DAV UNIVERSITY

+91 - 181- 270 8844 Telephone
naac@davuniversity.org E-mail
www.davuniversity.org Website

3.7.1.1: Number of functional MoUs with institutions/ industries in India and abroad for internship, on-the-job training, project work, student / faculty exchange and collaborative research during the last five years

Index - 2018-2019

Sr.No.	Year of signing MoU	Name of the organization with whom MOU/Collaboration being signed	Duration	Purpose of MOU/Collaboration	List the actual activities under each MOU year-wise	Page No.
1	2018-2019	Institution of Electronics & Telecommunication Engineers (IETE), New Delhi	Two Years	Establishment of IETE Sub-Centre, Jalandhar	1. Technical visit of experts from IETE 2. Webinar by IETE expert	1
2	2018-2019	Centre for Development of Advanced Computing, Mohali	Five years	For promoting Research & Development and creation of human capital in the fields of Biomedical, Electronics, Cyber Security, Software Engineering and allied areas	Student visit to Centre for Development of Advanced Computing (C-DAC)	9
3	2018-2019	Semi-Conductor Laboratory, SAS Nagar	Ten years	Collaboration on Research and Development faculty and Students	Student visit to Semi-Conductor Complex Limited Mohali	13
4	2018-2019	Harvard Business School	One Year	Membership in the India Site License Program	HBP content usage report for DAV	16

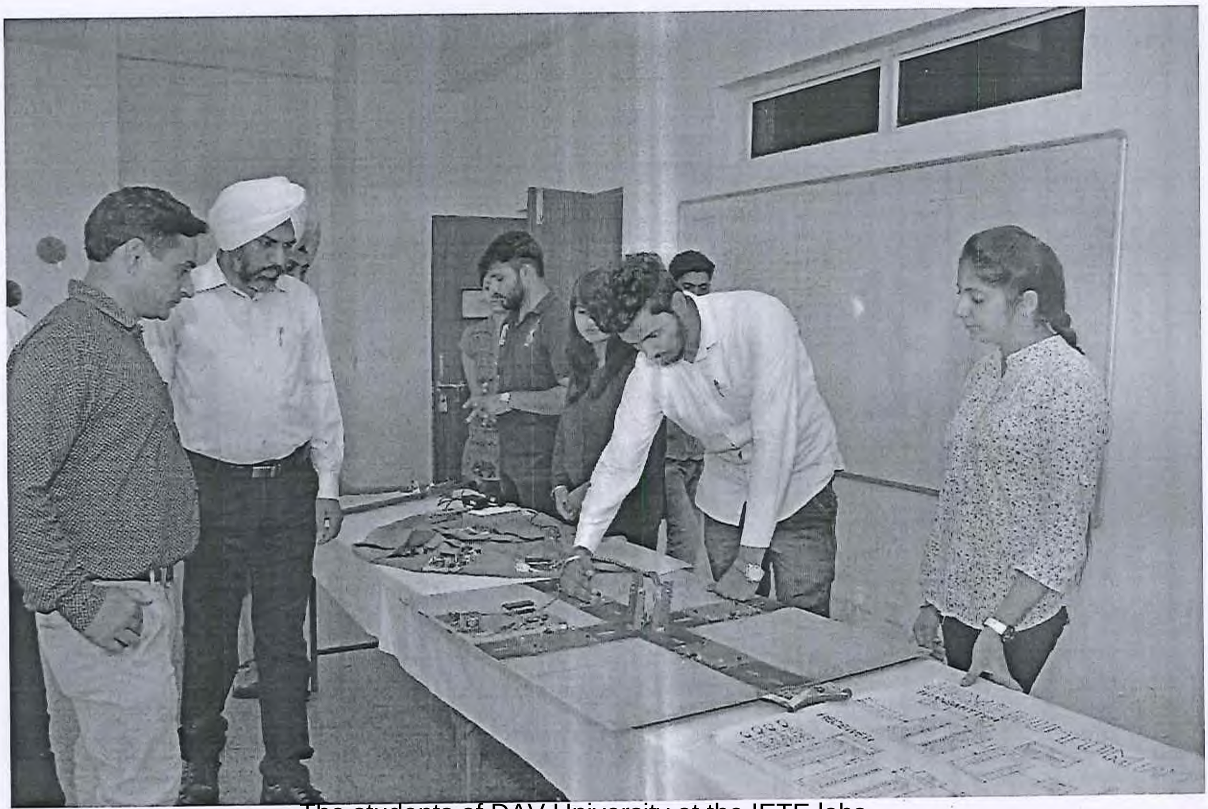
		Publishing, United States		and the terms associated	University for the **period of January to March 2020.**	
5	2018-2019	Amity University, Noida	Perpetual	Research Collaboration	Publication	19
6	2018-2019	National Institute of Technology Jalandhar	Perpetual	Research Collaboration	Publication	24
7	2018-2019	University of Allahabad	Perpetual	Research Collaboration	Publication	30
8	2018-2019	NIT Jalandhar	Perpetual	Research Collaboration	Publication	31
9	2018-2019	Kurukshetra University	Perpetual	Research Collaboration	Publication	32
10	2018-2019	DAV college Chandigarh	Perpetual	Research Collaboration	Publication	33

DAV University, Jalandhar
Department of ECE
Event Report

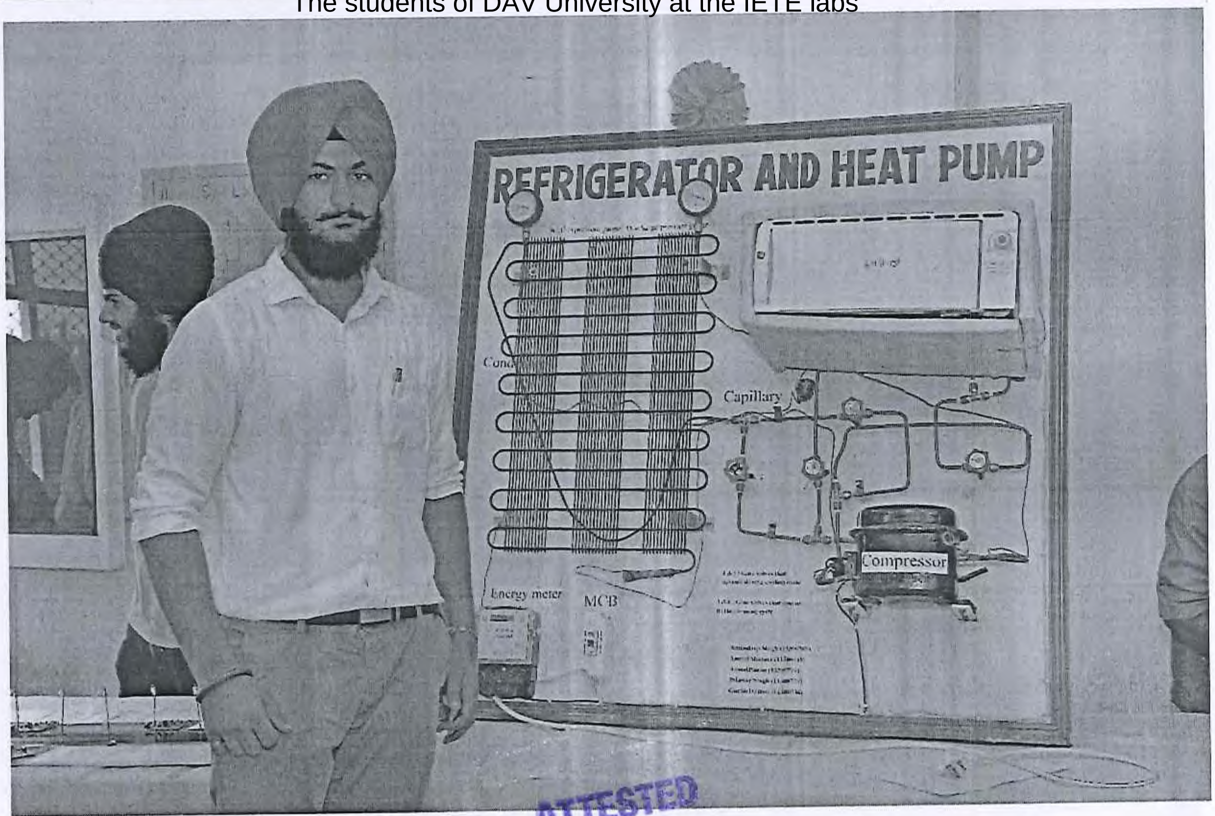
Name of Event: Technical Event
Date of Event: 26 September 2018.
Organized By: ECE Department
No. of Participants: 53
Brief Description: The Institution of Electronics and Telecommunication Engineers (IETE) is India's leading recognized professional society devoted to the advancement of science and technology of Electronics, Telecommunication and IT. Under the guidance of IETE the department of ECE have collectively organized different technical events in september2018.

The students of DAV University at the IETE campus

ATTESTED
Registrar
DAV University, Jalandhar



The students of DAV University at the IETE labs



The students of DAV University at the IETE labs

ATTESTED
Registrar
DAV University, Jalandhar

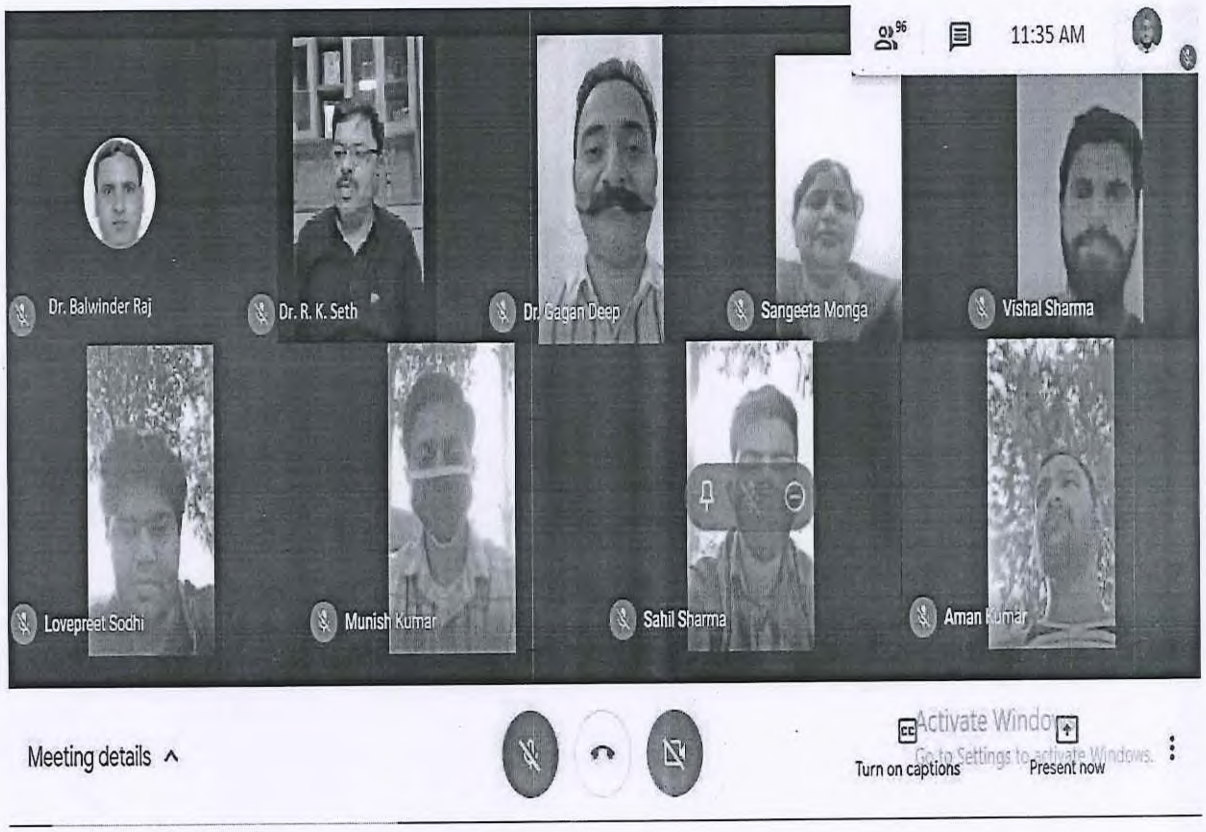
Dr Gagan delivering the talk

DAV University, Jalandhar
Department of ECE
Event Report

Name of Event: Webinar
Date of Event: March 17, 2021
Organized By: ECE Department
Name of Resource Person: Dr. Balwinder Raj
No. of Participants: 40
Brief Description: Under the guidance of The Institution of Electronics and Telecommunication Engineers (IETE) the Department of Electronics and Communication Engineering organized an online Webinars on the topic Low Power Techniques for Computer Applications on March 17, 2021. The Keynote Speaker was Dr. Balwinder Raj, Associate Professor, NITTTR Chandigarh. Dr. Raj explained the upcoming spintronic technology enabling low power memories, inmemory computing and neuromorphic computing. The event was attended by students of ECE and CSE departments.

