Investigation phase
in case of Bragg coupling

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Abstract

These results of investigation have show higher controlling possibility by light waves diffraction phases in case Bragg coupling Diffraction of isotropic, anisotropic interaction which take place simultaneously.

The occurrence source These distinction case of interaction produced from additional phase shift of light pass through the ultrasonic waves meshes as diffraction grating ,and controlling by parameters dual interaction Through (Raman-Nath) Parameters.

This evident variation in light waves diffraction phases ($\varphi_0, \varphi_i, \varphi_a$) which reach to ($\pi$) with wide range value of Raman-Nath Parameters ($1.95\pi > v_i$,a $>1.7\ \pi$) and unappearance of jump in phase of diffracted wave light in any order of diffraction must be to take in to consideration when the modern (Acousto-optics) devices design.

1. Introduction

The laser invention has led the development of acousto-optics interaction and its application, mainly for grating phase, deflection, modulation and signal processing. Technical progresses in utilization of efficient birefringent crystals and high frequency piezoelectric transducer have brought valuable benefit to acousto-optics components improvement[1,2,4].

In these types of interactions can show the light diffraction by ultrasound in crystals in usually is accompanied by change in optical polarization and intensities, with important change in matching phase. All this important changes can be describe as a sum of single collision , each of which involves the annihilation of one incident photon at frequency (ω_i) and one phonon at frequency (Ω) and simulations creation of a new (diffracted) photon at frequency (ω_d) as.

$$\omega_d = \omega_i + \Omega \qquad \text{……………………………………………..(1)}$$

Which propagates along the direction of scattered beam? The conservation of momentum requires that the momentum ħ(k+K) of colliding particles be equal to the momentum $\hbar k_d$ of scattered photon ,so that.

$$k_d = k_i + K \qquad \text{……………………………………………...(2)}$$

Therefore the diffracted beam is shifted in frequency by an amount equal the sound frequency (Ω) this lead $\omega_d > \omega_i$. But were reversed the direction of the sound beam, the scattering process could be considered as on in which a new photon (diffracted photon) and a new phonon are generated while the incident photon is annihilated. In this case, the conservation of energy from the two case as [2-5].

$$\omega_d = \omega_i \pm \Omega \qquad \text{……………………………………………..(3)}$$

This relation between the sign of frequency change and sound propagation direction is consistent with Doppler-shift. This phenomena which occurs in isotropic and anisotropic media simultaneously also in birefringent crystals only or homogenous crystals [7,6].

The present investigation concentrates on phases additional in case Bragg Coupling matching that is take place during so-called mixed isotropic –anisotropic diffraction. As coupling additional phases in up-down shifted regimes of interaction,

in two orders diffraction. This mater acquires the property of an optical phase grating for a period to the acoustic wavelength.

2. Theory Part

Under The supposition of plane waves, the light phase in all diffraction orders during the interaction of Bragg coupling phase (φ) in isotropic-anisotropic diffraction which occurs simultaneously as additional phase-shift .May be determine from system of coupled waves equation (is known) as function of Raman –Nath parameters (v_a and v_i) [2,5].

$$v = \frac{\pi l}{\lambda}\sqrt{M_2 P} \qquad \text{..........................(4)}$$

Equation (4) show The Raman-Nath parameter is proportional to the squire root of acousto – optic figure merit ($v \propto \sqrt{M_2}$) .

$$M_2 = \frac{p^2{}_{ia}\, n_{ia}^6}{\rho V^3} \qquad \text{..........................(5)}$$

It is know that (M_2) proportional to the second power of effective photoelastic constant (p_a or p_i) providing the isotropic or anisotropic acousto – optic interaction, $M_2^{(a)} \propto p_a^2$ and $M_2^{(i)} \propto p_i^2$ [1, 7].

Therefore the ratio of Raman-Nath parameters during the combined interactions is equal The ratio of effective photoelastic constants ($v_a / v_i = p_a / p_i$).The values of effective photoelastic constants (p_a , p_i) were found from the changes of the coefficients of optical indicatrix [3,6].

