Electro-optical Modulator - 2 Harmonics

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1. Introduction

This work demonstrates the generation of frequency components of the laser beam modulated by an electro-optic modulator (EOM) with the frequency of 230.5 MHz. This method of laser harmonic generation can be used in experiments with ultra-cold atoms, to excite several transitions simultaneously in ^{6}Li atoms, and in quantum calculations with cold trapped ions. Objective of this work was to generate frequency harmonics using an electro-optical modulator in a monochromatic laser beam and measuring the harmonics power as a function of the amplitude of the signal applied to the electro-optical modulator.

2. Experiment

Experimental setup is shown on fig.1. The laser radiation of horizontal polarization is directed through an optical fiber into the EOM and is focused on the interferometer using a lens. For the most efficient operation, it is necessary that the Gaussian beam fully enters the EOM along the normal. Sinusoidal signal with a frequency of 230.5 MHz and regulated voltage of 0-4.5 V is fed to the EOM, depending on which the level of harmonics of the laser radiation at the output of the EOM changes. The signal applied to the EOM has the form: $U = U_m \sin{(2\pi f_m)}$.

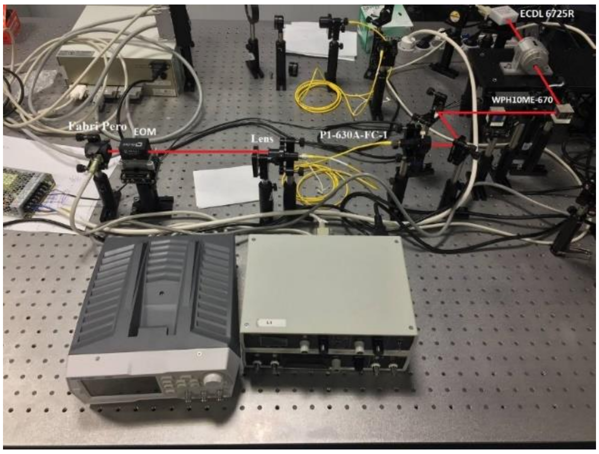

Fig. 1: *Experimental setup*

3. Results

Considering the phase-modulated laser signal at the EOM output, its representation in the form $E(t) = E_0 \sum_{n=-\infty}^{\infty} J_n(\varphi_0) \cos{[(2\pi f_0 + n 2\pi f_m)t]}$ was obtained where J_n is the Bessel function, E_0 is the laser amplitude, f_0 is the laser frequency, f_m is the frequency of the sinusoidal signal fed to the EOM, φ_0 is the

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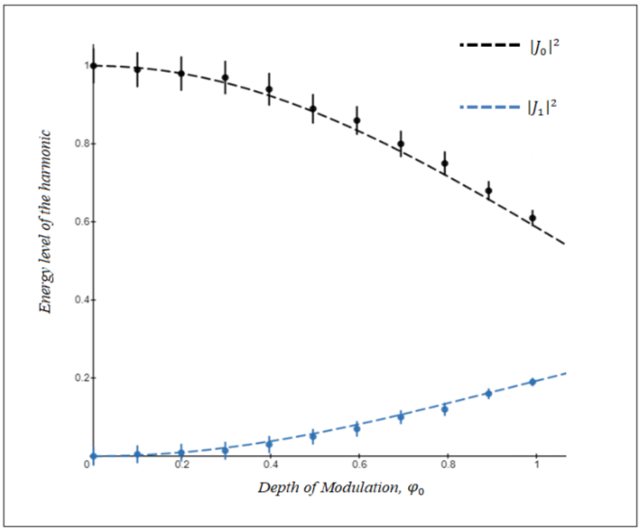

Fig.2: *Plot of the level of the first and second harmonic of the laser as a function of the modulation depth*

modulation depth, which is defined as $\varphi_0 = 0.22 \cdot U_m$. Due to this representation, we can obtain the ratio for the power levels of the first and second harmonics defined as $\frac{|J_0|^2}{|J_1|^2}$.

The harmonic power level was normalized to the laser energy $|E_0|^2$.

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