ATTESTED

Registrar
DAV University, Jalandhar



ATTESTED

Registrar
DAV University, Jalandhar

List of participants

S. No	Name of student	Registration Number	SIGNATURE
1	AKASHDEEP AHIR	11300599	
2	AKSHEEN KAUR	11300600	
3	ANISH THAKUR	11300604	
4	ANKIT KAUSHAL	11300605	
5	ANSHUMAN SINGH CHIB	11300606	
6	BHASKER SINGH	11300608	
7	BIMLESH KUMAR SINGH	11300609	
8	Chakshu	11300610	
9	GAGAN	11300611	
10	GAGANDEEP SINGH	11300612	
11	HARKAWAL SINGH	11300613	
12	HARKIRAT SINGH CHEEMA	11300614	
13	HARPREET KAUR	11300615	
14	JAIWANT SINGH PARMAR	11300617	
15	JASMEEN KAUR	11300618	
16	JASPREET KAUR	11300619	
17	LAKHAN PAL SINGH	11300622	
18	MANPREET SINGH	11300623	
19	MANPREET SINGH	11300624	
20	NIKITA KUMRA	11300625	
21	PALLAV SHARMA	11300626	
22	RAHUL KAHOL	11300627	
23	RAHUL SOPHIE	11300628	
24	RAJKAMAL SINGH	11300630	
25	RAMNEEK KAUR	11300631	
26	KASHISH	11300621	
27	SHUBHAM BAHRI	11300636	
28	Varun Sharma	11300646	
29	Vijeyta Kapoor	11300647	
30	VISHAL DUTTA	11300648	
31	YUVRAJ SHARMA	11300649	
32	ADITYA KAPOOR	11300650	
33	AKSHIT DHANDA	11300651	
34	ANISH DATTA	11300652	
35	DINESH NANDA	11300654	

ATTESTED
Registrar
DAV University, Jalandhar

36	KIRAN PREET KAUR	11300655	
37	KOMAL THAKUR	11300656	
38	KSHITIJ V CHAUDHARY	11300657	
39	MANMEET KAUR	11300658	
40	PRACHI LAMBA	11300659	
41	ROHIT KUMAR	11300663	
42	SAHIL GHABRU	11300664	
43	SAVY GULATI	11300665	
44	SHUBHRIKA PUNNI	11300666	
45	SUDHANSHU SHARMA	11300667	
46	TANYA NAGPAL	11300668	
47	VIKRAM BHAGAT	11300669	
48	ABHISHEK RAMBANI	11300670	
49	RAJAT KUMAR BHANDARI	11300775	
50	SATVIR SINGH JAJ	11300789	
51	Devanshu Kapoor	11300896	
52	GAURAV PHULL	11300897	
53	PRATYAKSH SAGAR	11300903	

ATTESTED

Registrar
DAV University, Jalandhar

List of participants

S. No	Name of student	Registration Number	Signature
1	MUNISH KUMAR	11700085	
2	ADITYA KUMAR SINGH	11700088	
3	RITESH	11700151	
4	SAHIL SHARMA	11700896	
5	Prince vaid	11701087	
6	Vishal	11701104	
7	POONAM PAUL	11701789	
8	AMAN KUMAR	11702193	
9	SNEH	11801446	
10	SAURAV	11801800	
11	GAGANDEEP KAPOOR	11501504	
12	GURPREET	11501505	
13	GURPREET SINGH	11501506	
14	KANISHAK	11501508	
15	MANJOT KAUR	11501509	
16	RIMPY	11501514	
17	RUSHALI SHARMA	11501515	
18	Shubham Sharma	11501517	
19.	SUDEEKSHA THAKUR	11501518	
20	SUMIT GUPTA	11501519	
21	ASHISH CHAMBIYAL	11501520	
22	BANEET KUMAR	11501521	
23	PAWANDEEP SINGH	11501523	
24	VISHAL KOUNDAL	11501524	
25	RISHAV RAJ	11501526	
26	UPASANA	11501529	
27	BALJIT	11501670	
28	NEETIKA	11602881	
29	AMANDEEP SINGH	11602882	
30	ASHIMA SHARMA	11401125	
31	ASTHA	11401126	
32	BALJINDER SINGH	11401127	
33	BARJINDER SINGH	11401128	
34	KAMALJIT KAUR	11401129	
35	MANOJ	11401132	

ATTESTED

Registrar
DAV University, Jalandhar

36	MEENAKSHI	11401133	
37	NARINDER PAL SINGH	11401134	
38	PANKHURI CHAUHAN	11401135	
39	PARVINDER KAUR	11401136	
40	PAVNEET KAUR	11401137	

ATTESTED

Registrar
DAV University, Jalandhar

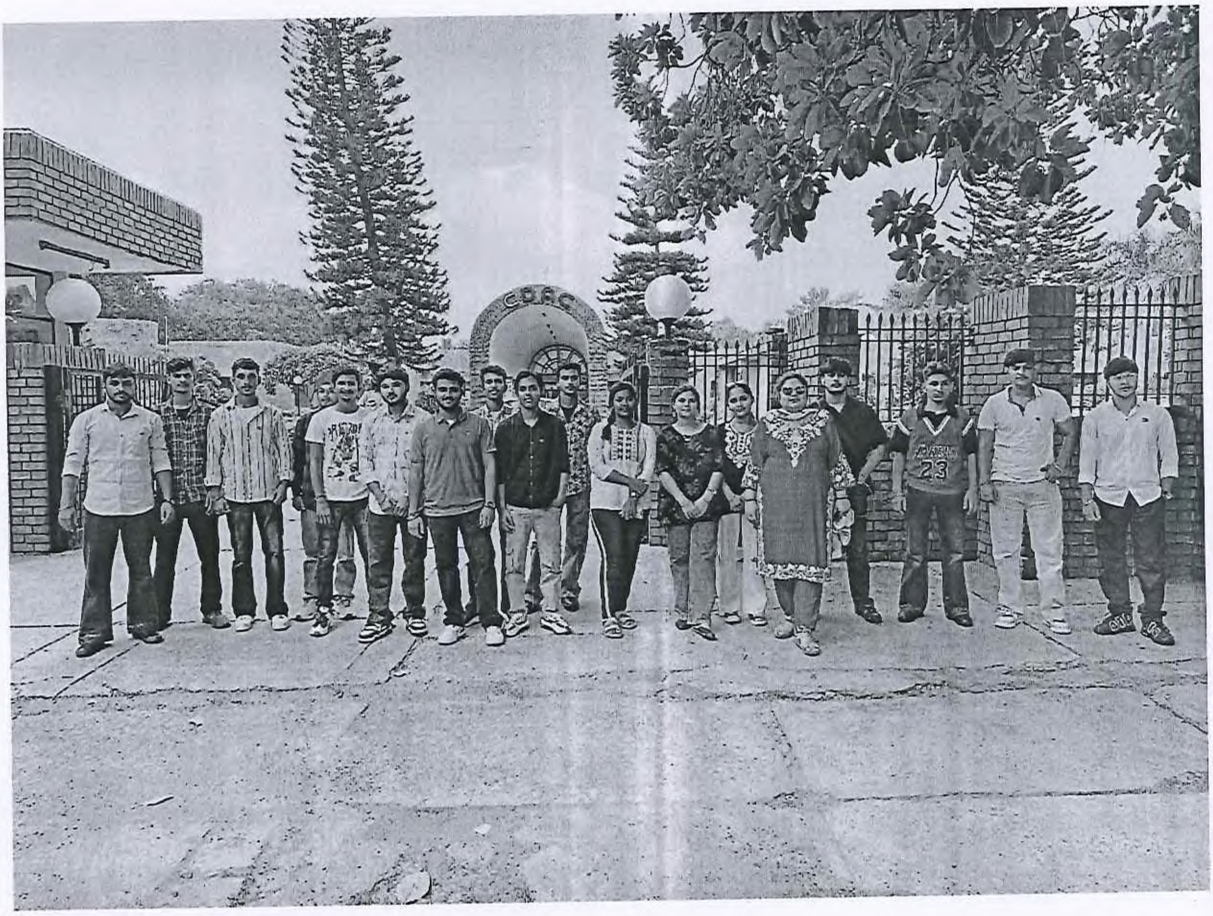
DAV University, Jalandhar
Department of ECE
Event Report

Name of Event: Visit to Centre for Development of Advanced Computing (C-DAC)
Date of Event: 23September 2021.
Organized By: ECE Department
No. of Participants: 27
Brief Description: Students of Electrical Engineering visited Centre for Development of Advanced Computing (C-DAC) Mohali. The students given awareness about Advanced Computing is uniquely positioned to establish dependable and secure Exascale Ecosystem offering services in various domains. C-DAC has crafted its strategic practical roadmap keeping in perspective the paradigm shift in the global technological ecosystem and ever-dynamic area of national ICT scenario. Accordingly, the roadmap has been devised with four-pronged approach based on the Core as HPC & Cloud., viz. Futuristic Research, Applied R&D, Applications and Services covering 28 thrust areas. Towards realisation of the roadmap, mission mode programmes were evolved to research, develop and deliver the futuristic technologies/solutions.

C-DAC has crafted its strategic practical roadmap keeping in perspective the paradigm shift in the global technological ecosystem and ever-dynamic area of national ICT scenario. The technological advancements in high-speed communication, intense computation, storage, and infrastructure coupled with mobility and accessibility has impacted the modalities of conducting business in a revolutionary manner.