The Bragg coupling phase in addition to the additional phases-shift ($\varphi_{i,a}$) where (i,a) referring to the isotropic and anisotropic diffraction respectively. Corresponding system of coupling waves equation [1].easily to obtain it where [$\Delta\varphi = \tan^{-1}(y/x)$] therefore the system of coupled waves Eg. Can be written as.

$$\left.\begin{aligned}
\Delta\varphi_0 &= \left[\tan^{-1}\left(Cos\frac{\sqrt{\nu_a^2 + \nu_i^2}}{2}\right)\right] - \frac{\nu_a}{4} \\
\Delta\varphi_a &= \tan^{-1}\left[\frac{-1}{\sqrt{\left(\frac{\nu_i}{\nu_a}\right)^2 + 1}} Sin\left(\frac{\sqrt{\nu_a^2 + \nu_i^2}}{2}\right)\right] + \frac{\nu_a}{2} \\
\Delta\varphi_i &= \tan^{-1}\left[\frac{-\frac{\nu_i}{\nu_a}}{\sqrt{\left(\frac{\nu_i}{\nu_a}\right)^2 + 1}} Sin\left(\frac{\sqrt{\nu_a^2 + \nu_i^2}}{2}\right)\right] + \frac{\nu_a}{2}
\end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

Remarkable the relation between Raman-Nath parameters present, the ratio v_a / v_i is evaluated on the basic of the used birefringent crystals, which dependent on the type of acoustic mode and on the chosen crystal cut.

3 .<u>Results and Dissection</u>

From Eg. (6), calculation the changes of phases coupling, are presented in two figures (1 and 2) as function of Raman- Nath parameter v_a (expressed in unites of π).

The figures shows the graph of the phases (φ_0,φ_i, φ_a) of zeroth and isotropic , anisotropic diffraction orders respectively, where The zeroth phases φ_0 is represented by square curve while the anisotropic diffraction phase φ_a is represented by sold and the isotropic diffraction phase φ_i is represented by dashed curve. Here observed important difference between all the figures from where the streamlined at all curves to reaches maximum value for change in phase, versus value of v_a which in range (1.7-1.95) π.

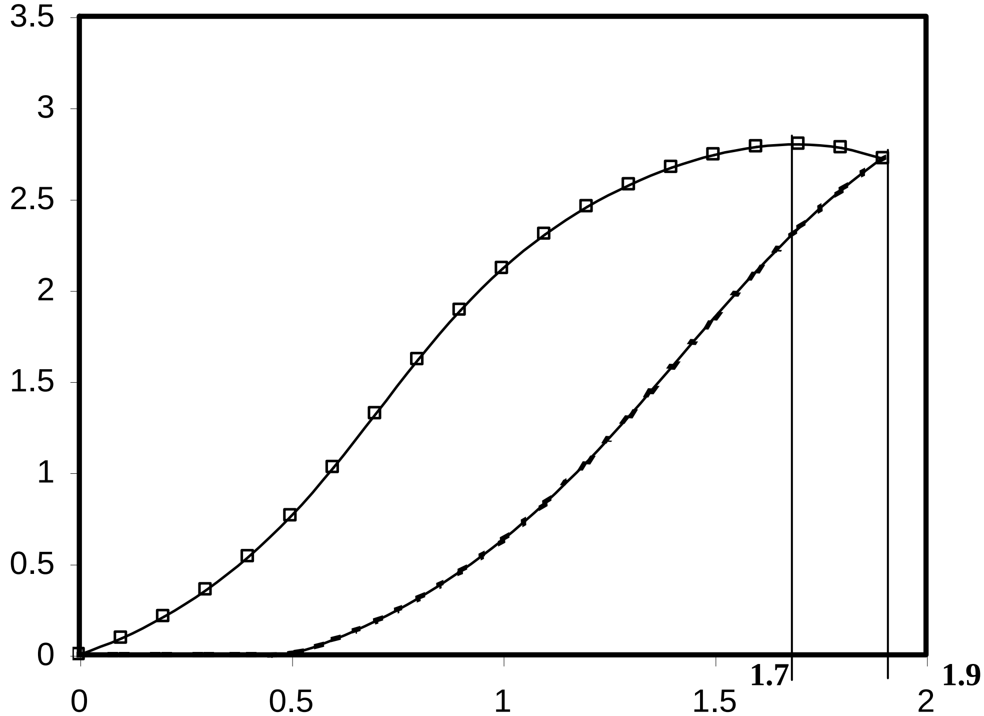
Moreover, more important observation the cutoff product of phases ($\varphi_{i,a}$) up to value (v_a = 0.5π) occurs only with ratio v_a / v_i =1 that means that the acousto-optics interaction will vanish at lower values of Raman- Nath parameter v_a.

