Bulletin of Pure and Applied Science Physics, Vol.43D No.2, July-December 2024 P.64-68
Original Research Article
Print version ISSN 0970 6569
Online version ISSN 2320 3218
Available online at www.bpasjournals.com

Characteristics of Bimodal Optical Nanoantennas Using Plasmonic Cavities Coupled to Quantum Emitter

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Received on 20.04.2024, Revised on n 04.08.2024, Accepted on 20.10.2024

ABSTRACT We have studied the characteristic features of nano antennas. For this purpose nano grant technology scalable fabrication technique was used. Non classical light emission in nano plasmonic cavities played positive role in the case of nano antennas. This is due to bimodal Plasmons. During the study it was found that time photon was generated and entanglement was high. The scattering was also found during this study and rate of scattering rate was calculated using nano cavity system. The study of different modes were also examined and was found stable in the regime of material of nano case. The efficiencies of nano antennas were found better than previously fabricated nano antennas. The bimodal containing plasmon state were also studied, which also produced the characteristic features. These situations are favorable for transmission and reception of radio waves.

KEYWORDS Characteristic Feature, Nano Antenna, Grant Technology, Emission Plasmons, Bimodal, Cavity Entanglement, Scattering.

How to cite this article: Kumar N. and Yadav G. (2024). Characteristics of Bimodal Optical Nanoantennas Using Plasmonic Cavities Coupled to Quantum Emitter. *Bulletin of Pure and Applied Sciences- Physics*, 43D (2), 64-68.

INTRODUCTION

Fitzgerald et al. [1] studied plasmonic excitations in the case of electrons of longitudinal modes and higher energies were obtained classically. The enhancement of large field for molecular level was found for plasmonic antennas. The effect of electromagnetic field was studied by Maier [2] and was found optical response of metal on plasmon frequency. It was found that it is useful for potential applications in sensing. Arslanagi et al. [3] studied multilayered cylindrical nanoantennas for directional cases and it was found that it was optimized for higher modes. It was also found that the system structure was scalable for frequencies of any regime. Ahmed and Gordon [4] studied the application of directivity of optical nano antennas. It was used for enhancement of Raman spectroscopy, single photons remote sensing, photo detection and power transmission. In the case of directionity the good response were found. Liu et al. [5] presented electric and magnetic dipolar methods for the study of broad radiation patterns and the directivity was found higher. Bauml et al. [6] studied the uses of optical nano antenna, which was made with array of Re/Pt bilayer strips. In this technique the plasmonic resonance was found of orthogonally polarized strips. The antenna arrays produced enhancement of Raman Signal with carbon nanotubes for obtaining results using the simulations. Novotny and Hechut [7] studied the properties of optical nanoantennas having plasmonic nanostructures. This was possible for long wavelengths. In this process there was amplification of near optical regime on the surface of localized plasmon resonance. This phenomenon affected the optical spectroscopy during finding single molecule. Zang et al. [8] studied the nanostructured eigen modes in the absence of excitation fields for effective mode matching fields due to backward propagation. When the inverse approach was used then favorable match was found for several eigen modes which favoured beam shaping to obtain control on tunable modes. Staude etal and others [9-12] studied the impact of optical usefulness of local field plasmonic during interaction of light field with nanostructures. The high index nano particles were found for directional scattering. Cambiasso et al. [13] and Camacho-Morales etal and others [14-15] studied tailing of second harmonic for enhanced Raman scattering. Zhang et al. [16] made presentation of hybrid resonances produced due to higher order vector beams during helical phase. Konecna et al. [17] studied the characteristic of electric effect on photonic systems due to induced optical fields. This technique was used for the study of vortex electron beams and generated loss of energy of electrons. In this study response of dielectric nanoantennas was found. The different efficiencies of electric and magnetic fields were used to calculate the results. The accelerated voltage determined the properties of excitations. The study of chirality was made to obtain dichroism in electron energy for obtaining nanostructure. Giannini et al. [18] presented strength of localized surface polariton for plasmonic nano structure for applications in engineering light within certain limits of optical phenomenon. Kfir et al. [19] studied experimentally the electron beams to present response of dielectric antenna by technique known as electron energy loss spectroscopy and also by Alexander et al. [20]. Vanacore et al. [21] studied the production of vortex electron beams which were useful for the interaction study having excitations in magnetic and electrical fields. Holsteen et al. [22] and Traviss et al. [23] studied dielectric system characterization considering magnetic and electric fields through wave guides.