ATTESTED

Registrar
DAV University, Jalandhar



The students of DAV university at the CDAC campus

ATTESTED

Registrar
DAV University, Jalandhar

The students of DAV university at the CDAC campus

ATTESTED
Registrar
DAV University, Jalandhar

List of Participants

Sr.. No.	StudentName	RegdNo	Signature
1	VAIBHAV	12400041	
2	SAMAR VASHISHT	12400508	
3	UPANSHU	12401098	
4	RISHAV BADYAL	12401264	
5	MANPREET SINGH	12401449	
6	MOHIT	12401587	
7	LALIT PAUL	12401710	
8	JASPREET SINGH	12401962	
9	ADITYA	12402057	
10	JASPREET SINGH	12300260	
11	K SUSHMITA	12300443	
12	ARYAN KATNORIA	12300912	
13	SUKHCHAIN SINGH	12301226	
14	HARMAN BAINS	12402243	
15	ASHISH	12200158	
16	AKASHDEEP SINGH BHATTI	12201437	
17	BIBHAKAR	12300270	
18	DIVYA	12300331	
19	DIKSHA	12300876	
20	VISHAL	12100215	
21	DHARAM PREET SINGH	12100229	
22	DEEPAK KUMAR	12100230	
23	SHUBHAM KUMAR	12100255	
24	KULVIR SINGH	12100625	
25	HIMESH KUMAR	12100661	
26	ARYAN THAKUR	12100977	
27	JATIN SINGH	12101014	

ATTESTED

Registrar
DAV University, Jalandhar

DAV University, Jalandhar
Department of ECE
Event Report

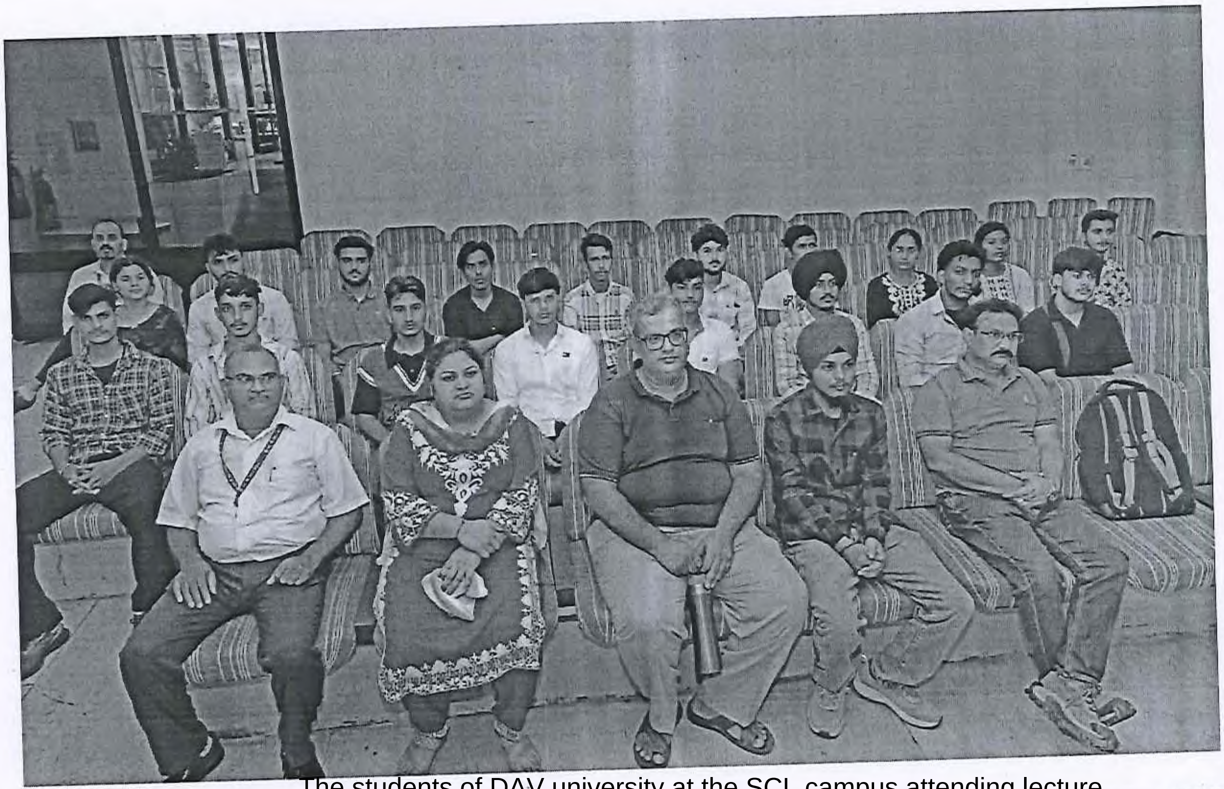
Name of Event: Visit to **Semi-Conductor Complex Limited (SCL), Mohali**

Date of Event: 15 September 2022.
Organized By: ECE Department
No. of Participants: 27

Brief Description: Students of Electrical Engineering visited Semi-Conductor Complex Limited(SCL), Mohali. The students given awareness about CMOS & MEMS manufacturing process and utilities 66KV sub-station. SCL has an 8" wafer fab line qualified to the JEDEC-JP001A standard with a 180 nm CMOS technology node. SCL also has a 6" fab line for MEMS development and is expanding it to include a compound semiconductor fabrication facility. Process capability at SCL enables a 1.8V, 1.8/3.3V, or 1.8V/5V power-supply solution with 4-6 Al-metal layers and analog modules. The VLSI design domain in SCL spreads over analog, digital, mixed-signal, memory, RF-CMOS, and optoelectronic in the form of silicon-proven and space-qualified ASICS, ASSPs, SoCs, SCL excels in developing ceramic packages and meets the demanding test requirements at the wafer and package level, along with test plan development for high-pin-count integrated circuits, RF, and MEMS devices. At SCL, quality and reliability assurance adhere to global performance specifications such as MIL-PRF-38535, JEDEC-JP001A, and MIL-STD-883. SCL possesses capabilities in power, water, and air management, bulk, and specialty gas distribution systems. The quality parameters of Ultra Pure Water (UPW) and bulk gases produced at SCL are at par with international standards. SCL brings decades of experience to provide customers with unparalleled microelectronics solutions in India. SCL is also engaged in the fabrication of Hi-Rel boards, Radio systems, and the indigenization of electronic subsystems.

ATTESTED

Registrar
DAV University, Jalandhar



The students of DAV university at the SCL campus attending lecture

The students of DAV university at the SCL campus

ATTESTED

Registrar
DAV University, Jalandhar

List of Participants

Sr.. No.	StudentName	RegdNo	Signature
1	VAIBHAV	12400041	
2	SAMAR VASHISHT	12400508	
3	UPANSHU	12401098	
4	RISHAV BADYAL	12401264	
5	MANPREET SINGH	12401449	
6	MOHIT	12401587	
7	LALIT PAUL	12401710	
8	JASPREET SINGH	12401962	
9	ADITYA	12402057	
10	JASPREET SINGH	12300260	
11	K SUSHMITA	12300443	
12	ARYAN KATNORIA	12300912	
13	SUKHCHAIN SINGH	12301226	
14	HARMAN BAINS	12402243	
15	ASHISH	12200158	
16	AKASHDEEP SINGH BHATTI	12201437	
17	BIBHAKAR	12300270	
18	DIVYA	12300331	
19	DIKSHA	12300876	
20	VISHAL	12100215	
21	DHARAM PREET SINGH	12100229	
22	DEEPAK KUMAR	12100230	
23	SHUBHAM KUMAR	12100255	
24	KULVIR SINGH	12100625	
25	HIMESH KUMAR	12100661	
26	ARYAN THAKUR	12100977	
27	JATIN SINGH	12101014	

ATTESTED

Registrar
DAV University, Jalandhar

Outlook

Fwd: April 2020: Harvard Business Publishing Usage Reporting (DAV University)

From Academic Affairs <dean.academics@davuniversity.org>
Date Sun 2024-09-29 11:41 AM
To lDr. Ahmad Husain <ahmad.husain@outlook.com>

1 attachments (32 KB)
DAV ETD (Starter) Usage Jan thru March 2020.xls;

Regards,

Dean (Academics)
DAV University, Jalandhar

---------- Forwarded message ---------
From: **Amandeep Kaur** <amandeep10077@davuniversity.org>
Date: Wed, 15 Apr 2020 at 11:49
Subject: Fwd: April 2020: Harvard Business Publishing Usage Reporting (DAV University)
To: <dean.academics@davuniversity.org>

Respected Sir.
Usage report is forward for your information.
Thanks
Regards
Amandeep kaur

ATTESTED
Registrar
DAV University, Jalandhar

---------- Forwarded message ----------
From: "globalsupport" <globalsupport@harvardbusiness.org>
Date: 6 Apr 2020 4:41 p.m.
Subject: April 2020: Harvard Business Publishing Usage Reporting (DAV University)
To: "amandeep10077@davuniversity.org" <amandeep10077@davuniversity.org>, "puneetdavuniversity@gmail.com" <puneetdavuniversity@gmail.com>
Cc: "Kathuria, Manik" <manik.kathuria@hbsp.harvard.edu>, "Pant, Taran" <taran.pant@harvardbusiness.org>, "Yadav, Radhika" <radhika.yadav@harvardbusiness.org>, "Hilpertshauser, Hans" <hans.hilpertshauser@harvardbusiness.org>

Dear Amandeep & Puneet,

Hope this mail finds you well.

Please find attached the HBP content usage report for your institute for the **period of January to March 2020.** We've included details of all the content for various programs in separate worksheets in the attached excel file.

You are requested to please verify the case usage in various programs and send us a confirmation by 20th April 2020.

Actions to be taken: Please review each worksheet in the attached file to confirm the usage for each of the following -

TYPE	DETAILS
HBS Usage	HBS Usage for usage in programs where you have paid flat license fees.
Outside Usage	Non – HBS Usage for programs under the contract/Open Enrolment Programs

Company Programs: Billable Company Programs	For usage in Company/MDP programs

Please direct any questions that you may have about this email to me or manik.kathuria@hbsp.harvard.edu or Hans Hilpertshauser at hans.hilpertshauser@harvardbusiness.org

Thank you for your continued support and cooperation under these challenging circumstances.

