

# ANIL KUMAR MALIK

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## RESEARCH INTEREST

Terahertz generation using laser-gas interaction, Particle acceleration, Metamaterial based terahertz biosensors, study of solar behaviour and Quantum Optics.

## EDUCATION

- 01/08- 10/12** **Ph.D., Indian Institute of Technology Delhi (IIT Delhi), India**  
**CGPA:** 9.75/10  
**Dissertation:** Plasma based Terahertz Generation and its Tunability  
**Thesis Committee:** Prof. Hitendra K Malik (IIT Delhi), Prof. V. K. Tripathi (IIT Delhi), Prof. Avinash Chandra (IIT Delhi), Prof. M Starodubtsev (Russian Academy of Science, Russia) and Prof. K P Singh (IIT BHU, Banaras, India)
- 07/97- 07/99** **Master of Science (Engineering Physics), IIT Roorkee, Uttarakhand, India**  
**CGPA (% Marks):** 9.0/10 (70%)  
**Division:** First  
**Dissertation:** Fault Detection in Combinational Logic Networks  
**Committee:** Prof. S K Tandan, Late Prof. S N Bharthwal
- 07/94 –07/97** **Bachelor of Science (B.Sc.), C.C.S. University Meerut, India**  
**Major Subjects:** Physics, Mathematics and Chemistry  
**Division:** First division (68%)

## PROFESSIONAL EXPERIENCE

- 01/18- till date** Professor, Department of Physics, **Ch. Charan Singh University Meerut, India**
- 09/14-09/15** Raman Post-Doctoral Fellow, **Institute of optics, University of Rochester, NY, USA**
- 09/10- 11/10** DAAD Fellow, **Institute of Plasma Forschung (IPF), Stuttgart University, Germany**
- 01/15-01/18** Associate Professor, Department of Physics, **M M College Modinagar, India**
- 01/06-01/15** Assistant Professor, Department of Physics, **M M College Modinagar, India**
- 01/06-01/15** Lecturer, Department of Physics, **M M College Modinagar, India**

## AWARDS / ACHIEVEMENTS

- **Raman Post-Doctoral Fellowship** under Indo-US 21st century knowledge initiative, at Institute of Optics, University of Rochester, Rochester, NY, USA (09/14 – 09/15)
- **DAAD Research Fellow** (Under PPP-2010) at IPF, Stuttgart University, Germany (09/10- 11/10).
- **Teachers' fellowship** by University Grant Commission (UGC) Delhi to complete Ph.D. at IIT Delhi, (11/07– 11/10)
- **Junior Research Fellowship** (NET+JRF) conducted by Council of Scientific and Industrial Research (CSIR), Ministry of Human Resource Development, India, (1999).
- **Graduate Aptitude Test for Engineers (GATE)** conducted by Indian Institute of Technology, India (1999 & 2000).
- **Institute merit Fellowship** at IIT Roorkee (During Masters), 07/98-06/99.
- **General GRE (2004)** (Score: English- 510/800, Mathematics – 800/800)
- **TOEFL (2004)** (Score: 183/200)
- **Subject GRE (2005)** with 96 percentiles.
- **Highest marks (70/75)** master's dissertation.
- **Merit holder** (2<sup>nd</sup> position) in Master of Science at IIT Roorkee, India.

## PROFESSIONAL RECOGNITION

- Reviewer of Optics Express (*an International Journal published by Optical Society of America, USA; Status: International*)
- Reviewer of Semiconductor Science and Technology (*an International Journal published by Institute of Physics (IOP) United Kingdom; Status: International*).
- Reviewer of Applied Physics Letter (*an International Journal published by American Institute of Physics (AIP), USA; Status: International*)
- Reviewer of Euro Physics Letter (*an International Journal published by Institute of Physics (IOP) United Kingdom; Status: International*)
- Reviewer of Physics of Plasma (*an International Journal published by American Institute of Physics (AIP), USA; Status: International*)
- Reviewer of Journal of Applied Physics (*an International Journal published by American Institute of Physics (AIP), USA; Status: International*)
- Reviewer of Physics Letters A (*an International Journal published by Elsevier; Status: International*)
- Reviewer of Laser and Particle Beams (*an International Journal published by Cambridge University Press, UK; Status: International*)
- Reviewer of contribution to theoretical Physics, (*an International Journal published by Cambridge University Press, UK; Status: International*)
- Reviewer of Journal of Plasma Physics (*an International Journal published by Cambridge University Press, UK; Status: International*)
- *Reviewer of J. of Pure and Applied Science (published by NISCAIR, India)*
- Member, American Physical Society, 12/11 – present
- Member, Institute of Electrical and Electronics Engineers (IEEE)
- Member, Plasma Science Society of India (PSSI)

