*Journal of Advances in Science and Technology*
*Vol. 20, Issue No. 2, September-2023, ISSN 2230-9659*

DOI: https://doi.org/10.29070/pqh6qj22

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# A study of Pulse slippage of Cosh- Gaussian lasers in corrugated magnetized plasma generates terahertz radiation

**Afzal Mushtaq [1] * , Dr. Satish Kumar [2]**

1. Research Scholar, Shri Krishna University, Chhatarpur, M.P., India
ouriginal.sku@gmail.com ,
2. Professor, Shri Krishna University, Chhatarpur, M.P., India

**Abstract:** The combined effects of pulse slippage and the transverse magnetic field are studied on terahertz radiation excitation by nonlinear beating of two cosh-gaussian (chg) laser pulses propagating in corrugated plasma. The beating lasers exert nonlinear ponderomotive force on plasma electrons. The oscillating electrons couple with corrugations presents in the plasma and resonantly excites a nonlinear current (at different frequencies) which drive the terahertz wave at proper phase matching conditions and the study in mainly discussed about terahertz radiation generation ,excitation of the wave generation by obliquely incident pump lasers on a hot magnetized plasma,terahertz radiation generation by pulse slippage of cosh-gaussian lasers in a corrugated magnetized plasma

**Keywords:** radiation, plasma

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## INTRODUCTION

Terahertz (THz) radiation has piqued attention due to its potential uses in a variety of areas, including material science, biomedicine, and communication. THz radiation has been driven by ultrafast powerful lasers in recent decades. Plasma-based THz generators have received a lot of interest since plasma is devoid of optical damage. THz radiation emitted by laser-induced plasma filaments in air or other low-density gases has been widely studied. However, at a pump laser intensity greater than $10^{15}$ W/cm$^2$, the THz yield is shown to be saturated owing to ionization-induced laser defocusing in the filaments.

Ultra-intense laser pulses may now have a concentrated intensity of far over $10^{18}$ W/cm2. A few organizations have explored the production of greater THz radiation in relativistic laser-plasma interactions to take use of such high laser intensity. Leemans et al., for example, produced THz radiation with energy in the sub-J range via strong laser-gas interactions. THz radiation produced by solid targets was three orders of magnitude greater than that generated by gas targets, according to Hamster et al. Sagisaka et al. and Gao et al. used an antenna model to study THz production. Tokita et al. and Poyé et al., for example, looked at the THz radiation produced by transient charge separation along the target. The production processes of THz radiation from laser-solid interactions are complex, as Gopal et al. recently produced extremely strong THz radiation with energy of 700 J from the back of a foil target, which was ascribed to the target normal sheath acceleration (TNSA). To further understand them, we looked studied THz radiation from the front or back of solid objects irradiated by relativistic femtosecond and picosecond laser pulses.

**Terahertz radiation Generation**

The terahertz (THz) region of the electromagnetic spectrum has expanded considerably in recent years. Terahertz radiation may be produced in a variety of ways. Traditional methods such as quantum cascade lasers, accelerator-based sources, and optical rectification in non linear crystals are used to produce terahertz waves. Solid state electronic devices may produce THz radiation with a frequency of less than or equal to 1 THz. The development of electronic-based devices operating at frequencies more than a few hundred GHz in the low frequency microwave domain has been hampered by the inherent need for very short carrier transit times in the active areas. The output power (10.9W) is the highest value recorded from a low temperature produced GaAs photoconductive switch at approximately 0.99 THz frequency, and it is the maximum value that can be obtained by a photodiode in the terahertz domain. It is not feasible to create the fundamentals of interband diode lasers (which operate on visible and near-infrared frequencies) to work in the mid-infrared region due to a lack of high quality semiconductor.

One technique for generating terahertz radiation is using quantum cascade lasers (QCL). These lasers are made up of a semiconductor heterostructure in which the conduction band splits into many different subbands owing to quantum confinement. The electrons in the linked quantum wells travel via the potential staircase. Many studies have been conducted in this area, but it is still insufficient for the production of high-power THz devices. Cryogenic temperatures are required for their functioning. Barbieri et al. presented a GaAs-AlGaAs heterostructure with tens of mW output power in continuous wave mode. The injector states are utilised at a lower point in QCL. Instead of just one state, two are used. The higher laser state is closely linked with these two lower injector states. The wavelength of the QCL is 7-9 m. The transition between three linked states allows for a wide gain spectrum breadth. The coupling in injector state and higher laser state has been selected for effective optical gain and carrier transport. With the aid of an analogue locking circuit, a nonlinear signal was stabilised between a 2.408 THz quantum cascade laser (QCL) and a $CH_2DOH$ THz $CO_2$ optically pumped laser (OPL) to establish a 3-4 kHz frequency at full width at half maximum (FWHM). This method' stability should be sufficient to use THz wave quantum cascade lasers as transmitters in low-range coherent transceivers and a variety of other applications.