Best Regards,

Isha Mundkur

Sales Support Team

HARVARD BUSINESS PUBLISHING

7th Floor, Piramal Tower, Peninsula Corporate Park, Ganpatrao Kadam Marg, Lower Parel (West), Mumbai 400013, India

hbr.org | harvardbusiness.org | hbsp.harvard.edu | hbrascend.org

ATTESTED
Registrar
DAV University, Jalandhar

					on	Expected Student Count							Course End			Desc
															ent	
1.9.2020								Pachpore	sity.org	sity.org	S_ADMIN					
MBA/International Business 1.9.2020	694669	M	DAV University	W16170	Economics of Gold	75	DAV University	Mr. Pranjal Pachpore	amandeep10077@davuniversity.org	amandeep10077@davuniversity.org	ROLE_MATERIALS_ADMIN	09-01-2020	07-07-2020	ACTIVE	Ivey	
MBA/International Business 1.9.2020	694669	M	DAV University	W17293	Tata Steel/Acquisition of	75	DAV University	Mr. Pranjal Pachpore	amandeep10077@davuniversity.org	amandeep10077@davuniversity.org	ROLE_MATERIALS_ADMIN	09-01-2020	07-07-2020	ACTIVE	Ivey	
MBA/International Business 1.9.2020	694669	M	DAV University	W18252	Competing with Patanjali/C	75	DAV University	Mr. Pranjal Pachpore	amandeep10077@davuniversity.org	amandeep10077@davuniversity.org	ROLE_MATERIALS_ADMIN	09-01-2020	07-07-2020	ACTIVE	Ivey	
MBA/International Business 1.9.2020	694669	M	DAV University	W19045	BMW/Decisions Under the Br	75	DAV University	Mr. Pranjal Pachpore	amandeep10077@davuniversity.org	amandeep10077@davuniversity.org	ROLE_MATERIALS_ADMIN	09-01-2020	07-07-2020	ACTIVE	Ivey	
MBA/International Business 1.9.2020	694669	M	DAV University	W19179	Bajaj Auto Ltd/Argentine P	75	DAV University	Mr. Pranjal Pachpore	amandeep10077@davuniversity.org	amandeep10077@davuniversity.org	ROLE_MATERIALS_ADMIN	09-01-2020	07-07-2020	ACTIVE	Ivey	

ATTESTED
Registrar
DAV University, Jalandhar

PHYSICS OF PLASMAS **24**, 043104 (2017)

Laser second harmonic generation in a magnetoplasma assisted by an electrostatic wave

Yachna Tyagi,[1] Deepak Tripathi,[1,a)] and Keshav Walia[2]
[1]*Department of physics, AIAS, Amity University Noida, UP 201303, India*
[2]*Department of physics, DAV University, Jalandhar 144012, India*

(Received 11 October 2016; accepted 20 March 2017; published online 5 April 2017)

A laser produced plasma, and an electrostatic wave, helps to generate a strong harmonic radiation. The electrostatic wave assists k matching and contributes to non-linear coupling. In the case of the Bernstein wave assisted second harmonic, the frequency of the second harmonic is shifted from the laser second harmonic by electron cyclotron frequency. The lower hybrid wave (LHW) assisted second harmonic has frequency slightly shifted from the laser second harmonic. The upper hybrid wave (UHW) assisted second harmonic has frequency shifted by an amount ω that lies between $\max(\omega_c, \omega_p)$ and ω_{UH}. At $a_0 = 0.1$ and $n_{\omega,\vec{k}}/n_0^0 = 0.1$, the normalized amplitude value the of electrostatic wave assisted second harmonic is quite high near the upper hybrid resonance. The effect of increasing ω_c/ω_p increases the max value of normalized amplitude. *Published by AIP Publishing.* [http://dx.doi.org/10.1063/1.4979673]

I. INTRODUCTION

Laser second harmonic generation in plasmas provides valuable information about the linear mode conversion of a laser into a plasma wave or a self-generated magnetic field, and hence it is a subject of much interest. The efficiency of harmonic energy conversion, however, is low unless the mismatch in the wave number of the second harmonic 'k_2' and two-times the wave number of the laser 'k' is minimized. Applications of a density ripple[1,2] or a magnetic wiggler are among the schemes suggested for phase matching.[3,4] In most laser interactions with homogeneous plasmas, odd harmonics are generated.[5–8] However, second harmonics have been observed in the presence of density gradients,[9–14] and they have also been related to filamentation.[15,16]

Strong self-generated magnetic fields have been observed in laser-produced plasmas.[17,18] The existence of a self-generated magnetic field in a laser-produced plasma allows a variety of collective modes of space charge oscillations, e.g., Bernstein modes, lower hybrid modes, and upper hybrid modes. These modes may be driven parametrically unstable by the laser and may play an important role in laser energy absorption and heat transport. Tripathi and Sharma[19] have examined the three wave parametric decay instability of laser radiation into lower hybrid and upper hybrid modes, ion acoustic and upper hybrid modes, and fast ion and plasma waves, in a uniform magnetoplasma. Sharma[20] has studied the resonant decay instability of plasma waves into electron Bernstein waves.

Jha *et al.*[21] have reported that an intense laser pulse interacts with a homogeneous plasma embedded in a transverse magnetic field, with the transverse current density oscillating with frequency twice that of the laser field. Krushelnick *et al.*[22] have observed a second harmonic shifted by the plasma frequency, giving information about the stimulated Raman scattering. Parasher and Pandey[23] have proposed a scheme of efficiency enhancement of a second harmonic by introducing a density ripple into the interactive region.

In this paper, we examine the second harmonic generation of a laser in the presence of electrostatic waves. The physics of the process is as follows: A high intensity laser of frequency ω_0 and wave number $\vec{k}_0$ is moving into the plasma, in which a self-generated magnetic field B_s is present in the $\hat{z}$ direction. The laser exerts a $(2\omega_0, 2\vec{k}_0)$ ponderomotive force on electrons to induce an oscillatory velocity $v_{2\omega_0 2\vec{k}_0}$. This oscillatory velocity of electrons in the presence of the density variation of electrostatic waves produces a non-linear current density at $(2\omega_0 + \omega, 2\vec{k}_0 + \vec{k})$, which gives rise to the electrostatic wave frequency shifted radiation field.

In Section II, we analyze the linear response of the pump wave in a magnetized plasma in the presence of electrostatic waves. In Section III, we analyze the phase matching condition for the second harmonic. In Sec. IV, we study the resonant electrostatic wave frequency shifted second harmonic generation of a laser. In Sec. V, we discuss and summarize the results.

II. LINEAR RESPONSE TO THE PUMP

Consider a plasma of equilibrium electron density n_0^0 and electron temperature T_e immersed in a static magnetic field $B_s\hat{z}$. In the second harmonic generation in a plasma in the presence of the electrostatic waves, a pump electromagnetic wave interacts with an electrostatic wave. Consider the propagation of a high intensity laser of frequency ω_0 through the plasma along the $\hat{x}$ axis as an extraordinary mode, with

$$\vec{E}_0 = (\hat{y} - i\alpha\hat{x})A_0 e^{-i(\omega_0 t - k_0 x)} \quad \text{and} \quad \vec{B}_0 = \frac{\vec{k}_0 \times \vec{E}_0}{\omega_0}, \quad (1)$$

where

a)Electronic mail: deepakkrt@gmail.com

1070-664X/2017/24(4)/043104/7/$30.00 Published by AIP Publishing.

ATTESTED Self-attested Keshav
Registrar
DAV University, Jalandhar

Optik - International Journal for Light and Electron Optics 186 (2019) 46–51

Contents lists available at ScienceDirect

Optik

journal homepage: www.elsevier.com/locate/ijleo

Original research article

Self-focusing of elliptical laser beam in cold quantum plasma

Keshav Walia[a,*], Deepak Tripathi[b]

[a] Department of Physics, DAV University Jalandhar, India
[b] Department of Physics, AIAS, Amity University Noida, India

ARTICLE INFO

PACS:
52.38.Hb
52.35.Mw
52.38.Dx

Keywords:
Elliptical laser beam
Cold quantum plasma
Plasma density
Classical relativistic plasma

ABSTRACT

In the present communication, self-focusing of elliptical beam in cold quantum plasma is investigated. WKB and paraxial theory approach are employed to set up second order differential equations for beam widths of semi major and semi minor axes of elliptical beam. Further, 4th order Runge-Kutta method is employed for solving these differential equations numerically. These beam width parameters are plotted with normalized distance for various parameters such as laser beam intensity, plasma density and beam radius. Results of present analysis are compared with the case of classical relativistic plasma.

1. Introduction

The self-focusing phenomenon was discovered by Askar'yan in 1962 [1]. Self-focusing phenomenon is attracting the interest of many researchers due to its several applications such as X-ray lasers, laser induced fusion, charged particle acceleration etc [2–9]. Significant contribution was given by Hora and Siegrist in relativistic self-focusing [10,11]. Many researchers have explored this phenomenon theoretically as well as experimentally in different media such as plasmas, clusters, liquids etc. Whenever interaction of lasers with plasma takes place, then various nonlinearities such as relativistic [12], thermal [13] and ponderomotive [14] are introduced. These nonlinearities results in variation in the medium's refractive index, which produces self-focusing of beam.

In laser-plasma interaction process, unique place is occupied by self-focusing, as it highly affects other nonlinear phenomena [15–27]. These days, the interaction of lasers with quantum plasmas is hot topic of research due to various applications of quantum plasma systems [28–32]. In case of quantum plasmas, the density of particles is very high and temperature is low. Researcher's interest in field of quantum plasmas is also due to their important applications in several other fields such as astrophysical environments, cosmological environments, quantum dots, nano technology and fusion science etc [33–38]. In case of quantum plasmas, statistical distribution used is Fermi dirac, whereas Maxwell Boltzman statistical distribution is used in classical plasmas. Moreover, wigner's formalism is used instead of vlasov equation in case of quantum plasmas [39]. In classical plasmas, we generally treat all particles as point like due to their small De-broglie wavelength. In case of quantum plasmas, De-broglie wavelength linked with particles is almost same as inter-particle distance [40]. In laser-plasma interaction process, most of research work is performed by researchers with cylindrical gaussian profiles [41–43]. Since beam produced by many laser systems have elliptical cross-section. So it is most important to study this realistic situation. So, present work's motivation is to investigate non-linear interaction of laser beam with quantum plasma.

In Section 2, second order differential equations governing the evolution of spot size of laser beam have been set up by making use of Wentzal-Kramers-Brillouin(WKB) and paraxial ray approximations. The computational results are shown in Section 3. Conclusion

* Corresponding author.
E-mail address: keshavwalia86@gmail.com (K. Walia).

https://doi.org/10.1016/j.ijleo.2019.04.081
Received 17 February 2019; Accepted 16 April 2019

Optik - International Journal for Light and Electron Optics 195 (2019) 163166

Contents lists available at ScienceDirect

Optik

journal homepage: www.elsevier.com/locate/ijleo

Original research article

Stimulated Raman scattering of high power beam in thermal quantum plasma

Keshav Walia[a,*], Yachna Tyagi[b], Deepak Tripathi[b], A.M. Alshehri[c], Nafis Ahmad[c]

[a] Department of Physics, DAV University Jalandhar, India
[b] Department of Physics, AIAS, Amity University Noida, India
[c] Department of Physics, College of Science, King Khalid University, P.O. Box: 9004, Abha, 61413, Saudi Arabia

ARTICLE INFO

Keywords:
Gaussian beam
Self-focusing
Thermal quantum plasma
Electron plasma wave
Reflectivity

ABSTRACT

Stimulated Raman Scattering (SRS) of high power beam in thermal quantum plasma (TQP) is investigated in present communication. There is an interaction of pump beam with electron plasma wave (EPW), which results in generation of back-scattered beam. Due to intense laser beam, oscillatory velocity associated with electrons becomes equivalent to velocity of light on account of intense laser beam. This results in modification of background density profile of plasma in a direction normal to axis of pump beam. There is increase in effective mass of electrons on account of relativistic nonlinearity, which in turn affects the incident beam, EPW and scattered beam. 2^{nd} order differential equations for the beam widths of input beam, EPW and scattered beam and also expression for back-reflectivity have been set up by using WKB and paraxial approximations. Effects of variation in laser parameters and plasma parameters on the beam widths of various beams involved and SRS back-reflectivity are analyzed. Observations made from the analysis show that SRS back reflectivity is greatly affected by self-focusing.

