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Small Scale Magnetic Therapy Distribution

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Abstract

Magnetic therapy is an alternative medicine practice involving the use of magnetic fields subjected to certain parts of the body and stimulates healing from a range of health problems. In this paper, an embedded nano antenna system using the optical spins generated from a particular configuration of micro rings (PANDA) is proposed. Magnetic moments could indeed arise from the intrinsic property of spins (optical spins). By controlling some important parameters of the system such as soliton input power, coupling coefficients and sizes of rings, output signals from micro ring resonator system can be tuned and optimized to be used as magnetic therapy array.

Keywords: Magnetic therapy; Radio therapy; Optical spin therapy; Spin therapy; Magnetic therapy distribution

Introduction

Magnetic therapy is the alternative medicine, which is used in the magnetic fields for speed healing, relative pain and inflammation, and improves bodily functions. Magnetic cures have been attracting gullible patrons for centuries. The magnetic therapy simulates the earth's magnetic field and places your body in an optimum environment to heal itself. The physiology of the wide range of benefits is not completely understood but it is believed to come from increased blood circulation for greater supplies of oxygen and nutrients, thus improving removal of contaminants and toxins from body tissues. Over the last few years, numerous world-wide research studies in magnetic therapy have been performed [1-3]. The results have been mixed with some studies showing very little benefit and others demonstrating very powerful results. The attractive utility of modern magnetic therapy is the capability of the magnetic field to be delivered efficiently toward the sample. Intensity-modulated radiotherapy enables shaping of the delivered radiation around the target thereby avoid the effect normal tissues. Image-guided radiation treatment (IGRT) delivery uses volumetric and imaging improves accuracy of treatment. In order to create the electromagnetic (EM) waves with a radiation pattern for magnetic radiation therapy, an antenna is an essential component for the signal radiation, which changes in their intensity, or to exploit the transmitted power [4]. In the nanoscale regime, the optical nano-antenna is an important device for converting propagating radiation into the confined/enhanced field. The transmission efficiency of nano-antennas should be quantified and optimized for potential utilization Yupapin et al. [5] have shown numerous potential applications that can be carried out from optical devices, which consists of an add-drop optical filter. This filter is known as a PANDA ring resonator which uses optical dark-bright soliton control within a semiconductor add-drop multiplexer [5-7]. Such system is very advantageous in securing signals at communication links because of dark soliton special properties which allows the soliton peak signal to be kept at a low level, rendering difficulties in detection of this signals [8,9]. In this research, dark and bright soliton will be used as input and control signals toward the system. The behaviors of bright and dark solitons pair within a PANDA ring resonator are examined. Both signals will interact with each other within the ring resonator and ejected as a pair of dark-bright soliton which is simultaneously detected at the output port. In principle, the orthogonal solitons can be used to form the two components of light, known as the soliton spin states. The set of solitons can be decomposed into left and right propagation waves. This can be done relative to any orthogonal set of axes. Typically plane wave of ordinary light consists of components with all polarizations mixed together. The use of a new orthogonal set of light pulses called an orthogonal soliton pair is proposed to form the two components of rotating waves. In operation, the nano-radio power transmission is proportional to the input power. However, it is limited by the power of the laser diodes that are available. Nano-antenna system design using photonic spin in a PANDA ring was first proposed by Thammawongsa et al. [10]. In the system, the transverse electric (TE) and a transverse magnetic (TM) fields are generated within PANDA ring resonator by a soliton pulse. The spin states are induced via and aluminum plate coupling to the micro-ring resonator. To date, there are numerous studies on magnetic therapy have been carried out. But still there is insufficient information available on nano-antenna for therapeutic use. In order for magnetic therapy to be accepted as a medical treatment by mainstream or conventional medicine, it is crucial that scientific study into magnetic therapy is performed. Thus, this paper will discuss on the concept of embedded nano-antenna in magnetic therapy array from orthogonal optical spins produced by dark-bright soliton pairs as output from a particular configuration of micro-rings.

Optical spins

In nanometer-scale system, photon from the interacting light can give significant effect towards the structure. Polarization is the role of the absorption cross section of a nano-antenna in which the radiation induced dipole in the atom and the intensity gradient. In this paper, PANDA ring resonator which contains nano and micro ring, which are integrated. The whole system performs dark-bright soliton conversion process, producing orthogonal set of dark and bright soliton pair, which can be decomposed into left and right circularly polarized waves.