## LITERATURE REVIEW

**Kumar et al. (2015)** conducted an experiment in which two lasers passed through the hot plasma were utilized. The laser went diagonally over the surface. There is a thoughtful motivating force and non-linearity. Only in one direction does the THz emission emanate. When combined with Langmuir Wave Production was enhanced.

**Yuan et al. (2014)** experimentation was carried out with a high intensity of THz radiation (~7 bis 2 W/cm). The strong pulse of the optical maser accelerated the protons once they heat up the target. They established that preheating and expansion of the target decreases the amount of THz emissions. Compared to the cold target reference, the entire energy of the THz radiation is decreased. Due to the advances in technology, the radical broadband THz detection and the discovery of ionization technology and many applications in the area of spectrum analytics, Jiayu Zho, etc., established how powerful superluminal THz propagates in the air. They investigated in their experiment that the length of the filament may be managed on a time unit optical maser and the THz pulse on that filament is radio controlled. They utilized the 1cm diameter Gaussian shift.

**Dai and Zhang (2009)** studied the use of the part compensator for the production of strong waves of THz with high potential generated plasma from optical maser with pulses of 800NM(t), and 400NM(t), respectively) exciting time unit pulses. They determined the experiment using unit of time part compensators which could be used for distant sensing and identification and jointly for coherent plasma creation management and high harmonic plasma gas production.

Due to the broad range of use of the terahertz radiation at the Pohang Accelerator Laboratory, **Kumar et al. (2013)** investigated the fact that the information measure of radionuclide was inflated by five terahertz by exploiting density modulation for relativistic electromagnetic waves. They utilized radical short lepton bundle of the unit of time to generate strong radiation. The lepton bunch's energy modulation was converted to density modulation using chicane. Their conclusion was to make an important contribution to increasing the amplitude of terahertz radiation: optical mast power, light-waist beam and chicane.

**Bhasin and Tripathi (2011)** It found that thirty times the amplitude of THz was inflated when 60 KV/cm were applied to force fields. THz amplitude is ~ at the optical mass intensities of the filament amplitude. The coupling is expanded because of the dc force field. They demonstrated together that the THz amplitude was inflated by the THz frequency.

**Jha and Verma (2014)** had a numerical one-dimensional model for learning THz production of radiation by intensive propagation of optical maser pulses in an exceptional plasma mode. In order to verified and compare quantitatively foresaw findings, 2-D PIC victimization XOOPIC codes are also conducted. The findings acquired via a simulation study are almost as comparable as those derived from the 1-D numerical model and the results gained are verified quantitatively. The simulation research examined the transmission of the wake fields across the plasma vacuum limit.

**Singh and Sharma (2013)** However, electrons are examined by the presence of a reflecting driver, which includes rippling density when the rate produces a cross concentration of 2 linear optical mass beams. Because of the frequency of the electrons, lasers include the density ripple, and the cross-sectional current creates a radiation rate up to the plasma frequency. This technique established many laser and plasma parameters through victimization. Therefore they have a high radiation rate of the sequence 8.

**Varshnety et al. (2013)** intended to produce constant radiation rates by beating 2 exceptional lasers with magnetized plasma. Ripped plasma magnetized density excites the rate waves resonantly by beating two X-mode frequency lasers with higher hybrid frequencies after the cyclist of the ripples meets the section of correspondence. The given ripple frequency will rise because the flow increases and decreases because the rate frequency increases. Thus, the frequency of THz radiation may easily be determined by changing plasma density and fluxes. The potency of the greatest order is obtained by improving these characteristics.

**Varshnety et al. (2014)** has done an experiment studying the kinetics of the THz wave production by the punching of 2 optical maser beams in the presence of the static 11 force field once non-linear motive reflects alone. The connection is further strengthened by the fact that the optical maser beams are static force and spatially-gaussian. The application of an instantaneous current field of fifty potential units results in a 6-fold increase in the normalized amplitude of THz. Effects of the modulated optical maser amplitude square measurement frequency, ray size, and cyclic issue for the cost-effective production of THz radiation. These findings may be utilized to generate regulated THz sources for the victimization of low filament intensities in medical applications (alias 10 2 W/cm).