1. Introduction

The interaction of ultra intense laser beams with plasmas is hot topic of research for experimental as well as theoretical researchers due to its applicability to laser induced fusion, charged particle acceleration, ionospheric modification and new radiation sources [1–9]. In laser-plasma interaction process, crucial role is played by the various instabilities such as SRS, SBS, filamentation and self-focusing. These instabilities results in great reduction in laser-plasma coupling efficiency. Moreover, highly energetic electrons can get produced on account of these instabilities. The fusion fuel can be preheated by these electrons, and results in reduction in compression rate. Intensity distribution of beam also get modified on account of these instabilities. In fact, laser beam energy propagation over large distances through plasmas is mainly governed by SRS process. Since, most of applications relating with laser-matter interaction depend on amount of energy of laser beam transmitted through plasmas [10–15].So, SRS process becomes an important research field for theoretical as well as experimental researchers [16–21].

In Stimulated Raman scattering, there is decay of incident light wave in to scattered wave and electron plasma wave(EPW). Further, there is production of highly energetic electrons on account of EPW. The target core can be preheated by these electrons. Extent of wasted energy is depicted by scattered wave. Raman reflectivity is an important parameter to get information regarding extent of useful and wasted energy is laser-plasma interaction process. Most of research work on scattering instabilities had been done in past by making use of plane waves. However, self-focusing phenomenon becomes important when pump beam intensity is kept

* Corresponding author.
E-mail addresses: keshavwalia86@gmail.com (K. Walia), deepakkrt@gmai.com (D. Tripathi).

https://doi.org/10.1016/j.ijleo.2019.163166
Received 9 May 2019; Accepted 28 July 2019

Self-attested
Keshav

Optik - International Journal for Light and Electron Optics 226 (2021) 165978

Contents lists available at ScienceDirect

Optik

journal homepage: www.elsevier.com/locate/ijleo

Original research article

Impact of self-focused high power beam on second harmonic generation in collisional plasmas

Vinit Kakkar [a], Keshav Walia [b,*], Deepak Tripathi [a]

[a] *Department of Physics, AIAS, Amity University Noida, India*
[b] *Department of Physics, DAV University Jalandhar, India*

ARTICLE INFO

Keywords:
Self-focusing
Non-uniform heating
Electron plasma wave
Second harmonic yield

ABSTRACT

In present communication, impact of self-focused high power beam on 2nd harmonic generation is explored in collisional plasmas. Non-uniform irradiance associated with Gaussian beam results in non-uniform heating of plasma electrons thereby causing focusing of main beam. There is production of strong density gradients in a direction perpendicular to input beam. The density gradients so created results in excitation of electron plasma wave (EPW) at input wave frequency. The main beam interacts with EPW leading to generation of second harmonics. With the help of WKB approximation and paraxial theory, 2nd order differential equation controlling the growth of main beam spot size is derived. Impact of laser and plasma parameters on focusing behavior of main beam and yield of second harmonics is explored through numerical simulations.

1. Introduction

Interaction of lasers having high power with plasmas is attracting the awareness of several theoretical and experimental research groups as a result of its direct relevancy to wide range of applications including laser induced fusion, acceleration of charged particles, X-ray lasers, generation of higher harmonics [1–8]. The propagation of intense lasers through plasmas up to long distances is highly preferable for success of these applications. Moreover, interaction of lasers with plasma medium results in emergence of several nonlinear phenomena including self-phase modulation, self-focusing, two plasmon decay [9–21]. In order to have complete awareness of interaction of lasers with plasma, analytical and numerical investigation of some of these nonlinear phenomena is highly advantageous. Among various nonlinear phenomena mentioned above, distinctive place is engaged by phenomenon of self-focusing. The phenomenon of self-focusing was discovered by Askaryan in 1962 [22]. This phenomenon is attracting the delight of numerous researchers as a result of its relation with several newly discovered processes. The phenomenon of self-focusing comes out due to nonlinear reaction of medium to intense field of EM beam. The dielectric properties associated with medium changes due to interaction with intense EM beam. In this way, medium begins acting like a convex lens. In case of collisional nonlinearity, there is ohmic heating of plasma electrons as a result of non-uniform intensity distribution of EM beam, thereby causing variation in dielectric properties of medium.

Most important nonlinear process in laser-plasma interaction is higher harmonics generation of EM radiations. Researchers are actively involved in investigating harmonic generation, since laser beam transit across plasmas is completely governed by this phenomenon. The generation of harmonics helps in getting details of important parameters connected with plasmas such as electrical

* Corresponding author.
E-mail addresses: keshavwalia86@gmail.com (K. Walia), deepakkrt@gmail.com (D. Tripathi).

https://doi.org/10.1016/j.ijleo.2020.165978
Received 5 November 2020; Accepted 5 November 2020
Available online 10 November 2020

Optik - International Journal for Light and Electron Optics 244 (2021) 167601

Contents lists available at ScienceDirect

Optik

journal homepage: www.elsevier.com/locate/ijleo

Original research article

Effect of pulse enhancement on beat wave THz generation in a ripple density magnetized plasma

Vinit Kakkar [a], Keshav Walia [b,*], Yachna Tyagi [c], Khushboo Sharma [a], Deepak Tripathi [a,*]

[a] Department of Physics, AIAS, Amity University Noida, UP 201303, India
[b] Department of physics, DAV University, Jalandhar, Punjab, India
[c] Department of Physics, RBA Government Degree College, Gajraula, Amroha, UP 244235, India

ABSTRACT

Generation of terahertz pulse by the method of nonlinear mixing of two lasers in a plasma which is magnetized and have ripple density is studied permitting the effect of pulse enhancement. Due to nonlinear ponderomotive force, coupling of electron flow with density ripples occurs which leads to production of nonlinear current. Terahertz radiation are resonantly driven by this nonlinear current at beat frequency. Since here magnetic field is transverse to propagation of laser so we have transverse component of current density, while density ripples are responsible for phase matching. Thus, enhancement of pulse occurs due to the mismatch in group velocity of laser pulses and terahertz radiation, which further results in saturation of amplitude of terahertz waves.

1. Introduction

Terahertz range in spectrum of EM waves has been widely used in many fields. These waves are electromagnetic waves with its frequency lying between the range 0.1 terahertz to 10 terahertz and have tremendous applications in various fields on the basis of its properties. In such a short time these waves have also invaded this new field of application, i.e., advanced imaging methods [1–8]. Over these years, a lot of research work is also going on to enhance the methods to modulate and generate these radiations. Mostly, the sources of these radiations are accelerator based [9–17]. Such type of accelerator-based sources produces THz waves by making use of short electron bunches which are ultra-relativistic through various methods, i.e., coherent synchrotron radiation [18] or undulator radiation [19] or free electron laser [20]. Presently, there are many methods to generate terahertz radiations, but the most preferred one is the method in which femtosecond laser pulses undergo optical rectification. More exploration is going on with optical rectification with various nonlinear materials. Up to now, we are able to get the terahertz pulses with a bandwidth of frequency ranging from 0.1 THz to 3 THz and with energy approximately equal to 10 micro joules. Sheng et al. [21] investigated the generation of terahertz waves through linear mode conversion of wave in plasma driven by laser wake field, where plasma either has transverse magnetic field or density gradient. In this method, very intense extraordinary mode laser pulses propagate via magnetized plasma. Here, the external magnetic field applied is static and its direction is at right angle with that of propagation of laser as well as its polarization. Further, an EM wave lying in the frequency range of terahertz wave is generated. While generation of THz radiation via intense interaction of short pulse laser and plasma, we encounter a major issue of phase matching. If the frequencies of two laser pulses are ω_1 and ω_2, then sum of their wave vectors is given by $(\omega_1 + \omega_2)/c$; the wave vector of the terahertz wave generated by beating of lasers is given by $((\omega_1 + \omega_2)^2 - \omega_p^2)^{1/2}/c$, where the plasma frequency is represented by ω_p. This phase matching of the resultant wave

* Corresponding authors.
E-mail addresses: keshavwalia86@gmail.com (K. Walia), deepakkrt@gmail.com (D. Tripathi).

https://doi.org/10.1016/j.ijleo.2021.167601
Received 9 June 2021; Accepted 5 July 2021
Available online 8 July 2021

Self-attested
Keshav

J Fusion Energ (2014) 33:83–87
DOI 10.1007/s10894-013-9644-7

ORIGINAL RESEARCH

Effect of Self-focusing of Gaussian Laser Beam on Second Harmonic Generation in Relativistic Plasma

Keshav Walia · Arvinder Singh

Published online: 7 November 2013

Abstract In the present paper, effect of self-focusing of gaussian laser beam on second harmonic generation in relativistic plasma is investigated. An expression for density perturbation associated with plasma wave has been derived, which acts as a source for second harmonic generation. Moment theory approach has been used to set up wave equation for the laser beam. Effect of the intensity of the laser beam and plasma density on the harmonic yield is studied in detail. It is predicted from the analysis that harmonic yield increases due to increase in the plasma density and intensity of the laser beam.

Keywords Self-focusing · Relativistic plasma · Plasma wave · Second harmonic generation

Introduction

An efficient coupling of a high power laser beam with plasma is a topic of current research in many areas such as laser induced fusion and charged particle acceleration [1, 2, 3, 4, 5]. Due to availability of lasers capable of delivering high power($10^{18} - 10^{21}$ W/cm^2), its interaction with plasma becomes a most interesting and important non-linear problem. At such intensities, the response of plasma free electrons is fully relativistic and highly non-linear. In the laser plasma coupling process, when a high power laser beam interacts with the plasma, various parametric instabilities such as self-focusing, filamentation, harmonic generation, SRS, SBS, etc. take place. Due to this, the energy of high power laser beam is not efficiently coupled with plasma [6, 7, 8, 9, 10]. Therefore, the study of these non-linear phenomenon at high power laser flux is being studied theoretically and experimentally.

Relativistic self-focusing is caused by the relativistic increase in mass of electrons, whenever they are traveling at speed approaching the speed of light, which modifies the effective dielectric constant of plasma and hence affects the self-focusing of beam. Relativistic self-focusing of the laser beams has been studied in detail both theoretically as well as experimentally [11, 12, 13, 14, 15]. Generation of harmonic radiation is an important subject of laser plasma interaction and attracts great attention due to its wide range of applications. Harmonic generation in intense laser plasma interaction has been studied extensively both experimentally and theoretically [16, 17, 18, 19, 20]. Most of the theories of harmonic generation are based on the assumption of a uniform laser beam. This is almost contrary to experimental situations, where laser beams of finite size, having non-uniform intensity distribution along their wavefront are used. Such beams may modify the background plasma density distribution and suffer strong self-focusing. Also, for a given power of beam, the average of square of electric vector in the wavefront is found to much higher for non-uniform irradiance distribution than that for uniform irradiance distribution; so, the magnitude of the generated harmonics is higher in the case of non-uniform irradiance. This provides a strong motivation for the study of the second harmonic yield by taking self-focusing in to account.

