22}\cos\Theta\cos\xi + p_{23}\sin\Theta\sin\xi - p_{14}\sin(\Theta+\xi))^2\sin^2\varphi_i \\ +(p_{32}\cos\Theta\cos\xi + p_{33}\sin\Theta\sin\xi)^2\cos^2\varphi_i + (p_{42}\cos\Theta\cos\xi + p_{44}\sin(\Theta+\xi))^2 \\ +(p_{42}\cos\Theta\cos\xi + p_{44}\sin(\Theta+\xi)) \\ \times((p_{22}+p_{32})\cos\Theta\cos\xi + (p_{23}+p_{33})\sin\Theta\sin\xi - p_{14}\sin(\Theta+\xi))\sin 2\varphi_i \end{array} \right\} \end{aligned} \tag{15}$$

$$
\begin{aligned}
p_{eff}^{2(\mathrm{VIII})} &= 0.5\left\{p_{13}\sin\Theta\cos\xi - p_{12}\cos\Theta\sin\xi + p_{14}\cos(\Theta+\xi)\right\}^2 \\
&+0.5\chi^2\left\{\begin{array}{l}
(p_{23}\sin\Theta\cos\xi - p_{22}\cos\Theta\sin\xi - p_{14}\cos(\Theta+\xi))^2\sin^2\varphi_i \\
+(p_{33}\sin\Theta\cos\xi - p_{32}\cos\Theta\sin\xi)^2\cos^2\varphi_i + (p_{44}\cos(\Theta+\xi) - p_{42}\sin\Theta\cos\xi)^2 \\
+(p_{44}\cos(\Theta+\xi) - p_{42}\sin\Theta\cos\xi) \\
\times((p_{23}+p_{33})\sin\Theta\cos\xi - (p_{22}+p_{32})\cos\Theta\sin\xi - p_{14}\cos(\Theta+\xi))\sin 2\varphi_i
\end{array}\right\}
\end{aligned} \quad (16)
$$

$$
\begin{aligned}
p_{eff}^{2(\mathrm{IX})} &= 0.5\left\{p_{66}^2\cos^2\Theta + p_{14}^2\right\} \\
&+0.5\chi^2\left\{\begin{array}{l}
p_{14}^2\sin^2\Theta\sin^2\varphi_i - p_{14}p_{44}\sin^2\Theta\sin^2\varphi_i + p_{44}^2\sin^2\Theta \\
+p_{66}^2\cos^2\Theta\sin^2\varphi_i + 0.5p_{14}p_{66}\sin 2\Theta\sin 2\varphi_i + p_{14}^2\cos^2\Theta\cos^2\varphi_i
\end{array}\right\}.
\end{aligned} \quad (17)
$$

Figs. 2-4 should be replaced by Fig. 2:

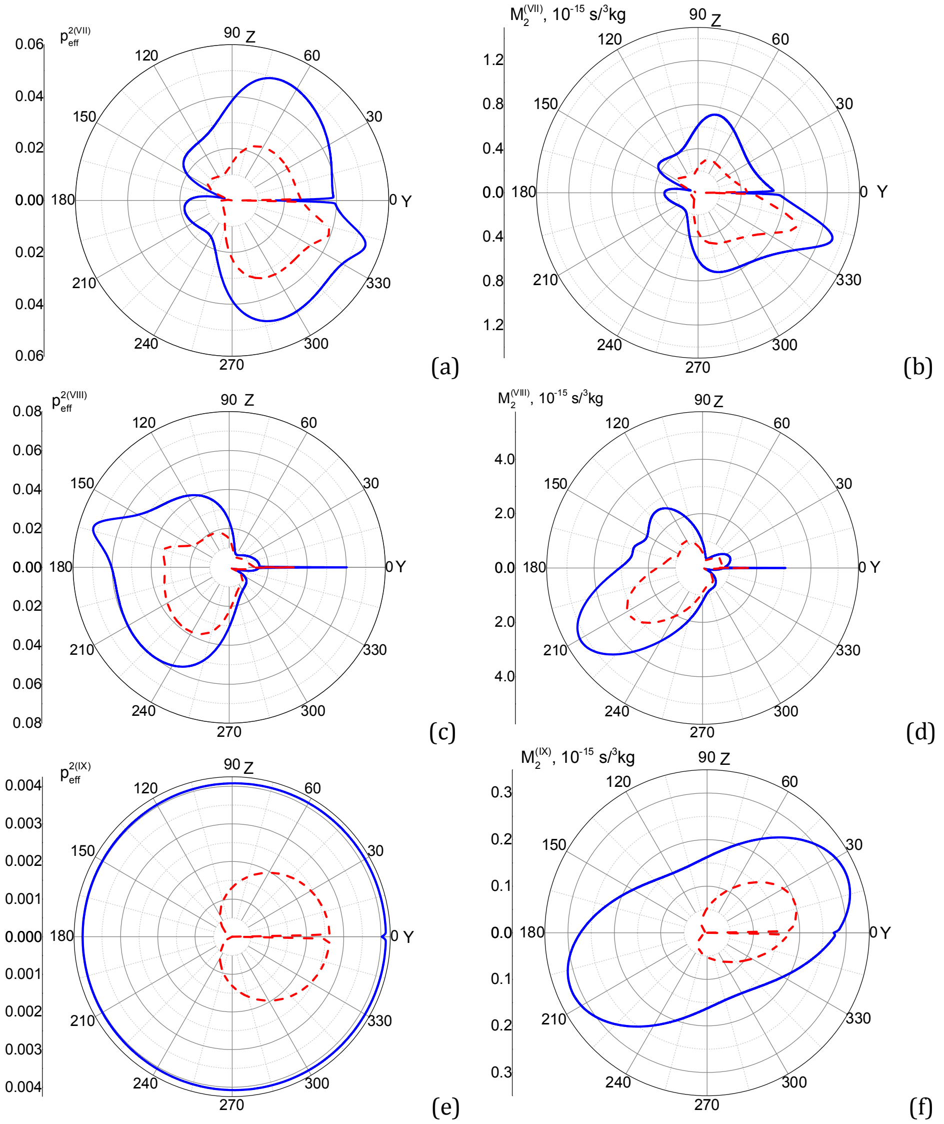

Fig. 2. Dependencies of the effective EO coefficient (a, c, e) and AO figure of merit (b, d, f) on the diffraction angle for the VII (a, b), VIII (c, d), and IX (e, f) types of AO interaction with accounting (blue solid curve) and ignoring (red dashed curve) the ellipticity of eigenwaves.

Figs. 5,6 should be replaced by Fig. 3:

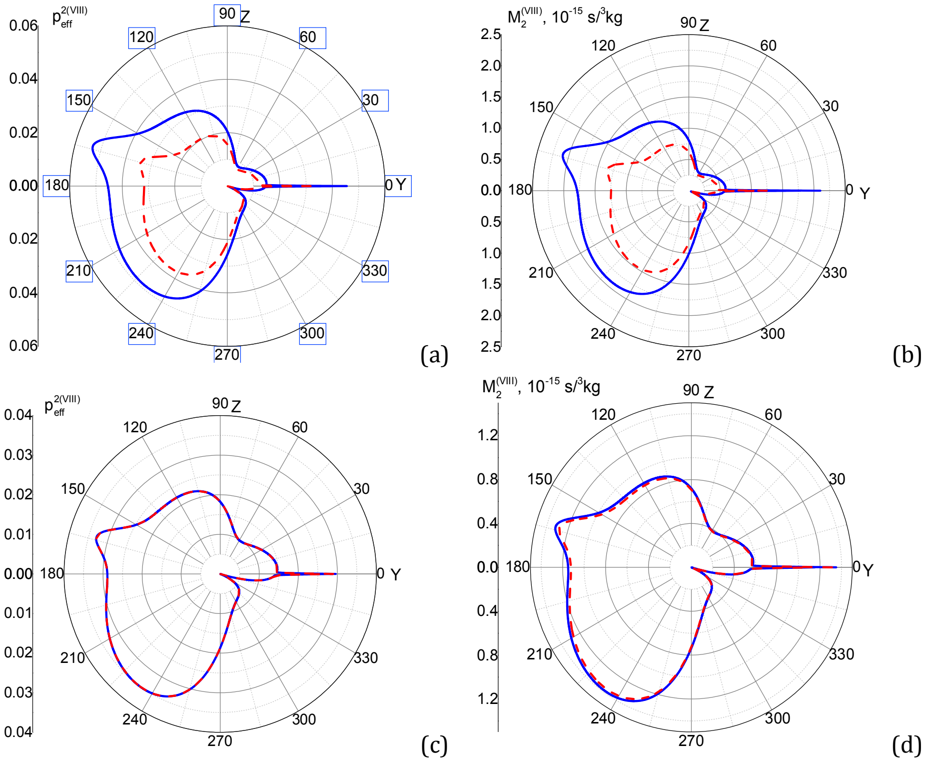

Fig. 3. Dependencies of effective EO coefficient (a,c) and AO figure of merit (b,d) on the diffraction angle at the incident angle equal to 88 deg (a,b) and 84 deg (c,d) for the VIII type of AO interaction with accounting (blue solid curve) and ignoring (red dashed curve) the ellipticity of eigenwaves.

Fig. 7 should be replaced by Fig. 4:

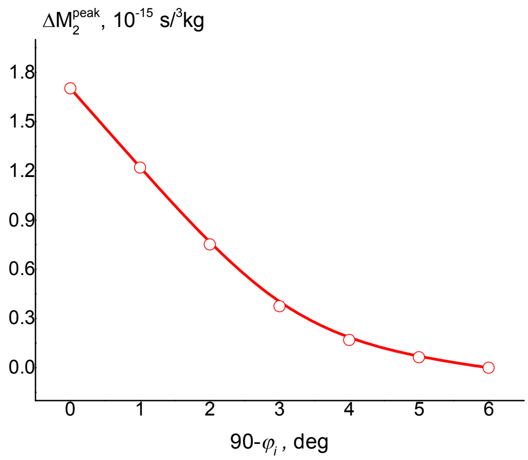

Fig. 4. Dependences of the peak increment magnitudes of the AO figure of merit on the angle $90-\varphi_i$ at the VIII type of AO interactions.

Paragraph "**3. Results and discussion**" should be written as:

As shown in Fig. 2, accounting for the circular polarization of the incident optical wave, which matches the polarization of the eigenwave, nearly doubles the effective EO coefficient and AO figure of merit for almost all diffraction angles. At the VII type of AO interaction with the quasi-longitudinal (QL) acoustic wave (AW), the maximal value of AO figure of merit (1.3×10^{-15} s^3/kg) is achieved at the diffraction angle -19 deg under conditions that account for the circular polarization of the incident optical wave (Fig. 2b). At the incidence of the linearly polarized optical wave, the AO figure of merit is equal to 0.96×10^{-15} s^3/kg. The increase in the AO figure of merit is 1.35 times. For the case of collinear AO diffraction on the QL AW, the AO figure of merit is 0.017 and 0.004×10^{-15} s^3/kg when accounting for and neglecting circular polarization of the incident optical wave, respectively (Fig. 2b). This results from the values of effective EO coefficients (Fig. 2a), which consider an additional term caused by ellipticity (Eq. 17). Note that collinear diffraction in this situation involves energy exchange between circularly polarized optical waves of different handedness.

The VIII type of AO diffraction on the QT_1 AW reaches a maximum AO figure of merit of 5.2×10^{-15} s^3/kg at the diffraction angle γ=211 deg, considering circular polarization of the incident light (Fig. 2c,d). These conditions correspond to nearly backward diffraction. For linearly polarized incident light, the AO figure of merit is 3.2×10^{-15} s^3/kg, which is 1.6 times lower. The AO figure of merit for the collinear type of diffraction increases from 1.7 to 3.1×10^{-15} s^3/kg, which is an increase of 1.8 times.