**Varshney et al. (2016)** assumed that the dynamics of production of terahertz Radiation is explored when only the excogitate motive non linearity is active by beating 2 x-mode optic device beams in the winded attractive plasma. In order to enhance the excogitate driver engaged on plasma electron, the triangular wrapping of x-Mode optical instrument beams is employed. A constant torsional density ripples give the extra momentum required to stimulate terahertz waves by tackling 2 x-mode Lasers of higher hybrid frequencies. The required rip frequency relies on the frequency of terahertz and the field of force applied. It lowers due to the rise in Terahertz frequency and the increasing force field. The rate of terahertz radiation may thus easily be determined by the changing density of plasma and by the application of the force field.

**Hematizadeh et al. (2016)** The topic of THz radiation production was proposed to take into account electron neutron collisions by beating a 2 spatial triangular optical device beams in a plasma with a spatially regular density. During this process, the optical device beams exercise an excogitate driver on the plasma electrons and transmit the periodical frequency with the distinguishing frequency, when the laser direction is parallel to a static force field. They demonstrated that the parallel forcefield is used to match the perpendicular forcefield with greater power and stronger terahertz radiation. For the production of terahertz radiation, the findings have been examined for beam size of laser, collision frequency, regularity of density onsets and the force field. Terahertz is discovered to be sensitive to collision frequency and intensity field in the emitted radiation. In this area, excellent power was obtained with improved plasma characteristics.

**Varshney et al. (2015)** suggested a THz radiation experiment by photo-mixing two super-Gaussian beams with completely distinct frequencies and wave numbers by applying the dc force field. The current theme 12 shows a significant level of dependence on the force field applied in dc, with q-indices and beam size parameters of Gaussian super lasers. Within this system, the power of these parameters is improved.

**Singh et al. (2013)** The subject of a plasma space density project was to achieve terahertz radiation by beating cosh-gaussian laser (ripple density). They have shown that the lasers have a nonlinear force that provides electrons regular rate that further tear pairs with the density to get a larger passing current due to their unique field variations, which leads to THZ radiation. Importance of factors for laser beam size, descent parameter, amplitude and density structure regularity assessed for the emission of terahertz. The decentered parameter may dynamically shift the laser's height intensity to the right direction and a significant change in the magnitude and conversion capacity of a terahertz field can be discovered.

**Cho et al. (2015)** the plasma interactions of the proposed method of replacement for the emission of magnetic force inside the THz (THZ). Two counter-propagating brief optical device pulses in an unsightly attractive plasma generate a confined and long-lasting direction wise current. They have shown that, while the frequency is close to the cut off of the nearby plasma, electromagnetic radiation diverges from that current source and increases towards the plasma-vacuum border producing a strong monochromatic terahertz wave.

**Gishini et al. (2016)** the terahertz radiation produced via laser pulse contact with the molecular hydrogen plasma has an ultra-short range. In the Cell-Monte Carlo Collision simulation, they utilized a two-dimensional particle to check the production of THz. They utilized high power, femtosecond laser with a Gaussian pulse with an intensity of 17 2 10 W/CM

**Miao and Antonson (2017)** THz radiation in corrugated plasma channels has been investigated for nonlinear arousal of plasma waves and laser pulse depletion. They created different theoretical analyses and PIC simulations in complete format for this purpose. Different plasma channel topologies and laser pulse characteristics were utilized to achieve the highest conversion efficiency from THz to optical energy.

**Bakhtiari et al. (2016)** Used two laser beams from Gaussian. They interact with the electron-neutral collisions plasma of Gaussian laser array beams, which produce radiation from THz using this method. If you utilize a Gaussian laser beam, the effectiveness of THz radiation utilizing this technique improves. By employing this technique, the THz radiation has an efficiency of 0.07%, three times that of the single laser beam from Gauss.

**Ding and Shang (2016)** proposed a technique wherein femtosecond laser and thin solid objective are applied, then interact and THz radiation is very intensive and highly peak. Through PIC simulations the THz radiations are investigated. They said that these THz radiations are extremely helpful for transporting hot electron.

**Singh, M. & Sharma, R.P. (2013)** This document describes the 3-wave process of parametric decay for the generation of Terahertz radiation (THz) in magnetized plasma. In exceptional mode (x mode), the pump wave (laser beam) is assumed to propagate perpendicular to the magnetic field background. This pump wave falls into a higher hybrid wave and a magneto sonic THz wave. The corresponding equations for the three wave interaction couplings are obtained and for THz wave amplitude. Then, the growth rate is also computed for uch decaying instability. Different parameters in laser and plasma have been adjusted, and we report the $\sim 1.4 \times 10$–2efficiency in the existing system.

**Hitendra K. Malik, Divya Singh & Ravinder Kumaı (2020)** Availability of an external magnetic field may provide an extra wakefield component appropriate in a collisional plasma for Terahertz (THz) radiation. Based on a quasi-static method to perturbation, research is carried out on the subject of emission of radiation pulses from the wakefield when the laser laser beams are utilised from SuperGaussian. When greater magnetic field is used, radiation gets stronger, and the same is true with higher index lasers.

