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EDUCATION

2003-2010 **Ph.D.,** Department of Physics, Indian Institute of Science (IISc), Bangalore, India.
Thesis: "Ultrafast response and time resolved spectroscopy of carbon nanotubes, Semiconductors and rare-earth titanates".
Thesis Supervisor: Prof. Ajay K. Sood.

1998-2000 **M.Sc (Physics),** Sri Sathya Sai Institute of Higher Learning,
Prashanthi Nilayam, Anantapur District, Andhra Pradesh, India.

1995-1998 **B.Sc (Hons) in Physics,** Sri Sathya Sai Institute of Higher Learning,
Brindavan campus, Whitefield, Karnataka, India.

PROFESSIONAL EXPERIENCE

May 2021-Current Associate Professor, IISER Kolkata

July 2016-May 2021 Assistant Professor, IISER Kolkata

Nov 2013 - Apr 2016 Postdoctoral Research Associate in Los Alamos National Lab.
Project: Magneto-Optical THz Spectroscopy of two dimensional electrons and holes.

Oct 2012 - Nov 2013 Postdoc in ECSE Department, Rensselaer Polytechnic Institute, Troy, NY.
Project: Application of plasma wave THz detectors for pulsed THz radiation

Oct 2010 - Sep 2012 Postdoc in Department of Physical Chemistry, Fritz-Haber-Institut der Max-Planck-Gesellschaft, Berlin
Project: Transient THz Metamaterials and Coherent Phonons.

Mar 2002 - July 2003 Research Assistant in Raman Research Institute, Bangalore, India.
Project: Laser cooling of Rb atoms.

Professional Recognition/ Award/ Prize/ Certificate, Fellowship

2010-2012 Max-Planck Society Grant for Postdoctoral Researchers scholarship by Max-Planck Society, Germany

2018 Outstanding *Reviewer 2018* *by* Nature: Light Science Applications (2019)

RESEARCH EXPERIENCE

Post-doctoral tenure @ LANL, NM
Magneto optical ultrafast THz spectroscopy (THz Quantum Hall effect) @ 1.2K and 0-8T, to explore quantum effects in low dimensional condensed matter systems like two dimensional electron/hole gas (2DEGs and 2DHGs), nanowires, and topological insulators.

Post-doctoral tenure @ RPI, Troy, NY
[1] Application of Plasma-Wave Detectors for Ultra-Short Pulse Terahertz Radiation.
[2] Design and modelling of different metamaterials and grating structures for various THz applications.

Post-doctoral tenure @ Max Planck Institute, Berlin
[1] Creating transient ultrafast THz plasmonic nanostructures and study how they dynamically manipulate the incoming THz radiation. These THz plasmonic nanostructures rely on a transient spatial modulation of the refractive index of a semiconductor. One example is a wire-grid polarizer that consists of parallel metallic stripes (exhibiting high carrier density) with dielectric stripes in-between. I have demonstrated this dynamic polarizer action on Si and this has appeared in **Nature: Light Science and applications** (**IF 14.06** - see publications).
[2] Investigation of femtosecond laser induced tellurium enrichment in ZnTe by coherent phonon spectroscopy (published in Applied Physics Letters).

PhD tenure
[1] Investigation of third order nonlinearity and ultrafast carrier dynamics in single and double-walled carbon nanotubes (SWNT and DWNT); Our results indicate that DWNTs are better suited as ultrafast optical switches compared to SWNTs.
[2] Direct demonstration of electron-phonon coupling: Chirping coherent phonons in narrow-band gap (Te and Bi_2Te_3).
[3] Coherent phonons in large band gap semiconductor, ZnTe and spin frustrated titanates ($Dy_2Ti_2O_7$, $Gd_2Ti_2O_7$, $Tb_2Ti_2O_7$): phase transition at 100K revealed by a change in the initial phase and line width of one of the coherent phonons in $Dy_2Ti_2O_7$.
[4] Time domain THz transmission experiments on free standing film of DWNTs, poly vinyl composite of SWNTs and silver nanoparticles; we observed low frequency vibrations in DWNT and SWNT, and confined acoustic modes in silver nanoparticles.