- Organizing Secretary of an International Webinar (e-Conference) on Prospective of Interdisciplinary Research in the Present Scenario on May 15-16, 2020 at Zoom APP at CCS University Meerut.
- Member Advisory Committee in one-week Workshop on the topic of nanoscience and nano Materilas organized by Internatinal Cell, C C S University Meerut during December 2020.
- Member, organizing Committee for the EMN PST (Plasma Science and Technology) Meeting 2016 at Melbourne, Australia on October 10-14, 2016. <http://emnmeeting.org/PST/>
- Member, Advisory Board of International Conference on 'Recent Trends in Interdisciplinary Science: Opportunities and Challenges' sponsored by faculty of science M.M. College Modinagar, India, February 28- March 01, 2014

## ADMINISTRATIVE RESPONSIBILITIES

- **Assistant Dean of Student Welfare (ADSW):** at CCS University Meerut, March 2018 - till date
- **Member:** Admission committee CCS University Meerut, June 2010 - till date
- **Convener:** University Flying Squad, February 2020 – till date
- **Convener:** University Flying Squad, February 2018 – December 2018
- **Coordinator,** IQAC Committee, M M College Modinagar, July 2012-June 2014
- **Member:** IQAC Committee, M M College Modinagar, July 2010-June 2012
- **Head/Teacher Incharge,** Department of Physics, M M College Modinagar, March 2011- December 2017
- **Observer,** B. Ed Entrance examination in 2012, 2013, 2016, 2018 and 2019.
- **Observer,** MD/MS/DM examinations at Meerut Medical College, Meerut 2018, 2019

## RESEARCH SKILLS

- Mathematical skills to solve analytical problems
- Numerical techniques like finite difference method, finite element method and runge-kutta method to solve ordinary and partial differential equations using MATLAB, C++ and their effective use in analysis the mathematical complexities
- Multi-Physics Simulation with COMSOL and CST.
- Knowledge with Linux, Mac and Window
- Writing code in MATLAB, C++, Python

## SELECTED RESEARCH WORK

### ➤ TERAHERTZ PHOTONICS:

#### ⇒ THz Source

- **Tunnel ionization:** Femtosecond laser, numerical study of spatial distribution of plasma density, study the effect of laser phase envelope on ionization process, the effect of inhomogeneity of plasma density on frequency, power and efficiency of emitted radiation. Study the effect of applied dc magnetic field in tuning the frequency and power of emitted radiation.
- **Optical Rectification in plasma:** Study the effect of laser profiles and beam width on field amplitude, efficiency and direction of the emission of terahertz radiations. Study

the importance of density ripples and their periodicity and applied external dc magnetic field on resonant excitation of terahertz radiation.

- **Quantum Mechanical Modeling:** we are working on Quantum Mechanical Modeling for THz radiation generation by two-color femtoseconds laser-gas interaction, THz generation from low dimensional plasmas.

⇒ **THz Biosensing:**

Metamaterials offers opportunities to enhance the imaging quality. We are developing THz sensors using metamaterials. In our study, we design new metamaterial-based THz sensor and optimize device parameters to achieve better sensitivity, high quality factor and high figure of merit in reflection and transmission modes.

➤ **PARTICLE ACCELERATION USING LASER PLASMA INTERACTION:**

Numerical and analytical study for electron acceleration using laser (Femto second pulse) wake field in paraxial and non-paraxial regimes. The effect of non-paraxial corrections on electron acceleration is investigated. The effect of frequency chirping of laser pulse in gas for electron acceleration is studied.