**A. R. Niknam, M. Joodaki, A. Abdolmaleki, M. Sedaghat, H. Saberi, M. R. Banjafar& F. Jahangiri (2021)** In addition, a heated inhomogeneous plasma emitted by strong laser beams in the presence of an external transverse magnetic field shows a higher emission of terahertz on hybrid resonant frequencies. In order to do that, we use the dielectric allowance tensor for plasma influenced by force and magnetic field direction and evaluate the nonlinear current density generated via the weight of two Gaussian laser beams by the power of the ponderomotor. Resonance emission calculations show at various frequencies that rely on the thermal velocity, waven number, frequency of the plasm electron, frequency of collision, and frequency of cyclotron. However, at these frequencies, THz waves rely primarily on the electron temperature and on the external intensity of the magnetic field.

**Yutong Li, Guoqian Liao, Chun Li, Weimin Wang, Zhengming Sheng, Jie Zhang (2017)**

Since plasma is a material devoid of harm, laser-plasma interactions offer a unique chance to create THz radiation sources with a high-field tabletop. Some studies and simulations on THz emissions from ultra-intensive laser interactions with solid objects have recently been published. In this talk we will demonstrate consistent THz transition radiation from laser-accelerated relativistic electrons traversing the back surface of a small solid objective. Various target characteristics and structures to describe the radiation properties of THz and differentiate the mechanism suggested from others are used to validate the generating process. The transition radiation model and the modelling of particles in cells provide a good explanation for the findings. The latest attempt towards small brilliant THz sources is the presented laser-solid THz transition radiation.

## METHODOLOGY

**To study about the THz Generation via Magnetized Hot Plasma-Laser Interaction**

The photo mixing of pump lasers with frequencies is a study of terahertz surge waves.$(\omega_1, \omega_2)$ and wave numbers $(k_1, k_2)$, In a hot nonlinear magnetized medium plasma respectively. Beat frequency differential laser pulses$(\omega_1 - \omega_2) \approx \omega_p$ is an incidence on the surface of plasma step density profile and produces a nonlinear nonlinear quasistatic weighing force on plasma electrons. Space charging field in the magnetised plasma occurs when plasma électrons begin to oscillate on the incidence plane to preserve plasma neutrality. Due to the combination of non-linear power and a space charge wave, a nonlinear time dependent current is generated on the reflective side. The T-wave emission is accountable for this nonlinear current. The transverse magnetic field intensifies the emitted terahertz wave, since the linkage between electromagnetic radiation and plasma wave becomes stronger when the static magnetic field is present. For the incidence angle value$\theta \sim 50 - 70^{0}$,THz waves amplitude is improved.

**Analysis of Pulse slippage of Cosh- Gaussian lasers in a corrugated magnetized plasma generates terahertz radiation (THz).**

Terahertz (THz) theoretical method of wave excitation by battering Cosh-Gaussian pump lasers with differences in frequencies and vector of the wave in corrugated plasma inserted with the transverse static magnetic dc champ. The striking laser beams impose a nonlinear, quasispin power on plasma electrons. In a magnetized nonlinear plasma, the interaction between oscillating plasma-electrons and density corrugations occurs. This mechanism inspires a frequency that is non-linear.$\omega = \omega_1 - \omega_2$ Those criteria drive the matching phase. As the THz wave group velocity is greater than the battering laser group velocity, the terahertz pulse slips out and the pump lasers are saturated. On the basis of terahertz emissions, the impacts of terahertz wave frequency, descent parameter, density structure periodicity and transverse dc magnetics are addressed. Efficiency ~10-4 for the laser intensity of the current system is achieved.~ $0.2 \times 10^{16} W / cm^2$.

**To analyze the Excitation of Terahertz radiation in a corrugated magnetic plasma by parametric coupling of a laser beam and its frequency shifted second harmonic**

The parametric connection of a linearly polarized pump laser creates an analysis system for exciting terahertz waves (THz).$(\omega_1, \vec{k}_1)$ And the second harmonic laser altered its frequency$(\omega_2, \vec{k}_2)$in magnetized plasma in corrugated form. Pump lasers give non-linear quantum power to nonlinear media plasma electrons at frequencies Pump lasers$2\omega_1$ and $\omega_1 - \omega_2$Therefore at these frequencies density disruptions occur. These density disturbances combine with plasma corrugations of the right wave number Q and create oscillations of density$(2\omega_1, 2\vec{k}_1 - q)$and $(\omega_1 - \omega_2, \vec{k} - q)$.The density oscillations beat electric oscillation at oscillatory velocities in ϖ 1 and oscillatory electrons in ϖ 2 (because of the laser).$\omega = 2\omega_1 - \omega_2$ and wave number $k = 2k_1 - k_2 - q$.T-rays electrical field amplitude is utilized for perturbation method. The electric field amplitude of the terahertz $8.04 \times 10^6 V/m$ is achieved in dense plasma with applied magnetic field ~175kG in 10 percent corrugated.