On the other hand, from figure (1a) the change in phase of zeroth order reach to value (π) as the streamlined uniform progressive without jump to (π) directly, as well know the Bragg traditional condition. It is evident that during Bragg scattering appear to us the value of anisotropic - isotropic phase, they are meeting in a high values at Raman- Nath parameter v_a. All this differences as a result of an increase of the ratio of the Raman-Nath parameters v_a / v_i from (1 to 4).

Remarkable the peak phases are obtained at high value of the Raman-Nath parameters. Figs. (1),(2) shows that the values of parameters v_a and v_i at maximum phases (φ_0,φ_i, φ_a) are always observed in range (1.95π > v_i ,a >1.7 π).

6. Conclusion

The study shows that in case of Bragg coupling in anisotropic – isotropic of acousto-optics interaction the change of light phase is take place with the two interactions simultaneously. The additional phase is consistent with Doppler-shift , in addition the magnitude of the change phase depended on the ratio of Raman-Nath parameters v_a / v_i which depended on acoustic power P and The ratio of effective photoelastic constants (p_a , p_i).That changes a given possibility controlled phase of light wave in isotropic or anisotropic diffraction simultaneously, with wide range value .



(a) For the ratio $\nu_a/\nu_i = 1$

(b) For the ratio $\nu_a/\nu_i = 2$

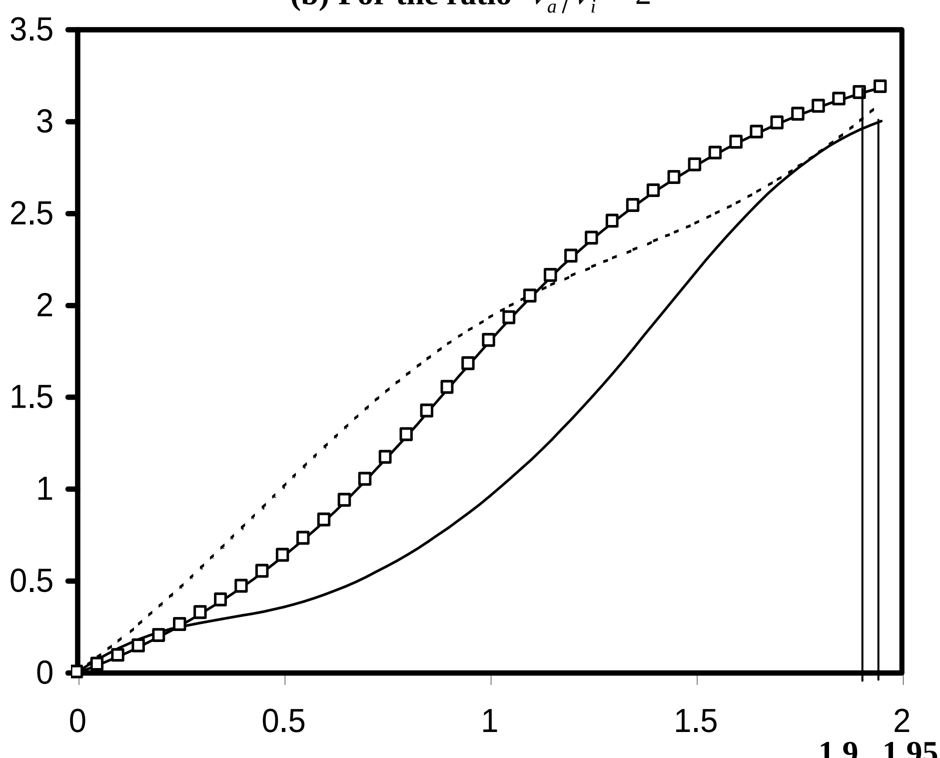
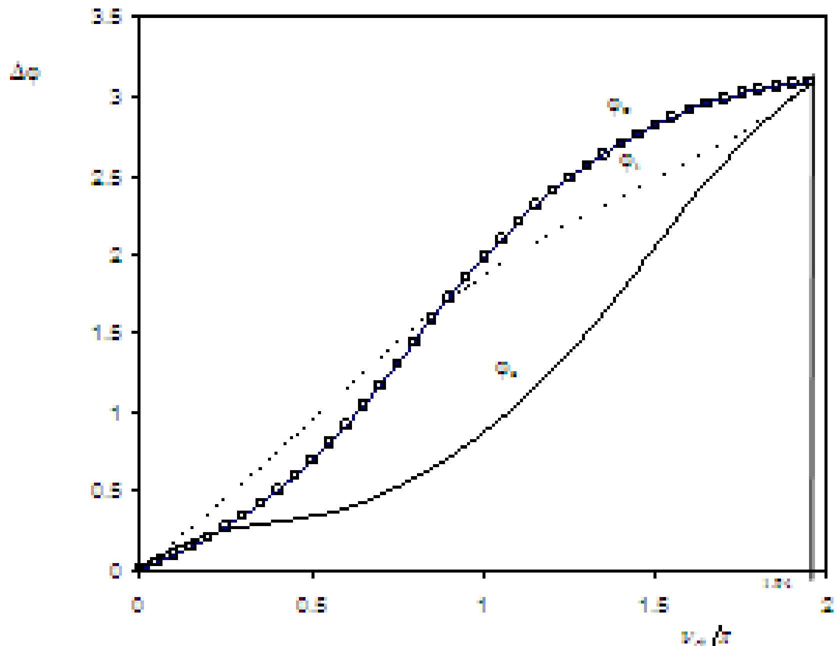
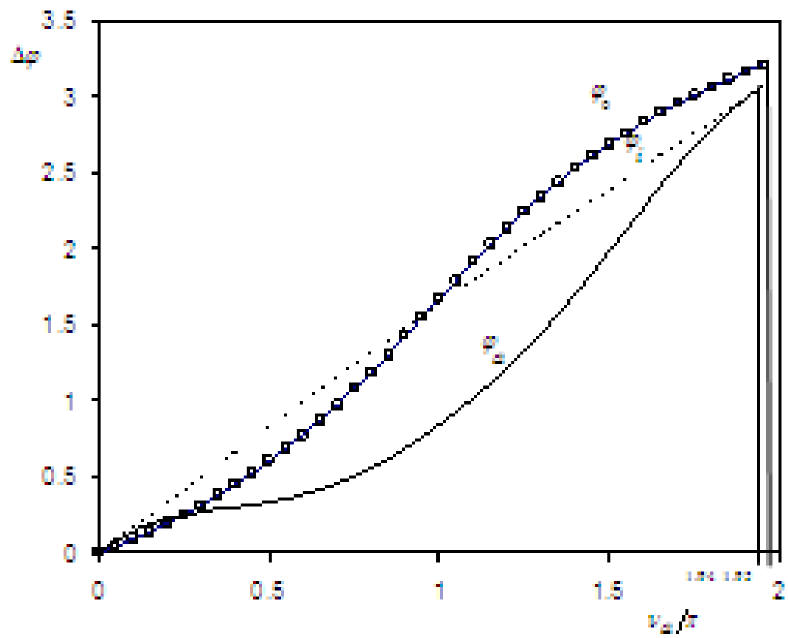


Fig.(1) Phase changing for combined processes.



v_s / v_i = 3 (a) For ratio



(b) For ratio v_s / v_i = 4

Fig.(2) Phase changing for combined processes.

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