➤ **ASTROPHYSICS:**

We have analyzed six wavelengths (AIA-94, AIA-131, AIA-171, AIA-193, AIA-211 & AIA-335) observations by flux modulation method from Solar Dynamics Observatory (A mission of NASA) and reported gross downward trend in rotation periods of coronal layers with increasing temperature (Published in MNRAS 2020). In future, we are planning to find out temporal and spatial variations in North-South asymmetry using SDO and STEREO observations. We also wish to establish the relation between the 11-yr solar activity cycle with the differential rotation with respect to latitude in future.

## **RESEARCH PROJECT:**

### **PROJECT: 1**

**Title:** *Terahertz Radiation from Plasma.*

**Funding agency:** UGC Delhi, India

**Amount:** Rs. 2377000.00

**Status:** Completed

### **PROJECT: 2**

**Funding Agency:** SERB (DST), Ministry of Science and Technology, Govt. of India

**Amount:** Rs. 2127400.00

**Status:** Ongoing

### **PROJECT: 3**

**Funding Agency:** DST (BRICS) **2019** (*Participating countries are India, Russia and China*).

**Amount:** Rs. 4.02 crore

**Status:** *Under review*

### **International Travel Grant:**

*Rs. 163000/= by UGC in Nov. 2010 to travel to Salt Lake City, USA*

*Rs. 142000/=by DST to travel to Rhode Island USA.*

## RESEARCH GUIDANCE:

Ph.D. completed:	One
Ph.D. ongoing:	Five
M. Phil completed:	Three
M. Phil ongoing:	One

## PEER-REVIEWED SCI JOURNAL PUBLICATIONS

### PUBLISHED

- K P Singh, **Anil K Malik**, J. Sharma, and M Yadav, “Effect of laser polarization and target location on acceleration of electrons generated during ionization of gases by a laser pulse” AIP Advances (2020) Accepted.
- S Chaudhary, Manendra, K P Singh, B P Singh, and **Anil K Malik\***, “Radially polarized terahertz (THz) generation by frequency difference of Hermite Cosh Gaussian lasers in hot electron-collisional plasma” Optics and Lasers in Engineering, (2020) 134, 106257.
- Manendra, K P Singh, R Bhati, and **Anil K Malik\***, “Bright terahertz (THz) generation by frequency mixing of dichromatic lasers in inhomogeneous cold plasma: Scaling of THz field” Physics of Plasmas (2020), 27, 063101.
- Manendra, K P Singh, R Bhati, and **Anil K Malik\***, “Efficient terahertz (THz) generation by nonlinear mixing of bicolor top-hat lasers in hot plasma” Physics of Plasmas (2020), 27, 023108.
- J Sharma, B Kumar, **Anil K Malik\*** and H O Vats, “On the variation of solar coronal rotation using SDO/AIA observations” Monthly Notices of The Royal Astronomical Society (MNRAS) (2020) 492, 539.
- S Chaudhary, K P Singh, B P Singh, Manendra, and **Anil K Malik\***, “Modeling of intense terahertz wave generation with controlled field distribution” Physics of Plasmas (2019), 26, 073107.
- Manendra, S Chaudhary, K P Singh, G Sheoran and **Anil K. Malik\***, “Terahertz wave generation by photo mixing of radially polarized hollow sinh super-Gaussian lasers in hot plasma” Euro Physics Letters (2019), 126, 55001.
- M B Semenov, V D Krevchik, O N Gorshkov, D O Filatov, Y Dakhnovsky, A V Nikolaev, A P Shkurinov, V Y Timoshenko, P V Krevchik, **A K Malik**, Y H Wang, T R Li, Y Zhu, S Zhuang, R V Zaytsev, I S Antonov, I M Semenov, A K Aringazin, A V Shorokhov “A comparative analysis of the observed effects of 2D tunneling bifurcations for quasi-one-dimensional and quasi-two-dimensional Au-QD systems in an external electric field” Nanosystems: Physics, Chemistry, Mathematics (2018), 9, 72.
- K P Singh, **Anil K. Malik**, and Rashmi Arya, “Quasimonoenergic collimated electrons from the ionization of low-density gases by a chirped intense Gaussian laser pulse”, Physics of Plasmas (2016), 23, 093111.