**To Excitation of Terahertz radiation production in a magnetized plasma by nonlinear four wave mixing**

The nonlinear photo mix of two pump lasers which have a frequency difference may cause THz radiation to be excited. $\omega_1 \sim \omega_2 \geq 2\omega_p$ In a plasma that's subsense. In the tuning of the amplitude of THz wave, the transverse dc magnetic field is used. Beating pump lasers provide to nonlinear medium-plasma electrons with nonlinear quasistatic and stimulate the nonlinear density distortion. Nonlinear disruption of density causes the non-resonant charge wave which, via a stimulated Raman dispersion, may decay into a few plasma waves and return electromagnetic terahertz waves. Through the transverse dc magnetic field, the development in THz wave is promoted. The greatest increase in excitement $\Gamma \sim 6.22 \times 10^6 \ s^{-1}$ s is achieved for a magnetic field of value ~175kG.

**To investigate the production of tunable and efficient terahertz radiation in a magnetized plasma by nonlinear mixing of plasma beat waves with a relativistic electron**

Terahertz (THz) wave may arise in a magnetized nonlinear medium plasma via nonlinear interaction between laser-driven beat wave and a relativist electron beam (REB). The pump lasers co-propagating has frequency variances$(\omega_1 \sim \omega_2 \geq 2\omega_p)$Excite the differential frequency of a space charge wave. Wave charging pairs with a negative beam energy mode non-linearly. It results in disturbance in beams and plasma electrons in terms of velocity and density. Modulated density electron beam interacts with the difference in the space charging mode non-linear and arouses the electromagnetic wave of terahertz$(\omega_T, \vec{k}_T)$Condition of the right phase matching. In order to achieve the growth T rays and process efficiency, the characteristic equation of the parameter process is determined. Numerous simulations indicate that the growth rate and process efficiency are very sensitive to electron beam energy and frequency of cyclotrons.

## DATA ANALYSIS

### EXCITATION OF THz WAVE GENERATION BY OBLIQUELY INCIDENT PUMP LASERS ON A HOT MAGNETIZED PLASMA

Eq. is solved numerically for the given parameter s : $a_1 = A_1 e / m\omega_1 c$ =0.1 $a_2 = A_2 e / m\omega_2 c$ =0.1, $\theta = 5^0 - 90^0$; $v_{th} = 0.09 \times 10^8$ and $B_s$ =35-178 kGFigure exhibits the variation in normalized THz amplitude of the reflected wave $\theta_\sigma$ f o rfour values of magnetic field at , $\omega = 1.1\ THz$

. The amplitude of T- , waves increases with applied dc magnetic field. Two peaks are obtained corresponding to $\theta_s \sim 10^0$ and $\theta_s \sim 50^0$-$60^0$. The dip between two peaks shifts towards higher value of θ as, magnetic field increases. These peaks are corresponding to the variation of nonlinear ,ponderomotive force as shown in Figure 1.1 and Figure 1.2. Real part of ponderomotive force is in z-direction, $f_{pz}^r$ is responsible for amplitude peak at $\theta_s \sim 10^0$, while imaginary part of ponderomotive force is responsible for peak at $\theta_s \sim 50^0$ -$60^0$. In the absence of magnetic field

$f_{pz}^r = 0$ ; only $f_{pz}^{im}$ exists; consequently only one peak at s θ ~500 survives without dc magnetic field. Figure. Shows the variation of terahertz radiation amplitude versus angle of incidence θ for four values of radiation frequency at magnetic field Bs=1071 G. Again, two THz amplitude peaks are obtained at θ ~$12^0$ and θ =50-$70^0$ . Peak height of THz amplitude at lower angle reduces with radiation frequency, while peak at higher angle enhances in height but shifts towards higher angle with radiation frequency. This trend is corresponding to the variation of $fpz^r$ and $fpz^{im}$ with radiation frequency.