At the IX type of diffraction on the pure transverse AW, the increase in AO figure of merit is 1.5 times, from 0.2 to 0.3×10^{-15} s^3/kg (Fig. 2e, f). The maximum AO figure of merit occurs at γ = 23 deg. It is notable that collinear diffraction cannot occur under the conditions of an incident linearly polarized optical wave. However, it becomes possible when the incident optical wave is circularly polarized. In this case, the AO figure of merit equals 0.27×10^{-15} s^3/kg.

Now, let us consider the influence of the changes in the incidence angle of the input optical wave on the effective EO coefficient and the AO figure of merit for the VIII type of anisotropic diffraction. As it is seen (Fig. 3), the contours of dependencies of the effective EO coefficient and AO figure of merit on the diffraction angle with and without accounting for the ellipticity of the eigenwaves approach each other. At the incidence angle equal to 84 deg (Fig. 3c,d), they become the same. Such behavior results from the fact that the ellipticity of the eigenwaves approaches almost zero as the incident angle decreases, and the two contours merge into one. At the same time, the peak increment of the AO figure of merit, which relates to collinear diffraction, approaches zero as the incidence angle decreases for the VIII type of AO interactions (see Fig. 4). This effect results from the decreasing ellipticity of optical eigenwaves that occurs when the incident optical wave deviates from the direction of the optic axis.

Paragraph **“4. Conclusions”** should be written as:

In the present work, we have analyzed the anisotropic AO interactions with the three possible acoustic eigenwaves in the quartz crystals. This has been done with consideration of a nonzero ellipticity of the incident optical eigenwaves, which is caused by the optical activity effect. Moreover, the analysis has been performed accounting for the changes in the characteristic surfaces of the refractive indices (or the wave vectors) that occur due to circular birefringence. The non-orthogonality of the AWs has also been taken into account. We have obtained the dependences of the effective EO coefficients and the AO figures of merit on the diffraction angle. It has been shown that for the incident circularly polarized optical wave propagated along the optical axis, the value of the AO figure of merit is almost two times higher than for the linearly polarized one. When the incident optical wave deviates from the optical axis, the contours of the dependencies of the effective EO coefficient and AO figure of merit on the diffraction angle become the same for both circular and linearly polarized waves. This occurs because the ellipticity of the eigenwaves approaches zero. The peak increase of the AO figure of merit, related to collinear diffraction, approaches zero as the incidence angle decreases for the VIII type of AO interactions. This is caused by the decreasing ellipticity of optical eigenwaves when the incident optical wave deviates from the optical axis.

References

1. Mys, O., Adamenko, D., & Vlokh, R. (2023). Increase in the acousto-optic figure of merit in SiO2 crystals due to optical activity. Anisotropic acousto-optic interactions. *Ukrainian Journal of Physical Optics*, *24*(3), 262-275.
2. Mys, O., Kostyrko, M., & Vlokh, R. (2024). Polarization of the Diffracted Optical Wave in the Crystals with Circular Optical Birefringence and Efficiency of Acousto-Optic Interaction Associated with Circularly Polarized Optical Waves in the Optically Active Crystals of Cubic System. *Ukrainian Journal of Physical Optics*, *25*(4), 04051-04062.

Mys, O., Adamenko, D. and Vlokh, R. (2025). Increase in the acousto-optic figure of merit in SiO_2 crystals due to optical activity. Anisotropic acousto-optic interactions. Errata**.** *Ukrainian Journal of Physical Optics*, *26*(4), 04109– 04113.
doi: 10.3116/16091833/Ukr.J.Phys.Opt.2025.04109

Анотація. *У цій роботі ми виправили помилки, що з'явилися в нашій нещодавній публікації [Mys O., et al., 2023. Ukr.J.Phys.Opt. 24(3) 262], і які пов'язані з врахуванням у співвідношеннях для ефективних пружнооптичних коефіцієнтів еліптичності дифрагованої хвилі.*

Ключові слова: *акустооптична дифракція, анізотропна дифракція, ефективність дифракції, кристали кварцу, оптична активність, еліптичність оптичних власних хвиль*