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The relative phase of the two output light signals after coupling into the optical coupler is π2. This means that the signals produced from throughput port and drop port undergone a π phase change from the origin input signal. The concept of orthogonal soliton spins can be assigned as optical dipole moment. Input and control signals in the form of dark and bright optical solitons are governed by equations (1) and (2) in [11-13], where *A* and *z* are the optical field amplitude and propagation distance, respectively. *T* is a soliton pulse propagation time in a frame moving at the group velocity, $T=t-\beta_{1z}$, where β_1 and β_2 are the coefficients of the linear and second-order terms of Taylor expansion of the propagation constant. *LD=202 T* β is the dispersion length of the soliton pulse. T_0 in equations (1) and (2) is a soliton pulse propagation time at initial input (or soliton pulse width), where *t* is the soliton phase shift time, and the frequency shift of the soliton is ω_0. In figure 1, the output field at throughput port, E_t is given by:

$$E_t = E_{in}x_1y_1 + j\sqrt{k_1}x_1x_2y_2E_LE_RE_1\exp(\varphi) - \sqrt{k_1k_2}x_1x_2E_LE_{Add}\exp(\varphi/2)$$

Output field at drop port, E_d is given by:

$$E_d = j\sqrt{k_2}x_2E_1E_R\exp(\varphi/2) + E_{Add}y_2x_2$$

The circulated field, E_1 is given by:

$$E_1 = \frac{j\sqrt{k_1}x_1E_{in} + j\sqrt{k_2}y_1x_1x_2E_LE_{Add}\exp(\varphi/2)}{1 - E_RE_Ly_1y_2\exp(\varphi)}$$

Where

$$y_1 = \sqrt{1-k_1}$$
$$y_2 = \sqrt{1-k_2}$$
$$x_1 = \sqrt{1-\gamma_1}$$
$$x_2 = \sqrt{1-\gamma_2}$$
$$\varphi = -(\alpha L/2) - jk_nL$$

L being the circumference of the ring which is given by L=2πR, R is the radius of the ring measured from the center of the ring to the center of the waveguide. γ is a coupling intensity loss for the field amplitude. For lossless coupling, γ is equal to 0. The coupler parameter κ is the power coupling coefficient of the coupler and it's assumed to be wavelength independent. During calculation, radii of both nanorings on the left and right hand sides of the PANDA ring are set at R1=R2=2.5 µm and radius of the center ring is Rad=30 µm respectively. In the formation of the initial spin states, R_{th} and R_{ct} is chosen to be at 20 µm, the magnetic field is induced by an aluminum plate coupled on AlGaAs waveguides for optoelectronic spin-up and spin-down states [10]. As shown in figure 2, the coupling coefficient ratios κ1:κ2 are 50:50, 90:10, 10:90 acting in the following manner: (A) dark soliton is input into input and control ports, (B) dark and bright solitons are fed for input and control signals, (C) bright and dark solitons are used for input and control signals, and (D) bright soliton is used for input and control signals. Effective core area of the waveguides is A_{eff}=0.25 µm^2 and the value of refractive index of InGaAsP/InP is 3.14 [13]. Waveguide loss coefficient α=0.1 dB/mm and center wavelength is chosen to be at λ_0=1.55 µm. By using equations (1-3), the transmission outputs can be obtained at the through and drop ports, in which the power can be obtained by the squaring outputs as shown in figures 3 and 4, where the transverse electric (TE) and transverse magnetic (TM) fields are generated by using a PANDA ring resonators are plotted against time. In figure 3A, a set of spins were obtained at through (spin up) and drop (spin down) ports respectively, where in figure 3B, soliton pulses propagated within a PANDA ring circuit, which was obtained by the whispering gallery mode (WGM) equation and found in reference [14], wherein this result shows that the spin up and spin down can also be obtained by using the WGM equation. From this result, we manage to show that many soliton

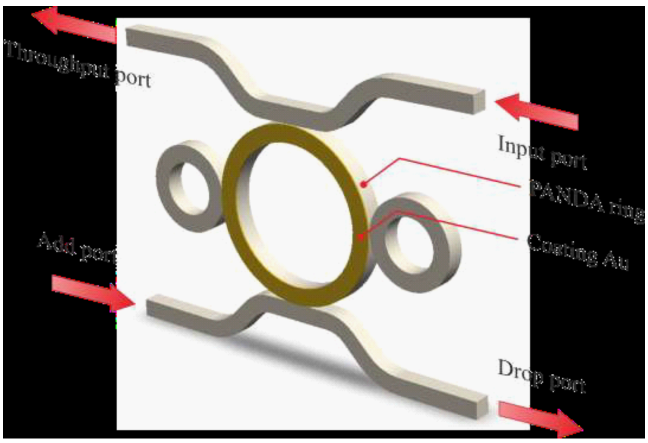

Figure 1: Schematic diagram of PANDA Ring resonator.