$$A_r = \frac{(k_{mx}^2 + k_z^2)}{v_{th}^2/c^2[k_x k_{mx}^2 k_{sx} + k_x k_z^2 k_{sx} + k_x^2 k_z^2 + k_{mx} k_{sx} k_x^2 + k_z^4 + k_z^2 k_{mx} k_{sx}]} \left[ \begin{array}{l} \frac{ik_z k_{sx} v_{th}^2/c}{\varepsilon_0 \omega^3}\left(\frac{(\omega^2 \varepsilon_{xx} - k^2 v_{th}^2) J_{\omega z}^{NL} - \omega^2 \varepsilon_{zx} J_{\omega x}^{NL}}{\varepsilon_{\omega,k}}\right) - \frac{ik_x k_z}{\varepsilon_0 \omega^3}\left(\frac{(\omega^2 \varepsilon_{xx} - k^2 v_{th}^2) J_{\omega z}^{NL} - \omega^2 \varepsilon_{zx} J_{\omega x}^{NL}}{\varepsilon_{\omega,k}}\right) + \\ k_z^2 (1 - v_{th}^2/c^2) \frac{i}{\varepsilon_0 \omega^3}\left(\frac{(\omega^2 \varepsilon_{zz} - k^2 v_{th}^2) J_{\omega x}^{NL} - \omega^2 \varepsilon_{xz} J_{\omega z}^{NL}}{\varepsilon_{\omega,k}}\right) \end{array} \right] \quad \text{...............1.1}$$

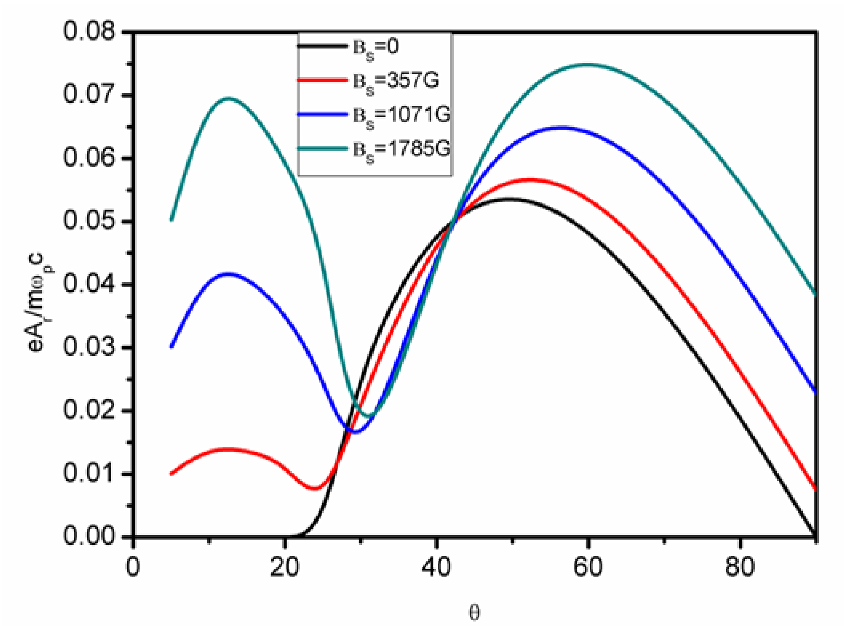


**Figure 1: Normalized THz amplitude $(eA_r/m\omega_p c)$ versus angle of incidence θ for four values of magnetic field at frequency 1.1 THz.**

Excitation of T-waves by non-linear photo mixing of two obliquely incident pump lasers in step density hot magnetized plasma is an attractive alternative because (i) the method can be easily realized and (ii) it provides higher efficiency due to coupling between THz radiation and plasma wave. In presence of transverse magnetic field, obliquely incident p-polarized beating lasers excite a surface current which in turn provides terahertz waves at resonance. For a particular (applied) magnetic field, terahertz amplitude can be attained at a particular value of angle (i.e. incident angle of lasers) e.g. maximum terahertz radiation amplitude of frequency 1.1 THz is achieved at an optimum angle ~$60^0$ for $B_S$=1785G. Optimum angle changes its position with THz radiation frequency and applied magnetic field due to change in resonance position. In absence of transverse magnetic field, only one peak in THz amplitude is observed, while two peaks along with a dip are observed in the existence of a $(\vec{B}_s)$

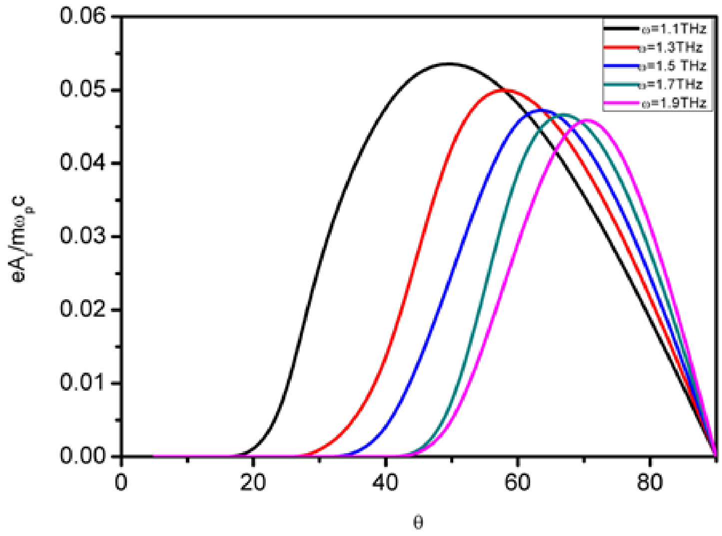


**Figure 2: Normalized THz amplitude $(eA_r/m\omega_p c)$ versus angle of incidence θ for five values of THz wave frequency without any external field.**