EXPERTISE
Experimental:
[1] Designed and built z-scan, low temperature degenerate pump-probe, Time domain THz setup (TDS-THz), Optical pump THz probe (OPTP), and THz pump-THz probe setups, Intense THz generation using difference frequency Mixing, and Magneto Optical Kerr (using Oxford 8T spilt coil superconducting magnet-cryostat) and Faraday rotation setups for THz and Optical region-TDS THz and OPTP setups.
[2] Hands on experience in aligning the femtosecond oscillator (< 10fs and < 30fs), amplifier (Spectra Physics and Coherent Inc.) and Optical parametric amplifier systems (Spectra Physics and Topaz Inc.) (Underwent training for 15 days in Spectra Physics Inc.)
[3] Actively involved in setting up Centre for Ultrafast spectroscopy (CULA), India in my PhD tenure. I also setup the ultrafast THz lab using 15 mJ amplifier (Coherent Legend system) and Topaz in Germany. In LANL, I built the TDS and OPTP setup in to investigate the materials in quantizing magnetic fields (0-8T).
[4] Raman Spectroscopy, Ultra high vacuum systems and laser cooling set-ups.

Computational:
[1] ORIGIN, MATLAB, MATHEMATICA and LABVIEW.
[2] Open phonon/Shell model based lattice dynamic calculations.
[3] COMSOL, Lumerical FDTD, DEVICE and MODE Solutions

RESEARCH INTERESTS:
Ultrafast dynamics in condensed matter systems using femtosecond pump-probe spectroscopy and time and frequency resolved terahertz (THz) spectroscopy. The pump and probe pulses range from UV, VIS, IR and THz wavelengths. Nonlinear response of the condensed matter will be investigated using femtosecond pulses in this electromagnetic region. Some examples of excellent candidates to use THz and femtosecond pulses are 2D systems like 2DEG/2DHG, 2D layered materials, topological systems, solar cells, strongly correlated systems and artificially created metamaterials.

PUBLICATIONS
(google scholar page: https://scholar.google.com/citations?hl=en&user=4AjMncoAAAAJ)

Peer reviewed

THz Spectroscopy of Materials:

- "Investigation of conductivity and shielding efficiency of the free-standing PVA-GO-Ag composite thin films in terahertz regime using time domain terahertz spectroscopy", Soumya Mukherjee, Anjan Kumar NM, B. Karthikeyan and N. Kamaraju,129, Appl. Phys. A 129, 343 (2023).

Understanding ultrafast photo-excitation and* the subsequent carrier dynamics *in various nano and bulk insulating materials:

- "Trapping and exciton-exciton annihilation assisted ultrafast carrier dynamics in nanosheets of 2H-MoSe2 and Cr doped 1T/2H-MoSe2", Soumya Mukherjee, Anjan Kumar N M, Ayan Mondal, Venkataramanan Mahalingam, N. Kamaraju, J. Chem. Phys., 159, issue #16, to be appeared on 2023-10-28 issue (2023).

- "Many-body interaction governed ultrafast relaxation dynamics of hot holes in CuS nanoflakes and photocatalytic efficiency enhanced CuS/Ag2S nanocomposites", Soumya Mukherjee, Anjankumar N M, Saranya Ramesh, Balasubramanian Karthikeyan, N. Kamaraju, ACS Appl. Opt. Mater., 1, 7, 1332–1342 (2023).

- "Photo Excited Ultrafast Dynamics of Free Carriers and Polarons in V2O5 Micro-Particles through Time-resolved Non-Degenerate Pump Probe Spectroscopy", Anjankumar NM, Soumya Mukherjee, Saranya Ramesh, Ayan Mondal, Venkataramanan Mahalingam, N. Kamaraju, J. Phys. Chem. C., 126, 20535–20541 (2022).

- "Investigation of self-trapped excitonic dynamics in hematite nano-forms through non-degenerate pump-probe transmission spectroscopy", Anjan Kumar N M, Soumya Mukherjee, Anoop Sunny, B. Karthikeyan, and N. Kamaraju, Appl. Phys. Lett., 121, 202102 (2022).
- "Ultrafast Carrier Dynamics of Undoped and Ho3+- Doped α-Bismuth Oxide Micro-Rods", Jit Sarkar, Shankar G Menon, N. Prasad, B. Karthikeyan and N. Kamaraju, J. Phys. Chem. C, 123(15), 10007 (2019).

- "Ultrafast electron hole plasma dynamics in chemically pristine and Ag-doped ZnO nanorods", Jit Sarkar, Shankar G Menon, C. Madhumitha, B. Karthikeyan and N. Kamaraju, J. Appl. Physics, 124, 243103 (2018).

