ΠΑΝΕΠΙΣΤΗΜΙΟ ΚΡΗΤΗΣ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΥΛΙΚΩΝ

ΠΑΡΟΥΣΙΑΣΗ ΜΕΤΑΠΤΥΧΙΑΚΟΥ ΔΙΠΛΩΜΑΤΟΣ ΕΙΔΙΚΕΥΣΗΣ

Τίτλος

«Electromagnetic Wave Control Through Photonic Crystals and Metamaterials»

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Abstract

The investigation of emission rates of quantum emitters placed in a variety of environments is a problem of fundamental importance in many branches of physics and engineering, such as quantum optics, classical and quantum information processing, lightning, sensing, and others. Despite that importance, it was not realized until the middle of the previous century that the rate at which quantum emitters de-excite spontaneously depends not only on the emitter itself but also on its local environment, which can lead from full suppression of spontaneous emission to extreme enhancements.

In this Master's thesis, using the Finite Difference Time Domain Method (FDTD), the conditions for either suppressed of enhanced emission rate are investigated in two physical systems: (a) three-dimensional photonic crystals of finite size, exhibiting a full band-gap; (b) metal films with subwavelength apertures. In the first system, which concerns photonic crystals of inverse wood-pile structure, the role of the crystal size was examined on the shielding of electromagnetic fluctuations of emitters placed in to the crystals. Modified emission rates are calculated for different crystal sizes, positions and orientations of the emitter. It is found that only a few unit cells per axis are enough to observe a 1000-fold inhibition of the emission rate for emitters placed at the center of the structure and for the central frequency of the photonic band gap. In the second system, the association of the phenomenon of Extraordinary Optical Transmission (EOT) observed in metal films with subwavelength apertures with the emission rate of emitters placed in the neighborhood of those apertures was attempted. Elevated emission rates up to 200 were found at the same wavelength as the EOT resonance.