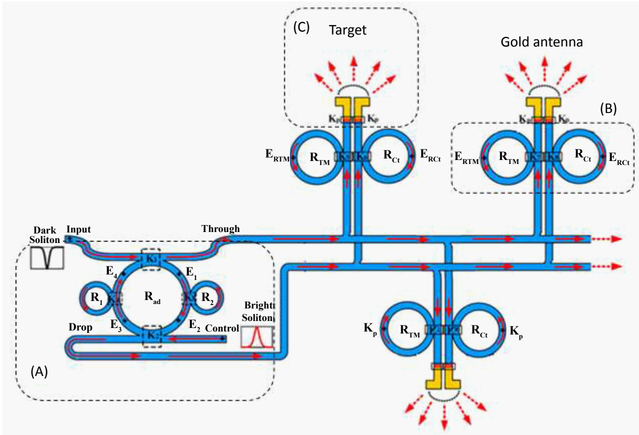

Figure 2: Schematic diagram of optical nano-antenna array system for magnetic therapy.

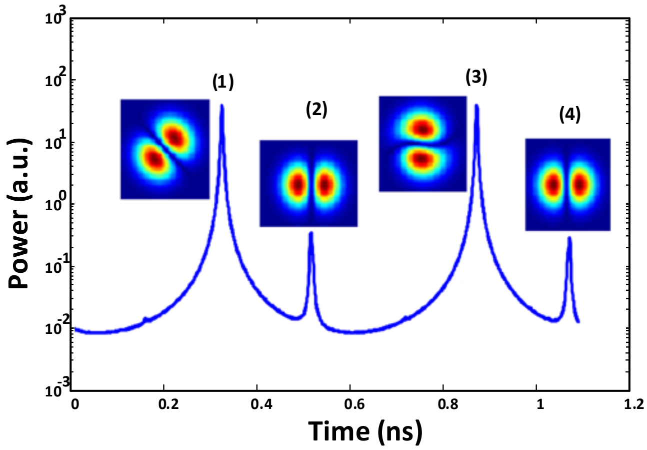

Figure 3: Spin rotations with time in a PANDA ring resonator [10].

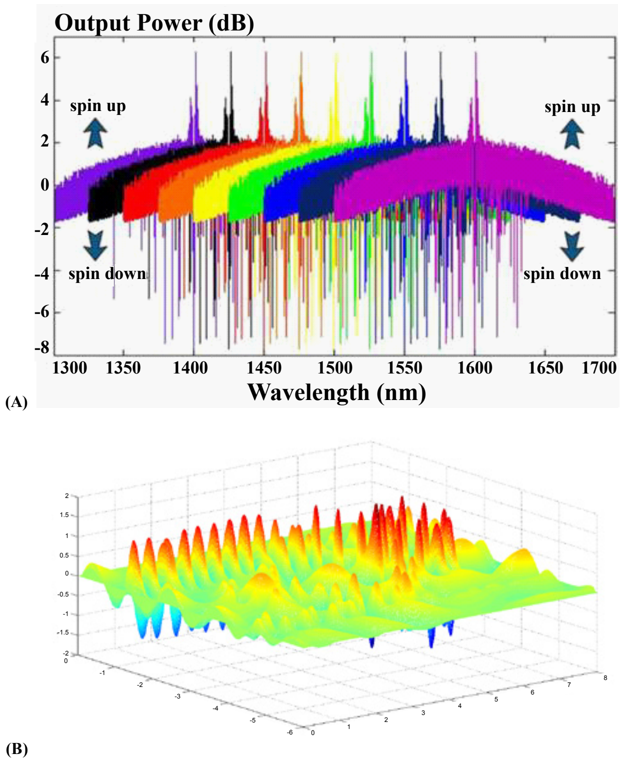

Figure 4: A schematic of (A) set of spins obtained at through (spin up) and drop (spin down) ports, (B) the soliton pulses in the a PADA ring obtained by the MATLAB program, where bright (peak or red) and dark (valley or blue) solitons are generated similarly to the spin-up and spin down in figure 4A.