- K P Singh, R Arya, **Anil K Malik**, and NJ Fisch, “*Electron energy enhancement by frequency chirp of a radially polarized laser pulse during ionization of low-density gases*”, **Plasma Physics and Controlled Fusion** (2016), 58, 115011.
- **Anil K. Malik**, “*Green Route Synthesis of High Quality CdSe Quantum Dots*” **J. Pur. Appl. Sci. Tech.** (2016), 6, 17.
- **Anil K. Malik**, “*Green Synthesis of High Quality CdSe Quantum Dots: High Luminescence in Green to Red Region*” **Asian J. Mat. Chem.** (2016), 1, 47.
- Kunwar Pal Singh, Rashmi Arya, **Anil K Malik**, “*Effect of initial phase on error in electron energy obtained using paraxial approximation for a focused laser pulse in vacuum*” **Journal of Applied Physics** (2015), 118, 104902.
- K P Singh, Rashmi Arya, and **Anil K Malik**, “*Acceleration of electrons generated during ionization of low-density gases by seventh order correction fields of a focused laser pulse*”, **Physics of Plasmas** (2015), 22, 083105.
- **Anil K. Malik\*** and Kunwar Pal Singh, “*High intensity terahertz generation by nonlinear frequency-mixing of lasers in plasma with DC magnetic field*”, **Laser and Particle Beams** (2015), 33, 519.
- **Anil K Malik\***, Kunwar P Singh, and V Sajal, “*Highly focused and efficient terahertz radiation generation by photo-mixing of lasers in plasma in the presence of magnetic field*” **Physics of Plasmas** (2014) 21, 073104.
- **Anil K Malik** and H K Malik, “*Tuning and focusing of Terahertz Radiation by DC Magnetic Field in a Laser Beating Process*”, **IEEE J. of Quantum electronics** (2013) 49, 232.
- H K Malik and **Anil K Malik\***, “*Strong and Collimated THz Radiation by Super-Gaussian Lasers*”, **Euro Physics Letter** (2012) 100, 45001.
- **Anil K Malik**, H K. Malik and U Stroth, “*THz Radiation Generation by Beating of two spatial-Gaussian Lasers in the Presence of Static Magnetic Field*”, **Physical Review E** (2012) 85, 016401.
- H K Malik and **Anil K Malik\*** “*Tunable and Collimated Terahertz Radiation Generation by Femtosecond Laser Pulses*”, **Applied Physics Letters** (2011) 99, 251101. *Selected for January 2012 Issue of Virtual Journal of Ultrafast Science.* <http://www.vjulfrafast.org>
- **Anil K Malik**, H K Malik and U Stroth, “*Strong Terahertz Radiation by Beating of Spatial-triangular Lasers in a Plasma*”, **Applied Physics Letters** (2011), 99, 071107. *Selected for September 2011 Issue of Virtual Journal of Ultrafast Science.* <http://www.vjulfrafast.org>
- **Anil K Malik**, H K Malik and Y Nishida, “*Terahertz Radiation Generation by Beating of Two Spatial Gaussian Lasers*”, **Physics Letters A** (2011) 375, 1191.
- **Anil K Malik**, H K Malik and S. Kawata, “*Investigations on THz Radiation Generated by Two Superposed Femtosecond Laser Pulses*”, **Journal of Applied Physics** (2010). 107, 113105. *Selected for July 2010 Issue of Virtual Journal of Ultrafast Science.* <http://www.vjulfrafast.org>

## COMMUNICATED

- K P Singh and **Anil K Malik**, Plasma Physics and Controlled Fusion (2020: Revised manuscript submitted).
- Manendra, K P Singh, S Chaudhary, and **Anil K Malik\***, Euro Physics Letter (2020: Communicated).