METHOD

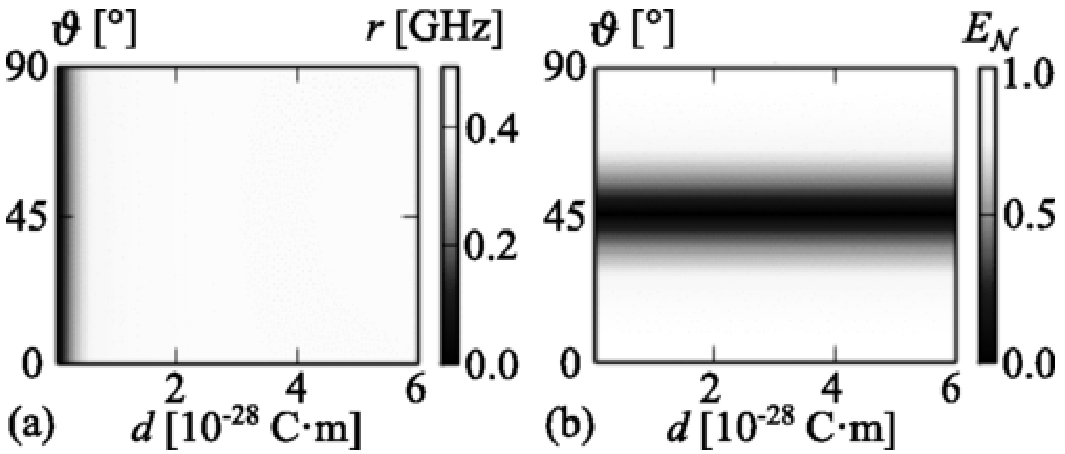
Nanoantennas are characterized by two overlapping resonances coupled to and adjacent quantum emitter. A hybrid plasmonic device emits light in two modes and entangled in the occupation number. Depending on the shape of nano antenna the emission of two modes differ in geometry patterns, polarization or involved emission frequencies. We have emphasized the similar bimodal nano antennas fabricated. The emitted states were used for quantum computing information processing. Quantum emitter is the source of photons and capable of emitting only one photon at a time. Due to presence of the nano antenna of a bimodal character the photons are emitted with a high probability in the two nano antenna modes. The nano antenna is the source of nonclassicality. The nano antennas whose scattering and absorption spectra are characterized by two overlapping but unoccupied resonances. The scattering and absorption rates and coupling strengths for quantum emitters in the vicinity were calculated. The nano antenna used had equidistant placement of quantum emitter with respect to the two nanorods. With the quantum emitter located, the coupling to the two different modes were controlled by the orientation of the transition dipole moment of the quantum emitter. The scattering spectra of nano antenna was found using the relation

$$P^{scat}(\omega) = \oint_A S^{scat}(r,\omega).dA.$$

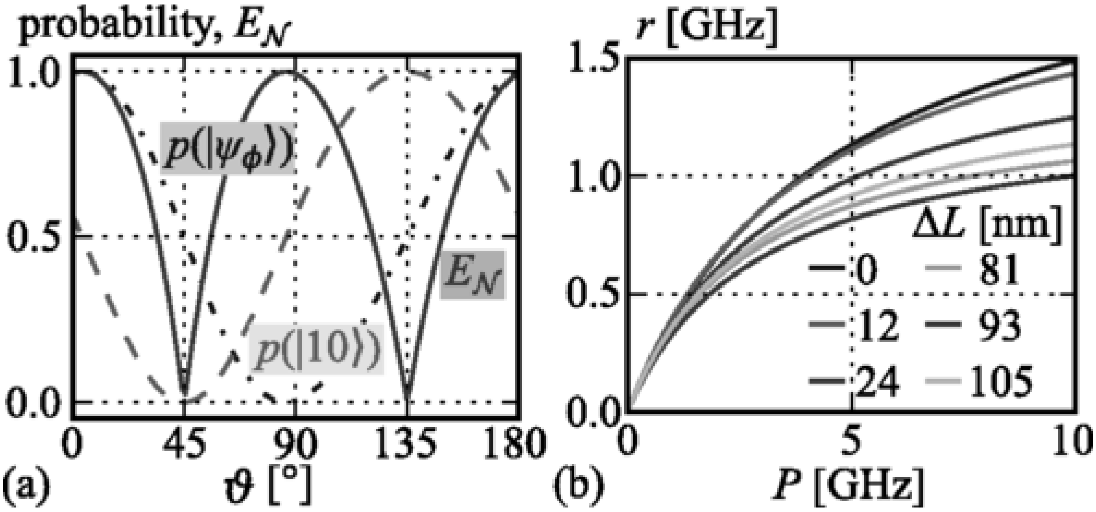
Where $S^{scat}(r,\omega)$ is the poynting vector, integrated over a closed surface A.