spins are produced from PANDA ring resonator, where the output signals were randomly collected at both throughput and drop port of the system. Thus, random transverse electric (TE) and transverse magnetic (TM) fields of the solitons corresponding to the left-hand and right hand photons are provided. The soliton radiation is formed by using the dark-bright soliton inversion pulses and they are orthogonal. In fact, they are photons, which behave like elementary particles. Hence, the spin axis of photons is always parallel to its direction of motion. Many orthogonal sets of solitons are also available and existed, in which the spin conservation of many solitons (photons) is simulated and seen for large scale system use. Therefore, by using the soliton property, the new era of magnetic therapeutic medication can be established by using soliton spin to form the magnetic moment and induced magnetic field. Whenever photon is absorbed by an object, there are two possible optoelectronic spin states will be exhibited and imparted to the object, which corresponds to the $+\hbar$ or $-\hbar$ angular momentum.

Magnetic therapy manipulation

For nano-antenna, the assumption of perfect electrical conductor is no longer valid due to high losses at optical frequencies. This process also exerts surface plasmon polarization, which is considered as unique phenomenon in nanoscale region. The most important different response of these structures is the sub-wavelength field confinement. Therefore, serious efforts are being devoted to extend current understanding from radio frequency antennas to their nano-antenna counterparts. The model of an infinitesimal dipole to discuss the different character of the fields in near- field and far-field region is used. Such model further helps to appreciate the difference between the radiated power and the power stored in the near-field of an antenna. Design of the proposed nano-antenna system was described in references [15-18]. The proposed magnetic therapy system using micro ring resonator system is shown in (Figure 4). The whole system can be categorize into three parts, first is called input signal part (A). In this part, dark and bright solitons are fed into a device called a PANDA ring resonator. Ring radiuses for both nanorings on the left and right hand sides are set to be $R_1=R_2=2.5$ µm and the values of coupling coefficient ratios $\kappa_1,\kappa_2,\kappa_3$ and κ_4 are 10:90, 10:90, 20:80 and 20:80. Two signals are modulated by cross-phase modulation in order to form the orthogonal set of dark-bright soliton pairs, which can be decomposed into right and left circularly polarized waves. The output intensities of spin-injected for transverse electric (TE) and transverse magnetic (TM) fields are generated at throughput and drop ports before delivery. The output intensities of spin-injected for transverse electric (TE) and transverse magnetic (TM) fields are generated by using a PANDA ring resonator as shown in [18], which the simulation result is obtained by using the commercial MATLAB software. The second part of the system is shown in part (B). This part comprises two micro-ring resonators with radius $R_{Th}=R_{Ct}=20$ µm and κ5=κ6=20:80. The optoelectronic fields generated by a dark-bright soliton pump via through and drop ports of a micro-ring resonator at the center wavelength 1.45 µm. The signals from throughput and drop port undergone a phase shift after passing through the micro-ring, this process can be controlled by tuning the ring radii sizes. After that, the optoelectronic spin state of dual micro-ring resonators are fed into the nano-antenna in part (C). In practice, the gold properties are appealed to establish the nano-antenna for biomedical applications. The benefit of gold particle without the cause cytotoxicity for human cells is confirmed by Huang [19] and extensive reasonable merit of radioactive properties of AU-198 that is reported [20]. Electromagnetic field is distributed to the disease cells from the end of the gold nano-antenna. Ordinary, the goal of all radiation treatment is that the radiation can be delivered and focused on the specific area. The adjacent normal tissues receive a little radiation. A gold nanoantenna is recommended to form such requirements, in which the required electromagnetic field strengths (near fields) can be generated, controlled and radiated to the target cells, where finally, the required therapeutic treatments can be achieved. Until now, magnetic therapy devices/machines are continuously being pushed to produce higher magnetic fields for more efficient therapeutic treatment. Most clinical magnets today are designed to operate in a range of 1-1.5 Tesla (T). Magnetic treatment associated with ultra-high field strength magnitude up to 8 T can be used in therapeutic device without leaving any adverse effect towards animal and human subjects [21]. All parameters used in this research were chosen according to the practical parameters, thus showing that this proposed device can be realized [22,23]. In order to generate the hyperthermia at specific frequencies to heat the targeted cells as the same way that reported [24], which is irreversible damage to diseased cells occurring at the temperature within the range from 40°C to about 46°C. Accordingly, the healthy cells are capable to survival at the temperatures up to around 46.5°C as confirmed [25]. A gold nano-antenna is recommended to form such requirements, in which the required electromagnetic field strengths (near fields) can be generated, controlled and radiated to the target cells, where finally, the required therapeutic cells treatments can be achieved. The model of wave interaction with biological tissue can be described by using the atomic Bohr Theory as shown in figure 5. When the radio frequency emits signals from the antenna through the diseased cells, the orbital electrons can be excited and moved to the excited state, in which the direct or indirect ionizations can be generated. The energy exchange between atoms and molecules is occurred, where finally, the system (diseased cells) is needed to adjust itself to be in the equilibrium state.