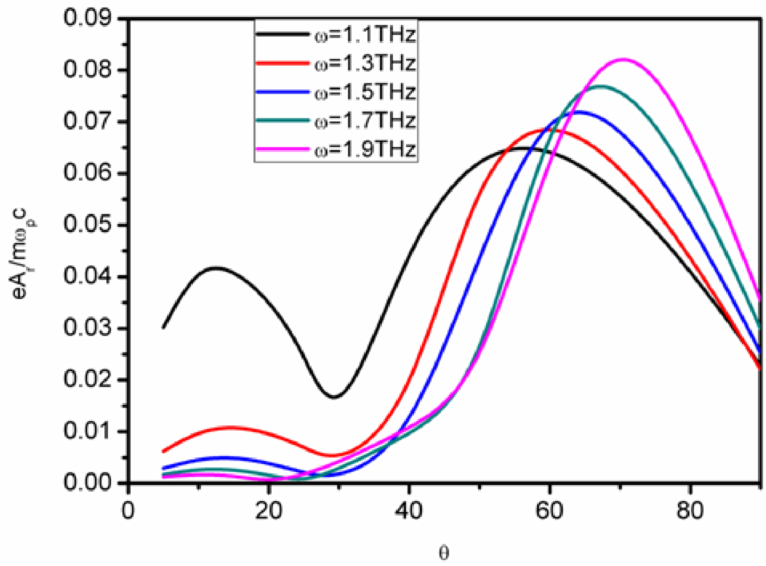


**Figure 3: Normalized THz amplitude $(eA_r/m\omega_p c)$ versus angle of incidence θ for five values of THz**

**wave frequency with applied dc field $B_S$=1071G.**

The presence of two peaks can also be explained in terms of changed polarization of THz radiation. Now, THz radiation propagates in the form of extraordinary wave which has two branches at different frequencies. Two peaks in Figure are corresponding to these branches. The dip between two peaks represents the damping regime which is corresponding to resonance at which wave dumps its energy to plasma electrons. Applied magnetic field changes not only the amplitude and the polarization of THz wave, but it also introduces an imaginary part to the ponderomotive force which represents the phase difference between $\vec{F}_p$ And $\vec{E}_{1,2}$ of beating lasers. Transverse magnetic field also controls the phase velocity and ,group velocity of THz radiation. Hot plasma is used to introduce frequency selectivity and for better coupling between Langmuir wave and THz radiation. In the present scheme, frequencies of beating lasers are ~100 THz which are corresponding to $CO_2$ laser. THz amplitude increases with applied magnetic field and radiation frequency due to enhanced coupling. Reduction in efficiency due to the collision of electrons is ignored in this scheme. In the present scheme, the kinetic effects are also ignored in deducing drift velocity due to ponderomotive force because $\omega >> kv_{th}$ For the electron response, isothermal approximation is inferred. The adiabatic approximation can be valid by appropriately multiplying the , temperature of electron with $c_p/c_v$ at constant volume and constant pressure. In this analysis the effect of finite beam size is ignored as beating lasers fall at an angle on plasma- vacuum interface. When incidence angle becomes zero, nonlinear current density does not have the transverse component and THz emission does not take place. The THz amplitude $8 \times 10^8$ V/m is turned out for laser intensity ,$3 \times 10^{16}$ W/cm$^2$. Analytical study gives that the present method for exciation of T-rays is quite effective.

## TERAHERTZ RADIATION GENERATION BY PULSE SLIPPAGE OF COSH-GAUSSIAN LASERS IN A CORRUGATED MAGNETIZED PLASMA

The effects of pulse slippage (in pump lasers and terahertz waves) and embedded transverse dc magnetic field are studied on the generation of terahertz waves by beating of two cosh-Gaussian (ChG) pump lasers travelling in a corrugated (rippled) plasma. The beating pump lasers gives nonlinear ponderomotive force to nonlinear medium plasma electrons. Oscillating electrons pair with corrugations exist in the plasma and resonantly excite a nonlinear surface current (at difference frequency) which drive the terahertz wave at proper phase matching conditions. As the group velocity of terahertz $(v_g)$ radiation is higher than the group velocity of beating lasers, T-wave slips forward the pump lasers, and its saturation takes place. The effect of THz wave frequency, periodicity of density structure, decentred parameter (of beating lasers), and embedded dc magnetic field are studied on terahertz emission.

