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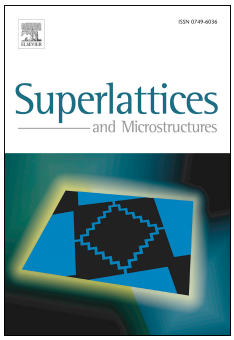

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Thermally and electrically controllable multiple high harmonics generation by harmonically driven quasi-two-dimensional electron gas.

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Abstract

In this paper, we consider the activation processes in nonlinear meta-stable system based on a lateral (quasi-two-dimensional) superlattice and study the dynamics of such a system externally driven by a harmonic force. The internal control parameters are the longitudinal applied electric field and the sample temperature. The spontaneous transverse electric field is considered as an order parameter. The forced violations of order parameter are considered as a response of a system to periodic driving. We investigate the cooperative effects of self-organization and high harmonic forcing from the viewpoint of catastrophe theory and show the possibility of generation of third and higher odd harmonics in output signal that lead to distortion of its wave front. A higher harmonics detection strategy is further proposed and explained in detail by exploring the influences of system parameters on the response output of the system that are discussed through numerical simulations.

Keywords: Lateral superlattices; Applied electric field; Spontaneous electric field; Nonequilibrium phase transitions; Synergetic potential; Multiple high-order harmonic generation; Forced bifurcations

1. Introduction

The influence of harmonic forcing on nonlinear dynamical systems is a very important area of research. The combination of harmonic forcing and nonlinear dynamics can produce high distortions of input harmonic signal. This is especially true in the vicinity of bifurcation points, where the external forcing has its greatest influence.

Analysis of forced vibrations as a response to periodic driving is major tool for characterizing physical systems. Substantial enhancement of nonlinear high-order harmonics generation based on nonlinear filtering systems has received growing interest due to their promising potential for developing integrated and advanced next-generation nano-devices (see [1, 2, 3] and references cited therein).

The traditional mechanism for generating higher harmonics is due to nonlinearities in the system transfer characteristics. The artificially grown quasi-two-dimensional structure – the lateral superlattice (2SL) may serve as an example of materials with required properties. The generic model of SLs, considered in [4, 5], is composed of cylinders of GaAs imbedded in a very thin epilayer of GaAlAs. The GaAs cylinders are arranged in a two-dimensional square-lattice array within the epilayer. The different parameters, including layout and material, can be changed while still retaining the superlattice nature of the structure. Such semiconductor structure being highly nonlinear in the non-equilibrium state represents rather suitable model system for investigation of general rules of self-organization and forced response output in complex nonlinear systems.

In this paper we follow an approach developed in [6, 7, 8, 9] and consider the non-equilibrium electron gas from a viewpoint of catastrophe theory which provides a powerful tool to discover a criterion for stability and instability in given system in a situation when the non-equilibrium phase transitions (NPTs) occur. The "seed" NPT consists in the appearance of a spontaneous transverse electric field. By variation of control parameters the reorganizations of the

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