## CONFERENCE PUBLICATIONS

- J Sharma, B Kumar, **AK Malik**, S Chandra, and HO Vats, "A study of solar-cycle variation of coronal rotation using the SDO/AIA 211 Å observations" **URSI Asia-Pacific Radio Science Conference (AP-RASC)**, (2019)1-1
- **Anil K. Malik**, "Intense terahertz generation by different frequency of super-Gaussian lasers in presence of transverse magnetic field " **46th Annual Meeting of the APS Division of Atomic, Molecular, and Optical Physics**, June 8-12, (2015) 60
- **Anil K. Malik** and H. K. Malik "Effect of laser shape and plasma density on THz Generation" **IEEE International Conference on Plasma Science (ICOPS)**, (2013) 1-1.
- **Anil K. Malik**, Sanjay Tomar and H. K. Malik," Role of density ripples to resonant Terahertz radiation excitation in laser beating process" **54th Annual Meeting of the Division of the APS Division of Plasma Physics** (Oct 28 – Nov 2, 2012), Providence, Rhode Island, USA, Y0032.
- H. K. Malik and **Anil K. Malik**, "A Comparative Study of Terahertz Radiation Generation by Beating of Two Spatial-Gaussian / Super-Gaussian Lasers" **53rd Annual Meeting of the Division of the APS Division of Plasma Physics** (Nov 14 - 18, 2011), Salt Lake City, Utah, USA, 291.
- **Anil K. Malik** and H. K. Malik, "Role of Phase Difference Between Superposing Lasers and Magnetic Field for Efficient Terahertz Radiation Generation by Tunnel Ionization" **53rd Annual Meeting of the Division of the APS Division of Plasma Physics** (Nov 14 - 18, 2011), Salt Lake City, Utah, USA, 364.
- H. K. Malik and **Anil K. Malik**, "Generation of THz Radiation by Beating of Two Gaussian Lasers" **52nd Annual Meeting of The American Physical Society-Division of Plasma Physics**, Chicago, Illinois, USA (Nov. 8 – 12, 2010), 230.
- **Anil K. Malik**, H. K. Malik and U. Stroth, "Tunnel Ionization by Two Linearly Polarized Lasers: Generation of THz Radiation" **52nd Annual Meeting of The American Physical Society-Division of Plasma Physics**, Chicago, Illinois, USA (Nov. 8 – 12, 2010), 236.
- **Anil K. Malik** and H. K. Malik, "THz Generation by Two Superposed Short Laser Pulses" **51st Annual Meeting of the American Physical Society (APS) Division of Plasma Physics**, Atlanta, Georgia, USA (2009) 123.
- **Anil K. Malik** and H. K. Malik, "Production of THz Radiation by Short Laser Pulses via Tunnel Ionization of a Gas under the Effect of External Magnetic Field" **17th International Conference on Advanced Laser Technology (ALT'09)**, Antalya, Turkey (2009) 113.

- **Anil K. Malik** and H. K. Malik, “*Tunable THz Generation by Short Laser Pulses*” **2<sup>nd</sup> International Conference on Attosecond Physics – 2009**, Kansas State University, USA (2009) 48

#### PEER-REVIEWED BOOK PUBLICATIONS

- **Anil K. Malik**, “*High Intensity Terahertz Radiation and Its Applications*”, Lambert Academic Publishing, Germany, ISBN: 978-3-330-06385-3 (**Published in 2017**).

#### INVITED/KEYNOTE TALK/CONFERENCE CHAIR

- Pandemic COVID -19 Awareness; Keynote talk delivered on May 24, 2020 at Shri Gulab Singh Mahavidyalaya, Chakrata, Dehradun, India.
- Perspective: 2018 terahertz science roadmap, PMP 2019, Jaypee Institute of Information Technology, Noida, Uttar Pradesh, India, February 14-16 (2019).
- Computational methods with MATLAB in Plasmas, workshop on Computational Physics & Applied Physics, Department of Applied Physics, Gautam Buddha University, Greater Noida, Uttar Pradesh, India, July 25-27 (2019)
- Sort Pulse Terahertz Generation from plasma, 2nd National Conference on physics of Engineering Materials (NCPem - 2016), Deenbandhu Chhotu Ram University of Science and Technology, Murthal, Sonapat, Haryana, India, March 10, 2016.
- Scope of Simulation studies for short pulse laser-mater interaction, at Institute of Optics, University of Rochester, NY USA, July 14, 2015.
- THz Radiation generation from Pre-pulse plasma, at Institute of Optics, University of Rochester, NY USA, February 04, 2015.
- Terahertz: an emerging Science, at Institute of Optics, University of Rochester, NY USA, October 12, 2014.
- **Session Chair:** Mental health challenges and Remedial Approaches-2014 at Gurukul Kangri University Haridwar, UK, India, February 14, 2014