The propagation of intense laser beams in underdense plasmas excite plasma wave which in turn interacts with

K. Walia (✉)
Department of Physics, DAV University, Jalandhar, India
e-mail: keshavwalia86@gmail.com

A. Singh
Department of Physics, National Institute of Technology, Jalandhar, India

Self-attested
Keshav

ATTESTED
Registrar
DAV University, Jalandhar

Optik - International Journal for Light and Electron Optics 225 (2021) 165745

Contents lists available at ScienceDirect

Optik

journal homepage: www.elsevier.com/locate/ijleo

Original research article

Second harmonic generation of laser beam in quantum plasma under collective influence of relativistic-ponderomotive nonlinearities

Keshav Walia [a,*], R.K. Verma [b], Arvinder Singh [c]

[a] Department of Physics, DAV University Jalandhar, India
[b] Department of Physics, Central University of Rajasthan, Ajmer, India
[c] Department of Physics, National Institute of Technology Jalandhar, India

ARTICLE INFO

Keywords:
Self-focusing
RP force
Second harmonic yield
Electron plasma wave
Quantum effects

PACS:
52.38.Hb
52.35.Mw
52.38.Dx

ABSTRACT

Second harmonic generation (SHG) of laser beam in quantum plasma under collective influence of relativistic-ponderomotive nonlinearities is explored. Combined influence of relativistic-ponderomotive forces (RP force) causes variation in mass of electrons and background density of electrons thereby producing self-focusing of input beam. Well known paraxial theory is utilized for deriving basic self-focusing equation of input beam. There is creation of density gradients inside plasma under influence of RP force, which results in generation of high frequency electron plasma wave (EPW). Nonlinear coupling between input beam and EPW produces SHG. Numerical simulations are executed in order to have understanding of impact of laser and plasma parameters on beam width of input beam and yield of SHG. Impact of inclusion of ponderomotive nonlinearity and quantum effects on beam width of input beam and yield of SHG is also explored.

1. Introduction

Laser-plasma coupling is immense research topic amongst various research groups worldwide as a result of its significance in various applications including inertial confinement fusion(ICF), super-continuum generation, X-ray lasers, acceleration of charged particles [1–8]. Exploration of laser-plasma interaction physics at intensities exceeding $10^{19} W/cm^2$ has been made possible by advancement in chirped pulse amplification technique (CPA). The behavior of plasma electrons becomes highly nonlinear and completely relativistic at such limit. Nonlinear laser-plasma interaction results in creation of various parametric instabilities including scattering instabilities, self-focusing, two plasmon decay, harmonic generation [9–21]. Therefore, for in-depth knowledge of physics of laser-plasma interaction, investigation of some of these instabilities are desirable.

Self-focusing phenomenon was reported for the first time by Askaryan in 1962[22]. This phenomenon is gaining interest amongst several research groups worldwide on account of its connection with many other nonlinear phenomena. Self-focusing phenomenon arises as a result of nonlinear response of material medium, whenever medium is subjected to electromagnetic (EM) beam. These phenomenon further results in change in dielectric properties linked with the medium. In collisionless plasma, ponderomotive force causes displacement of electrons to off-axial region thereby causing redistribution of carriers. In laser produced plasmas, the phenomenon of harmonic generation is an important nonlinear process. Due to harmonic generation, there is a strong influence on

* Corresponding author.
E-mail addresses: keshavwalia86@gmail.com (K. Walia), arvinders@nitj.ac.in (A. Singh).

https://doi.org/10.1016/j.ijleo.2020.165745
Received 4 July 2020; Accepted 30 September 2020
Available online 9 October 2020

Self-attested
Keshav

Optik - International Journal for Light and Electron Optics 244 (2021) 167608

Contents lists available at ScienceDirect

Optik

journal homepage: www.elsevier.com/locate/ijleo

Original research article

Second harmonic generation of intense Laguerre-Gaussian beam in relativistic plasma having an exponential density transition

Aman Bhatia [a], Keshav Walia [b], Arvinder Singh [a,*]

[a] Department of Physics, Dr. B.R. Ambedkar National Institute of Technology Jalandhar, India
[b] Department of Physics, DAV University Jalandhar, India

ARTICLE INFO

Keywords:
Self-focusing
Laguerre-Gaussian beam
Electron plasma wave
Second harmonic generation
Density ramp/transition

ABSTRACT

The present communication explores the second harmonic generation (SHG) of intense Laguerre-Gaussian beam (L-G beam) in relativistic plasma having an exponential density transition. The carrier redistribution is observed on account of relativistic nonlinearity in presence of intense L-G beam. This results in establishment of transverse intensity gradients thereby generating electron plasma wave (EPW) at the frequency of pump wave. Further, there is an interaction of pump beam with EPW resulting in production of second harmonics. The approach of method of moments is utilized for deriving 2nd order differential equation for beam waist of beam and yield of SHG. It is predicted from the results that a vital role is played by exponential density ramp and different L-G beam modes in enhancing focusing ability of beam and yield of SHG.

1. Introduction

The laser-plasma interaction is a vast research topic amongst theoretical/experimental research groups due to their relevance in large applications such as inertial confinement fusion (ICF), medical imaging, X-ray lasers, particle acceleration etc. [1–8]. Innumerable phenomena including self-focusing, filamentation, scattering instabilities and many more are originated as a result of interaction of intense lasers with plasma medium [9–21]. In ICF, the relativistic effects are induced by intense lasers with intensity range $10^{18} - 10^{20}\ W/cm^2$. At such range, laser-plasma interaction causes quiver speed of electrons equivalent to light's speed thereby causing variation in plasma dielectric properties. The plasma medium simply behaves as convex lens thereby leading to focusing of beam.

The harmonic generation plays a vital role in laser-plasma interaction. In fact, there is a vigorous impact on transition of laser through plasma medium due to harmonic generation. The power of beam gets penetrated through overdense region on account of generation of harmonics. One can easily gather information regarding various parameters such as electrical conductivity, opacity, expansion velocity etc. through harmonic generation [22–24]. Since pulse duration for harmonic radiations is very small, so they play crucial role in ultrafast spectroscopy [25–29]. SHG has large applications in second harmonic imaging microscopy due to productivity of low wavelength radiation. The production of harmonics in plasmas can be done through several ways including EPW excitation, resonant absorption and photon acceleration [30–34]. However, the most well known method of generating harmonics is through EPW excitation. In this method, there is an excitation of EPW at main beam frequency which in turn interacts with main beam thereby producing second harmonics. SHG phenomenon has already been explored by several theoretical/experimental research groups

* Corresponding author.
E-mail addresses: bhatiaaman709@gmail.com (A. Bhatia), keshavwalia86@gmail.com (K. Walia), arvinders@nitj.ac.in (A. Singh).

https://doi.org/10.1016/j.ijleo.2021.167608
Received 28 June 2021; Accepted 6 July 2021
Available online 9 July 2021

Self-attested
Keshav

Optik - International Journal for Light and Electron Optics 245 (2021) 167627

Contents lists available at ScienceDirect

Optik

journal homepage: www.elsevier.com/locate/ijleo

Second harmonic generation of Cosh-Gaussian beam in unmagnetized plasmas: Effect of relativistic-ponderomotive force

Keshav Walia[a,*], Prashant Sharma[a], Arvinder Singh[b]

[a] Department of Physics, DAV University Jalandhar, India
[b] Department of Physics, Dr. B.R. Ambedkar National Institute of Technology Jalandhar, India

ARTICLE INFO

Keywords:
Second harmonic generation
Cosh-Gaussian beam
Pump beam
Electron plasma wave
Density fluctuations

ABSTRACT

Second harmonic generation (SHG) of Cosh-Gaussian beam in unmagnetized plasma is investigated in present communication. The relativistic-ponderomotive force (RP force) is jointly taken in present investigation. The combined action of RP force produces electron redistribution thereby producing density fluctuations in plasma in transverse direction. Electron plasma wave (EPW) is generated at pump beam's frequency on account of these density fluctuations. The pump beam couples with EPW resulting in generation of 2nd harmonics. The nonlinear differential equation associated with pump beam and second harmonic yields (SHY) are obtained by employing WKB and paraxial theory approximations. The overall impact of established laser plasma parameters and RP force on pump beam's focusing ability and SHY is also explored.

1. Introduction

The researchers have given significant attentiveness to ultra-intense laser plasma interaction due to their connection with diverse applications including laser driven fusion, super continuum generation and plasma based accelerators [1–8]. In order to accomplish success in above mentioned applications, much deeper beam transition through plasmas is extremely preferable. The beam transition through plasmas causes origination to abundant nonlinear phenomena including scattering instabilities, Compton scattering, higher harmonic generation and self-focusing [9–21]. Much attentiveness is given by researchers to self-focusing phenomena due to its direct connectivity with abundant applications including charged species acceleration, X-ray lasers and laser driven fusion. Several other phenomena are directly influenced on account of self-focusing. Self-focusing causes change in plasma dielectric function. The beam's lateral dimensions get reduced on account of self-focusing. Main causes behind self-focusing are either ponderomotive force or increase in relativistic electron mass [22–25].

Higher harmonic generation (HHG) occupies a distinctive place in laser produced plasmas. The extensive research work has already been carried out on HHG by leading theoretical/experimental research groups due to its connection with innumerable applications [26–37]. HHG in laser produced plasmas can be produced through several ways including producing transverse density gradients, photon acceleration, and electron plasma wave (EPW) excitation [38–42]. However, EPW excitation is commonly used technique for SHG. In this technique, EPW is excited at main beam frequency. There is further coupling of main beam with EPW to give SHG. In fact, the beam transition through plasmas is significantly affected by SHG. There is transit of beam power in overdense portion thereby giving useful information on parameters including local electron concentration, density gradients and expansion velocity [43,44]. SHG

* Corresponding author.
E-mail addresses: keshavwalia86@gmail.com (K. Walia), arvinders@nitj.ac.in (A. Singh).

https://doi.org/10.1016/j.ijleo.2021.167627
Received 8 July 2021; Accepted 12 July 2021
Available online 18 July 2021

Self-attested
Keshav

Physics of Plasmas ARTICLE scitation.org/journal/php

Laguerre–Gaussian laser beam guiding and its second harmonics in plasma having density ramp

Cite as: Phys. Plasmas **29**, 092107 (2022); doi: 10.1063/5.0103924
Submitted: 17 June 2022 · Accepted: 28 August 2022 ·
Published Online: 26 September 2022

View Online Export Citation CrossMark

Aman Bhatia,[1,a)] Keshav Walia,[2,b)] and Arvinder Singh[1,c)]

AFFILIATIONS

[1]Department of Physics, National Institute of Technology, Jalandhar 144027, Punjab, India
[2]Department of Physics, DAV University, Jalandhar 144012, Punjab, India

[a)]Author to whom correspondence should be addressed: bhatiaaman709@gmail.com
[b)]Electronic mail: keshavwalia86@gmail.com
[c)]Electronic mail: arvinders@nitj.ac.in

ABSTRACT

This paper presents the optical guiding of a laser beam in plasma by using a preformed plasma channel. The density ramp in plasma density due to the plasma pressure has also been considered. The effect of ponderomotive force has been taken into account which originates due to the intensity gradient present in the laser beam. This force produces a plasma gradient by expelling plasma electrons from a high-field to a low-field region, providing heavy ions remain immobile. Plasma oscillations result from a gradient in plasma density that excites an electron plasma wave. The equation governing the plasma wave excitation has been found by using linear perturbation theory. An in-phase mixing of an incident laser beam with this plasma wave generates its second harmonics. Laguerre–Gaussian laser profile has been used for harmonic production. Moment theory has been used to obtain a differential equation for beam waist, which has been solved numerically by Runge–Kutta's fourth-order method. The effect of different modes of Laguerre–Gaussian profile, beam intensity, plasma density, channel depth, and slope of density ramp has been explored.