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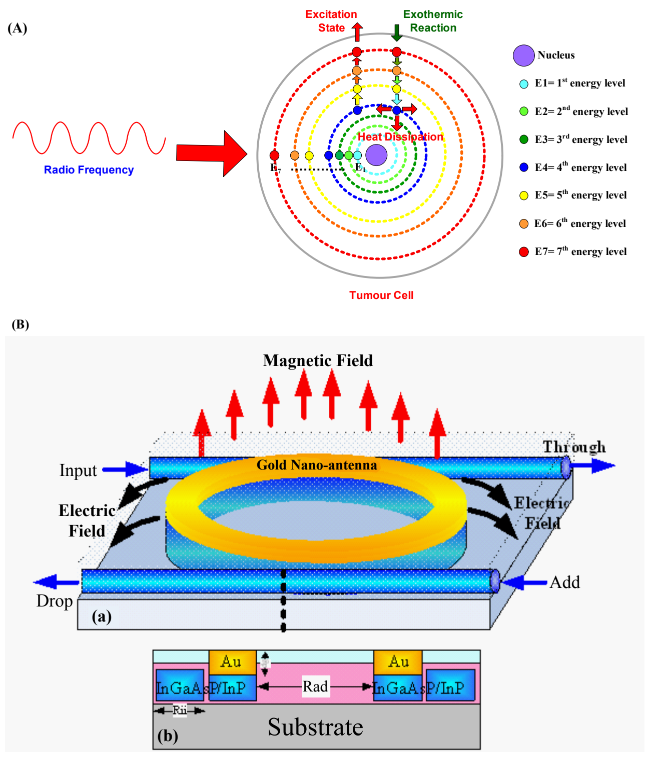

Figure 5: Show schematic diagram of (A) model of wave interaction with the biological tissue, (B) an antenna model that can produce the Rabi oscillation frequency.

Consequently, the heat dissipation or energy exchange is released by the exothermic reaction process, where the diseased cells can be destroyed, i.e. killed. Accordingly, the healthy cells are capable to survive at the temperatures up to around 46.5°C [19]. A coated gold nano-antenna is recommended to form such requirements, in which the required electromagnetic field strengths (near fields) can be generated, controlled and radiated to the target cells, where finally, the required therapeutic cells treatments can be achieved. However, the coated ring antenna is also available when the Rabi frequency [26,27] is generated and propagated to biological tissue, in which the similar manner with the coated case can be performed, where in this case the antenna model is as shown in figure 5B.

Conclusion

This paper uses the concept of orthogonal soliton pairs within a PANDA ring resonator for multipurpose magnetic therapeutic applications. The source from different wavelengths can be used to apply for suitable treatment targets generated by the two optical dipole components (TE and TM waves) that come from throughput and drop port of the micro-ring system. The output signals from both ports formed the optoelectronic spin up and spin down states, which can be used to form the orthogonal soliton spins. Some crucial parameters on the system is tuned and controlled to optimize the nano-antenna transmission. In this case, the suitable thermal distribution of a gold nanoantenna is 45°C, which is no harmful for healthy cells. The main advantage of the proposed system is the size of the system itself is in nanometer scale, allowing it to be fabricated in a form of thin film which can then be embedded near the targeted areas. In addition, the optical dipole with long distance therapy with high effective power nanoantenna resonance can be achieved, which can be realized and collaborated in the diagnostic of many physical ailments.

Disclosure

The authors declare no conflicts of interest in relation to this work.

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