#### CONFERENCES

- Manendra, S Chaudhary, and **Anil K Malik**, “*Investigation of Electron Plasma Current Density during the Interaction of Bessel Gaussian (BG) Lasers with Plasma*” **PMP 2019 (international Conference), Jaypee Institute of Information Technology, Noida, UttarPradesh, India**, February 14-16, (2019)
- S Chaudhary, Manendra, **Anil K Malik**, “*Terahertz radiation generation by beating of two Hermite Cosh Gaussian (HCG) Lasers in collisional Plasma*” **PMP 2019 (international Conference), Jaypee Institute of Information Technology, Noida, Uttar Pradesh, India**, February 14-16, (2019).
- **Anil K Malik** and Manendra, Terahertz (THz) “*Radiation Frequency Control by DC Magnetic Field in a Laser Beating with nanocluster*” **Plasma Science Society of India, University of Delhi, India**, December 4-7, (2018).
- Manendra and **Anil K Malik**, “*Control on Terahertz (THz) Radiations by Laser Profile Indices*” **Plasma Science Society of India, University of Delhi, India**, December 4-7, (2018).



- S Chaudhary and **Anil K Malik**, “Control on Terahertz (THz) Radiations by Laser Profile Indices” **Plasma Science Society of India, University of Delhi, India**, December 4-7, (2018).
- **Anil K. Malik**, "Intense terahertz generation by different frequency of super-Gaussian lasers in presence of transverse magnetic field " **46th Annual Meeting of the APS Division of Atomic, Molecular, and Optical Physics, June 8-12, (2015)**.
- **Anil K. Malik** and H. K. Malik “Resonant Terahertz Radiation Generation by Mixing of Two Spatial-Gaussian Lasers in nonuniform Plasma” **QIP/CEP Topical Conference on Laser Driven Charged Particle Acceleration and Applications** (April 5-7, 2013)), Indian Institute of Technology Delhi, India.
- **Anil K. Malik** “Synthesis of comparable high quality CdSe quantum dots using different precursors” **Forth International Conference on Recent Advances in Composite Materials** (February 18-21, 2013), International Centre Goa, India.
- **Anil K. Malik**, Sanjay Tomar and H. K. Malik,” *Role of density ripples to resonant Terahertz radiation excitation in laser beating process*” **54th Annual Meeting of the Division of the APS Division of Plasma Physics** (Oct 28 – Nov 2, 2012), Providence, Rhode Island, USA.
- H. K. Malik and **Anil K. Malik**, “A Comparative Study of Terahertz Radiation Generation by Beating of Two Spatial-Gaussian / Super-Gaussian Lasers” **53<sup>rd</sup> Annual Meeting of the Division of the APS Division of Plasma Physics** (Nov 14 - 18, 2011), Salt Lake City, Utah, USA.
- **Anil K. Malik** and H. K. Malik, “Role of Phase Difference Between Superposing Lasers and Magnetic Field for Efficient Terahertz Radiation Generation by Tunnel Ionization” **53<sup>rd</sup> Annual Meeting of the Division of the APS Division of Plasma Physics** (Nov 14 - 18, 2011), Salt Lake City, Utah, USA.
- **Anil K Malik**, Co-Chair a session in a national Conference on ‘**Mental Health Challenges and Remedial Approaches**’ Gurukul Kangri, Haridwar, India (Feb. 15-16, 2014).
- **Anil K Malik**, participated in state level ‘*seminar/workshop held at Dr. Ram Manohar Lohiya Law University Lucknow, India*’, Organized by Department of higher education Govt. of Uttar Pradesh and U.P. state higher education council (September 30,2013)
- **Anil K Malik**, participated in state level ‘*seminar/workshop held at Dr. Ram Manohar Lohiya Law University Lucknow, India*’, Organized by Department of higher education Govt. of Uttar Pradesh and U.P. state higher education council (March 2-3, 2013)
- **Anil K Malik**, participated in ‘*Topical workshop on Terahertz Radiation Generation and Applications*’ at Indian Institute of Technology Delhi, New Delhi-110016, (March 26-27, 2011)