I. INTRODUCTION

An interest in the study of a laser beam traveling through a non-linear medium is increasing day by day with the invention of ultraintense lasers. The laser peak powers achieved from kilowatt to terawatt and time duration of femtoseconds in laser pulses have also been obtained with the help of chirped pulse amplification (CPA).[1,2] The propagation of such lasers in the plasma medium leads to several interesting phenomena such as self-focusing, filamentation, two-plasmon decay, plasma acceleration, and terahertz generation. These phenomena are useful in a wide range of applications such as harmonic generation,[3,4] plasma-based particle accelerators,[5,6] inertial confinement fusion,[7–9] and many more. Most of these applications require the propagation of laser into plasma medium over long distances. However, because of the diffracting nature of laser with increasing distance, the laser beam starts diffracting and can only travel up to several Rayleigh distance (R_H) in plasma. Because of such diffraction, the laser will not be able to transfer its energy effectually to the whole plasma. Many scientific studies have been made earlier to overcome the defocusing of laser in a plasma medium. Out of optical guiding is an effective tool to guide the laser beam in the plasma medium. In this, a preformed channeled plasma has been used to guide the laser beam in plasma medium. In addition to that, some self-acting phenomena such as self-focusing[10] and self-trapping have also been studied to guide the laser in plasma to travel up to many Rayleigh lengths. Plasma channeling is used more than conventional optical fibers because a breakdown occurs for high intensities in optical fibers. To make the theoretical calculations much fine and more trustworthy, non-uniform plasma has been taken with some transitions in the density as it is expelled from inside to outside with plasma pressure. From the literature it has been observed that some of the authors have used different kinds of density transitions such as exponential density transition,[11] tangential density transition,[12–14] sinusoidal density transition,[15] etc. Durfee and Milchberg[16] used a two-pulse technique in their experiment and guided laser (intensities $10^3 - 10^{14}\,\mathrm{W/cm^2}$) over a distance of more than $20R_H$. Ehrlich[17]

Self-attested
Keshav

© 2022 Institute of Theoretical Physics CAS, Chinese Physical Society and IOP Publishing Printed in China and the UK Communications in Theoretical Physics

Commun. Theor. Phys. 74 (2022) 105502 (9pp) https://doi.org/10.1088/1572-9494/ac846e

Second harmonic generation of high power Cosh-Gaussian beam in cold collisionless plasma

Keshav Walia[1,*], **Kulkaran Singh**[1] **and Deepak Tripathi**[2]

[1] Department of Physics, DAV University, Jalandhar, India
[2] Department of Physics, AIAS, Amity University, Noida, India

E-mail: keshavwalia86@gmail.com and deepakkrt@gmail.com

Received 25 May 2022, revised 25 July 2022
Accepted for publication 27 July 2022
Published 26 September 2022

CrossMark

Abstract

The purpose of this study is to explore the second harmonic generation (SHG) of a high power Cosh-Gaussian beam in cold collisionless plasma. The ponderomotive force causes carrier redistribution from high field to low field region in presence of a Cosh-Gaussian beam thereby producing density gradients in the transverse direction. The density gradients so produced the results in electron plasma wave (EPW) generation at the frequency of the input beam. The EPW interacts with the input beam resulting in the production of 2nd harmonics. WKB and paraxial approximations are employed for obtaining the 2nd order differential equation describing the behavior of the beam's spot size against normalized distance. The impact of well-established laser-plasma parameters on the behavior of the beam's spot size and SHG yield are also analyzed. The focusing behavior of the beam and SHG yield is enhanced with an increase in the density of plasma, the radius of the beam and the decentred parameter, and with a decrease in the intensity of the beam. The results of the current problem are really helpful for complete information of laser-plasma interaction physics.

Keywords: second harmonic generation, cold collisionless plasma, ponderomotive force, electron plasma wave, Cosh-Gaussian beam

(Some figures may appear in colour only in the online journal)

1. Introduction

Several theoretical and experimental research groups are interested in exploring laser-plasma interaction physics as a result of its connection with a variety of applications including laser-driven fusion, plasma-based accelerators and higher harmonic generation [1–8]. One can achieve success in the above-mentioned applications through much deeper transition of laser beam inside plasma and acquiring minimum spot size so that maximum energy from the laser beam to the system could be transferred. Several nonlinear phenomena such as harmonic generation, scattering instabilities, self-focusing etc are produced on intense laser interaction with plasma [9–21]. Researchers are exploring these instabilities theoretically as well as experimentally for detailed information of intense laser interaction with plasma [22–27]. Amongst these nonlinear phenomena, the phenomenon of self-focusing occupies a distinctive place. This phenomenon was first time discovered by Askaryan in 1962 [28]. The self-focusing phenomenon is receiving major attention of many researchers on account of its direct relevance to other nonlinear phenomena. This phenomenon arises on account of a change in the plasma's overall dielectric function. The overall plasma's dielectric function can change as a result of three main mechanisms namely relativistic effects, collisions and ponderomotive force.

The most important research area in the laser-plasma interaction process is the production of harmonics. In fact, plasma is the most promising medium for the production of harmonics. It results in the conversion of the laser beam fundamental frequency into several harmonics. Harmonic

* Author to whom any correspondence should be addressed.

Self-attested
Keshav

CrystEngComm

ROYAL SOCIETY OF CHEMISTRY

PAPER

Check for updates

Cite this: *CrystEngComm*, 2021, **23**, 7855

A tryptophan-based copper(II) coordination polymer: catalytic activity towards Suzuki–Miyaura cross-coupling reactions†

Ahmad Husain, [*a] Pooja Rani,[b] Kuldeep Kaur Nar,[a] Amit Pratap Singh, [c] Rakesh Kumar,[d] K. K. Bhasin[b] and Girijesh Kumar [*b]

Herein, we report the synthesis and crystal structure determination of a new Cu(II) coordination polymer (CP) with the formula $[Cu(L\text{-tryp})(azpy)_{1/2}(H_2O)(NO_3)]_\infty$ (**CP1**), which exhibits an unusual tryptophan coordination mode with copper(II) *via* carboxylate monodentate binding as well as chelation *via* N_{amino} and $O_{carbonyl}$ groups. **CP1** was prepared using the ligand L-tryptophan (L-tryp) and the co-ligand 4,4′-azopyridine (azpy), adapting the mixed-ligand approach and a solvothermal protocol. Single crystal X-ray structural analysis revealed that in **CP1**, Cu(II) sites show a distorted octahedral geometry, wherein the ligand L-tryp is coordinated through the carboxylate and amine groups, whereas the co-ligand azpy is coordinated to Cu(II) ions through the $N_{pyridyl}$ atom and thus maintains a distorted octahedral geometry around the Cu(II) ions. FT-IR and EPR spectra were also recorded to corroborate the structural analysis. Finally, **CP1** was employed as a heterogeneous catalyst for the Suzuki cross-coupling reaction and afforded ~98% yield under normal reaction conditions.

Received 23rd September 2021, Accepted 18th October 2021

DOI: 10.1039/d1ce01282g

rsc.li/crystengcomm

Introduction

The design and synthesis of amino acid-based coordination polymers (CPs) is undertaken by inorganic chemists because of the structural diversity of these polymers and their variety of applications in the areas of catalysis,[1–4] gas sorption and separation,[5–8] sensing,[9–13] drug delivery, proton conductivity,[14,15] magnetism,[16–18] *etc.*[19,20] Amino acids are known to form a five-membered ring with metal ions through *N,O*-chelation that arises from the amine and carboxylate moieties.[21–23] Thus, the structural design can be rationalized by selecting metal ions and organic tethers to obtain desired one-, two- and three-dimensional CPs.[24,25] In addition, the careful choice of the organic co-ligand plays an important role in directing the topology and dimensionality of the resulting CPs.[24–26] Besides, amino acids are well known for their non-classical interactions, such as hydrogen bonds, π–π stacking of aromatic rings, cation–π interactions, and charge transfer, which play crucial roles in the determination of resultant structures and their functions.[27] In this regard, tryptophan (tryp), an α-amino acid having one amino group, one indolic group and one carboxylic group, is a versatile ligand in coordination chemistry due to the electron donor capability of its amino acid groups, whereas the presence of N-heterocyclic moieties reinforces the non-classical interactions, thus providing another advantage over other contemporary classical ligands.[28] On the other hand, the employment of co-ligand [4,4′-azopyridine (azpy)] along with the tryp ligand can be useful to extend supramolecular architectures and tune the metal ion coordination geometry.[29–31] Further, the utilization of transition metal-based complexes as a catalyst for organic transformation reactions has been widely explored.[32–35] In addition, reports are available wherein metal–(amino acid) complexes (metal = Pd and Ni) have been used as catalysts for organic transformation reactions, particularly the Suzuki–Miyaura cross-coupling reaction.[36] However, Cu(II)–amino acid complexes have drawn less attention from the scientific community towards their utilization as catalysts for the abovementioned catalytic transformation,[37,38] although the weak interactions and stacking behaviour of Cu(II)–amino acid complexes in aqueous medium play significant roles and

[a] *Department of Chemistry, DAV University, Jalandhar-144012, Punjab, India. E-mail: ahmad.husain@outlook.com, ahmad10620@davuniversity.org*
[b] *Department of Chemistry & Centre for Advanced Studies in Chemistry, Panjab University Chandigarh, Chandigarh, India. E-mail: gkumar@pu.ac.in, girijeshchem@gmail.com*
[c] *Department of Applied Sciences, National Institute of Technology, New Delhi-110040, India*
[d] *Department of Chemistry, MCM DAV College, Kangra-176001, Himachal Pradesh, India*

† Electronic supplementary information (ESI) available: Additional experimental data, FT-IR, elemental analysis, TGA traces, PXRD data and crystallographic bond angle table. CCDC 2019236. For ESI and crystallographic data in CIF or other electronic format see DOI: 10.1039/d1ce01282g

J. Chem. Sci. (2020)132:15
https://doi.org/10.1007/s12039-019-1700-z

REGULAR ARTICLE

A hydrogel based on dialdehyde carboxymethyl cellulose–gelatin and its utilization as a bio adsorbent

SAPNA SETHI[a,*], BALBIR SINGH KAITH[b], MANDEEP KAUR[a], NEERAJ SHARMA[a] and SADHIKA KHULLAR[b,*]

[a]Department of Chemistry, DAV University, Jalandhar 144 012, Punjab, India
[b]Department of Chemistry, Dr. B.R. Ambedkar National Institute of Technology, Jalandhar 144 011, Punjab, India
E-mail: sapna10062@davuniversity.org; khullars@nitj.ac.in

MS received 10 May 2019; revised 23 August 2019; accepted 30 August 2019

Abstract. In the present study, the dialdehyde carboxymethyl cellulose (DCMC) was cross-linked covalently to gelatin *via* the Schiff base reaction to form a three-dimensional hydrogel (DCMC-cl-G). The crosslinking degree of DCMC and gelatin was estimated to be 50.31 ± 2.65. The maximum swelling capacity of the hydrogel in aqueous medium was around 74 g/g at pH 10.0 and 37 °C with equilibrium swelling attained in three hours and the compressive strength of the hydrogel was found to be 55 ± 0.76 kPa at 60% strain. The biodegradation studies confirmed 82.67% degradation of the hydrogel sample within a period of twelve weeks. Further, the hydrogel was evaluated as a bio adsorbent for the removal of hazardous dyes, namely Rhodamine B (RhB) and Methyl Violet (MV) from water due to its decent swelling capacity and good mechanical strength. The maximum percentage of RhB and MV removed from the respective dye solutions using DCMC-cl-G hydrogel was 96.5% and 90% at pH 6.0, respectively. Both dyes followed Langmuir adsorption isotherm, which considers monolayer adsorption of adsorbate over adsorbent, with a pseudo-second-order kinetic model.

