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ANALYSIS OF SOLUTION VARIETY OF THE FWM PROBLEM AT CO-PROPAGATING LASER BEAMS WITH THEIR NONZERO INCIDENT INTENSITIES [1]

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As it is well-known, FWM is widely used in various problems for laser interaction with matter (see, for example, [1, 2]). As a rule, FWM accompanies with self-action of interacting laser beams. To explain physical experiments and to increase efficiency of FWM we propose an analytical solution, based on the problem invariants (conservation laws for laser pulse interaction).

We consider the FWM for co-propagating laser pulses in a medium with cubic nonlinear response. In the framework of slowly varying envelope, the considered process is governed by the set of dimensionless nonlinear Schrödinger equations with respect to complex amplitudes of interacting waves. In the long pulse approximation the waves interaction can be described by following equations

$$\begin{aligned}
&\frac{da_1}{dt} + 2\alpha_1 a_2 a_3 a_4 \sin\varphi = 0, \frac{da_2}{dt} - 2\alpha_2 a_1 a_3 a_4 \sin\varphi = 0,\\
&\frac{da_3}{dt} + 2\alpha_3 a_1 a_2 a_4 \sin\varphi = 0, \frac{da_4}{dt} - 2\alpha_4 a_1 a_2 a_3 \sin\varphi = 0,\\
&\frac{d\varphi}{dt} + 2\cos\varphi(\alpha_1 \frac{a_2 a_3 a_4}{a_1} - \alpha_2 \frac{a_1 a_3 a_4}{a_2} + \alpha_3 \frac{a_1 a_2 a_4}{a_3} - \alpha_4 \frac{a_1 a_2 a_3}{a_4}) -\\
&- \alpha_1 {a_1}^2 + \alpha_2 {a_2}^2 - \alpha_3 {a_3}^2 + \alpha_4 {a_4}^2 = 0, \varphi = \varphi_2 - \varphi_1 + \varphi_3 - \varphi_4
\end{aligned} \tag{1}$$

with initial conditions $a_1|_{z=0} = a_{10}, a_2|_{z=0} = a_{20}, a_3|_{z=0} = a_{30}, a_4|_{z=0} = a_{40}, \varphi|_{z=0} = \varphi_0$.

Above, an amplitude a_j and phase φ_j are real functions and they relate with a complex amplitude A_j; z denotes a spatial coordinate along which a pulse propagates. Parameters α_j characterize laser beam self-action due to cubic nonlinear response.

In our method we have obtained an algebraic equation with respect to a function φ and intensities of the interacting waves instead the differential equation. Using this equation we solved the set (1). The problem solution analysis has shown the variety of FWM modes, which include a bistable mode also. We have analyzed explicit dependence of intensities on problem parameters.

REFERENCES

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