Review (2021) on THz Spectroscopy:

- "A review on numerical methods for thickness determination in terahertz time-domain spectroscopy", Soumya Mukherjee, N. M. Anjan Kumar, Prashanth C. Upadhya, and N. Kamaraju, Eur. Phys. J. Spec. Top. 230: 4099-4111 (2021).

Transient THz metamaterial:

- "Transient GaAs Plasmonic Metasurfaces at Terahertz Frequencies ", Y. Yang, **N. Kamaraju**, S. Campione, S. Liu, J L. Reno, M B. Sinclair, R P. Prasankumar, and I. Brener, ACS Photonics **4**, 15-21 (2017).
- "Sub-cycle control of terahertz waveform polarization using all-optically induced transient metamaterials", **N. Kamaraju**, Andrea Rubano, Linke Jian, Surajit Saha, T. Venkatesan, Jan Nötzold, R. Kramer Campen, Martin Wolf, Tobias Kampfrath, Nature Light Science and Applications, **3**, e155 (2014).

Magneto-Optical THz Spectroscopy:

- "Magnetoelastoelectric coupling in core–shell nanoparticles enabling directional and mode-selective magnetic control of THz beam propagation", Moumita Dutta, **N. Kamaraju**, Soutik Betal, Rohit P. Prasankumar, Amar S. Bhallaa and Ruyan Guo", *Nanoscale* **9**, 13052 (2017).
- "Using terahertz pulses to shed new light on quantum materials", P Bowlan, **N Kamaraju**, DA Yarotski, AJ Taylor, RP Prasankumar, Infrared, Millimeter, and Terahertz waves (IRMMW-THz), IEEE, **1**, 14770919 (2016).
- "THz Magneto-optical Spectroscopy of two dimensional hole", **N. Kamaraju**, W. Pan, U. Ekenberg, D. Gvozdic, S. Boubanga-Tombet, P. C. Upadhya, J. Reno, A. J. Taylor, R. P. Prasankumar, *Applied Phys. Lett.* **106**, 031902 (2015).

Coherent Phonons:

- "Indication of Te segregation in laser-irradiated ZnTe observed by in situ coherent-phonon spectroscopy", **N. Kamaraju**, T. Shimada, C. Frischkorn, T. Kampfrath, and M.Wolf, Appl. Phys. Lett. **105**, 111908 (2014).
- "Coherent Phonons in Pyrochlorate titanates $A_2Ti_2O_7$ (A = Dy, Gd and Tb): a phase transition in $Dy_2Ti_2O_7$ at 110K", **N. Kamaraju**, Sunil Kumar, Surajit Saha, S. Singh, R. Suryanarayanan, A. Revcolevschi, and A.K. Sood, Phys. Rev. B **83**, 134104 (2011).

- "Large-amplitude chirped coherent phonons in tellurium mediated by ultrafast photo excited carrier diffusion ", **N. Kamaraju**, Sunil Kumar, M. Anija and A. K. Sood, Phys. Rev. B **82**, 195202(2010).
- "Temperature-dependent chirped coherent phonon dynamics in Bi_2Te_3 using high intensity femtosecond laser pulses." **N. Kamaraju**, Sunil Kumar, and A. K. Sood, Euro Phys. Lett. **92**, 47007(2010).

- "Influence of two phonon absorption induced free carriers on coherent polarization and phonon generation in ZnTe", **N. Kamaraju**, Sunil Kumar, Eric Freysz and A. K. Sood, J. Appl. Phys. **107**, 103102(2010).

Nonlinear Optics and Electron dynamics in carbon nanotubes, graphene, BCN and gold nanorods:

- "Femtosecond photo excited carrier dynamics in reduced graphene oxide suspensions and films", Sunil Kumar, **N. Kamaraju**, K. S. Vasu and A. K. Sood, Int. J. Nanoscience **10**, 669 (2011).
- "Graphene analogue BCN: Femtosecond non-linear optical susceptibitlity and hot carrier dynamics", Sunil Kumar, **N. Kamaraju**, K. S. Vasu, A. Nag, A. K. Sood and C. N. R. Rao, Chem. Phys. Lett. **499**, 152 (2010).
- "Ultrafast dynamics of gold nanorods: Tuning between photo-bleaching and photo-induced absorption", M. Anija, Sunil Kumar, **N. Kamaraju**, Neha Tiwari, S. K. Kulkarni and A. K. Sood, Int. J. Nanoscience **10**, 687 (2010).
- "Ultrafast switching time and third order nonlinear coefficients of microwave treated single walled carbon nanotube suspensions", **N. Kamaraju**, Sunil Kumar, B. Karthikeyan, B. Kakade, V. K. Pillai and A. K. Sood, Journal of Nanoscience and Nanotechnology **9**, 5550 (2009).
- "Double walled carbon nanotubes as ultrafast optical switches", **N. Kamaraju**, Sunil Kumar, Y. A. Kim, T. Hayashi, H. Muramatsu, M. Endo and A. K. Sood, Applied Physics Letters **95**, 081106 (2009).
- "Femtosecond carrier dynamics and saturable absorption in graphene suspensions", Sunil Kumar, M. Anija , **N. Kamaraju**, K. S. Vasu, K. S. Subrahmanyam, A. K. Sood and C. N. R. Rao, Applied Physics Letters, **95**, 081106(2009).
- "Ultrafast electron dynamics and cubic optical nonlinearity of free standing thin film of double walled carbon nanotubes", **N. Kamaraju**, Sunil Kumar, B. Karthikeyan, A. Moravsky, R. O. Loutfy, and A. K. Sood, Applied Physics Letters **93**, 091903 (2008).
- "Large nonlinear absorption and refraction coefficients of carbon nanotubes estimated from femtosecond Z-scan measurements", **N. Kamaraju**, Sunil Kumar, S. Krishnamurthy, S. Guha, A. K. Sood, C. N. R. Rao, Applied Physics Letters **91**, 251103 (2007).

Time domain THz spectroscopy:

- "Terahertz Time Domain Spectroscopy to Detect Low-Frequency Vibrations of Double-Walled Carbon Nanotubes", Sunil Kumar, **N. Kamaraju**, M. Tondusson, E. Freyz and A. K. Sood, European J. Inorg. Chem. **2010**, 4363-4366 (2010).
- "Terahertz spectroscopy of single-walled carbon nanotubes in a polymer film: observation of low-frequency phonons", Sunil Kumar , **N. Kamaraju**, B. Karthikeyan, M. Tondusson, E. Freyz and A. K. Sood, J. Phys. Chem. C **114**, 12446-12450(2010).
- "Direct observation of low frequency confined acoustic phonons in silver nanoparticles; Terahertz time domain spectroscopy", Sunil Kumar , **N. Kamaraju**, B. Karthikeyan, M. Tondusson, E. Freyz and A. K. Sood, J. Chem. Physics **133**, 014502 - 014505 (2010).

FDTD Simulations:

- "Asymmetric Backscattering of Ultraviolet Light by Low-Refractive Index Thin Film of Tilted Alumina Nanorods", Xing Yan, Kamaraju Natarajan, Tanuj Saxena, and Michael Shur, CLEO Conference paper, **JW2A.42** (2013).

THz Electronics:

- "Application of Plasma-Wave Detectors for Ultra-Short Pulse Terahertz Radiation", A. Gutin, A.V. Muraviev, N. Kamaraju, X. Shen, Y. Yamaguchi, and M.S. Shur, Infrared, Millimeter, and Terahertz waves (**14770919** IRMMW-THz), 2014.

Raman spectroscopy and Laser Cooling of Rb atoms:

- "Bilayer Interference Enhanced Raman Spectra of Single Walled carbon Nanotubes", **N. Kamaraju**, S. Balaji, D. V. S. Muthu, S. Mohan, and A. K. Sood, Chemical Physics Letters **423** , 266 (2006).).
- "Raman Scattering in CaFeO3 and La0:33Sr0:67FeO3 across the charge disproportionation phase transition", S. Ghosh, **N. Kamaraju**, M. Seto, A. Fujimori, Y. Takeda, S. Ishiwata, S. Kawasaki, M. Azuma, M. Takano and A. K. Sood, Physical Review B **71**, 245110 (2005).).
- "Observation of narrow fluorescence from doubly-driven four-level atoms at room temperature", U. K. Khan, J. Sebastian, **N. Kamaraju**, N. Andal, R. Srinivasan and Hema Ramachandran, Euro physics Letters, **67**, 35 (2004).