RESULTS AND DISCUSSION

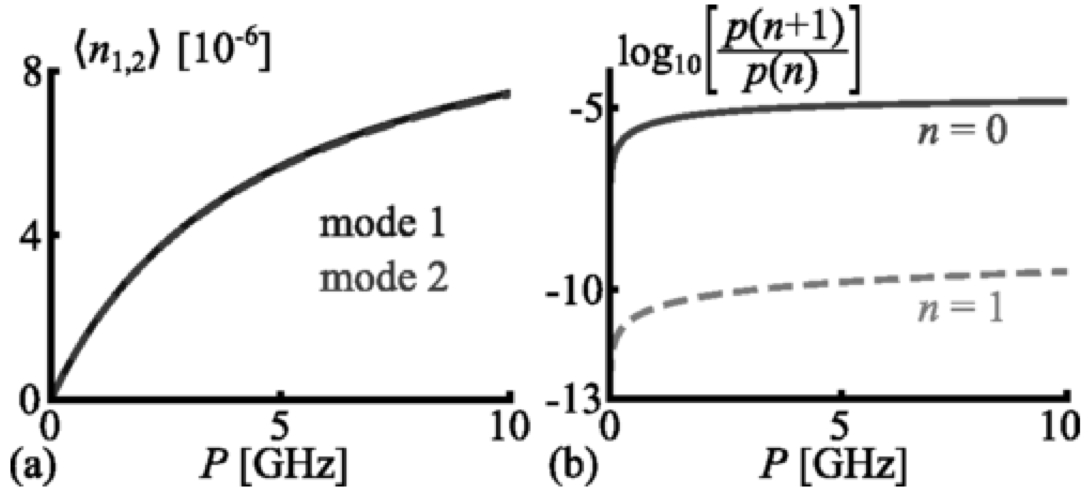
The photonic emission rate and degree of entanglement of light emitted by the hybrid system of bimodal nano antenna and quantum emitter were calculated and they have been represented as a function relevant parameters. Graph (1) (a) shows the dependence of the emission rate on the transition dipole moment of the quantum emitter. In plasmonic cavities nanoantenna grown into corresponding proportional to the dipole moment magnitude for each of the two modes. Graph (1) (b) shows the plot of entanglement versus rescaling and the balance in properties of both modes leaded to the high degree of entanglement. This balance occurred naturally only for selected orientation of the quantum emitter which corresponded to a parallel excitation of both modes. Graph (2)(a) shows the logarithmic negativity depending on the quantum emitter orientation. At the orientation it was parameterized by $\Theta = 45^o$ and 135^o. Graph (2) (b) shows the rate and degree of entanglement of the emitted light. For calculations we have fixed the quantum emitter transition frequency and result was found very stables, when the lowest brightness of nano antenna were available, and it was found that the emission rate was reduced by 30% with respect to the best symmetric one. We have shown that the presence of both symmetric Lorentzian state corresponding to isolated modes and asymmetric Fano state corresponding to coupled modes were found in the spectra of golden nano rods. In quantum mechanical representation as individual bosonic modes, we have found that two uncoupled Lorentzians accurately represent the simulated spectra. A small occupation number found enormous scattering and absorption rates of the nano antenna and the probabilities of the total number of photons larger than one were an additional 10 orders of magnitude lower as shown in graph (3)(b).



Graph 1: Plot of total photon emission rate as function of the dipole moment.



Graph: 2: Plot of logarithmic dependence vs quantum emitter orientation.



Graph 3: Plot of stationary exception values of the number of photon modes as function of pump rate.

CONCLUSION

We have studied the characteristics of bimodal optical antenna using plasmonic cavities coupled to quantum emitters. The spectra of nano antennas were characterized by two overlapped resonances coupled to an adjacent quantum emitter. A hybrid plasmonic device emitted light in two modes were entangled in the occupation number. Depending on the shape of nano antenna the emission of two modes differed in geometry patterns and polarization. The fabricated bimodal nano antennas emphasized similarly. The obtained results were found in good agreement in comparison to previously obtained results.

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