Keywords. Eco-friendly; biodegradation; cross-linked; dye removal; natural polysaccharides.

1. Introduction

Water pollution by various industrial effluents such as dyes, heavy metal ions, and other organic contaminants such as pesticides, drugs, etc., has increased leaving an intimidating remark on the environment.[1] Out of these effluents, the waste from the dye industry contributes enormously to the water quality and thus makes it unfit for drinking. The world is suffering from severe scarcity of water and thus protecting drinking water is the need of the hour. Therefore, the scientific and general community should contribute immensely to protecting it. There are many techniques such as membrane filtration, coagulation, ozone treatment, photocatalytic degradation, ion exchange, biological treatment, etc., which are employed to remove dyes from wastewater. Out of all these methods, adsorption is an easy, practical, and cost-effective method.[2] Thus the synthesis of materials with high adsorbing quality is essential to efficiently adsorb dyes from water.

Hydrogels are hydrophilic in nature with three-dimensional structures which can retain water in it, showing its good absorbing capacity. Polymeric hydrogels of natural polysaccharides, such as starch, gelatin, chitosan, sodium alginate, gums, polypeptides, agar, etc., and carboxymethyl cellulose (CMC) have been receiving considerable attention due to their promising wide range of applications in the fields of biomedical, pharmacy, nanotechnology, electrochemical capacitor, water and soil treatment, etc.[3] Many hazardous dyes, namely, Rhodamine B (RhB), Methyl orange (MO), and Methyl violet (MV), are released

*For correspondence

Electronic supplementary material: The online version of this article (https://doi.org/10.1007/s12039-019-1700-z) contains supplementary material, which is available to authorized users.

Published online: 20 December 2019

Journal of Molecular Liquids 322 (2021) 114971

Contents lists available at ScienceDirect

Journal of Molecular Liquids

journal homepage: www.elsevier.com/locate/molliq

Molecular interactions of l-glutamic acid and l-aspartic acid in aqueous solutions 1-heptyl-3-methyl imidazolium tetrafluoroborate $[C_7mim][BF_4]$ at different temperatures

Rekha Gaba [a,*], Jigyasa Malhotra [a], Amalendu Pal [b], Dinkar Sharma [c], Harsh Kumar [d]

[a] Department of Chemistry, DAV University, Jalandhar, Punjab, India
[b] Department of Chemistry, Kurukshetra University, Haryana, India
[c] Department of Mathematics, Lyallpur Khalsa College, Jalandhar, Punjab, India
[d] Department of Chemistry, Dr B. R. Ambedkar National Institute of Technology, Jalandhar, Punjab, India

ARTICLE INFO

Article history:
Received 21 August 2020
Received in revised form 13 November 2020
Accepted 4 December 2020
Available online 10 December 2020

Keywords:
1-heptyl-3-methyl imidazolium tetrafluoroborate ($[C_7mim][BF_4]$)
Apparent molar volume
Apparent molar isentropic compression
Ionic liquid

ABSTRACT

To study the molecular interactions between the ternary mixtures containing 1-heptyl-3-methyl imidazolium tetrafluoroborate $[C_7mim][BF_4]$ as a common solvent with l-glutamic acid and l-aspartic acid respectively, densities and speed of sound have been measured at three different temperatures viz. $T = 288.15$ K, 298.15 K and 308.15 K under 0.1 MPa Pressure. The density and speed of sound data have been further utilized to calculate apparent molar volume and apparent molar isentropic compression. From the apparent molar volume and apparent molar isentropic compression, both properties at infinite dilution i.e. V_ϕ^0 and $K_{\phi,S}^0$ have also been computed. To draw the conclusion from the volumetric and acoustic data, limiting apparent molar expansion E_ϕ^0, as well as hydration numbers, n_H have been studied. It is quite worthwhile to study all of these derived or calculated parameters to perceive the solvation behavior, mixing aspects and various types of interactions born in the ternary solutions of (amino acid + $[C_7mim][BF_4]$ + water) due to change in structure.

1. Introduction

One of the crucial component of all the living systems is protein. The most prominent structural feature of all the proteins is that they are long chains of amino acid residues joined together through peptide bonds. Proteins perform divergent biological functions of life ranging from DNA replication, catalysis, formation of cell skeletal system, homeostasis, transport of oxygen, cell signaling, regulation of gene expression, transcription as well as storage function [1–3]. The interactions of water with the functional groups of proteins play important factor in determining the conformational stability of proteins. The study of the solvent effect on the properties of model compounds such as amino acid is quite helpful in understanding water-protein interactions in solutions. Moreover, physico-chemical and thermodynamic investigations of ionic liquid with amino acid is of much significance in order to understand the nature and the extent of the patterns of interaction in solutions and their variations with temperature and composition. So, with view of biological importance of amino acids and proteins, we have tried to generate a novel study on liquid mixtures with non-essential amino acids. Two non-essential acidic-polar amino acids viz. l-glutamic acid and l-aspartic acid containing a carboxylic acid side are utilized in the present work. Both of the chosen amino acids can release a proton and acquire a negative charge at the pH of body fluids due to presence of an additional carboxyl group. In the body glutamic acid turns into glutamate. Glutamate is produced by retinal ganglion cells [4]. Glutamate as an excitatory neurotransmitter in central nerves system, is a leading intercessor of sensory information, motor coordination, cognitive functions and emotions, including memory formation and memory retrieval [5]. Glutamic acid is also vital oxidative fuel for the intestine and immune cells [6,7]. Aspartic acid is chiral and exists in two enantiomeric forms, l-asparate and d-asparate. L-asparate is proteinogenic and multifunctional amino acid like glutamate. Beyond biological importance, l-aspartic acid is also used as an effective crystal modifier for preparation of short columnar hemihydrates [8] and as an electrochemical micro sensor for simultaneous detection of copper and lead [9].

The other component chosen for study is 1-heptyl-3-methyl imidazolium tetrafluoraborate $[C_7mim][BF_4]$ which is an ionic liquid. We can observe an explosion of curiosity in ionic liquids since last decades. These thermally stable molten salts have gained so much attention due to their wide applicability like bio-catalytic activity, enzymatic activity, geometric and in structural features of protein molecules [10–15]. We can also find a lot of research papers published on utility of room temperature ionic liquids [16–23]. Like amino acids, thermodynamic and physico-chemical properties of ionic liquids in solutions are

* Corresponding author.
E-mail addresses: rekhagaba@gmail.com, rekha10043@davuniversity.org (R. Gaba).

https://doi.org/10.1016/j.molliq.2020.114971
0167-7322/

BIOENGINEERED
2023, VOL. 14, NO. 1, 2260919
https://doi.org/10.1080/21655979.2023.2260919

Taylor & Francis
Taylor & Francis Group

OPEN ACCESS Check for updates

Nanotechnology-assisted treatment of pharmaceuticals contaminated water

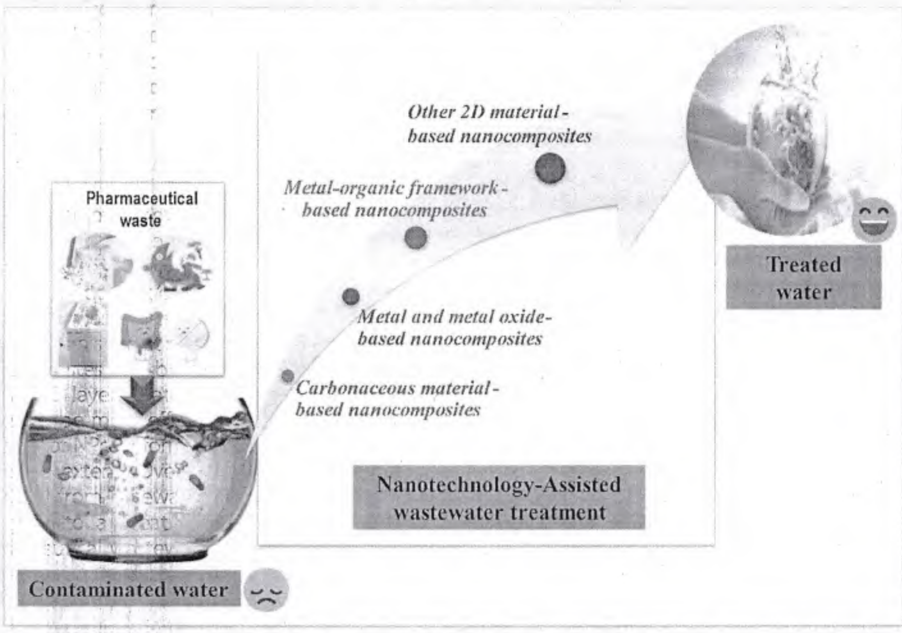
Amandeep Saroa[a], Amrit Singh[b], Neha Jindal[c], Raj Kumar[d], Kulvinder Singh[e], Praveen Guleria[f], Raj Boopathy[g], and Vineet Kumar [h]

[a]Department of Chemistry, Sri Guru Teg Bahadur Khalsa College, Sri Anandpur Sahib, India; [b]Department of Physics, Sri Guru Teg Bahadur Khalsa College, Sri Anandpur Sahib, India; [c]Department of Chemistry, DAV College, Bathinda, India; [d]Department of Chemistry, School of Basic and Applied Sciences, Maharaja Agrasen University, Baddi, India; [e]Department of Chemistry, DAV College, Chandigarh, India; [f]Department of Biotechnology, DAV University, Jalandhar, India; [g]Department of Biological Sciences, Nicholls State University, Thibodaux, LA, USA; [h]Department of Biotechnology, School of Bioengineering and Biosciences, Lovely Professional University, Phagwara, Punjab, India

ABSTRACT
The presence of pharmaceutical compounds in wastewater due to an increase in industrialization and urbanization is a serious health concern. The demand for diverse types of pharmaceutical compounds is expected to grow as there is continuous improvement in the global human health standards. Discharge of domestic pharmaceutical personal care products and hospital waste has aggravated the burden on wastewater management. Further, the pharmaceutical water is toxic not only to the aquatic organism but also to terrestrial animals coming in contact directly or indirectly. The pharmaceutical wastes can be removed by adsorption and/or degradation approach. Nanoparticles (NPs), such as 2D layers materials, metal-organic frameworks (MOFs), and carbonaceous nanomaterials are proven to be more efficient for adsorption and/or degradation of pharmaceutical waste. In addition, inclusion of NPs to form various composites leads to improvement in the waste treatment efficacy to a greater extent. Overall, carbonaceous nanocomposites have advantage in the form of being produced from renewable resources and the nanocomposite material is biodegradable either completely or to a great extent. A comprehensive literature survey on the recent advancement of pharmaceutical wastewater is the focus of the present article.

ARTICLE HISTORY
Received 15 March 2023
Revised 24 August 2023
Accepted 13 September 2023

KEYWORDS
Pharmaceuticals; wastewater treatment; functionalized nanocomposites; adsorption; photocatalysis; metal organic frameworks (MOF)



Graphical representation showing water contamination and its treatment by nanotechnology assisted approach to obtain treated water.

CONTACT Vineet Kumar vineetkumar22@gmail.com Department of Biotechnology, School of Bioengineering and Biosciences, Lovely Professional University, Phagwara, Punjab, India