The terahertz wave generation is studied by using the slippage of two ChG pulses is studied in a plasma when the ponderomotive force is the only operative nonlinearity. Terahertz radiation amplitude varies with the magnitude of rippled plasma density $n_{q0}$ . density ripples contributes more Higher amplitude of density ripples contributes more.

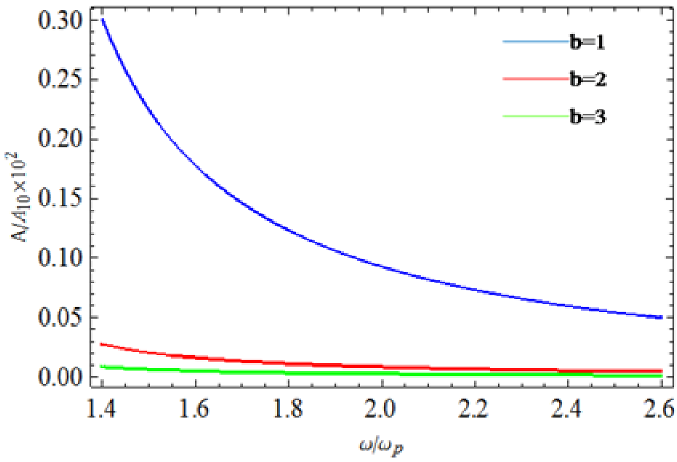


**Figure 4: Normalized terahertz tradiation amplitude $|A/A_{01}|\times 10^2$ with normalized terahertz frequency $\omega/\omega_p$ for different values of decentred parameter (b) of pump lasers.**

electrons to participate in the excitation of oscillating nonlinear current $J^{NL}$ for powerful T-rays emission. Frequency of T-rays is matched by changing rippled plasma density, corrugation factor and dc magnetic field. The phase ( resonance) matching condition

$$q = \omega / c\left[1-\left(1-\frac{\omega_p^2}{\omega^2}\frac{\omega^2-\omega_p^2}{\omega^2-\omega_p^2-\omega_c^2}\right)^{1/2}\right]$$

provides an idea about periodicity of corrugated plasma. When this condition is satisfied maximum energy transfer takes place from nonlinear mixing lasers to terahertz waves. The periodicity factor $q$ decreases with THz frequency, $q$ becomes maximum at resonance $\omega \sim \omega$. where high value of THz radiation amplitude ,amplitude is obtained. The ripple wavelength $(\lambda)$varies inversely to periodicity $q\ (=2\pi/\lambda)$; thus corruagtions at near value of distances are preferred for efficient terahertz waves generation. This result matches with the results obtained by Antonsen *et al.*They suggested axial corrugated plasma density for maximum energy transfer to T-rays at resonance. The periodicity factor $q$ also increases with applied magnetic field, thus one can tune T-rays frequency by changing rippled plasma density, ripple amplitude and dc magnetic force field. The embedded transverse dc magnetic flux has two key roles: It regulates the phase velocity and group velocity of the nonlinear photomixing laser and daughter waves on one side and it also decides polarization of the T-rays. Malik *et al.* discussed the effects of applied magnetic field on the emission of terahertz radiation by using Gaussian beams. Bhasin *et al.* have presented a method to generate terahertz waves by mixing of two x- mode pump lasers in a corruagated magnetized plasma via optical rectification.

## CONCLUSION

In the presence of magnetic fields, by pulse slapping the Gaussian cosh laser, by nonlinking the fundamental layer cup and frequency of the second harmonic laser, by stimulating Raman scattering and by using relativistic electron we proposed a variety of systems to generate terahertz irradiation through the nonlinear blending of the two lateral pulses. Laser plasma characteristics and the transversal static magnetic field may be used to control the THz amplitude. The magnetic field performs two functions in all of these systems: it regulates I the phase speed and the group speed for laser sweepers and (ii) the polarization of the THz wave produced. The THz amplifier scales up to and maximizes the frequency of density ribs.( ω ) approaches to resonance frequency $(\approx \omega_k)$. The real and imaginary portions of nonlinear power play a very important role in hot magnetized plasma. As a result, the two summits are the same $\theta \sim 10^{\circ}$ and $\theta = 50 - 70^{\circ}$. As compared to earlier researchers report on THz production by laser plasma contact, results from the suggested thesis have shown a substantial increase in the amplitude, efficiency and tunability of excited THz radiation.

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